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Analysis of the Effectiveness of Internet of Things Implementation in the Supply Chain At PT Pelni Logistics

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Abstract : This study investigates the effectiveness of the implementation of the Internet of Things (IoT) in the supply chain at PT Pelni Logistics. The research focuses on evaluating how IoT technology improves operational efficiency and optimizes supply chain performance by providing real-time data, automating processes, and improving inventory management. A descriptive quantitative approach was adopted, with data collected through questionnaires distributed to 40 employees in supply chain divisions, these findings reveal that the use of IoT significantly impacts supply chain effectiveness by improving monitoring and control systems, reducing errors, and improving response times. The results underscore the importance of integrating advanced technologies such as IoT to achieve a more agile and responsive supply chain, leading to increased competitiveness. Statistical analyses conducted using SPSS show a strong correlation between IoT implementations and supply chain performance, providing valuable insights for companies aiming to digitize their logistics operations.
Keywords : *Internet of Things, Supply Chain, Operational Efficiency, Logistics, PT Pelni*

1. Introduction

Internet of Things (IoT) technology has revolutionized the way businesses operate by enabling unprecedented connectivity and data exchange between devices. It is essential to manage and analyze huge amounts of data as the applications of the Internet of Things continue to evolve across various industries. Internet of Things (IoT) technology can be used to improve the performance and traceability of supply chains by distributing data collected through networks, increasing trust and increasing transparency along the supply chain.

A supply chain is a set of actions (in the form of entities or facilities) that contribute to a transformation process that includes various aspects from the management of goods from the starting point to reaching the final destination. IoT in the supply chain enables real-time oversight and control, which contributes to efficiency and accuracy in the process of distributing goods.

The author thoroughly researches literature and case studies to provide insight into various aspects of the supply chain's adoption of Internet of Things (IoT) systems. The authors also focus on the problems faced by companies when implementing and managing

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such systems, as well as current opportunities to improve the efficiency and decision-making process.

2. Literature review

2.1 Internet of Things (IoT)

The Indonesian term for the Internet of Things (IoT) is "the Internet for everything." IoT is essentially the idea of devices or objects that are outfitted with software and sensors. This technology allows the object to establish connections and have internet-based communication with other gadgets.(Hanif, 2024)

Junaidi (2015) stated in a journal (Ritonga et al., 2020), the Internet of Things in its application can also identify, find, track, monitor objects and trigger related events automatically and in real time, The development and application of computers, the Internet and other information and communication technologies (ICT) have a great impact on society, economic management, production operations, social management and even personal life.

One of the earliest technologies of the industrial revolution era is the Internet of Things. 4.0. An object is considered to be part of the Internet of Things if it can transfer data using a network without requiring human contact or intervention. The Internet of Things is made up of four main parts: user interface, data processing, connection, and sensor devices. The Internet of Things (IoT) is a network of interconnected things, including digital and mechanical equipment, computers, and other gadgets..(Yazmi et al., 2023)

The Internet of Things (IoT) is a concept that allows various objects or objects to be equipped with technologies such as sensors and software, so that they can connect and communicate through the internet. IoT enables real-time identification, tracking, monitoring, and automatic triggering of objects without the need for human interaction. The technology is an integral part of the industrial revolution 4.0 and consists of components such as sensor devices, data processing, connectivity, and user interfaces. IoT connects various computing devices, digital machines, and mechanical devices to create integrated and efficient systems. An illustration of how PT Pelni Logistics is utilizing the Internet of Things is as follows: Containers can be tracked in real time using RFID and GPS sensors., providing better visibility of the movement of goods from the port of origin to the destination, IoT sensors in warehouses help in real-time monitoring of goods stock, ensuring sufficient availability of goods without overstocking, Real-time data from GPS and analytics systems allow optimization of shipping routes, reduce travel time and fuel costs, and improve delivery efficiency.

2.2 Supply Chain

The supply chain is a tool for increasing a company's overall efficiency by optimizing the movement of commodities in terms of quantity, time, and location. As a

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result, businesses need to increase the effectiveness of their logistics systems. (Pongoh, 2016)

Fradinata (2022) stated in a journal (Elnathan Symphony et al., 2024) This supply chain functions to create and deliver a product to the end user, namely the customer. Good supply chain management is essential for service companies to increase their productivity and efficacy. Variable lead times, fluctuating demand, and uncertain pricing bring uncertainty in the supply chain management of service companies.

Supply Chain is a mechanism that connects customers and suppliers who work together but in their own best interests by buying, changing, distributing, and selling goods and services among themselves so that they can create a certain final product is the definition of supply chain. (Sudrajat M, F. Renaldi, F. Umbara, R, 2018)

The goal of the supply chain is to boost the overall productivity of the business involved in the supply chain. The optimization of material quantity flow, placement, and timing allows for this improvement. When implementing the supply chain, the business must be able to satisfy customers, produce goods on schedule, incur minimal expenses for inventory and product delivery, and exercise cautious and adaptable industry management. The efficiency of the logistics process is also an important factor that companies must improve. This efficiency involves reducing the waste of time, costs, and resources in the entire service process, from order receipt to final service delivery to customers. Supply chains connect customers and suppliers who work together, despite their respective interests, in the process of purchasing, changing, distributing, and selling goods and services to create a specific final product.

Tables and Figures

Tables are presented in the following:

Table 1. Measurement of variables

Variable	Operational definition	Items	Source
Internet of Things (IoT)	The Internet of Things (IoT) refers to a network of physical devices that are connected to the internet, allowing them to send and receive data.	1. Real-time Tracking 2. Process Automation 3. Predictive Maintenance 4. Demand Forecasting	(Iot et al., 2024)

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		5. Route Optimization 6. Risk Management 7. Operational Efficiency 8. Sustainability 9. Customer Satisfaction	
Supply Chain	It is a mechanism to increase the productivity of the company through the optimization of the flow of time, location, and quantity of materials.	1. Shipping 2. Inventory control for material 3. Finished goods inventory 4. Production schedules 5. Anticipated demand 6. Monitoring & coordinating performance & activities	(Singh & Teng, 2016)

Figures are presented as follows:

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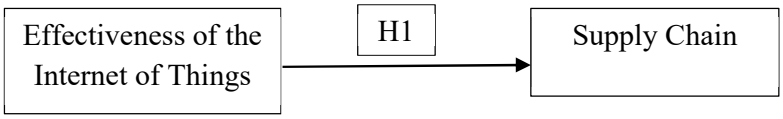

Fig. 1. Hypotheses

H0 : The effectiveness of the supply chain is not significantly increased by the use of the Internet of Things in it.
Although the Internet of Things is not implemented in various aspects of supply chain operations, it does not have a significant impact on improving the effectiveness, efficiency, or overall performance of the supply chain.
H1 : **Increasing the effectiveness of the supply chain is significantly impacted by the use of the Internet of Things in the chain.**
In this study, an alternative hypothesis states that the use of IoT technology, such as sensors, smart devices, and data analytics in supply chain management, can significantly improve operational effectiveness, optimize the flow of information and goods, and provide a competitive advantage through more efficient and responsive supply chain management.

3. Research method

3.1 Research Design

The type of research used by the author is quantitative descriptive research, the data used in this study is primary data collected directly through questionnaires and google forms as the main media with a likert scale that contains variables related to the Effectiveness of the Implementation of the Internet of Things, Supply Chain.

3.2 Population and Sample

The 40 employees (100% of the total employees) of the Pelni Logistics Supply Chain division who use the Internet of Things make up the study's population. Given the relatively small number of populations, this study uses Saturation Sampling, which is to include the entire population in a sample. This method ensures comprehensive data collection and analysis, capturing the full scope of the employee's experience and perspective.

3.3 Data Analysis Tools

The data collected from the survey was analyzed using SPSS version 25 software. The use of SPSS allows researchers to efficiently manage, process, and interpret survey data to draw meaningful conclusions about acceptance, employee experience, productivity, and workflow improvements related to the Internet of Things.

4. Results and discussion

4.1 Test Validity & Reliability

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Validity testing were carried out on Windows using SPSS version 25. Validity tests are performed to ascertain the validity of a questionnaire, according to Ghozali (2016). The validity test was performed by comparing the r_{count} value with the r_{table} value at an error level of 5%, assuming degrees of freedom (df) = n-2. The query or indicator is deemed legitimate if the r_{count} number is greater than the r_{table}.

Sugiyono (2018) stated in a journal (Mamuaya, Nova Ch., 2023) that reliability tests were carried out on statements in questionnaires that had been declared valid and used repeatedly to measure the same object. To determine whether a statement in this research questionnaire is reliable or not, the reliability value is measured or analyzed using Cronbach Alpha which has a reliability level of 0.6. If the value of Cronbach Alpha > r_{table}, the variable is considered reliable.

Table 2. Results Test Validity and Reliability

No.	Variable	Items	Counted	Cronbach Alpha	rtabel	Cronbach Alpha standart	Explanation	
1	Effectiveness of Implementing Internet of Things (X)	X.1	0.719	0.896	0.3120	0.60	Valid	Reliable
		X.2	0.770	0.891			Valid	
		X.3	0.738	0.893			Valid	
		X.4	0.660	0.900			Valid	
		X.5	0.767	0.891			Valid	
		X.6	0.755	0.892			Valid	
		X.7	0.785	0.889			Valid	
		X.8	0.837	0.884			Valid	
		X.9	0.732	0.894			Valid	
2	Supply Chain (Y)	Y.1	0.602	0.773	0.3120	0.60	Valid	Reliable
		Y.2	0.802	0.715			Valid	
		Y.3	0.720	0.743			Valid	
		Y.4	0.676	0.764			Valid	
		Y.5	0.638	0.767			Valid	
		Y.6	0.732	0.751			Valid	

Source : processed in accordance with the findings of the survey data, 2024

The validity of the table was 0.3120 when the researcher gave the questionnaire to 40 respondents, df = 40 - 2 or df = 38 with alpha (5% = 0.05). The instrument is deemed good if the $r_{count} > 0.3120$ and invalid if the $r_{count} < 0.3120$, according to the r_{table}, the study's criteria.

The results of the reliability test in table 2, each variable produces an alpha value that exceeds the Cronbach alpha value by 0.60. So it can be concluded that indicators

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and questionnaires are trustworthy or consistent.

4.2 Normality Test

Priyastama (2017) According to a journal article (Imron, 2019), the normality test determines whether or not the regression's residual values follow a normal distribution.

Table 3. Test Normality

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		40
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1.20213596
Most Extreme Differences	Absolute	.064
	Positive	.059
	Negative	-.064
Test Statistic		.064
Asymp. Sig. (2-tailed)		.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Based on the data that the author processed using SPSS version 25, it can be determined that the data on the regression in this study are normally distributed since the Asymp value, Sig. (2-tailed) of 0.200 is greater than the significance value of 0.05.

4.3 Analysis of Simple Linear Regression Equations

Sugiyono (2017) stated in a journal (Santosa & Luthfiyyah, 2020), Simple regression analysis describes the relationship between one dependent variable and one independent variable. In a simple regression analysis, the change in the dependent variable (Y) is permanently followed by the relationship between the independent variables (X), while the change in the X variable is not followed by the change in the non-linear relationship.

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Table 4. Equation of Simple Linear Regression and Test t

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.172	1.073		2.024	.050
	Effectiveness of IoT Implementation	.596	.036	.938	16.649	.000

a. Dependent Variable: Supply Chain

A regression equation can be created based on the data that the author processed using SPSS version 25 to determine how the effectiveness of the Internet of Things affects the supply chain. It looks like this:

$$\mathbf{Y = 2.172 + 0.596X}$$

Explanation : Y = Supply Chain
X = Effectiveness of the Internet of Things

According to the basic linear regression equation, the value of Y (the supply chain) will rise by 0.596 for every unit increase in the value of variable X (the effectiveness of the Internet of Things).

4.4 Results Test T (Partial)

Priyastama (2018) stated in a journal (Imron, 2019), the t-test was used to test the influence of the independent variable partially on the dependent variable. And it can be used to determine the hypothesis test of each variable.

Tabel 5. Test t (Partial)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.172	1.073		2.024	.050
	Effectiveness of IoT Implementation	.596	.036	.938	16.649	.000

a. Dependent Variable: Supply Chain

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The effectiveness of the Internet of Things has a t_{count} value of 16,649 compared to a t_{table} value of 1,685, based on data analyzed by the author using SPSS version 25. This indicates that the t_{count} is greater than the t_{table} value, and the significance value of 0.000 is less than 0.05. In light of this, the SPSS output findings above demonstrate that the Internet of Things' effectiveness has a favorable and notable impact on the supply chain.

4.5 Coefficient of Determination

Kuncoro (2019) stated in a journal (Sehangunaung et al., 20230) that the multiple determination coefficient (R^2) is a measure of the model's ability to explain the influence of dependent variables on dependent variables. The coefficient of determination shows the contribution of the independent variable to the bound variable, which is shown by the presentation. The more the percentage, the more the independent variable (X) has contributed or had a part in shaping the bound variable; the remaining % is an additional independent variable not covered in this study. On the other hand, the smaller the percentage, the less of an impact the free variable (X) has on the bound variable.

Tabel 6. Equation of Simple Linear Regression and Test t Coefficients[a]

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.938[a]	.879	.876	1.218

a. Predictors: (Constant), Effectiveness of IoT Implementation

Based on data that the author processed using SPSS version 25, it is known that the value (Adjusted R Square) is 0.879. This means that in a simple linear regression, the independent variable of the Effectiveness of the Implementation of the Internet of Things (X) has an 87.9% influence on the Supply Chain variable (Y), with the remaining 12.1% being influenced by factors not covered in this study.

5. Conclusion

This study emphasizes how crucial it is to use the Internet of Things to increase the efficiency of PT Pelni Logistics' supply chain. The investigation demonstrates how the Internet of Things has a significant positive impact on supply chain operations, particularly when it comes to transparency, real-time monitoring, and overall efficiency. The findings show that integrating the Internet of Things into supply chain processes not only optimizes the flow of materials but also reduces operational risks, resulting in a more agile and

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responsive system. This study shows that the implementation of the Internet of Things is an important factor in improving supply chain performance.

6. Implications

This study's conclusions have significant theoretical and practical ramifications. Organisations such as PT Pelni Logistics have the opportunity to utilise Internet of Things technology to improve coordination and efficiency across their supply chain by streamlining their operations. The report also offers a road map for businesses looking to use Internet of Things solutions, highlighting important topics including automation, real-time tracking, and inventory management. The research provides proof of the significant influence of the Internet of Things on supply chain performance and operational effectiveness, theoretically contributing to the expanding understanding of this technology in supply chain management.

7. Research limitations

This research has limitations even if it provides insightful information. The success of IoT in PT Pelni Logistics' supply chain can serve as a model for other businesses or sectors that utilize IoT systems. However, the scope of this research is restricted to PT Pelni Logistics. Second, because the study's sample size was uniform, it was mostly dependent on data gathered from particular employee groups, which may have introduced mistakes. This study only addresses a small portion of the Internet of Things' implementation; it ignores issues like long-term sustainability and implementation concerns. To strengthen the findings, more study in these areas and with a more varied sample size may be conducted in the future.

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