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The role of the Internet of Things in increasing the efficiency of logistics companies

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Abstract: Raising efficiency encourages logistics companies to use modern technologies. Using Internet of Things (IoT) devices improves logistical efficiency. The aim of the research is to determine the role of IoT in increasing the efficiency of logistics processes. The study was based on information about the logistics activities of the Supply Chain of one of the largest logistics companies in the world — DHL Group. The study covers the period 2009-2022. The research was conducted using linear regression models tested by the least squares method. The impact of the use of IoT devices was introduced into the model through the use of a dummy variable. It was established that the implementation and use of IoT devices has a positive, statistically significant effect on such indicators of logistical efficiency as Profit Margin and Operating Efficiency Ratio. It was proved that IoT positively affects logistical efficiency and does not entail reducing jobs, which is a socially important factor. The obtained results can be applied in developing and justifying the policy of implementing IoT in the activities of logistics companies. The conducted research opens up prospects for further studies, in particular regarding the impact of IoT on other performance indicators of logistics companies, particularly on their market capitalization.

1 Introduction

The key to the success of a logistics company is the ability to meet the customers' needs in fast, timely delivery of goods to the specified destination. Modern technologies contribute to ensuring fast and accurate address delivery of shipments and the ability to monitor the route of shipped goods. Moreover, they enable identifying and optimizing places where the efficiency of logistics chains decreases. The relevance of the research topic is determined by several key factors currently affecting the logistics industry and business in general. The volume of cargo transported around the world continues to grow. This challenges logistics companies to manage huge volumes of goods efficiently, and Internet of Things (IoT) can help to ensure this efficiency. Consumers and businesses expect faster and more accurate deliveries. IoT allows receiving real-time information about cargo status and location, which improves service and increases customer satisfaction. IoT offers many sensors and devices to collect data that can be used for analysis and strategic decision making. Considering these factors, research on the role of IoT in logistics remains relevant and important for the development of the logistics industry, increasing the competitiveness of companies and achieving greater customer satisfaction.

The Internet of Things can improve the efficiency of a logistics company in many ways, providing greater control and optimization of important processes. Sensors placed on goods or packaging allow logistics companies to monitor the location and condition of cargo in real time. This helps to avoid losses, monitor the delivery time and prevent bad conditions for the goods (for example, negative temperature). IoT can provide data on road conditions, traffic, etc. These data help companies to optimize delivery routes, which reduces travel time and fuel costs. IoT enables logistics companies to provide customers with an interactive consumer experience. This includes tracking deliveries in real time, receiving notifications of estimated arrival times, and providing a convenient way to communicate with customers.

Sensors and RFID tags provide real-time inventory tracking. This helps to avoid overstocking or shortage of goods. IoT can provide data on the status of equipment and vehicles. This enables planning preventive maintenance and avoiding accidents and stoppages, which reduces travel costs and downtime. IoT can help to resolve energy efficiency issues by monitoring and managing energy consumption in warehouses and vehicles. Data collected from IoT devices can be used to analyze and forecast trends in logistics, which helps companies make strategic decisions. Overall, IoT helps logistics companies make their operations more efficient, accurate, and cost-effective. It also opens up new opportunities to improve customer service and create competitive advantages in the logistics market.

So, the aim of this study is to determine the role of IoT in increasing logistical efficiency. The aim involved the fulfilment of the following research objectives:

- analyze the dynamics of the logistics company's performance indicators;
- determine the impact of the use of IoT devices on the company' performance;
- determine the impact of the use of IoT devices on the performance indicators of logistics activities.

2 Literature review

Growing demand is forcing the traditional logistics industry to transform into smart logistics. There are many recent technologies that have helped transform the logistics industry. In particular, researcher [1] examines the technologies required to implement smart logistics and determines the role of IoT and big data in developing the smart logistics industry. The author claims that the coronavirus pandemic has significantly accelerated the inevitable logistics digitalization process. Now, the implementation of digital technologies, particularly IoT, is not determined by the forced circumstances of the external environment but by the need to improve logistical efficiency.

Authors [2] examine the conceptual framework for the impact of IoT on supply chain management. The conceptual framework developed by the authors ensures the organization of the logistics company's supply chain management process, starting from determining its advantages and ending with the impact on the financial result. It is worth noting that the conceptual framework developed by the authors can be effectively implemented only if all supply chain links are fully provided with IoT devices, as the effects specified by the authors can be achieved through the availability of complete information.

A joint report by DHL and Cisco [3] is interesting, in which the authors identify promising directions for the implementation of IoT in the activities of logistics companies. It is noted that the greatest effect of the implementation of IoT will be in the field of last mile delivery. The fact is that last mile delivery is the most expensive in the entire supply chain. The authors note that the effective implementation of IoT requires the cooperation of managers at all levels - from top management to functional managers at delivery points.

The fourth industrial revolution (Industry 4.0) provides new resources for qualitatively changing how businesses and supply chains work. Authors [4] consider the unique potential of IoT, together with other technologies of Industry 4.0, in particular, blockchain [5], that can cause significant changes in the world. The authors argue that the IoT guarantees a massive revolution in logistics over the next decade. This creates new benefits for businesses by minimizing the price of device components, increasing the speed of wireless networks, and expanding the possibilities of receiving data on the network.

In the work [6], authors note that transport and logistics companies may have different goals for IoT implementation. On this basis, authors [7,8] consider it necessary to build a different architecture to implement IoT devices and determine the corresponding targets. However, the process of implementing the use of IoT is almost the same despite the difference in goals. That is why implementing this technology is worth considering competitors' experience and mistakes, which will increase the efficiency of using IoT to improve logistics activities [9].

The analysis of studies by [10] revealed a gap in the academic literature in the study of reverse logistics. It is worth noting that the use of IoT in this logistics segment has significant prospects for improving efficiency. Monitoring and tracking cargo is extremely important when a shipment is redirected, or other route changes occur. The use of IoT increases the accuracy of cargo movement and reduces the number of unproductive losses thanks to the optimal loading of container capacities. According to [11], IoT enables the creation of a virtual system for managing logistics flows. This system facilitates interaction between all participants of the logistics process in a new way. The virtual system automatically updates all data on logistics chains and allows for real-time evaluation of all cargo delivery parameters [12].

The work [13] shows that IoT affects not only the operational efficiency of a logistics company but also its strategic management. The authors conducted a study based on a survey of managers of logistics companies and found that the use of IoT leads to the transformation of approaches to strategic management of logistics flows. Besides, the authors found that the implementation of IoT itself had a greater impact on the growth of operational efficiency compared to changes in the strategic management of the studied companies.

Authors [14] state that the successful implementation of IoT in logistics requires close collaboration and a high level of participation between players and competitors in the supply chain. Clear interaction is required to exchange sensor information in heterogeneous environments at all cargo movement stages. There is a need to build trust and data ownership and overcome privacy challenges in the IoT-based supply chain. This requires a clear focus on a reference architecture for IoT and a shift in business mindset to embrace the full potential of IoT.

IoT can also provide effective inventory management in warehouses, which is also extremely important for effective management in logistics [15]. The warehouse system becomes less dependent thanks to the automation of warehouse operations and responds to changes in human work. The flow of goods through warehouses becomes smoother by applying autonomous systems in transportation, handling and palletizing operations to the warehouse. However, stand-alone systems must be adapted to the storage environment to minimize the risk of overlays.

Authors [16] state that as more companies adopt IoT systems, their use will combine data and flows of real objects, revolutionizing real-time organizations. This is why logistics companies will turn into e-commerce companies, where cargo movement will be serviced thanks to the operation of automated systems. The authors point out that the costs and benefits of implementing IoT at different stages change according to the technology development. We can conclude that the development of technologies will ensure the growth of the economic feasibility of implementing IoT systems in logistics companies. Similar conclusions about the impact of the Internet of Things on the efficiency of logistics companies have also been reached by the authors of studies [17-19]. It is noted that the Internet of Things provides operational and accurate information in real time about the load of logistics facilities and the movement of goods. Such information makes it possible to optimize the use of container capacities and the loading of vehicles to avoid downtime and delays in the shipment of goods.

3 Methods

The research hypothesis is that the implementation and use of IoT contribute to improving logistical efficiency. Within the scope of this study, efficiency means a reduction in costs and an increase in income. One of the largest logistics companies in the world — DGL [20], which operates in 220 countries and territories— was chosen for the study.

The research will be conducted in two stages. The first stage provided for analyzing the dynamics of the main indicators of the working hypothesis of the study: Total Revenue; Profit (Loss) from Operating Activity; Expenses on fuel; Expenses on Aircraft Fuel; Wages, Salaries, Compensations. The indicators of Total Revenue and Profit (Loss) from Operating Activity are taken from reports by segments for DHL's departments. For the purposes of the study, the data were used only for the Supply Chain segment: only for those divisions of the company that are directly engaged in logistics operations. This made it possible to separate the influence of other company divisions engaged in other activities. At this stage, the methods of graphical display of time series and the trend method will be used to analyze the dynamics of changes in the indicators. Figure 1 shows the logic of the impact of the use of IoT on the resulting indicators is shown.

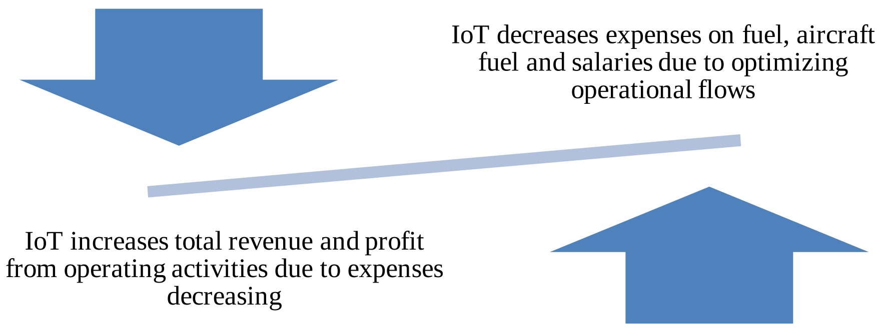

Figure 1 The logic of the impact of IoT on the resulting indicators

IoT provides an increased utilization efficiency of both warehouses and container capacities. This makes it possible to optimize the utilization of such facilities and reduce the number of air transport flights and the movement of ground transport for cargo transportation. As a result, it helps to reduce fuel consumption. IoT also replaces workers in the performance of certain operations for monitoring and registering the movement of goods, which leads to decreased labour costs. As a result, the reduced costs should lead to increased operating profit. Optimization of the use of storage facilities and transport capacities will lead to increased transportation volumes. This ensures an increase in the company's total revenue.

To achieve the research objective, IoT is considered as an independent variable influencing the resulting performance indicators.

The second stage provided for the analysis of the impact of the use of IoT on the resulting indicators. The OLS linear regression method will be used for this purpose, and the impact of IoT will be introduced into the model as a dummy variable. According to DHL, the use of IoT began in 2017 [21]. The IoT will be introduced into the model as a dummy variable from 2017:

Model 1: Total Revenue = f(IoT)
Model 2: Profit (Loss) from Operating Activity = f(IoT)
Model 3: Expenses on Fuel = f(IoT)
Model 4: Expenses on Aircraft Fuel = f(IoT)

Model 5: Wages, Salaries, Compensations = f(IoT)

The third stage involves the calculation of the performance indicators based on expenses, which are affected by the use of IoT:

ROI = Profit (Loss) from Operating Activity / Σ(Expenses on Fuel + Expenses on Aircraft Fuel + Wages, Salaries, Compensations)

Profit Margin = Profit (Loss) from Operating Activity / Total Revenue

Operating Efficiency Ratio = Total Revenue / Σ(Expenses on Fuel + Expenses on Aircraft Fuel + Wages, Salaries, Compensations)

The impact of IoT; Total Revenue; Profit (Loss) from Operating Activity; Expenses on Fuel; Expenses on Aircraft Fuel; Wages, Salaries, Compensations on efficiency indicators by the OLS linear regression method will be determined:

Model 6: ROI = f(IoT; Total Revenue; Profit (Loss) from Operating Activity; Expenses on Fuel; Expenses on Aircraft Fuel; Wages, Salaries, Compensations)

Model 7: Profit Margin = f(IoT; Total Revenue; Profit (Loss) from Operating Activity; Expenses on Fuel; Expenses on Aircraft Fuel; Wages, Salaries, Compensations)

Model 8: Operating Efficiency Ratio = f(IoT; Total Revenue; Profit (Loss) from Operating Activity; Expenses on Fuel; Expenses on Aircraft Fuel; Wages, Salaries, Compensations)

Data from DHL's annual financial statements [22] for 2010-2022 were used for the study.

4 Results

Analysis of the dynamics of DHL Group's performance indicators for 2009-2022 shows a long-term growth trend (Figure 2). However, different indicators show a different trend in different periods. The Total Revenue had a steady upward trend from 2009 to 2015 and a steady downward trend from 2015 to 2020. And a growing trend has been observed again since 2020.

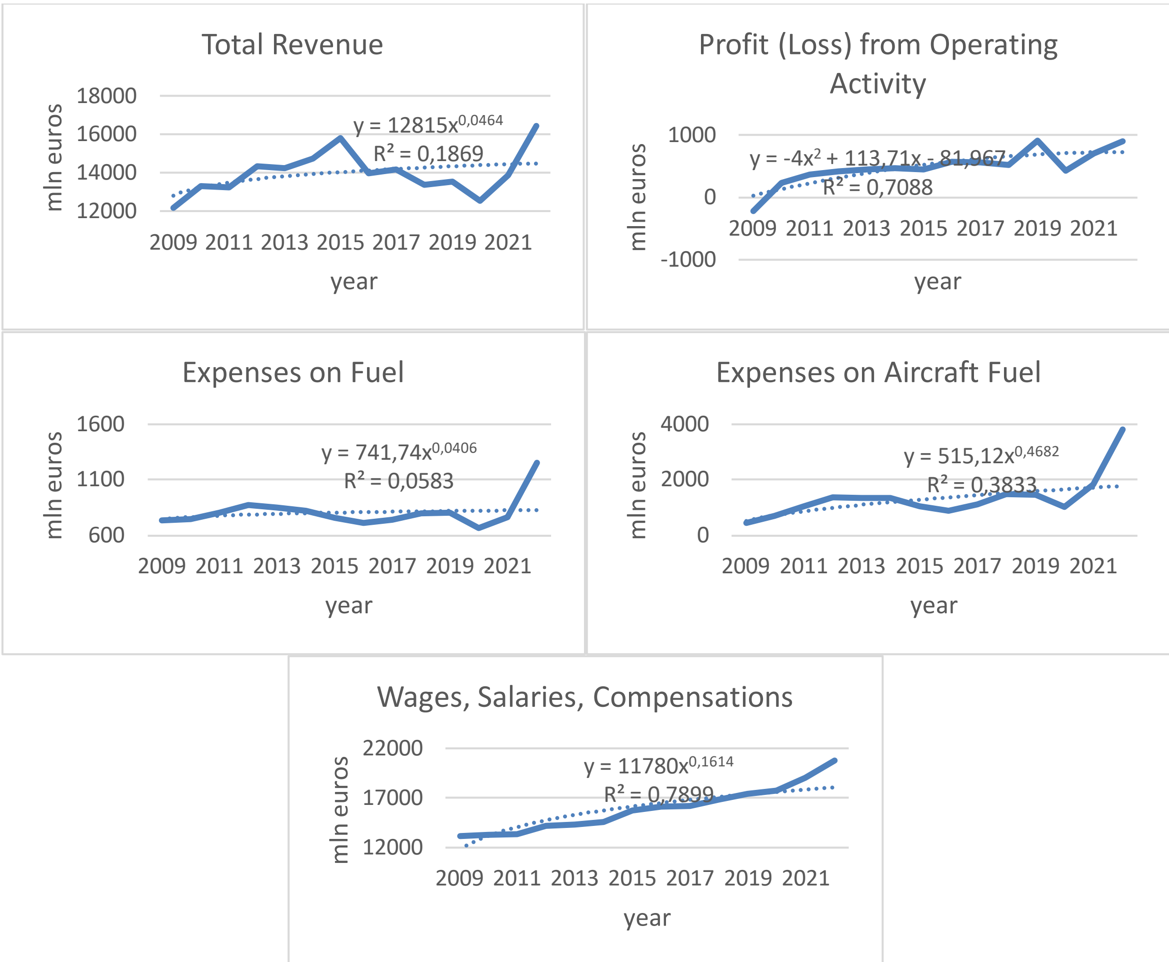

Figure 2 Analysis of the dynamics of DHL Group performance indicators for 2009-2022

At the same time, the Profit (Loss) from Operating Activity indicator does not have such volatility during the analyzed period. A significant decline in the values of this indicator is observed only during 2019-2020, after which the trend returns to growth. It is obvious that the drop in the Profit (Loss) from Operating Activity in 2019-2020 is explained by the Covid19 pandemic and the decreased volume of international transportation during this period.

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So, although the Total Revenue has fluctuated, the Profit from Operating Activity in the long run is constantly increasing. It is worth noting that the growth dynamics of both indicators are decreasing gradually.

The analysis of Expenses on Fuel and Expenses on Aircraft Fuel shows that there has been a rapid increase in the volume of these expenses since 2020. During 2009-2020, the growth dynamics of these costs were insignificant. Such an abnormally sharp increase in fuel expenses against the background of revenue growth may indicate an increase in transportation volumes.

The company's labour costs have a steady upward trend throughout the 2009-2022. It did not decrease during the crisis periods for the world economy in 2013-2014 and 2019-2020, indicating that the company did not reduce staff. At the same time, the constant growth of labour costs indicates a regular revision of wages towards their increase.

The analyzed indicators show DHL Group's fairly good financial position regarding the Supply Chain.

Appropriate impact models were tested to determine the impact of IoT use on the resulting indicators. Tables 1-5 show the results of the tested models.

Table 1 Results of testing the IoT impact model on Total Revenue. Model 1: OLS, using observations 2009-2022 (T = 14). Dependent variable: Total Revenue

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	13969.9	421.255	33.16	<0.0001	***
Dummy IoT	7.95833	643.478	0.01237	0.9903	

Mean dependent var	13973.29	S.D. dependent var	1144.753
Sum squared resid	17035758	S.E. of regression	1191.489
R-squared	0.000013	Adjusted R-squared	-0.083320
F(1, 12)	0.000153	P-value(F)	0.990336
Log-likelihood	−117.9475	Akaike criterion	239.8950
Schwarz criterion	241.1731	Hannan-Quinn	239.7767
rho	0.342875	Durbin-Watson	1.015813

The following conclusions can be drawn based on the regression analysis results of Model 1. The P-value for the Dummy_IoT coefficient is 0.9903. This high p-value indicates that Dummy_IoT is not statistically significant. This means that no statistically significant effect of IoT on Total Revenue was found for the analyzed period. R-squared indicates the amount of variation in the dependent variable (Total Revenue) that can be explained by the model. In this case, the R-squared is very low (0.000013), which means that the chosen model cannot explain the variation in Total Revenue.

Table 2 Results of testing the IoT impact model on Profit (Loss) from Operating Activity. Model 2: OLS, using observations 2009-2022 (T = 14). Dependent variable: Profit (Loss) from Operating Activity

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	340.250	80.5356	4.225	0.0012	***
Dummy IoT	328.083	123.020	2.667	0.0205	**

Mean dependent var	480.8571	S.D. dependent var	276.1969
Sum squared resid	622654.8	S.E. of regression	227.7892
R-squared	0.372135	Adjusted R-squared	0.319813
F(1, 12)	7.112388	P-value(F)	0.020528
Log-likelihood	−94.78397	Akaike criterion	193.5679
Schwarz criterion	194.8461	Hannan-Quinn	193.4496
rho	0.022788	Durbin-Watson	1.380127

The Model 2 regression analysis results give grounds for drawing the following conclusions. The P-value for the Dummy IoT is 0.0205. This indicates that the Dummy IoT is statistically significant at the 0.05 significance level. This means that there is a statistically significant effect of IoT on profit (or loss) from operating activities for the considered period. R-squared indicates the variation in the dependent variable (Profit (Loss) from Operating Activity) that the model can explain. In this case, the R-squared is 0.372135, which means that this model can explain approximately 37.21% of the variation in operating profit (or loss). The F-statistic is 7.112388, and the p-value(F) is 0.020528. This indicates that the model is statistically adequate to explain Profit (Loss) changes from Operating Activity.

Table 3 Results of testing the IoT impact model on the Expenses on Fuel. Model 3: OLS, using observations 2009-2022 (T = 14). Dependent variable: Expenses on Fuel

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	785.375	50.4812	15.56	<0.0001	***
Dummy IoT	50.6250	77.1113	0.6565	0.5239	

Mean dependent var	807.0714	S.D. dependent var	139.6228
Sum squared resid	244641.9	S.E. of regression	142.7824
R-squared	0.034673	Adjusted R-squared	-0.045771
F(1, 12)	0.431016	P-value(F)	0.523881
Log-likelihood	−88.24459	Akaike criterion	180.4892
Schwarz criterion	181.7673	Hannan-Quinn	180.3709
rho	0.172961	Durbin-Watson	1.179201

The following conclusions can be drawn based on the Model 3 regression analysis results of the dependent variable Expenses on Fuel and the impact of Dummy IoT. The P-value for the Dummy IoT is 0.5239. This high p-value indicates that the Dummy IoT is not statistically significant at the conventional significance level of 0.05. So, no statistically significant effect of IoT on the Expenses of Fuel for the considered period was found. R-squared indicates the variation in the dependent variable (Expenses on Fuel) that the model can explain. In this case, the R-squared is very low (0.034673), which means the chosen model can hardly explain the variation in the Expenses on Fuel.

Table 4 Results of testing the model of the impact of IoT on the Expenses on Aircraft Fuel. Model 4: OLS, using observations 2009-2022 (T = 14). Dependent variable: Expenses on Aircraft Fuel

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1019.25	252.806	4.032	0.0017	***
Dummy IoT	761.583	386.167	1.972	0.0721	*

Mean dependent var	1345.643	S.D. dependent var	790.5224
Sum squared resid	6135430	S.E. of regression	715.0426
R-squared	0.244780	Adjusted R-squared	0.181845
F(1, 12)	3.889415	P-value(F)	0.072085
Log-likelihood	−110.7989	Akaike criterion	225.5977
Schwarz criterion	226.8759	Hannan-Quinn	225.4794
rho	0.552980	Durbin-Watson	0.912934

The results of the Model 4 regression analysis of the dependent variable Expenses on Aircraft Fuel and the impact of Dummy IoT give grounds for the following conclusions. The P-value for the Dummy IoT is 0.0721. This value is close to but does not reach, the 0.05 significance level. This indicates that the Dummy IoT may be statistically significant at a certain significance level (e.g. 10%). As the chosen significance level is 0.05, we can state that IoT does not significantly impact the Expenses on Aircraft Fuel. R-squared indicates the variation in the dependent variable (Expenses on Aircraft Fuel) that the model can explain. In this case, the R-squared is 0.244780, which means that this model can explain approximately 24.48% of the Expenses on Aircraft Fuel variation. The F-statistic is 3.889415, and the p-value(F) is 0.072085. This shows that the model as a whole may be statistically adequate for explaining the Expenses on Aircraft Fuel.

Table 5 Results of testing the IoT impact model on the Wages, Salaries, Compensations. Model 5: OLS, using observations 2009-2022 (T = 14). Dependent variable: Wages, Salaries, Compensations

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	14332.3	483.347	29.65	<0.0001	***
Dummy IoT	3653.25	738.325	4.948	0.0003	***

Mean dependent var	15897.93	S.D. dependent var	2290.221
Sum squared resid	22427953	S.E. of regression	1367.112
R-squared	0.671079	Adjusted R-squared	0.643669
F(1, 12)	24.48294	P-value(F)	0.000337
Log-likelihood	−119.8725	Akaike criterion	243.7449
Schwarz criterion	245.0231	Hannan-Quinn	243.6266
rho	0.515449	Durbin-Watson	0.918698

The following conclusions can be drawn based on the Model 5 regression analysis results of the dependent variable Wages, Salaries, Compensations and the impact of the Dummy IoT.

The P-value for the Dummy IoT is 0.0003. This low p-value indicates that the coefficient of Dummy IoT is statistically significant at the 0.05 significance level. This means a statistically significant effect of IoT on Wages, Salaries, Compensations for the studied period. R-squared indicates the variation in the dependent variable (Wages, Salaries, Compensations) that the model can explain. In this case, the R-squared is 0.671079, which means that this model is able to explain approximately 67.11% of the variation in wages, salaries, and compensation. The F-statistic is 24.48294, and the p-value(F) is 0.000337. This shows that the model is statistically adequate to explain changes in Wages, Salaries, Compensations.

Analysis of the dynamics of DHL Group's estimated performance indicators shows that not all indicators have a positive long-term trend (Figure 3). The values of the ROI indicator grew rapidly during 2009-2010 and remained almost unchanged until 2018. In 2018-2019, this indicator rose and fell, and its value stabilized after 2021. The Profit Margin, which almost duplicates the ROI dynamics, demonstrates the ascending dynamics. However, the long-term trend has positive dynamics. As for the Operating Efficiency Ratio, it has a steady downward trend throughout the analyzed period. This is a negative trend.

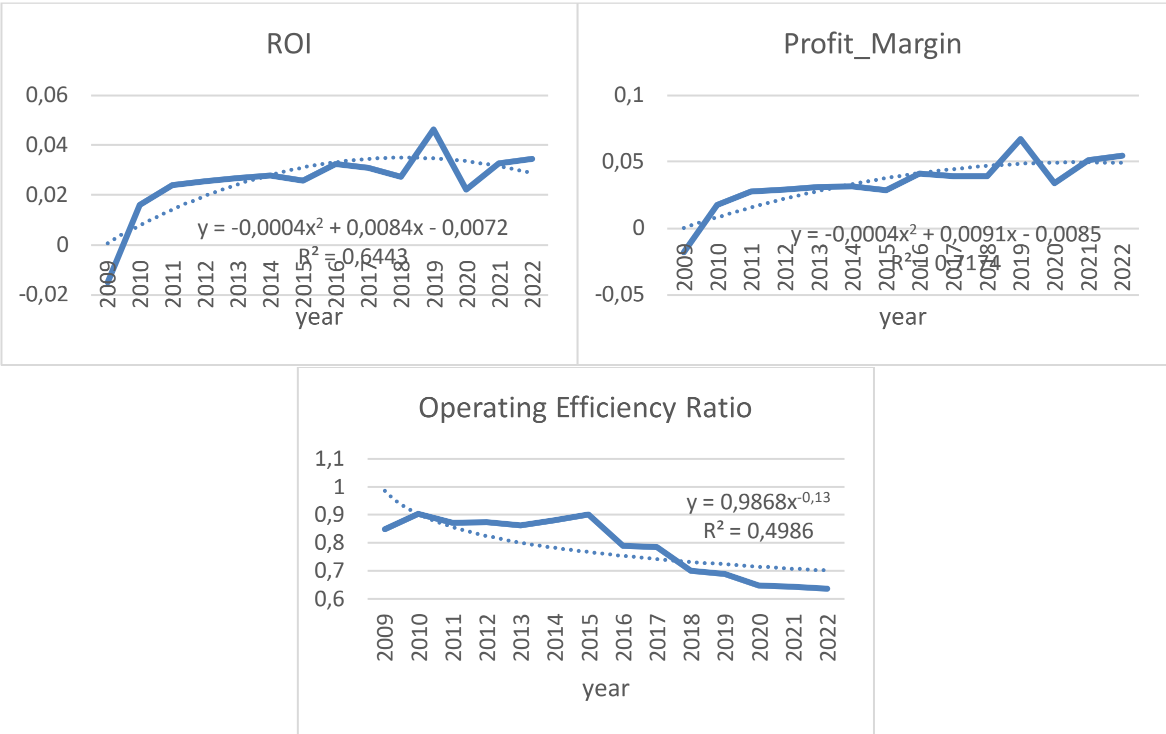

Figure 3 Analysis of the dynamics of DHL Group performance indicators for 2009-2022

Next, we will analyze whether IoT had a statistically significant impact on the calculated performance indicators (Table 6-8).

Table 6 Results of testing the IoT impact model on ROI. Model 6: OLS, using observations 2009-2022 (T = 14). Dependent variable: ROI

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0203076	0.00446736	4.546	0.0007	***
Dummy IoT	0.0119471	0.00682401	1.751	0.1055	

Mean dependent var	0.025428	S.D. dependent var	0.013602
Sum squared resid	0.001916	S.E. of regression	0.012636
R-squared	0.203456	Adjusted R-squared	0.137078
F(1, 12)	3.065088	P-value(F)	0.105488
Log-likelihood	42.41123	Akaike criterion	−80.82246
Schwarz criterion	−79.54435	Hannan-Quinn	−80.94078
rho	0.059813	Durbin-Watson	1.225377

The results of the Model 6 regression analysis of the dependent variable ROI and the impact of the Dummy IoT give grounds to draw the following conclusions. The P-value for the Dummy IoT is 0.1055. This value exceeds the 0.05 significance level, indicating that the Dummy IoT is not statistically significant at the conventional significance level. So, there is no statistically significant effect of IoT on ROI for the studied period. R-squared indicates the variation in the dependent variable (ROI) that the model can explain. In this case, the R-squared is 0.203456, which means that this model can explain about 20.35% of the variation in ROI. The F-statistic is 3.065088, and the p-value(F) is 0.105488. This shows that the model as a whole is not statistically adequate to explain the ROI.

Table 7 Results of testing the IoT impact model on the Profit Margin. Model 7: OLS, using observations 2009-2022 (T = 14) Dependent variable: Profit Margin

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0235177	0.00559709	4.202	0.0012	***
Dummy IoT	0.0239263	0.00854970	2.798	0.0161	**

Mean dependent var	0.033772	S.D. dependent var	0.019553
Sum squared resid	0.003007	S.E. of regression	0.015831
R-squared	0.394905	Adjusted R-squared	0.344481
F(1, 12)	7.831601	P-value(F)	0.016089
Log-likelihood	39.25493	Akaike criterion	−74.50986
Schwarz criterion	−73.23175	Hannan-Quinn	−74.62818
rho	−0.020421	Durbin-Watson	1.458632

Based on the results of the Model 7 regression analysis of the dependent variable Profit Margin and the impact of the Dummy IoT, the following conclusions can be drawn. The P-value for the Dummy IoT is 0.0161. This low p-value indicates that the Dummy IoT is statistically significant at the 0.05 significance level. This means that there is a statistically significant effect of IoT on profitability (Profit Margin) for the studied period. R-squared indicates the variation in the dependent variable (Profit Margin) that the model can explain. In this case, the R-squared is 0.394905, which means that this model can explain approximately 39.49% of the variation in the Profit Margin. The F-statistic is 7.831601, and the p-value(F) is 0.016089. This shows that the model as a whole is statistically adequate to explain the Profit Margin.

Table 8 Results of testing the IoT impact model on the Operating Efficiency Ratio. Model 8: OLS, using observations 2009-2022 (T = 14). Dependent variable: Operating Efficiency Ratio

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.866406	0.0161436	53.67	<0.0001	***
Dummy IoT	−0.183622	0.0246598	−7.446	<0.0001	***

Mean dependent var	0.787711	S.D. dependent var	0.104004
Sum squared resid	0.025019	S.E. of regression	0.045661
R-squared	0.822079	Adjusted R-squared	0.807252
F(1, 12)	55.44569	P-value(F)	7.78e-06
Log-likelihood	24.42504	Akaike criterion	−44.85007
Schwarz criterion	−43.57196	Hannan-Quinn	−44.96839
rho	−0.253729	Durbin-Watson	2.360651

Based on the results of the Model regression analysis of the dependent variable Operating Efficiency Ratio and the impact of the Dummy IoT, the following conclusions can be drawn. The P-value for the Dummy IoT is <0.0001, which is extremely low. This indicates that the Dummy IoT is statistically significant at any significance level. This means that there is a statistically significant effect of IoT on Operating Efficiency Ratio for the studied period. R-squared indicates the variation in the dependent variable (Operating Efficiency Ratio) that the model can explain. In this case, the R-squared is 0.822079, which means that this model can explain approximately 82.21% of the variation in the Operating Efficiency Ratio. The F-statistic is 55.44569, and the p-value(F) is 7.78e-06, which is extremely low. This shows that the model as a whole is statistically adequate to explain the Operating Efficiency Ratio.

The obtained results give grounds to state that IoT has a positive effect on the efficiency of DHL Group activities, which is confirmed by the corresponding calculations.

5 Discussion

Authors [23] argue that the modern logistics industry still incurs high costs and yields low efficiency. The development of smart logistics opens up opportunities to solve these problems. As one of the important information and communication technologies, IoT can generate large amounts of data and explore the complex relationships between transactions represented by these data through various mathematical analysis technologies. These features contribute to the development of smart logistics. Our research supports this view. The results of our research prove the positive effect of the use of IoT on the efficiency of the logistics company.

In the work [24], the authors consider the ability to deliver cargo on time as one of the key factors in the competitiveness of a logistics company. Researcher [25] states that IOT data can be used to develop new or improve existing shipping algorithms, loading of warehouses or container capacity, as evidenced by the study results. The results of our research indicate an increase in logistical efficiency due to the use of IoT.

The research results indicate the possibility of constantly optimizing the geographical cargo delivery routes. This opinion is confirmed by the results obtained by the work [26], in which the authors note that optimizing geographic delivery routes is a key issue in increasing the efficiency of logistics companies. The solution to this issue is based on an extensive system of sensors that record all cargo movements and other events in logistics activities. The results obtained in this study about the statistically significant impact of IoT on the Profit from Operating Activity confirm the importance of geographical optimization of delivery routes. Route optimization reduces the time and resources spent on delivery, which directly affects the size of Profit from Operating Activity.

Research results from [27,28] show that technical services [29] are the most important aspect of applying IoT for smart logistics. Our research confirms that the more information is available, the wider the opportunities for optimization and increasing logistics efficiency. In particular, we found that IoT entails increased labour costs. This shows that the employees of the logistics company increase their productivity using IoT devices. As a result, their payment also increases, together with labour productivity growth. The use of IoT contributes to the improvement of the social function of entrepreneurship.

Optimization models and algorithms can be built based on data from IoT devices, as proven in several studies [17-19,30-33]. Optimization models are designed to detect non-productive losses of logistics activities. The widespread use of IoT devices can provide control points to detect such losses. The results of our research showed that such non-productive losses can be transformed into increased labour productivity thanks to the use of IoT devices.

6 Conclusions

Logistics companies use the IoT to increase logistical efficiency. The research results show that the implementation and use of IoT devices have a statistically significant impact on Profit (Loss) from Operating Activity and Wages, Salaries, Compensations. The positive significant effect of IoT on the wages of logistics company employees indicates that wages are increasing. So, using IoT does not mean technology replaces people and leads to their dismissal. IoT provides an increase in labour productivity, which entails an increased amount of payment.

It was established that the implementation and use of IoT has a positive statistically significant effect on such indicators of logistics efficiency as Profit Margin and Operating Efficiency Ratio. It was proved that IoT has a positive effect on increasing the efficiency of logistics activities and does entail a reduction in jobs, which is a socially important factor.

The obtained results can be applied in developing and justifying the policy of implementing IoT in the activities of logistics companies.

The conducted research has methodological and implementation limitations. A methodological limitation is that the study was conducted for one company. However, the large-scale use of IoT devices by logistics companies is not a common phenomenon, so it is impossible to form a representative sample of the study. The study used data on only one direction of the company's operations — Supply Chain. If the proposed model considers the data of the company's entire operational activity, the results may differ from those in this study. The implementation limitation is that the obtained results can be applied only in logistics companies engaged in transportation by road and air transport.

The conducted research opens up prospects for further research, in particular regarding the impact of IoT on other performance indicators of logistics companies, particularly on their market capitalization.

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