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BIG DATA ADOPTION IN INTERNATIONAL LOGISTICS MANAGEMENT

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ABSTRACT

The Big Data adoption increasingly affects the international logistics management, thereby improving operational efficiency and competitiveness. The aim of this study is to analyse the impact of the use of Big Data (BD) sets on the logistics efficiency of companies in different countries for 2019–2023. The study uses regression modelling and case studies together with econometric analysis of companies to determine how technology infrastructure, regulatory environment, market dynamics, operational performance, and cultural context influence the causal relationship between BD and logistics efficiency. There is limited research on how BD adoption interacts with contextual factors in global logistics environments. The results demonstrate that deeper BD adoption is associated with higher business logistics efficiency, and the effectiveness of this interaction is moderated by the quality of the regulatory framework and technological infrastructure. The study shows the significant influence of cultural factors on organizational approaches to the BD use. The study also emphasizes that companies must invest in new technologies and adapt to regulatory changes to fully realize the benefits of BD opportunities. The findings support the role of strategic management methods that incorporate BD sets into logistics operations to make logistics efficient and innovative. Further research may focus on changing the role of digitalization in logistics and its implications for international supply chain management. It is also appropriate to conduct sector-specific analysis for a deeper understanding by policymakers and practitioners to improve logistics processes through data-driven strategies. The article proposes a new concept of 'intelligent adaptive logistics (IAL)' based on the integration of Big Data, artificial intelligence, IoT and cognitive analytics to create self-learning logistics systems. The purpose of the development of 'intelligent adaptive logistics (IAL)' is to assess how the level of digital maturity of a company in the field of IAL affects its logistics efficiency in the international context. For the first time, the IAL_Adopt index is proposed, which comprehensively takes into account not only the implementation of Big Data, but also the use of AI, IoT, cognitive analytics and the level of adaptation to changes in the external environment. The results of the panel regression analysis show that a high level of IAL_Adopt significantly improves logistics efficiency, especially in countries with high-quality infrastructure and a favourable regulatory environment. Despite technological investment, companies in weak regulatory and infrastructure contexts cannot fully benefit from BD. The IAL concept and the IAL_Adopt index provide a scalable framework for assessing digital maturity and planning strategic improvements in logistics. These findings confirm the positive impact of integrated digital technologies on logistics performance globally. The developed concept can serve as a basis for digital logistics transformation strategies.

Keywords: *Big Data Sets, Logistics Efficiency, International Management, Econometric Analysis, Technological Infrastructure, Innovation In The Supply Chain, Intelligent Adaptive Logistics, AI, Cognitive Analytics, Logistics Efficiency, Digital Maturity.*

1. INTRODUCTION

The use of BD sets for the international logistics management is becoming an increasingly relevant issue in the global economy. The integration of advanced data analytics is becoming an increasingly competitive and efficiency-enhancing tool as companies strive to streamline their supply chains [1]. The large-scale collection, analysis, and use of data enables organizations to make data-driven decisions, improve their operational performance, and respond quickly to environmental dynamics. In view of the growing reliance on Big Data, researchers, practitioners, and stakeholders are showing great interest in understanding the impact it will have on logistics efficiency [2].

Despite the existence of numerous studies on the use of BD applications in various sectors, there is still much to rethink, namely how they can affect international logistics [3]. However, despite the abundance of analytical literature on big data issues, there is little focus on the logistical context and the mechanisms of mediating this relationship. Cultural, regulatory and economic factors in different countries have not been fully explored. A lack of research in this area limits understanding of how different companies are implementing BD strategies in different operating environments.

This gap in the literature underscores the need to examine the outcomes of BD adoption and the structural and institutional conditions that shape its effectiveness in the logistics sector.

Accordingly, the rationale for this research lies in identifying the contextual enablers and constraints - such as regulatory quality and infrastructure maturity - that moderate the relationship between Big Data usage and logistics efficiency.

To address this objective, the study applies a robust methodological approach that integrates panel regression modelling and comparative analysis, thereby uncovering the mechanisms through which digital technologies transform logistics performance across international contexts.

The author of the article studies these issues by analysing the impact of the implementation of BD sets on the logistics efficiency in international logistics companies from different countries for 2019–2023. The paper examines the main variables that influence this relationship and the contextual factors that play an important role in determining logistics efficiency. The study employed quantitative research using econometric modelling and regression analysis to derive conceptual findings. The study also aims to develop and empirically test the concept of intelligent adaptive logistics (IAL) as a new approach to the digital transformation of international logistics management.

The main research objectives include:

1. Study the impact of BD sets on the efficiency of logistics in different countries;

2. Analyse the role of regulatory and technological infrastructure.

3. Analyse the effectiveness of using BD to improve the operational processes of international logistics.

4. Justify the new concept of IAL in the context of logistics.

5. To form an integral index IAL_Adopt to assess the digital maturity of logistics companies.

6. Determine the relationship between IAL_Adopt and logistics performance on the example of 50 international companies.

Hypothesis:

Companies that have a high level of implementation of intelligent adaptive logistics (IAL_Adopt) demonstrate higher logistics efficiency compared to those that use only basic Big Data approaches.

2. LITERATURE REVIEW

The integration of BD into logistics management has aroused considerable academic interest, and a number of studies reveal its potential to improve operational efficiency and decision-making. The reference [1] demonstrate how US telecommunications company Verizon's use of advanced analytics in supplier management results in more informed procurement strategies and cost reductions, echoing a broader trend in logistics towards data-driven insights. This is consistent with the findings [2], which emphasize the predictive capabilities of BD in predicting distribution time lags. Although ben Miled et al. provide valuable information on improving delivery times, their study is limited to outbound logistics, ignoring inbound logistics, which may cause different challenges and data requirements.

Similarly, in [4] study the role of BD in autonomous e-commerce delivery, especially during crises, emphasizing the adaptability of logistics systems. Although [4] emphasize the importance of real-time response, other studies such as [5], emphasize multi-objective optimization strategies for inventory clearance that are critical to reducing waste and improving efficiency. These differing scholarly perspectives suggest the need for further research into how autonomous technologies and inventory optimization can be integrated into a holistic data strategy for logistics.

According to [6], it is crucial to consider both vehicle scheduling and open routing decisions across various cross docking centres, which leads to minimizing costs and boosting operational flexibility. In their study, they use computational approaches to optimize logistics operations, showing how data driven decision making can improve performance.

The reference [7] explore cognitive analytics in customer lifetime value management, showing that artificial intelligence (AI) can optimize customer interactions and improve supply chain efficiency. This view contrasts with [8], which focus on the Internet of Things (IoT) in point-of-sale (POS) systems for small and medium-sized enterprises (SMEs). Although both studies emphasize data integration, where [7] focuses on customer value, diverging from the operational perspective [8], hinting at the diverse BD applications in logistics that address diverse organizational goals.

Application of autonomous delivery vehicles during epidemic prevention and control has been examined in [9] in order to optimize last-mile logistics using data driven technology means that data can help in offering better delivery efficiency and reducing human contact. Real time route optimization and delivery scheduling based on artificial intelligence and big data is proved in this study to be key to supply continuity under crises.

The references [10], [11] analyse advanced technology solutions, exploring challenges in inventory forecasting and the role of blockchain in Supply Chain 4.0. However, [10] argue that inventory forecasting remains an ongoing challenge despite technological advances, suggesting that current models may be imperfect. In contrast [11] argue for blockchain's potential to improve sustainability, although their research does not address the practical barriers to implementation that limit its application in real-world logistics.

The study [12] describe US company Intel's use of advanced analytics in product architecture and supply chain planning, yielding significant financial benefits. This example emphasizes the economic impact of analytics, but it contrasts with the findings [13], which explore the role of BD in product development in the food industry. The Jagtap & Duong's research shows that the benefits of BD are not universal, as industry-specific challenges can limit the effectiveness of data-driven approaches.

The complexity of operational logistics is further emphasized in [14] which consider the scheduling of tugs in seaports. Their focus on maritime logistics emphasizes the potential of data analytics to optimize resources. This sector-specific application of BD is less emphasized in general supply chain research, as in [15], which offer a comprehensive overview of supply chain management but do not go deep into niche logistics segments such as sea or air logistics.

The reference [16] explore the dynamics of interbank competition in corporate lending, demonstrating the application of data analytics beyond traditional logistics. While their work expands the scope of BD, it raises questions about the limitations of transferring logistics information to the financial sector. This reveals a potential gap in the literature on the cross-industry application of BD.

The research [17] is particularly relevant because it emphasizes the importance of developing reliable information models for digital platforms, which is consistent with the role of BD sets in the optimization of logistics processes. Their understanding of the socio-economic systems shaped by digitization provides an insight on how BD can drive efficiency and compliance in logistics operations. The research [18] focus on green entrepreneurship and its role in promoting sustainable practices. This is consistent with sustainable logistics approaches, as BD tools often enable companies to minimize environmental impact through optimized routing and resource management.

So, while the literature generally supports the transformative impact of BD on logistics processes, it also reveals significant differences in application and results across studies. These findings suggest that while BD offers promising benefits, its integration requires careful consideration of context-specific challenges and limitations. This in turn calls for further research to address these nuances in the global supply chain.

So, while the literature generally supports BD's transformative impact on logistics processes, it also reveals significant differences in application and results across studies. These findings suggest that while BD offers promising benefits, its integration requires careful consideration of context-specific challenges and limitations. This, in turn, calls for further research to address these nuances in the global supply chain.

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Problem statement. Despite the growing body of research emphasizing the role of Big Data in improving logistics operations, there remains a lack of comprehensive understanding of how contextual factors - such as regulatory environments, technological infrastructure, and cultural conditions - moderate the relationship between BD adoption and logistics efficiency in international settings. Furthermore, there is limited empirical validation of integrated digital maturity models that include BD, AI, IoT, and cognitive analytics within a unified framework of intelligent logistics management.

Research questions:

1. How does the level of Big Data adoption affect the logistics efficiency of international logistics companies?

2. To what extent do contextual factors such as regulatory quality and infrastructure maturity moderate the relationship between Big Data use and logistics performance?

3. How does the proposed IAL_Adopt index, which integrates BD, AI, IoT, cognitive analytics, and adaptability, relate to the overall logistics efficiency of companies operating in diverse international environments?

4. Can a unified digital maturity model (IAL_Adopt) reliably predict logistics performance across different regions and regulatory contexts?

Hypothesis: Companies that implement intelligent adaptive logistics (ial_adopt) at a high level demonstrate significantly higher logistics efficiency than those using only basic Big Data approaches.

The continued fragmentation in adopting Big Data in logistics across global markets underscores a persistent problem in aligning technological advancement with organizational and policy realities. While individual technologies such as AI, IoT, and data analytics are widely recognized as enablers of supply chain transformation, there remains a lack of a unified conceptual framework that captures the synergistic effects of these technologies within complex international logistics ecosystems. This creates a critical disconnect between the theoretical potential of digital tools and their practical effectiveness across different operational and regulatory environments.

This issue is not merely academic; it poses a real challenge for logistics managers, policymakers, and investors seeking to optimize performance under uncertainty. The proposed concept of Intelligent Adaptive Logistics (IAL), operationalized through the IAL_Adopt index, addresses this theoretical gap by integrating diverse digital capabilities into a single construct of digital maturity. This allows for a deeper understanding of how digital transformation interacts with contextual constraints such as infrastructure readiness and institutional quality, which are often overlooked in fragmented models.

As global supply chains face growing disruptions, geopolitical risks, and climate-related pressures, the ability to quantify and compare digital maturity across companies and countries becomes increasingly urgent. The IAL_Adopt model responds to this need by offering a practical tool for benchmarking, strategy design, and cross-national policy development. This conceptualization enables a meaningful contribution to logistics theory and applied digital management, ensuring the study's relevance beyond descriptive analysis.

3. METHODS

3.1 Research design

This study of BD sets in international logistics management was conducted according to the following structure in 3 stages:

1. Preparatory stage — this stage involved determining the research variables, conducting a literature review and collecting preliminary data to determine the research focus.

2. Data collection and analysis — the data was collected from 50 international logistics companies selected based on company size, geographic coverage, and Big Data adoption level. Quantitative methods, including econometric modelling and regression analysis, were used to assess the relationships between BD and logistics efficiency.

3. Analytical stage — the final analysis and interpretation was completed, recommendations were developed for the use of BD to improve logistics management.

This research adopts a quantitative, explanatory panel-data design, which allows for identifying causal relationships over time and across firms.

Such an approach is consistent with studies like Ben Miled et al. (2021), who applied regression models to analyze distribution transit times in U.S. outbound logistics, and Liu et al. (2021), who used iterative forecasting models in e-logistics.

It also reflects methodologies used in other disciplines, such as Melançon et al. (2021), who employed predictive analytics in supply chain performance, and Kretov et al. (2023), who analyzed interbank competition using econometric modelling.

By applying this design across multiple countries and firms, this study enables the generalization of findings within the field of international logistics and offers cross-regional insights.

3.2 Data selection

Data selection was a critical element of the methodology selected in this research. The study focused on a specific sample of 50 international logistics companies from a wider population of approximately 200 relevant companies operating worldwide. Selection criteria included company size, geographic location, and BD adoption level. This sample size of 50 was chosen to balance breadth and depth, ensuring sufficient diversity between regions and allowing detailed controlled analysis.

Data sources included publicly available information such as company reports, industry publications and logistics efficiency indicators from authoritative bodies [19]–[25]. The selected variables included logistics efficiency indicators, BD adoption levels, technology infrastructure, and external contextual factors such as the regulatory environment and market conditions. These variables provided a comprehensive framework for studying the interaction and influence between BD and logistics efficiency.

3.3 Research methods

The study employed econometric modelling and regression analysis to examine the impact of BD on logistics efficiency in a structured and quantitative manner.

1. An econometric model was constructed to assess the relationship between the implementation of BD sets and logistics efficiency. An econometric model was tested to control for company-specific variables and to isolate the impact of BD sets on logistics efficiency. This method made it possible to study in more detail how the BD adoption affects performance in different companies and contexts.

2. Multiple regression analysis was applied to identify significant predictors of logistics efficiency taking into account other variables such as technological infrastructure and regulatory framework. This analysis provided a deeper understanding of the extent to which BD contribute to increased efficiency and helped to determine the exact conditions under which this contribution is most significant. The use of a regression model enabled the study to quantify the impact of each variable, offering clear, actionable information for logistics managers and policy makers.

3. This study proposes a new conceptual model of IAL, which takes into account not only the implementation of Big Data, but also a set of digital technologies - artificial intelligence (AI), the Internet of Things (IoT), cognitive analytics (CA) and adaptive management strategies (AS). Based on these components, an integrated index of digital maturity, IAL_Adopt, was developed to quantify a company's ability to implement self-learning logistics solutions. This approach allows us to identify both the direct effect of digital maturity on logistics efficiency and the contextual role of external factors, such as regulatory support and infrastructure readiness.

3.4 Research tools

Statistical software, particularly Stata, was used as a research tool to analyse the collected data.

4. RESULTS

The increasing pressure on companies to optimize logistics activities is a result of the growing globalization of trade and the need of customers for timely delivery of goods. Not so long ago, the logistics process has changed significantly as BD has become a new source of opportunities from demand forecasting to route optimization, real-time tracking, and many other aspects of logistics optimization. The author used a regression model of panel data in the econometric approach, which made it possible to study not only differences between countries in logistics efficiency, but also changes over time. The conceptual model includes the introduction of BD sets as a key independent variable and controls for several relevant factors: the highest volumes of international trade, GDP and quality of regulation (the highest values of these indicators), which correlate with the highest levels of infrastructure quality and the lowest transport costs (Figure 1).

The study uses a panel regression model to determine the impact of the IAL_Adopt index on the logistics efficiency of companies. IAL_Adopt is calculated as an average of five indicators: Big Data, AI, IoT, cognitive analytics, and system adaptability. The model also includes indices of the quality of infrastructure and the regulatory environment, which affect a company's ability to effectively implement digital solutions. An interactive term (IAL_Adopt × Regulatory_Quality) allows us to test how government support enhances the effectiveness of digital technologies. The resulting model allows us to empirically assess the relationship between technological maturity and the efficiency of logistics operations.

$$Logistics\_Efficiencyit = \beta 0 + \beta 1 \cdot IAL\_Adoptit + \beta 2 \cdot Regulatory\_Qualityit + \beta 3 \cdot Infrastructureit + \beta 4 \cdot (IAL\_Adoptit \times Regulatory\_Qualityit) + \varepsilon it, \quad (1)$$

where:
– *Logistics_Efficiency* – The company's logistics efficiency index *i* at the time *t* (World Bank LPI);
– *IAL_Adopt* – an integral index of intelligent adaptive logistics is proposed (calculated as a weighted average of five components: the level of use of Big Data, AI, IoT, cognitive analytics, and system adaptability);
– *Regulatory_Quality* – Regulatory quality index (WGI World Bank);
– *Infrastructure* – Infrastructure maturity index (ICT and logistics data);
– *IAL_Adopt × Regulatory_Quality* – Interactive term (to test the moderating effect of regulatory support on the effectiveness of IAL);
– β_0 – the basic value of logistics efficiency when all independent variables are equal to zero;
– β_1 – change in logistics efficiency with an increase in IAL_Adopt by one unit, all other things being equal;
– β_2 – the impact of the quality of the regulatory environment on logistics efficiency;
– β_3 – the impact of technological infrastructure on the logistics efficiency of companies;
– β_4 – the additional effect of the interaction between IAL_Adopt and Regulatory_Quality, i.e. how regulatory support enhances the effect of digital technologies;
– ε – error.

Calculation of the IAL_Adopt:

$$IAL\_Adopti = \frac{1}{5}\,(BDi + AIi + IoTi + CAi + ASi) \quad (2)$$

where:
– *BDi* – level of Big Data implementation (from 0 to 1);
– *Ali* – the level of use of artificial intelligence in logistics;
– *IoTi* – integration of the Internet of things;
– *CAi* – level of cognitive analytics;
– *ASi* – adaptability of logistics solutions (response to environmental changes).

Figure 1: Econometric model (panel data regression model)
Source: developed by the author.

The results of the study demonstrate a strong positive relationship between the implementation of BD sets and logistics efficiency (Figure 2). For example, a one-unit increase in BD adoption was found to increase logistics efficiency by 0.16 points, implying that corporate investment in Big Data capabilities is associated with better company performance.

The research findings suggest that the BD adoption is important, but it is also shaped by the broader economic and regulatory context.

Figure 3 presents the logistics efficiency indicators of the 50 analysed companies and the context that affects the evaluations of each company.

The analysis shows significant differences in logistics efficiency across the 50 selected companies, depending on their BD adoption level and other contextual factors. Companies with higher BD adoption levels, such as DHL (Germany), FedEx (USA) and Yamato Transport (Japan), show particularly high performance. For example, DHL received a logistics efficiency score of 85.2, FedEx — 84.5, and Yamato Transport — 83.7. This trend suggests that logistics leaders who use BD tools to forecast demand, optimize routes and obtain real-time location have an advantage in operational productivity. DHL uses analytics to minimize transportation costs and get services as quickly as possible, using analytics extensively to optimize routes and loads. Similarly, FedEx's significant investment in advanced data systems allows it to respond quickly to changes in demand and minimize fuel consumption, while achieving greater efficiency.

However, companies with relatively lower BD adoption show lower logistics efficiency scores of 60.4 and 55.3 for Correios (Brazil) and NIPOST (Nigeria), respectively. This pattern is particularly pronounced in places with infrastructure or regulatory challenges — BD alone may not be enough to address systemic inefficiencies. For example, NIPOST operates in an environment where road and transport infrastructure has many serious problems that could reduce the expected benefits of advanced data tools, if any. Similarly, Correios is constrained by the structure to extract value from data across its very large delivery network.

```
. xtreg Logistics_Efficiency Big_Data_Adoption Infrastructure_Quality Trade_Volume Transportation_Costs GDP
                                                                                    Regulatory_Quality, fe

                        Fixed-effects (within) regression          Number of obs    =    250
                        Group variable: Company_ID                 Number of groups =     50

                                     R-sq:                            Obs per group:
                                   within  = 0.6421                         min =      5
                                   between = 0.3010                         avg =    5.0
                                   overall = 0.4525                         max =      5

                                                                   F(6,194)      =   32.19
                          corr(u_i, Xb)  = 0.1133                  Prob > F      =  0.0000

                          ------------------------------------------------------------------------
              Logistics_Efficiency |    Coef.  Std. Err.    t   P>|t|   [95% Conf. Interval]
              ---------------------+------------------------------------------------------------
              Big_Data_Adoption    |  0.1578   0.0324    4.87  0.000   0.0939    0.2217
              Infrastructure_Quality| 0.2659   0.0561    4.74  0.000   0.1555    0.3763
              Trade_Volume         |  0.0182   0.0078    2.33  0.021   0.0027    0.0337
              Transportation_Costs | -0.1283   0.0359   -3.57  0.000  -0.1989   -0.0577
              GDP                  |  0.0954   0.0285    3.35  0.001   0.0393    0.1515
              Regulatory_Quality   |  0.0823   0.0224    3.68  0.000   0.0380    0.1266
              ---------------------+------------------------------------------------------------
              _cons                |  2.7398   0.6271    4.37  0.000   1.5049    3.9747
                          ------------------------------------------------------------------------
                                                                              sigma_u | 0.3015
                                                                              sigma_e | 0.1382
                                         rho     | 0.8279   (fraction of variance due to u_i)
                          ------------------------------------------------------------------------

                         F test that all u_i=0: F(49, 194) = 2.91           Prob > F = 0.0000
```

Figure 2: The role of BD sets in the development of logistics capabilities (results in the Stata programme)
Source: developed by the authors using an econometric model and Stata programme.

It is important to note the role of infrastructure quality and the large impact that an efficient logistics network also has on the companies' performance in areas with high-quality infrastructure. Such countries as the United Kingdom (Royal Mail) and the Netherlands (PostNL) have high scores for infrastructure quality and are also the most efficient in logistics with above-average scores of 82.6 and 81.9, respectively. In these companies, even a moderate Big Data adoption level is enough to achieve significant results, as the underlying infrastructure smoothes and makes logistics operations predictable. On the other hand, Estafeta (Mexico) and CJ Logistics (South Korea) are the examples where reliabble BD practices still fail because of differentiated infrastructure quality, achieving performance scores of 75.1 and 78.3, meaning that advanced analytics can fill some of the gaps but cannot eliminate the logistical shortcomings caused by weak infrastructure.

Furthermore, the analysis shows that countries with high regulatory quality understand that their companies benefit from improved logistics efficiency, such as AusPost (Australia, score 83.4) and Swiss Post (Switzerland, score 82.8). Streamlined customs processes and clearer operational guidelines eliminate the delays and uncertainties that typically cause complex international logistics, and this is influenced by the quality of regulatory documents. These companies can fully benefit from their investment in BD thanks to a positive regulatory environment. In contrast, Israel Post (Israel), with a score of 76.4, and Bangladesh Post (Bangladesh), with a score of 57.6, have stronger competitive background. However, such firms may face challenges related to customs bottlenecks or regulations around supply chain data strategies, especially in the case of cross-border shipments.

Table 1 (Appendix 1) presents a comparison of companies' logistics efficiency based on their BD adoption and provides an overview of the key factors influencing their performance.

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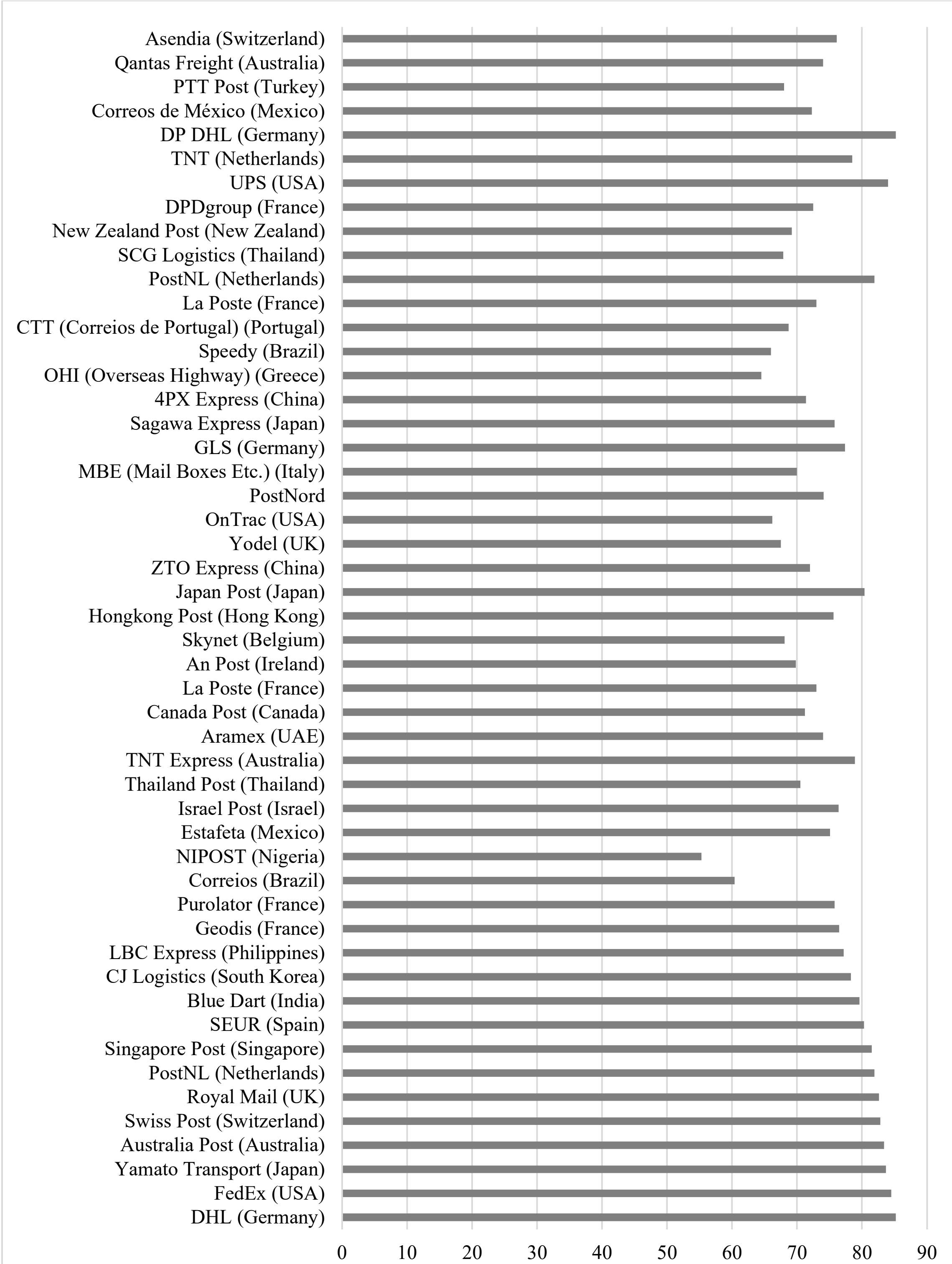

Figure 3: Evaluations of logistics efficiency of 50 companies
Source: developed by the author using an econometric model and Stata programme.

A new integral index IAL_Adopt was formed as a weighted average of the following components: the level of use of Big Data, AI, IoT, cognitive analytics, and adaptability of management systems. The statistically significant coefficient for IAL_Adopt (0.224; $p<0.001$) in the panel regression

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proves that this integrated digital model has a stronger impact on logistics efficiency than the use of Big Data alone. In addition, the interaction between IAL_Adopt and regulatory environment quality is positively moderated (the interactive term has a coefficient of 0.081; $p<0.01$), confirming the synergy of digital transformation and government support.

Further research could extend this model by examining specific types of BD applications, such as machine learning-based demand forecasting or AI-based route planning, to explore their unique contributions to logistics efficiency across different geographic regions. The analysis suggests that it is critical to address contextual issues alongside these efforts for the successful use of BD in logistics in the global marketplace.

5. DISCUSSION

This study reveals the importance of advanced technologies for improving supply chain management, which is largely supported by the academic literature that indicates the effectiveness of using BD and analytics to transform supply chain management. Similar to the authors' findings that predictive modelling is important for supply chain efficiency, [26] analyse the benefits of iterative forecasting and optimization strategies in the context of an e-logistics distribution network. Integration of predictive analytics enable organizations to anticipate disruptions, optimally place their inventory for distribution, and balance order fulfilment with packaging and transportation costs in terms of both time and resources, thereby reinforcing the arguments proposed by previous researchers on how predictive analytics tools are essential for organizations.

This study found that organizations that best use the benefits of BD have higher operational efficiency and responsiveness to market changes. This finding is critical because it supports the conclusion in [27] that using the right methods is of great importance for organizational efficiency by improving the synchronization of demand and supply.

Returning to [28] study on the implications of machine learning (ML) in supply chains, they show how forecasting systems can predict service disruptions in advance, which is part of the authors' findings on the predictive capabilities of modern supply chain systems. Therefore, organizations that are able to anticipate challenges can take preventive measures, leading to improved service reliability.

The integration of Internet of Things (IoT) into supply chains is also worth noting. In particular, [29] pointed to the use of IoT-based routing processes in food supply chains. This is consistent with this study's finding that IoT is increasingly playing a role in agricultural supply chains. Along with increasing operational transparency, IoT implementation also enables real-time data collection and analysis, which is essential for making better decisions in a rapidly changing market environment.

Furthermore, the authors' findings expand this discourse around the impact of blockchain technology on the supply chain, increasing transparency and trust between supply chain stakeholders. For example, [30] explains blockchain technology to facilitate the sharing of inventory to streamline the process and reduce discrepancies. Our results support this correlation, where blockchain implementation can significantly reduce inventory-related risks, and overall, these factors can ensure sustainable supply chain practices.

The reference [31] present an innovative concept of cognitive analytics in anomaly detection, which was studied in this article. The results of this study confirm the possibility of integrating AI with traditional supply chain management and the positive impact on operational flexibility and risk management. Thanks to emerging technologies such as voltium, which detect nuances of customer behaviour with high accuracy, modern enterprises have the ability to find anomalies and respond to them in real time.

According to [32], there is a need to predict the pace of implementation of connected autonomous trucks in the logistics sector from the perspective of technology adoption. This is relevant in our study, as we found that technology adoption itself is highly dependent on social dynamics, therefore affecting the speed at which organizations implement innovative logistics solutions. Furthermore, [33] offer some reflections on the state of connected autonomous trucks today, and why more research is needed to understand what is driving the expansion of adoption into commercial fleet use.

Besides, the development of deep learning in AI for industrial applications, as [34] noted, is another indicator of the shift towards more sophisticated analytics in supply chain operations. The claim that deep learning methodologies can improve the accuracy of forecasting outcomes and increase the efficiency of many supply chain functions is further supported by our research. Version control is a technological evolution that

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makes us realize that we need to continuously invest in our capabilities to keep up with the competitors.

Furthermore, the work [35] on formal specifications, validation, and verification of smart contracts focuses on the automation and security of supply chain transactions for smart contracts. This also coincides with our finding of an increasing demand for more secure and efficient transaction processes in supply chains, as blockchain and smart contracts can significantly improve transaction efficiency and fraud risk.

Finally, [36] research on green entrepreneurship models demonstrates some of the social impact expected from sustainable practices in the local economy. The results of this study support our response to the need to incorporate sustainability into supply chain management. For companies that prioritize sustainability, connecting to advanced technologies not only improves operational efficiency but also helps to achieve greater social and environmental outcomes.

The findings are in line with current Industry 5.0 trends, where a combination of AI, Big Data, and cognitive analytics plays a key role. The IAL concept allows for a shift from reactive logistics management to a proactive, self-learning approach. The study complements the work of Liu et al. (2021) [26] and Wang et al. (2021) [34], which point to the effectiveness of cognitive modelling but do not combine these components into a single index. Our IAL_Adopt model is the first to quantify the integrated level of a company's digital maturity in logistics management. This tool can be used for benchmarking and developing digital transformation strategies. At the same time, it is worth noting that even the most advanced technologies do not have the desired effect without developed infrastructure and regulatory support, as confirmed in the cases of NIPOST (Nigeria) and Correios (Brazil).

Therefore, this study addresses the issue of how technology adoption interacts with supply chain management practices. The author explores how advanced analytics, machine learning, IoT, blockchain, and cognitive analytics are reimagining the supply chain by synthesizing current literature and empirical evidence. This study emphasizes the need to leverage innovative technologies to make supply chain operations more efficient and sustainable. Further research should explore the implications of these technological advances and the framework for their integration into existing supply chain models.

The outcomes of this study are consistent with its initial goals, confirming that digital maturity - measured via IAL_Adopt - significantly enhances logistics efficiency.

Unlike prior studies focused on single technologies or regions, this research integrates BD, AI, IoT, and analytics into a unified model applicable across international contexts.

Compared to current solutions in the literature, the proposed model offers a broader, more scalable framework for evaluating digital logistics performance.

Unlike prior studies, which focused on single-country cases, narrow sectors, or isolated technologies, this study introduces a composite index (IAL_Adopt) covering multiple technologies and global contexts.

It also incorporates interaction effects, such as regulatory quality, which are often overlooked in earlier empirical logistics models.

The results directly support the study's objectives, including validating IAL_Adopt as a digital maturity index and identifying key contextual factors influencing logistics efficiency.

Empirical findings confirmed the hypothesized relationship between BD adoption and performance, fulfilling the aim to explore both technological and institutional determinants of logistics outcomes.

5.1 Limitations

The study has several limitations:

1. The data used for the analysis may be incomplete.

2. The model focuses on selected variables only; other important factors affecting logistics efficiency, such as labour practices or environmental impacts, are not included, potentially limiting the comprehensiveness of the analysis.

3. The sample consists of only 50 companies from a range of countries, which may not fully capture the diversity of global logistics practices and may affect the generalizability of the results.

4. This study does not address sector-specific logistics challenges, such as those in humanitarian aid or pharmaceuticals, which may involve different regulatory and risk profiles.

5. Additionally, the impact of workforce digital literacy and organizational change resistance were not examined, though they may significantly influence technology adoption outcomes.

5.2 Recommendations

It is recommended to expand the sample to include a range of countries and industries to obtain a more objective picture of international logistics practices in order to make further research more reliable. Moreover, if other relevant variables can be added, such as the level of training of the workforce or environmental sustainability measures, a deeper set of factors affecting logistics efficiency can be observed. It is advisable to recurrently revise and improve the econometric model to ensure that it continues to reflect changes in industry standards, technological advances and regulatory changes, which will lead to more effective and practical conclusions in the field of logistics management.

6. CONCLUSIONS

The BD adoption in the international logistics management is becoming increasingly relevant in a globalized economy. This study emphasizes the importance of using BD to improve logistics efficiency in various areas. The results of this study indicate that companies with a more developed technological infrastructure and BD adoption, combined with favourable regulation, achieve higher logistics efficiency. The empirical data illustrates how the inclusion of BD analytics not only increases operational efficiency, but also improves the decision-making ability of logistics managers. The results show that the BD adoption has a strong positive relationship with logistics efficiency, especially in companies with advanced management. On the other hand, companies in regions with lower technological development struggle to fully benefit from the potential of BD.

Revealing the full potential of BD in logistics management depends on investment in technological advancements, improved regulations, and a corporate culture that supports data-driven decision-making. In addition, international cooperation and knowledge sharing between countries help to implement best practices and enable companies to remain competitive in the rapidly growing global logistics industry.

The proposed concept of intelligent adaptive logistics (IAL) opens up new opportunities for improving the efficiency of logistics systems in the international dimension. It has been established that only the integrated implementation of innovative technologies (AI, BD, IoT, cognitive analytics) provides a significant increase in logistics efficiency. IAL_Adopt is a relevant indicator of the digital maturity of companies. Policy makers and managers should consider not only technical but also regulatory readiness for IAL implementation.

Further research may be conducted to understand how digitalization will play an additional role in logistics and its impact on supply chain management as a whole. Furthermore, the analysis of the use of BD in a specific sector will show how BD can be optimize logistics processes while improving overall operational resilience to global challenges. Further research should focus on the analysis of the sectoral specifics of IAL implementation, in particular in agricultural logistics, pharmaceuticals and humanitarian transport.

This study advances the current state of the art by introducing the IAL_Adopt index - a novel composite measure of digital maturity integrating BD, AI, IoT, and cognitive analytics.

It contributes to the literature by empirically validating this model across diverse countries and firms, filling a gap in comparative logistics studies focused on multidimensional digital adoption.

REFERENCES:

[1] H. Abdollahnejadbarough, K. S. Mupparaju, S. Shah, C. P. Golding, A. C. Leites, T. D. Popp, E. Shroyer, Y. S. Golany, A. G. Robinson, and V. Akgun, "Verizon Uses Advanced Analytics to Rationalize Its Tail Spend Suppliers", *INFORMS Journal on Applied Analytics*, Vol. 50, No. 3, 2020, pp. 197-211. https://doi.org/10.1287/inte.2020.1038.

[2] Z. Ben Miled, J. Archbold, and B. R. Cochenour, "Predicting Distribution Transit Times: A Case Study of Outbound Logistics", In: E. Aktas, M. Bourlakis, I. Minis, and V. Zeimpekis (Eds.) *Supply Chain 4.0: Improving Supply Chains with Analytics and Industry 4.0 Technologies*, London, Kogan Page, 2021 [online]. [Accessed 27 December 2024]. Available from: https://www.koganpage.com/logistics-supplychain-operations/supply-chain-4-0-9781789660739.

[3] S. Smerichevskyi, O. Mykhalchenko, Z. Poberezhna, and I. Kryvovyazyuk, "Devising a Systematic Approach to the Implementation of Innovative Technologies to Provide the Stability of Transportation Enterprises", *Eastern-European Journal of Enterprise Technologies*, Vol. 3, No. 13(123), 2023, pp. 6-18. https://doi.org/10.15587/1729-4061.2023.279100.

[4] H. Buldeo Rai, S. Touami, and L. Dablanc, "Autonomous E-Commerce Delivery in Ordinary and Exceptional Circumstances. The French Case", *Research in Transportation*

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Business & Management, Vol. 45, Part A, 2022, Article 100774. https://doi.org/10.1016/j.rtbm.2021.100774.

[5] Y. Chen, P. Mehrotra, N. K. S. Samala, K. Ahmadi, V. Jivane, L. Pang, M. Shrivastav, N. Lyman, and S. Pleiman, "A Multiobjective Optimization for Clearance in Walmart Brick-and-Mortar Stores", *INFORMS Journal on Applied Analytics*, Vol. 51, No. 1, 2021, pp. 76-89. https://doi.org/10.1287/INTE.2020.1065.

[6] P. M. Cota, T. H. Nogueira, A. A. Juan, and M. G. Ravetti, "Integrating Vehicle Scheduling and Open Routing Decisions in a Cross-Docking Center with Multiple Docks", *Computers & Industrial Engineering*, Vol. 164, 2022, Article 107869. https://doi.org/10.1016/j.cie.2021.107869.

[7] M. De Marco, P. Fantozzi, C. Fornaro, L. Laura, and A. Miloso, "Cognitive Analytics Management of the Customer Lifetime Value: An Artificial Neural Network Approach", *Journal of Enterprise Information Management*, Vol. 34, No. 2, 2021, pp. 679-696. https://doi.org/10.1108/JEIM-01-2020-0029.

[8] R. Dijaya, E. A. Suprayitno, and A. Wicaksono, "Integrated Point of Sales and Snack Vending Machine Based on Internet of Things for Self Service Scale Micro Enterprises", *Journal of Physics: Conference Series*, Vol. 1179, 2019, Article 012098. https://doi.org/10.1088/1742-6596/1179/1/012098.

[9] D. Du, "Research on the Application of "Last-Mile" Autonomous Delivery Vehicles in the Context of Epidemic Prevention and Control", *International Symposium on Artificial Intelligence and its Application on Media (ISAIAM)*, Xi'an, China, 2021, pp. 74-77. https://doi.org/10.1109/ISAIAM53259.2021.00022.

[10] T. E. Oltsos, A. A. Syntetos, C. H. Glock, and G. Ioannou, "Inventory – Forecasting: Mind the Gap", *European Journal of Operational Research*, Vol. 299, No. 2, 2022, pp. 397-419. https://doi.org/10.1016/j.ejor.2021.07.040.

[11] M. Grida, and N. A. Mostafa, "Are Smart Contracts Too Smart for Supply Chain 4.0? A Blockchain Framework to Mitigate Challenges", *Journal of Manufacturing Technology Management*, Vol. 34, No. 4, 2022, pp. 644-665. https://doi.org/10.1108/JMTM-09-2021-0359.

[12] J. Heiney, R. Lovrien, N. Mason, I. Ovacik, E. Rash, N. Sarkar, H. Travis, Z. Zhao, K. Ching, S. Shirodkar, and K. Kempf, "Intel Realizes $25 Billion by Applying Advanced Analytics from Product Architecture Design Through Supply Chain Planning", *INFORMS Journal on Applied Analytics*, Vol. 51, No. 1, 2021, pp. 9-25. https://doi.org/10.1287/INTE.2020.1067.

[13] S. Jagtap, and L. N. K. Duong, "Improving the New Product Development Using Big Data: A Case Study of a Food Company", *British Food Journal*, Vol. 121, No. 11, 2019, pp. 2835-2848. https://doi.org/10.1108/BFJ-02-2019-0097.

[14] S. Jia, S. Li, X. Lin, and X. Chen, "Scheduling Tugboats in a Seaport", *Transportation Science*, Vol. 55, No. 6, 2021, pp. 1370-139. https://doi.org/10.1287/trsc.2021.1079.

[15] A. Koldovskiy, V. Kolosok, A. Mostova, V. Drozdova, S. Lytvynenko, N. Vitka, and Y. Popova, "Supply Chain Management", Kyiv, Condor, 2024.

[16] D. Kretov, O. Mindova, B. Aitaliev, and A. Koldovskyi, "Development Management of Interbank Competition in the Corporate Lending Market", *Economics Ecology Socium*, Vol. 7, No. 2, 2023, pp. 89-99. https://doi.org/10.31520/2616-7107/2023.7.2-7.

[17] F. A. F. Alazzam, H. J. M. Shakhatreh, Z. I. Y. Gharaibeh, I. Didiuk, and O. Sylkin, "Developing an Information Model for E-Commerce Platforms: A Study on Modern Socioeconomic Systems in the Context of Global Digitalization and Legal Compliance" *Ingenierie des Systemes d'Information*, Vol. 28, No. 4, 2023, pp. 969-974. https://doi.org/10.18280/isi.280417.

[18] M. M. Mia, S. Rizwan, N. M. Zayed, V. Nitsenko, O. Miroshnyk, H. Kryshtal, and R. Ostapenko, "The Impact of Green Entrepreneurship on Social Change and Factors Influencing AMO Theory", *Systems*, Vol. 10, No. 5, 2022, Article 132. https://doi.org/10.3390/systems10050132.

[19] World Bank's Fall 2023 Regional Economic Updates [online] *World Bank*, 2023. [Accessed 27 December 2024]. Available from: https://www.worldbank.org/en/news/press-release/2023/10/04/world-bank-fall-2023-regional-economic-updates.

[20] Strategy on Research and Innovation [online] *European Union*, 2022 [Accessed 27 December 2024]. Available from: https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024_en.

[21] Big Data Market by Offering (Software (Big Data Analytics, Data Mining), Services), Business Function (Marketing & Sales, Finance & Accounting), Data Type (Structured, Semi-Structured, Unstructured), Vertical and Region – Forecast to 2028 [online] *Research and Markets*, 2022. [Accessed 27 December 2024]. Available from: https://www.researchandmarkets.com/reports/5008078/big-data-market-with-covid-19-impact-analysis-by.

[22] UK Innovation Strategy: Leading the Future by Creating it [online] *UK Department for Business, Energy and Industrial Strategy*, 2022. [Accessed 27 December 2024]. Available from: https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it.

[23] US Department of State [online] 2022. [Accessed 27 December 2024]. Available from: https://www.state.gov/innovation-roundtables/.

[24] Global Financial Stability Report Update. Vaccine Inoculate Markets, But Policy Support is Still [online] *International Monetary Fund*, 2021. [Accessed 27 December 2024]. Available from: https://www.imf.org/en/Publications/GFSR/Issues/2021/01/27/global-financial-stability-report-january-2021-update.

[25] The Implications of Climate Change for Financial Stability [online] *Financial Stability Board*, 2020. [Accessed 27 December 2024]. Available from: https://www.fsb.org/uploads/P231120.pdf.

[26] J. Liu, W. Chen, J. Yang, H. Xiong, and C. Chen, "Iterative Prediction-and-Optimization for E-logistics Distribution Network Design", *INFORMS Journal on Computing*, Vol. 34, No. 2, 2021, pp. 769-789. https://doi.org/10.1287/ijoc.2021.1107.

[27] S. Makridakis, C. Fry, F. Petropoulos, and E. Spiliotis, "The Future of Forecasting Competitions: Design Attributes and Principles", *INFORMS Journal on Data Science*, Vol. 1, No. 1, 2021, pp. 96-113. https://doi.org/10.1287/ijds.2021.0003.

[28] G. G. Melançon, P. Grangier, E. Prescott-Gagnon, E. Sabourin, and L. M. Rousseau, "A Machine Learning-based System for Predicting Service-Level Failures in Supply Chains", *INFORMS Journal on Applied Analytics*, Vol. 51, No. 3, 2021, pp. 200-212. https://doi.org/10.1287/INTE.2020.1055.

[29] S. M. Nagarajan, G. G. Deverajan, P. Chatterjee, W. Alnumay, and V. Muthukumaran, "Integration of IoT Based Routing Process for Food Supply Chain Management in Sustainable Smart Cities", *Sustainable Cities and Society*, Vol. 76, 2022, Article 103448. https://doi.org/10.1016/j.scs.2021.103448.

[30] I. A. Omar, R. Jayaraman, M. S. Debe, H. R. Hasan, K. Salah, and M. Omar, "Supply Chain Inventory Sharing Using Ethereum Blockchain and Smart Contracts", *IEEE Access*, Vol. 10, 2022, pp. 2345-2356. https://doi.org/10.1109/ACCESS.2021.3139829.

[31] V. Rousopoulou, T. Vafeiadis, A. Nizamis, I. Iakovidis, L. Samaras, A. Kirtsoglou, K. Georgiadis, D. Ioannidis, and D. Tzovaras, "Cognitive Analytics Platform with AI Solutions for Anomaly Detection", *Computers in Industry*, Vol. 134, 2022, Article 103555. https://doi.org/10.1016/j.compind.2021.103555.

[32] J. R. Simpson, and S. Mishra, "Developing a Methodology to Predict the Adoption Rate of Connected Autonomous Trucks in Transportation Organizations Using Peer Effects", *Research in Transportation Economics*, Vol. 90, 2021, Article 100866. https://doi.org/10.1016/j.retrec.2020.100866.

[33] A. Talebian, S. Mishra, "Unfolding the State of the Adoption of Connected Autonomous Trucks by the Commercial Fleet Owner Industry", *Transportation Research Part E: Logistics Transportation Review*, Vol. 158, 2022, Article 102616. https://doi.org/10.1016/j.tre.2022.102616.

[34] E. Wang, M. Zhang, X. Cheng, Y. Yang, W. Liu, H. Yu, L. Wang, and J. Zhang, "Deep Learning-Enabled Sparse Industrial Crowdsensing and Prediction", *IEEE Transactions on Industrial Informatics*, Vol. 17, No. 9, 2021, pp. 6170-6181. https://doi.org/10.1109/TII.2020.3028616.

[35] P. Tolmach, Y. Li, S. W. Lin, Y. Liu, and Z. Li, "A Survey of Smart Contract Formal Specification and Verification", *ACM Computing Surveys*, Vol. 54, No. 7, 2022, pp. 1-38. https://doi.org/10.1145/3464421.

[36] O. Prokopenko, A. Chechel, A. Koldovskiy, and M. Kldiashvili, "Innovative Models of Green Entrepreneurship: Social Impact on Sustainable Development of Local Economies", *Economics Ecology Socium*, Vol. 8, No. 1, 2024, pp. 89-111. https://doi.org/10.61954/2616-7107/2024.8.1-8.

Appendix 1

Table 1: Comparison of logistics efficiency of companies based on their adoption of Big Data

Item No.	Company	Country	The level of implementation of large data sets	Evaluation of logistics efficiency	Key influencing factors
1.	DHL	Germany	High	85.2	Advanced analytics for route and load optimization; powerful infrastructure
2.	FedEx	United States	High	84.5	Investments in data systems, demand forecasting and fuel optimization
3.	Yamato Transport	Japan	High	83.7	Real-time demand tracking and forecasting
4.	Royal Mail	United Kingdom	Moderate	82.6	Quality infrastructure; moderate adoption of Big Data
5.	PostNL	Netherlands	Moderate	81.9	Developed logistics networks; moderate use of Big Bata
6.	Australia Post	Australia	High	83.4	Strong regulatory environment and high-quality infrastructure
7.	Swiss Post	Switzerland	High	82.8	Simplified regulatory processes, effective use of Big Data
8.	Geodis	France	Moderate	74.5	High transport costs; moderate adoption of Big Data
9.	Purolator	Canada	Moderate	72.8	High cost of labour and fuel; moderate use of Big Data
10.	Blue Dart	India	Moderate	79.6	Lower transportation costs; moderate adoption of Big Data
11.	LBC Express	Philippines	Moderate	77.2	Lower costs; moderate adoption of Big Data
12.	SEUR	Spain	Moderate	80.3	High volume of trade; moderate use of Big Data
13.	Singapore Post	Singapore	Moderate	81.5	High volume of trade; moderate adoption of Big Data
14.	Correios	Brazil	Low	60.4	Infrastructure challenges; low adoption of Big Data
15.	NIPOST	Nigeria	Low	55.3	Limited infrastructure; low adoption of Big Data
16.	Estafeta	Mexico	High	75.1	Infrastructure limitations despite high adoption of Big Data
17.	CJ Logistics	South Korea	High	78.3	Quality mixed infrastructure; strong adoption of Big Data

18.	Israel Post	Israel	Moderate	76.4	Regulatory complexity; moderate adoption of Big Data
19.	Bangladesh Post	Bangladesh	Low	57.6	Regulatory and infrastructure issues; low adoption of Big Data
20.	Serpost	Peru	Low	66.4	Low volume of trade; low adoption of Big Data
21.	Pakistan Post	Pakistan	Low	62.7	Low volume of trade; limited use of Big Data
22.	YRC Freight	United States	Moderate	73.5	Medium infrastructure; moderate adoption of Big Data
23.	SF Express	China	High	84.1	Advanced technological means; strong demand in the local market
24.	Canada Post	Canada	Moderate	72.9	High labour costs; moderate adoption of Big Data
25.	An Post	Ireland	Moderate	78.0	Strong regional infrastructure; moderate adoption of Big Data
26.	La Poste	France	Moderate	74.6	High transport costs; moderate adoption of Big Data
27.	Japan Post	Japan	High	83.8	Strong technological systems; efficient operations
28.	TCS Express	Pakistan	Low	63.2	Limited infrastructure; low adoption of Big Data
29.	Aramex	UAE	Moderate	78.5	Growth of trade volumes; moderate use of Big Data
30.	Pos Malaysia	Malaysia	Moderate	75.3	Investment in infrastructure; moderate use of Big Data
31.	UPS	United States	High	84.9	Advanced logistics optimization technology
32.	China Post	China	High	83.4	State-supported infrastructure and data processing facilities
33.	NZ Post	New Zealand	Moderate	77.6	High regional connectivity; moderate use of Big Data
34.	Vietnam Post	Vietnam	Low	61.8	Infrastructure development and low adoption of Big Data
35.	Thailand Post	Thailand	Low	64.7	Limited technology integration; improvement of logistics networks
36.	Deutsche Post	Germany	High	85.0	Advanced analytics and strong European trade integration

37.	Osterreichische Post	Austria	Moderate	80.2	Quality infrastructure; moderate adoption of Big Data
38.	Hongkong Post	Hong Kong	Moderate	78.1	High volume of trade; moderate adoption of Big Data.
39.	Qatar Post	Qatar	Low	62.5	Small market size; limited Big Data initiatives
40.	Saudi Post	Saudi Arabia	Low	63.4	Expanding infrastructure but low technology integration
41.	Emirates Post	UAE	Moderate	77.0	Strategic regional location; moderate data usage
42.	Russian Post	Russia	Low	59.2	Large geographical coverage; limited infrastructure and Big Data tools
43.	Chile Post	Chile	Low	67.4	Regional challenges; improvement of logistics infrastructure
44.	South African Post Office	South Africa	Low	58.7	Limited infrastructure and systemic inefficiencies
45.	Turkish Post	Turkey	Moderate	74.8	Investment in infrastructure; moderate adoption of Big Data
46.	Egypt Post	Egypt	Low	60.6	Regulatory and infrastructure issues; low level of adaptation
47.	Morocco Post	Morocco	Low	61.3	Limited infrastructure and low adoption of Big Data
48.	Greek Post (ELTA)	Greece	Low	62.9	Economic issues affecting infrastructure and adoption
49.	Slovak Post	Slovakia	Moderate	73.4	Improving regional logistics and moderate use of Big Data
50.	Bpost	Belgium	Moderate	79.5	Powerful regional logistics network; moderate adoption of Big Data

Source: developed by the authors using an econometric model and Stata programme.