THE EFFECT OF ELECTRIC VEHICLE IMPLEMENTATION, UTILIZATION OF RENEWABLE ENERGY, AND OPERATIONAL DIGITALIZATION ON OPERATIONAL COST EFFICIENCY AT PT POS INDONESIA (PERSERO)

[*1]Danan Prasetya Sudarso,[2]Melia Eka Lestiani,[3]Maniah

[1,2,3]Master of Logistics Management, Universitas Logistik dan Bisnis Internasional (ULBI), Indonesia

Author's email:
[1]dhanzpz@gmail.com; [2]meliaeka@ulbi.ac.id; [3]maniah@ulbi.ac.id

**Corresponding author:dhanzpz@gmail.com*

Abstract. *Transformation towards sustainable, environmentally friendly, and cost-effective operations has become a strategic need for PT Pos Indonesia (Persero) amid increasing competition in the logistics sector. This study examines the impact of electric vehicle implementation, renewable energy utilization, and operational digitalization on operational cost efficiency. The underlying problem lies in the realization of these initiatives that are not optimal due to gaps in system integration, lack of use of environmentally friendly technology, and lack of data-based performance evaluation. Causal-associative quantitative methods were used in this study. Data was gathered via a structured questionnaire distributed to 165 employees from the operations and logistics divisions. These employees are directly involved in the implementation of digital logistics devices, solar energy systems, and electric vehicles. The results of the study, which was conducted using SMARTPLS 4.0 and Partial Least Squares Structural Equation Modeling (PLS-SEM), showed that the implementation of electric vehicles had a positive and significant effect on cost efficiency (coefficient = 0.268, p-value = 0.000). The use of renewable energy also showed a significant positive influence (coefficient = 0.336, p-value = 0.000). Operational digitalization has the strongest influence (coefficient = 0.306, p-value = 0.000). These findings show that the integration of these three elements of innovation contributes to a substantial increase in cost efficiency in PT Pos Indonesia's logistics services. The study provides practical insights for logistics companies looking to adopt environmentally sustainable and digitally enhanced operational strategies.*

Keywords: *Cost Efficiency; Digitalization; Electric Vehicles; Logistics; Renewable Energy*

1. INTRODUCTION

In the age of industry 4.0 marked by technological disruption, automation, and digital connectivity, the logistics sector faces great challenges and opportunities to improve operational efficiency. One of the crucial issues in this industry is the high operational costs, especially those sourced from fossil energy consumption and inefficiencies in manual operational processes. As stated by the International Energy Agency (IEA) indicates that the transportation sector consitutes for more than 37% of global final energy consumption and is a significant contributor to carbon emissions and the ever-increasing burden of operational costs (IEA, 2023).

PT Pos Indonesia (Persero), as a state-owned logistics company with national distribution coverage, faces major challenges in controlling operational costs, most of which come from transportation and energy consumption. In its annual report (2022), it was stated that more than 65% of the company's operating expenses came from logistics and operations, with the largest proportion related to the use of fuel for vehicles transporting letters and packages. Realizing this, PT Pos Indonesia has initiated strategic steps such as electric vehicle trials and the installation of solar panels in several sorting centers as part of the green operation initiative.

However, these efforts are still limited. Internal data from the Directorate of Operations (2023) states that only about 7% of the logistics fleet has used electric vehicles and only 5 sorting center locations utilize solar energy. This raises an important question: to what

extent can the adoption of this green technology improve the efficiency of a company's operational costs?

In addition to energy and vehicle factors, another factor that is increasingly determining operational efficiency in the digital era is operational digitalization. Digital transformation includes the application of technology, which has been proven to increase service speeds, lower error rates, and cut labor costs and processing time. In the context of PT Pos Indonesia, digitalization is a vital aspect that allows real-time monitoring of the fleet, automation of the sorting and tracking process of goods, and the integration of customer service based on digital platforms. However, the optimal level of adoption of operational digitalization has not been fully achieved across all of the company's operational units.

Most previous studies have only highlighted one aspect, such as electric vehicles (Susilo et al., 2022), the renewable energy mix in the power generation sector (Rachmatullah et al., 2021), or digitalization in the context of the manufacturing and financial industries. Very few studies have simultaneously examined the influence of electric vehicles, renewable energy, and operational digitalization on cost efficiency in the context of the national logistics sector, especially in state-owned companies such as PT Pos Indonesia.

Therefore, this study has novelty in filling the literature gap by presenting a quantitative and empirical analysis of the combinative influence of three main strategies—electric vehicles, renewable energy utilization, and operational digitalization, on the operational cost efficiency of PT Pos Indonesia. This research is expected not only to make an academic contribution to the development of green operational management and logistics, but also to produce strategic recommendations that are applicable to policy makers within PT Pos Indonesia.

The solutions offered in this study emphasize the holistic integration of green technology and digitalization, including strengthening digital infrastructure, collaboration with clean energy technology providers, and data-based efficiency measurement systems. With this step, PT Pos Indonesia can strengthen its competitiveness as a modern, cost-effective, and environmentally friendly national logistics service provider.

2. LITERATURE REVIEW

2.1 Introduction to the Literature

Literature reviews are crucial in developing the conceptual framework of research by synthesizing existing knowledge and identifying gaps in the literature that remain available for further investigation. In the context of the operational transformation of state-owned logistics companies, especially PT Pos Indonesia, this review focuses on the key concepts underlying operational cost efficiency through the application of sustainable technology. The literature will be compiled into several main themes, namely the definition and role of electric vehicles in reducing transportation energy costs, the utilization pertaining to renewable energy as a means of energy efficiency, and operational strategy, and operational digitalization that includes the integration of information technology in modern logistics systems. Previous empirical studies that are relevant from both international and national contexts (e.g., Wang et al., 2020; Siregar et al., 2021) will also be analyzed to identify the factors driving the successful implementation and the contribution of each variable to operational efficiency, especially in the logistics and SOE sectors. With this structure, the literature review will provide a theoretical foundation and direction of analysis in testing the relationship between the three main variables and operational cost efficiency quantitatively.

2.2 Definition and Concept of Electric Vehicle Implementation

"Electric vehicle implementation" is a term that refers to the process of implementing and using electric vehicles in operational activities to improve energy efficiency and lessen reliance on fossil fuels.

In the theory of innovation diffusion, Rogers (2003) states that things like relative superiority, compatibility, complexity, testability, and observability influence the adoption of new technologies such as electric vehicles. The IEA (2023) states that, because electric vehicles are more energy-efficient and require less maintenance than conventional fuel vehicles, there is a possibility of a reduction in operational costs of up to 40%.

2.3 Definition and Concept of Renewable Energy Utilization

Based on Energy Conservation Theory (Boyle, 2004), the substitution of fossil energy with renewable energy can reduce total energy consumption and improve the energy efficiency of companies. According to REN21 (2022), the utilization of renewable energy within the logistics sector can save energy costs by up to 30% and significantly reduce the carbon footprint.

2.4 Definition and Concept of Digitalization Effectiveness

Operational digitalization is the process of applying digital technology to improve efficiency, accuracy, and speed in company work processes, such as logistics automation, system-based package tracking, the use of management dashboards, and IoT (Westerman et al., 2011).

2.5 Definition and Concept of Operational Cost Efficiency

Operational cost efficiency is a measure of a company's effectiveness in managing costs to produce certain outputs. Based on the Theory of Operational Efficiency (Chase, Jacobs & Aquilano, 2006), efficiency is achieved if the inputs used produce maximum output at minimal cost, especially through the application of cost-effective and resource-efficient technology. According to Kotler & Keller (2016), operational efficiency is achieved when a company is able to reduce cost-to-serve through the optimization of resources, technology, and work processes.

3. RESEARCH METHODS

To analyze this study, a quantitative method with a causal associative approach was used to examine the influence of electric vehicle implementation, renewable energy utilization, and operational digitalization on operational cost efficiency at PT Pos Indonesia (Persero). Data was gathered through the dissemination of questionnaires to 165 respondents selected from a total population of about 200 employees working in the operational, distribution, and technology units at PT Pos Indonesia. The purposive sampling method was employed for respondent selection, with the criterion that they have worked for at least 1 year in a division directly involved in the company's operational processes, digitalization, or energy efficiency programs.

PLS-SEM, assisted by SMARTPLS 4.0, is used to perform data analysis. This method can be used to test the causal relationship between independent variables (electric vehicles, renewable energy, and operational digitalization) and dependent variables (operational cost efficiency) simultaneously. In addition, the sample is small and the data is not well distributed. The research method consists of a questionnaire with a Likert scale from 1 to 5 that measures the number of indicators derived from four main variables. Validity and reliability assessments were conducted first, where the outer load value was exceeding 0.7, the mean variation extracted (AVE) was greater than 0.5, and the composite reliability > 0.7.

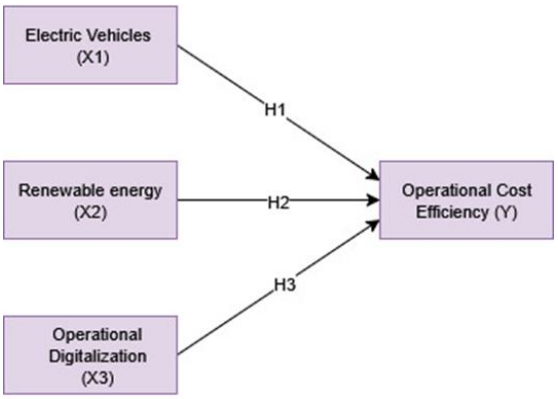

Figure 1. Research Model

4. RESULTS AND DISCUSSION

The outcomes of the validity and reliability tests demonstrate that the data is worthy of further study. To ensure that the research tool can assess the desired variables appropriately and consistently, validity and reliability tests are carried out. With external loading criteria above 0.7, AVE above 0.5, and composite reliability above 0.7, the questionnaire showed a high level of internal consistency.

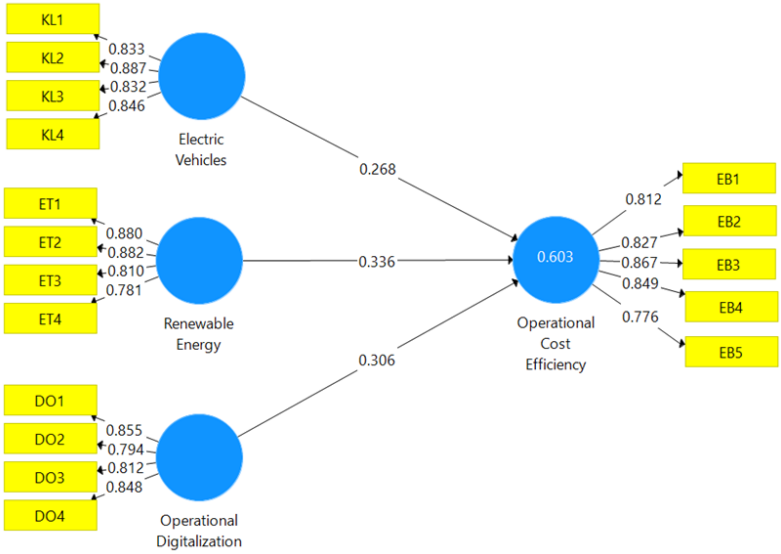

Figure 2. PLS Model

Figure 2 shows the validity, reliability, and determination coefficient test model and the path of the equation model.

a. Validity Test

According to the data, the external charge value of each metric is higher than 0.7. This indicates that each variable meets the criteria of convergent validity, and its indications can be explained. The findings of the convergent validity test can also be ascertained using the extracted mean value of variance (AVE) in addition to the external charge value. Successful measurement models are indicated by AVE values of better than 0.5 for each latent concept.

Table 1. AVE and Reliability Test

	Cronbach's Alpha	***rho_A***	***Composite Reliability***	***Average Variance Extracted (AVE)***
Operational	0.846	0.848	0.897	0.685

Digitalization				
Operational Cost Efficiency	0.884	0.888	0.915	0.684
Renewable Energy	0.859	0.864	0.905	0.705
Electric Vehicles	0.872	0.876	0.912	0.722

(Source: Researchers, 2025)

b. Reliability Test

All constructions are considered reliable because they have a composite reliability coefficient between 0.6 and 0.7 and a Cronbach alpha value of more than 0.7 (Sarstedt et al., 2011).

c. Test Model Fit

The following table 2 shows the value of R2.

Table 2. Test Model Fit

	R Square	R Square Adjusted
Operational Cost Efficiency	0.603	0.596

(Source: Researchers, 2025)

According to Table 2, the R-Squared value of the length of the endogenous variable Operational Cost Efficiency is 0.603, which shows the variable strength of electric vehicles, renewable energy and operational digitalization in predicting the Operational Cost Efficiency is 60.3%.

d. Hypothesis Testing Analysis

The following Path Coefficient test results are the results:

Table 3. Hypothesis Testing Results through Analysis Path Coefficient with the Method Bootstrapping

	Original Sample (O)	***Sample Mean (M)***	***Standard Deviation (STDEV)***	***T Statistics (|O/STDEV|)***	***P Values***
Operational Digitalization -> Operational Cost Efficiency	0.306	0.314	0.077	3.966	0.000
Renewable Energy -> Operational Cost Efficiency	0.336	0.327	0.086	3.925	0.000
Electric Vehicles -> Operational Cost Efficiency	0.268	0.271	0.075	3.599	0.000

(Source: Researchers, 2025)

1. The Effect of Electric Vehicles on Operational Cost Efficiency in Logistics Services at PT Pos Indonesia (Persero).

With a coefficient of 0.268 and p = 0.000 (<0.05), the influence of electric vehicles on operational cost efficiency is positive and significant, this shows that there exists a positive and substantial impact on operational cost efficiency. That electric vehicles directly affect operational cost efficiency in the context of this study. The successful adoption of electric vehicles can increase efficiency, especially if supported by technological readiness and appropriate implementation strategies (Sierzchula et al., 2014). Thus, the use of electric vehicles not only supports the sustainability aspect but is also an effective strategy in reducing operational costs significantly.

2. The Effect of Renewable Energy on Operational Cost Efficiency in Logistics Services at PT Pos Indonesia (Persero).

A considerable beneficial impact of renewable energy on operational cost efficiency

is also demonstrated, with a coefficient of 0.336 and p = 0.000 (< 0.05). This indicates that the use of renewable energy is able to support operational cost efficiency through reducing dependence on more expensive and fluctuating fossil energy sources. Theoretical support from research conducted by IRENA (International Renewable Energy Agency) indicates that renewable energy investments in the long term can reduce operational costs while providing environmental benefits, which supports business sustainability.

3. The Effect of Digitalization on the Efficiency of Logistics Service Operational Costs at PT Pos Indonesia (Persero).

The p-value is 0.000 (<0.05) and a path coefficient of 0.306, operational digitalization has a positive and substantial impact on operational cost efficiency. Which means that operational digitalization substantially improves the efficiency of a company's operational costs. This is in line with the theory that digitalization allows for automation and optimization of processes that can lower costs and increase productivity (Bharadwaj et al., 2013). In addition, various studies have confirmed that digital transformation in the field of operations can accelerate decision-making and reduce the waste of resources (Rogers, 2016).

CONCLUSION

This study shows that operational digitalization, the utilization of renewable energy, and the adoption of electric vehicles have a positive and significant impact on operational cost efficiency, respectively. This shows that digital transformation, energy transition, and green vehicle innovation can really help businesses keep costs down while improving productivity and operational sustainability. Adaption of electric vehicles can increase operational cost efficiency.

REFERENCES

ABharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. MIS Quarterly, 37(2), 471–482.

Boyle, G. (2004). Renewable Energy: Power for a Sustainable Future (2nd ed.). Oxford University Press.

Brynjolfsson, E., & McAfee, A. (2014). The second machine age: Work, progress, and prosperity in a time of brilliant technologies. W. W. Norton & Company.

Chase, R. B., Jacobs, F. R., & Aquilano, N. J. (2006). Operations Management for Competitive Advantage (11th ed.). McGraw-Hill/Irwin.

International Energy Agency (IEA). (2023). Global Energy Review 2023. IEA. Accessed from https://www.iea.org/reports/global-energy-review-2023

International Renewable Energy Agency (IRENA). (2019). Renewable Energy Benefits: Measuring the Economics. IRENA Report. Retrieved from https://www.irena.org/publications/2019/Jan/Renewable-Energy-Benefits-Measuring-the Economics

International Renewable Energy Agency (IRENA). (2022). Renewables 2022: Global Status Report. IRENA. Accessed from https://www.irena.org/publications/2022.

Kotler, P., & Keller, K. L. (2016). Marketing Management (15th ed.). Pearson Education.

Presidential Regulation of the Republic of Indonesia No. 55 of 2019 concerning the Acceleration of the Battery-Based Electric Motor Vehicle Program.

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92(11), 64-88.

Rachmatullah, R., Sari, A. R., & Prasetyo, A. (2021). A study on the utilization of the renewable energy mix in Indonesia. Journal of Renewable Energy, 5(1), 45-60.

REN21. (2022). Renewables Global Status Report 2022. Renewable Energy Policy Network for the 21st Century. Retrieved from https://www.ren21.net/reports/global-status-report/

Rogers, E. M. (2003). Diffusion of Innovations (5th ed.). Free Press.

Rogers, D. L. (2016). The digital transformation playbook: Rethink your business for the digital age. Columbia Business School Publishing.

Siregar, M. F., Prasetyo, Y., & Wibowo, T. (2021). Digitalization in the manufacturing and financial industries: A case study in Indonesia. Journal of Technology and Management, 10(2), 150-165.

Susilo, J., Hartono, R., & Nugroho, D. (2022). The effect of electric vehicle adoption on operational cost efficiency in the logistics sector. Journal of Logistics Management, 8(3), 210-224.

Westerman, G., Bonnet, D., & McAfee, A. (2011). Leading Digital: Turning Technology into Business Transformation. Harvard Business Review Press.

Wang, Y., Han, J., & Huang, Y. (2020). Digitalization and sustainable logistics: Evidence from Chinese supply chain practices. Sustainability, 12(9), 3862. https://doi.org/10.3390/su12093862.