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Improving Freight Forwarding Efficiency Through Digital Innovation, Regulation, And Infrastructure As Mediation

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Abstract: The research aims discusses the impact of digital innovation, regulation, and infrastructure on operational efficiency in the freight forwarding industry in Indonesia freight forwarding industry. The study explores how technologies such as Track and Trace systems, IoT, and machine learning are transforming logistics by enhancing transparency and efficiency. However, challenges such as readiness, accessibility, and regulation hinder optimal digital adoption. The research uses the SEM-PLS method to analyze data from 150 logistics companies, revealing that digital innovation and regulation significantly influence operational efficiency, primarily mediated through infrastructure. Accessibility, while not directly impactful, strengthens infrastructure, which indirectly enhances efficiency. This study provides a comprehensive perspective on the enablers and barriers to digital adoption, offering useful policy and managerial implications for the logistics industry in Indonesia. The study concludes that digital innovations, supported by infrastructure development and regulations, are critical to improving the performance of logistics operations, particularly in the context of the digital economy.

Keyword: Freight Forwarding, Digital Innovation, Infrastructure

INTRODUCTION

Improving operational efficiency is one of the main goals in the freight forwarding industry in today's digital era. The use of digital innovations, such as Track and Trace technology, has an important role in achieving this efficiency. However, the adoption of digital technology by most freight forwarding companies in Indonesia is still not optimal. This causes the maximum potential for operational efficiency to not be achieved. Some of the obstacles faced include the readiness of human resources, accessibility to technology, regulations, and infrastructure that supports digitalization (Riedl et al., 2018).

This research aims to optimize the use of Track and Trace digital innovation by freight forwarding companies in Indonesia. The adoption of this technology is important considering that digital innovation is able to improve operational efficiency, strengthen competitiveness, and allow companies to adapt faster to market changes (Venkatachalam, 2022). Information technologies such as machine learning, the Internet of Things (IoT), and artificial intelligence have changed the way the logistics industry works by accelerating information exchange and data-driven decision-making(Heinbach et al., 2022). However, the big challenge faced is the need to adjust the business model of logistics companies to meet the demands of the digital economy era (Palkina, 2022).

Track and trace systems play an important role in monitoring and tracking goods in real-time along the supply chain. The implementation of this technology facilitates the management of orders, tracking functions, customer service, and invoicing processes, all of which are heavily influenced by digitalization (Giraldo-Diaz & Fuerst, 2019). In the logistics industry, digital solutions such as Track and Trace have a significant impact on operational efficiency, making it easier for logistics companies to provide transparent and reliable services(Cahyadi et al., 2021). This system is even one of the performance indicators in the Logistics Performance Index (LPI), which assesses the company's ability to track goods in a timely manner (Wiranto & Sanjaya, 2022).

The logistics industry continues to grow, and the market projections show a significant increase. According to the Indonesia E-Commerce Association (idEA), the market value of the logistics business in 2021 will reach IDR 320 trillion, with a projected average growth of 30% per year over the next three to five years (Kholidin, 2024). This growth is driven by the increasing demand for freight forwarding in the e-commerce sector, which relies heavily on ground transportation(Perdana, 2011). Therefore, a policy strategy that supports the accessibility of digital technology is urgently needed to ensure the smooth delivery process of goods and maintain the competitiveness of logistics companies (Jahn et al., 2019).

The ability of logistics companies to track and trace goods along the supply chain is becoming increasingly important in maintaining operational efficiency and ensuring smooth distribution of commodities. Previous studies have shown that the implementation of a good tracking system is also important in maintaining the quality and quantity of commodities, especially in the agricultural sector (Büyüközkan & Göçer, 2018). Technologies such as IoT, which connects various devices and collects data in real-time, support the efficiency of logistics management within the framework of Logistics 4.0 (Chen et al., 2021). However, the complexity of the data generated by this technology can be a challenge in determining real-time travel time (Sivakumar et al., 2020).

Digitalization also allows for better collaboration among supply chain actors. Projects funded by leading organizations have encouraged collaboration and provided guidance on how to build and sustain those collaborations (Çimen et al., 2023). Supply chain digitalization not only improves efficiency, but also creates a new, more collaborative and sustainable business ecosystem(Korchagina et al., 2020). In the era of the digital economy, modern logistics management systems are increasingly relying on digital control and automation to optimize transportation and delivery processes(Marjona, 2023).

In Indonesia, tracking systems such as the Baggage Handling System (BHS) used at airports are able to improve operational efficiency in passenger baggage management. This digital innovation has made a major contribution to improving efficiency in the aviation sector (Frikha & Hlali, 2023). In a broader context, digital innovation has great potential to improve overall company performance through improved service quality, process efficiency, and delivery optimization (Edward et al., 2022). The application of this innovation is also able to improve the company's financial performance by accelerating delivery times, increasing visibility, and optimizing delivery routes (Sari et al., 2022).

However, the adoption of digital technology also brings its own challenges. Key challenges include data security issues, over-reliance on technology, and technical glitches that can slow down operational processes (Adnyana et al., 2018). Additionally, the complexity of technology choices can lead to confusion in decision-making and slow down implementation

(Witjaksono, 2022). Therefore, while digital innovation can significantly improve operational efficiency, companies must consider the negative impacts that may arise, including the potential for a digital divide (Fatoni et al., 2023).
Based on the above background, the hypothesis of this research is:
Hypothesis 1: Digital innovation affects company efficiency.
Hypothesis 2: Accessibility affects company efficiency.
Hypothesis 3: Regulations affect company efficiency.
Hypothesis 4: Digital innovation affects efficiency through infrastructure.
Hypothesis 5: Accessibility affects efficiency through infrastructure.
Hypothesis 6: Regulations affect efficiency through infrastructure.
Hypothesis 7: Infrastructure affects through company efficiency

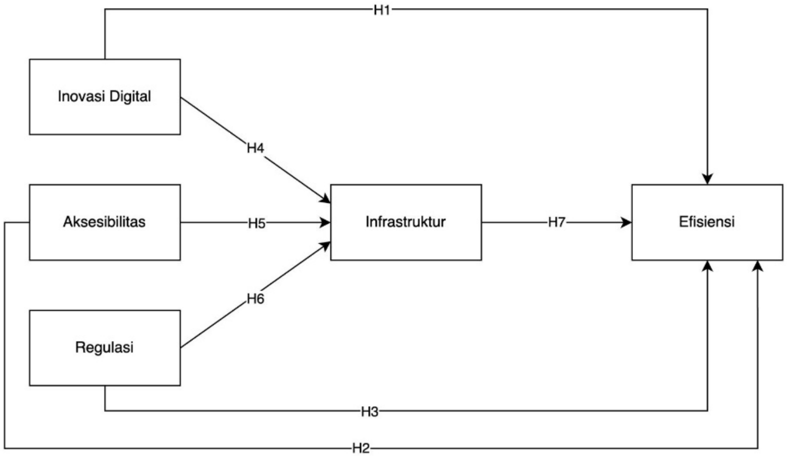

Figure 1. Conceptual Framework

Several gaps has been identified such as limited studies on the Indonesia freight forwarding sectors and lack of integration between digital innovation, regulations, and infrastructure. By integrating technology, regulatory frameworks, and infrastructure to assess their combined impact on operational efficiency, this study fills the gap. This study provides empirical evidence that extends beyond existing conceptual discussions by using SEM-PLS analysis. This makes it extremely relevant for both policymakers and industry practitioners.

However, whether accessibility affects efficiency indirectly through fortifying infrastructure has not been investigated in prior research. According to this study, accessibility improves infrastructure, which raises operational performance even if it has no direct effect on efficiency. This indirect effect is a novel addition because it hasn't been examined in the freight forwarding sector before.

METHOD

This study uses a quantitative approach with the Structural Equation Modeling-Partial Least Squares (SEM-PLS) method to analyze the influence of digital innovation, accessibility, regulations, and infrastructure on operational efficiency in freight forwarding companies in Indonesia. The subject of the study is 150 companies that are members of the Association of Indonesia Express, Post, and Logistics Service Companies (ASPERINDO). Data was collected through questionnaires distributed to company managers and employees, as well as related literature studies. The variables measured include digital innovation, accessibility, regulation, infrastructure (as a mediating variable), and operational efficiency (as a dependent variable). The sampling technique was carried out by the purposive sampling method. Data analysis was carried out using SEM-PLS, which allowed researchers to analyze complex relationships between variables and identify significant pathways of influence. This statistical model involves confirmatory factor test, regression test, covariant analysis, and path analysis. The results of the research are expected to provide guidance for freight forwarding companies to optimize digital innovation in improving operational performance.

RESULTS AND DISCUSSION

The results demonstrate how important digital innovation and well-developed infrastructure are to efficiency gains, both of which need robust regulatory backing. While legislators concentrate on developing legal frameworks that support infrastructure expansion and digital transformation, businesses should invest in technology-driven solutions. Organizations and governments may increase efficiency, simplify processes, and maintain their competitiveness in the quickly changing digital economy by coordinating these agendas.

Outer Model Measurement

Convergent validity is a measure to assess whether manifest variables are able to reflect the latent variables being measured. In this study, there are 32 manifest variables out of 5 latent variables. Validity measurements for latent variables use a one-level measurement, namely the lower order construct. The manifest variable was stated to be able to measure the latent variable when the loading factor (LF) value of each manifest variable produced a > value of 0.700 and an average variance extracted (AVE) value > 0.500. All measurements of latent variables are reflective. Furthermore, the measurement of the outer model is internal consistency (reliability). Reliability testing aims to test the level of consistency of manifest variables against latent variables. The measure used to evaluate the level of reliability is composite reliability – CR (rho a) with the limit of CR value is ≥ 0.700.

The following is a summary of the results of the convergent validity test for each latent variable.

Table 1. Convergent Validity and Reliability – Lower Order Construct (LOC)

Variable	Item	Loading Factor	AVE	CR
Digital Innovation	ID1	0,761	0,511	0,848
	ID2	0,031		
	ID3	0,434		
	ID4	0,856		
	ID5	0,689		
	ID6	0,846		
	ID7	0,942		
Accessibility	AK1	0,628	0,549	0,803
	AK2	0,856		
	AK3	0,928		
	AK4	0,912		
	AK5	0,803		
	AK6	0,594		
	AK7	0,148		
Regulation	RE1	0,845	0,356	0,778
	RE2	0,811		
	RE3	0,672		
	RE4	0,260		
	RE5	0,626		
	RE6	0,083		
	RE7	0,450		
Infrastructure	IN1	0,797	0,526	0,904
	IN2	0,963		
	IN3	0,964		
	IN4	0,751		

	IN5	0,665		
	IN6	0,425		
	IN7	-0,069		
Efficiency	EF1	0,869	0,728	0,880
	EF2	0,832		
	EF3	0,885		
	EF4	0,825		

The AVE value on each latent variable has resulted in a > value of 0.500. This means that the manifest variable has well reflected the latent variables measured. In other words, the validity of convergence has been well fulfilled. Furthermore, because the CR value for each latent variable > 0.700, it can be concluded that all manifest variables consistently measure their latent variables.

Based on Table 1, it can be seen that the AVE root value for each construct is greater than the correlation value between constructs. In other words, the ratio of the square root value of AVE and the correlation value of the latent variable with its own latent is greater than the correlation value of that latent with other latent.

Table 2. Results of the Validity Test of Discrimination with FLC

	Accessibility	Efficiency	Infrastructure	Digital Innovation	Regulation
Accessibility	0,741				
Efficiency	0,570	0,853			
Infrastructure	0,449	0,825	0,725		
Digital Innovation	0,408	0,632	0,421	0,715	
Regulation	0,487	0,545	0,750	0,001	0,597

Discriminatory validity is a measure of a construct that is different from other constructs. Therefore, the determination of the validity of discrimination is to provide an indication that a construct is uniquely and capable of explaining a phenomenon that is not represented by other constructions in the model. The validity test of discrimination uses the Fornell Lacker Criterion (FLC) approach.

Inner Model Measurement

In addition to testing the research hypothesis, inner model measurements are also carried out to evaluate the structural model. Evaluation of the structural model refers to the R-Square (R2), F-Square-effect size (F2) value and predictive power with PLS-predict.

To answer the research hypothesis, a t test (t-statistic) was carried out using the bootstrapping method. The basis for decision making refers to the t-table two tail test value of 1.96 and a significance level of 0.05. Furthermore, the t-table value (1.96) is used as the cut off value for accepting or rejecting the hypothesis.

Table 3. analysis bootstrapping

Direct	**STDEV**	**T stats**	**P values**	**Decision**
ID→EF	0,056	10,791	**0,000**	Accepted
AK→EF	0,060	1,313	**0,190**	Rejection
RE→EF	0,056	9,018	**0,000**	Accepted
ID→IN	0,064	7,527	**0,000**	Accepted
AK→IN	0,066	2,222	**0,027**	Accepted
RE→IN	0,061	13,539	**0,000**	Accepted
IN→EF	0,095	6,665	**0,000**	Accepted

Based on Table 3, it can be seen that of the 7 direct hypotheses tested, 6 hypotheses were accepted and 1 hypothesis was not accepted.

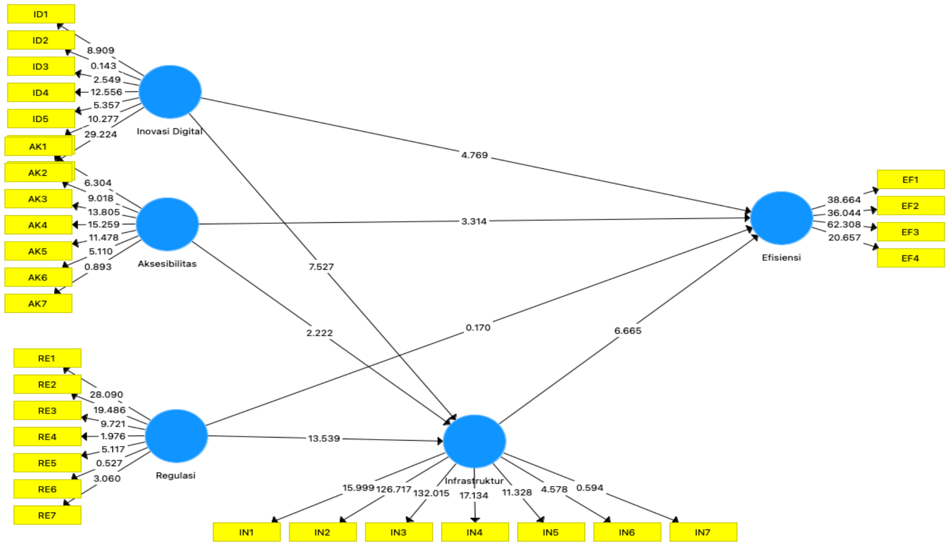

Figure 2. Bootstrap analysis

Table 4. Path Analysis Result

	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Criteria
Accessibility -> Infrastructure -> Efficient	0,044	2,123	0,034	Full Mediation
Innovation Digital -> Infrastructure -> Efficient	0,052	5,891	0,000	Partial Mediation
Regulation -> Infrastructure -> Efficient	0,098	5,310	0,000	Partial Mediation

R-Square is the contribution or explanation of exogenous latent variables to endogenous latent variables at the structural model level. The R-Square assessment criteria in the structural model follow the opinion of Hair, 2021, namely an R-Square value ≥ 0.75, meaning that the exogenous latent variable makes a strong contribution to the endogenous latent variable at the structural model level. The R-Square value is 0.50 – 0.74, meaning that the exogenous latent variable makes a moderate contribution to the endogenous latent variable at the structural model level. The R-Square value is 0.25 – 0.49, meaning that the exogenous latent variable makes a weak contribution to the endogenous latent variable at the structural model level.

Table 5. R-Square Value

	R Square	Explanation
Efficiency	0,800	Strong
Infrastructure	0,753	Strong

F-Square is the magnitude of the influence of the exogenous latent variable on the partial endogenous latent variable. Hair 2021 provides limitations for interpreting F-Square values. The F-Square value of 0.020 – 0.149 means that the influence between variables is weak. An F-Square value of 0.150 – 0.349 means that the influence between variables is moderate and finally, an F-Square value ≥ 0.35 means that the influence between variables is strong.

Table 6. F-Square Value

Direct	F-Square	Explanation
ID→EF	**0,196**	Moderate
AK→EF	**0,085**	Weak
RE→EF	**0,000**	No Influence
ID→IN	**0,730**	Strong
AK→IN	**0,052**	Weak
RE→IN	1,955	Strong
IN→EF	**0,501**	Strong

Based on the results of the research that has been described, there are several significant findings regarding the relationship between the variables tested, namely digital innovation, accessibility, regulation, infrastructure, and efficiency. Validity and reliability tests show that the manifest variables used in this model have good convergent validity, with loading factor values > 0.700 and AVE > 0.500, as well as high reliability based on composite reliability (CR) values which are all above 0.700. This shows that the instruments used in the study are able to consistently measure the latent variables tested.

Hypothesis testing also revealed some interesting results. Of the seven hypotheses tested, six were accepted and one was rejected. The test results show that digital innovation and regulation have a significant influence on efficiency, while accessibility does not have a significant influence on efficiency. On the other hand, both digital innovation, accessibility, and regulation have proven to have a significant effect on infrastructure, which then mediates the relationship with efficiency. This indicates that infrastructure plays a key role in improving efficiency, especially when influenced by digital innovation and regulation.

The results of this study emphasize the importance of infrastructure development supported by digital innovation and effective regulation. Digital innovation has been proven to have a significant influence on efficiency, both directly and through infrastructure mediation. This shows that the adoption of new technologies in company operations can increase efficiency, especially if supported by good infrastructure management. In contrast, accessibility does not have a significant direct effect on efficiency, but rather plays a role in strengthening infrastructure which in turn increases efficiency.

In the context of regulation, the results of the study show that clear and consistently implemented regulations can drive efficiency, both directly and through infrastructure. Therefore, there is a need for a regulatory framework that supports the use of technology and infrastructure development so that the expected results, namely increased efficiency, can be achieved.

CONCLUSION

This study successfully shows that digital innovation and regulation play an important role in improving operational efficiency through infrastructure mediation. While accessibility, while not having a significant direct influence on efficiency, contributes to strengthening infrastructure which ultimately also affects efficiency. Good infrastructure development, especially those supported by innovative technologies and supportive regulations, is key in improving efficiency.

This research has several limitations that need to be considered. First, the study focused on only five latent variables, so there may be other factors that affect efficiency but are not included in the model. Second, this study uses cross-sectional data that may not fully describe the dynamics of changes between variables in the long term. Future research is suggested to consider a longitudinal approach to gain a more comprehensive understanding of the long-term effects of digital innovation, accessibility, and regulation on efficiency.

In addition, further development on more specific aspects of technology, such as automation technology or the Internet of Things (IoT) in the context of infrastructure, can provide additional insights into how best to improve operational efficiency. This study also underlines the importance of regulatory policies that are adaptive to technological changes, so that further studies on regulatory aspects in the face of technological developments can be an interesting research field in the future. With the implementation of track and trace applications, freight forwarding companies can improve operational efficiency, reduce costs, speed up delivery, and increase customer satisfaction. Therefore, the adoption of this technology is no longer an option, but a primary need in facing the challenges of the modern logistics industry.

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REFERENCE

Adnyana, I. made, Nauli, S., & Sari, M. (2018). Penggunaan Sistem Aplikasi Out Of Gauge Dengan Baggage Handling System pada Terminal 3 Ultimate Domestik di Bandara Soekarno Hatta. *Jurnal Manajemen Bisnis Transportasi & Logistik*, *4*(3), 1–23.

Büyüközkan, G., & Göçer, F. (2018). Digital Supply Chain: Literature review and a proposed framework for future research. *Computers in Industry*, *97*, 157–177. https://doi.org/10.1016/j.compind.2018.02.010

Cahyadi, E. R., Widianti, K. R., & Slamet, A. S. (2021). The Use Behavior of Tracking and Tracing Services in E-Commerce Logistics. *Jurnal Manajemen Dan Organisasi*, *12*(1), 10–20. https://doi.org/10.29244/jmo.v12i1.35373

Chen, Y. T., Sun, E. W., Chang, M. F., & Lin, Y. B. (2021). Pragmatic real-time logistics management with traffic IoT infrastructure: Big data predictive analytics of freight travel time for Logistics 4.0. *International Journal of Production Economics*, *238*(December 2019), 108157. https://doi.org/10.1016/j.ijpe.2021.108157

Çimen, M., Benli, D., İbiş Bozyel, M., & Soysal, M. (2023). A review on sustainability, Industry 4.0 and collaboration implications in vehicle allocation operations. *International Journal of Logistics Management*. https://doi.org/10.1108/IJLM-03-2023-0115

Edward, A. I., Fadhillah, F., Sari, M., & Pribadi, S. (2022). Analysis of Shipment Handling, Tracking System, and Timeliness of the Performance of Gosen Service. *Global Reserach on Sustainable Transport and Logistics*, *5778*, 166–177.

Fatoni, I., Umar, U., & Esabella, S. (2023). Analisis Pengaruh Orientasi Kepemimpinan, Inovasi Produk Dan Implementasi Inovasi Terhadap Kinerja Operasional Karyawan. *Jiip - Jurnal Ilmiah Ilmu Pendidikan*. https://doi.org/10.54371/jiip.v6i5.1974

Frikha, R., & Hlali, A. (2023). The Evolution of Logistics Management Toward the Digital Transition. *International Journal of Commerce, Industry and Entrepreneurship Studies (Utisgad Journal*, *3*, 2791–6987. www.utisgad.org%7Cwww.sitso.org.tr%7CArticleLink

Giraldo-Diaz, J. M., & Fuerst, S. (2019). Shipstra: The lean start-up of a digital freight-forwarding marketplace. *Global Business and Organizational Excellence*, *38*(5), 6–17. https://doi.org/10.1002/joe.21946

Heinbach, C., Beinke, J., Kammler, F., & Thomas, O. (2022). Data-driven forwarding: a typology of digital platforms for road freight transport management. *Electronic Markets*, *32*(2), 807–828. https://doi.org/10.1007/s12525-022-00540-4

Jahn, C., Kersten, W., & Christian Ringle. (2019). Digital transformation in maritime and city logistics : smart solutions for logistics. *The Hamburg International Conference of Logistics*. https://search.ebscohost.com/login.aspx?direct=true&db=edsbas&AN=edsbas.98972ED6&site=eds-live&authtype=uid

Kholidin, A. (2024). Peran Kebijakan Strategis Inovasi Teknologi Digital dalam Transportasi Barang: Studi Perusahaan Logistik di Semarang. *Reslaj: Religion Education Social Laa Roiba Journal*, *6*(3), 3070–3082. https://doi.org/10.47476/reslaj.v6i3.6246

Korchagina, E., Kalinina, O., Burova, A., & Ostrovskaya, N. (2020). Main logistics digitalization features for business. *E3S Web of Conferences*, *164*. https://doi.org/10.1051/e3sconf/202016410023

Marjona, T. (2023). Directions for Increasing Economic Efficiency by Providing Logistics Services to the Population. *Academic Journal of Digital Economics and Stability*, *29*(c), 41–46.

Palkina, E. (2022). Transformation of business models of logistics and transportation companies in digital economy. *Transportation Research Procedia*, *63*, 2130–2137. https://doi.org/10.1016/j.trpro.2022.06.239

Perdana, Y. R. (2011). Pengembangan Model Tracking dan Tracing dalam Distribusi Komoditi Pertanian. *Jurnal Ilmiah Teknik Industri*, *Vol. 10*(1), 1–6.

Riedl, J., Chan, T., Schöndorfer, S., & ... (2018). The digital imperative in freight forwarding. *... /Digital-Imperative ...*. https://image-src.bcg.com/Images/BCG-The-Digital-Imperative-in-Freight-Forwarding-Nov-2018_tcm108-207934.pdf

Sari, M., Mohamed, W. M. W., & Jalil, S. A. (2022). The Optimization Using Electric Ground Support Equipment in Aviation Industry. *International Journal of Energy Economics and Policy*, *12*(1), 401–406. https://doi.org/10.32479/ijeep.11711

Sivakumar, V., Ruthramathi, R., & Leelapriyadharsini, S. (2020). Internet of things: Benefits and challenges of logistics service providers in India. *International Journal of Scientific and Technology Research*, *9*(2), 1949–1953.

Venkatachalam, V. S. (2022). Challenges of Emerging Technology in Freight Forwarding Agents with Respect to V . O . C . Port. *EasyChair Preprint N0 4766*, *December 2020*.

Wiranto, R., & Sanjaya, R. (2022). E- Logistic Optimization For MSME ' s To Prepare the New Normal Era (Conceptual Framework). *Journal of Business and Technology*, *2*(1), 16–28.

Witjaksono, H. (2022). Hubungan Antara Strategi Inovasi Terhadap Kinerja Keuangan Di Perusahaan Manufaktur (Sebuah Tinjauan Literatur Sistematis Pada Penelitian Inovasi Dan Kinerja Perusahaan). *J-Mas (Jurnal Manajemen Dan Sains)*. https://doi.org/10.33087/jmas.v7i1.392