DINASTI PUBLISHER
DIJEFA: Dinasti International Journal of Economics, Finance & Accounting
E-ISSN: 2721-303X
P-ISSN: 2721-3021
https://dinastipub.org/DIJEFA dinasti.info@gmail.com +62 811 7404 455
**DOI:** https://doi.org/10.38035/dijefa.v5i5


# Analysis of Air Cargo Cost Efficiency at Sentani Airport Papua: The Role of Logistics Infrastructure, Tariff Policies, and Technological Innovation

**Andi Batari Toja[1*], Rifqi Raza Bunahri[2]**
[1]Politeknik Penerbangan Jayapura, Papua, Indonesia, bataritoja24@yahoo.co.id
[2]Politeknik Penerbangan Jayapura, Papua, Indonesia, rifqiraza@gmail.com

[*]Corresponding Author: bataritoja24@yahoo.co.id

**Abstract:** This study examines the factors influencing air cargo cost efficiency in Papua, where shipping costs are disproportionately high. The research focuses on three variables: logistics infrastructure, tariff policy, and technological innovation. A quantitative approach was applied, with data collected from 50 logistics employees at Sentani Papua Airport using a Likert scale questionnaire. Multiple linear regression analysis was used to assess the partial and simultaneous effects of these factors. The results show that logistics infrastructure and tariff policy have significant positive effects on air cargo cost efficiency, with t-test values of 6.774 and 9.972, respectively. However, technological innovation has no significant effect, with a significance value of 0.076. The F-test results indicate that the independent variables jointly influence the dependent variable, with an Fcount of 40.635, far exceeding the Ftable value of 2.81. The three factors account for 72.1% of the variation in air cargo cost efficiency, while the remaining 27.9% is influenced by other factors. This study suggests that improving logistics infrastructure and tariff policies can enhance cost efficiency, benefiting companies and consumers.

**Keyword:** Air Cargo, Cost Efficiency, Logistics Infrastructure, Tariff Policy, Technological Innovation

## INTRODUCTION

Papua, the easternmost province of Indonesia, possesses a unique and challenging geography characterized by steep mountains and dense tropical rainforests, making it one of the regions with the highest biodiversity in the world. Its central mountain range, such as the Jayawijaya Mountains with its famous peak, Puncak Jaya or Carstensz Pyramid, along with large rivers like the Mamberamo and Baliem Rivers, plays a crucial role in local transportation (Widiastono & Angriani, 2018).

However, the complex geography also presents significant challenges for infrastructure development, goods distribution, and access to essential services like healthcare and education. Addressing these challenges requires innovation in transportation technology and logistics management, as well as collaboration between the government, local communities, and the private sector to harness Papua's potential and improve its geographical conditions (Teti et al., 2020).

The difficult topography, comprising mountains, dense forests, and large rivers, creates a challenging environment for logistics operations (Badarudin et al., 2021). Steep mountains and dense forests hinder access to remote areas, complicating the transportation of goods. Land transport routes are often interrupted or difficult to navigate, slowing delivery processes and increasing the risk of accidents (Aboda et al., 2023). Meanwhile, large rivers present additional challenges for safe and efficient water transportation due to unpredictable currents and unstable weather conditions, particularly for small boats. Careful logistics planning and appropriate technology are therefore necessary to overcome these obstacles and ensure smooth and efficient distribution of goods in such complex geographical conditions (Sugiarti et al., 2022).

These factors contribute to higher logistics costs and unpredictable delivery times, which can hinder economic growth and infrastructure development in the region (Maharani, 2021). Despite these challenges, efforts continue to address the constraints and improve efficiency in freight operations in Papua. Innovations in transportation and logistics technology, such as the use of airplanes, ships, and specialized vehicles for rugged terrain, are key to navigating the region's difficult geography. In addition, collaboration between the government, industry, and local communities is crucial for developing resilient and sustainable logistics infrastructure (Sudira & Feneteruma, 2022). Limited accessibility and logistics infrastructure, such as the lack of airports and underdeveloped road networks, are major barriers to improving the efficiency of air cargo costs in the region. With limited airports, especially in remote areas, air cargo distribution becomes more difficult, and transportation costs tend to rise due to limited route options and flight frequencies (Giban, 2019).

Moreover, underdeveloped road networks complicate the process of transporting goods to and from airports, leading to increased costs and time needed to move cargo from origin to final destination (Paais, 2019). This condition calls for innovative solutions and significant investment in logistics infrastructure development to expand airport accessibility and improve road connectivity to overcome these barriers and enhance the efficiency of air cargo costs in the affected region. These challenges are further exacerbated by tariff policies that may not always take into account the local context and market dynamics in Papua, potentially resulting in inefficient and uncompetitive air cargo costs (Yuliana et al., 2019). Tariff policies set without considering Papua's unique geographical conditions and limited logistics infrastructure often fail to adjust to local needs and different market dynamics (Mahasyahputra et al., 2023). Consequently, air cargo costs become higher than necessary, burdening companies and consumers with disproportionate costs.

This situation not only affects industrial competitiveness in Papua but can also impede economic growth and access to goods and services for the local population. On the other hand, there is significant potential to improve air cargo cost efficiency in Papua through technological innovations in the aviation and logistics industries (Bunahri, et al., 2023). With ongoing technological advancements, there is potential to implement smarter, digitally connected solutions in logistics management, including real-time cargo tracking, flight route optimization, and more accurate cargo condition monitoring (Pereira et al., 2022). The use of drones for delivering goods to remote or hard-to-reach areas is also an attractive option (Heiets et al., 2022).

Additionally, the development of more efficient and environmentally friendly cargo aircraft can help reduce operational costs and environmental impact. By wisely leveraging these technological innovations, logistics companies and airlines in Papua can improve efficiency in air cargo delivery, reduce operational costs, and enhance customer satisfaction with faster and more reliable services (Bunahri, 2023). Technological advancements, such as the use of more efficient cargo aircraft, integrated supply chain management systems, and IoTbased logistics monitoring, can help address some of the challenges faced in air cargo operations in the region (Caetano & Pinto Alves, 2019). However, the adoption of new technologies may face challenges related to the availability of supporting infrastructure and the need for skilled human resources to operate and maintain these technologies (Adenigbo et al., 2023).

In this context, a comprehensive analysis of air cargo cost efficiency in Papua is essential. The aim of this research is to analyze several factors influencing air cargo cost efficiency in Papua. Specifically, it seeks to determine the impact of logistics infrastructure on the efficiency of air cargo shipping, assess the effect of tariff policies on air cargo costs, explore the role of technological innovation in improving air cargo efficiency, and identify efforts that can be made to enhance air cargo cost efficiency based on the findings of this analysis. Through these objectives, the research aims to provide practical recommendations to optimize air cargo operations in Papua.

## METHOD

### Type of Research

This study employs a quantitative research approach, utilizing a survey method to collect data on factors affecting Air Cargo Cost Efficiency in Papua. The survey is designed to gather numerical data for statistical analysis, helping to accurately measure relationships between variables. Key stakeholders, including airlines and cargo entrepreneurs, are surveyed to understand their perceptions and experiences regarding factors influencing cost efficiency in air cargo. The study was conducted at the Aviation Polytechnic of Jayapura during the 2023/2024 academic year, with research spanning several months. The research design framework consists of three independent variables and one dependent variable, represented as follows: X1 = Logistics Infrastructure, X2 = Tariff Policy, X3 = Technological Innovation, Y = Air Cargo Cost Efficiency. The hypotheses include: H1, H2, H3, and H4, which hypothesize that logistics infrastructure, tariff policies, and technological innovation individually and collectively influence Air Cargo Cost Efficiency

### Population and Sample

The population for this research includes logistics staff working at Sentani Airport, focusing on variables related to their performance, job satisfaction, or tariff policy needs. By narrowing the population to logistics staff, the study aims to provide in-depth insights into the challenges and needs of airport workers. The total population of logistics employees at Sentani Airport is 214 people. The sample, chosen using purposive sampling, includes 50 logistics employees responsible for air cargo operations. This method ensures that respondents with relevant knowledge and experience, such as operational staff and warehouse supervisors, provide diverse perspectives on factors affecting Air Cargo Cost Efficiency in Papua.

### Variables and Operational Definitions

The operational definitions of variables serve as the foundation for the questionnaire design, as detailed below. The independent variables include Logistics Infrastructure (X1), referring to facilities and transportation networks; Tariff Policy (X2), referring to pricing and cost structures in cargo services; and Technological Innovation (X3), referring to new solutions in logistics operations. The dependent variable, Air Cargo Cost Efficiency (Y), refers to optimizing costs related to cargo management, storage, and distribution, with indicators such as shipping distance and goods pricing.

**Data Collection Techniques**

The data collection techniques used in this research include observation, documentation, and questionnaires. Observation is employed at the initial stage, allowing researchers to observe and note behaviors or phenomena directly in the field without external interference. Documentation is used throughout the study to systematically record all stages and processes, including gathering relevant policies or official documents. The questionnaire is distributed to respondents meeting the research criteria, enabling efficient and structured data collection through a series of questions related to the research topic.

**Instrument Testing (Validity and Reliability Tests)**

To ensure the accuracy and reliability of the questionnaire instruments used in this study, validity and reliability tests were conducted. The validity test employed the Pearson product-moment correlation, comparing the calculated value of r (r_count) to the r_table value. If r_count > r_table, the item is considered valid, otherwise, it is deemed invalid (Sugiyono, 2019). A total of 20 respondents participated in the test, with a significance level of $\alpha = 0.05$. In terms of reliability, the study used Cronbach's Alpha coefficient to measure the internal consistency of the questionnaire items. According to Guilford's classification, a reliability coefficient close to 1.0 indicates high reliability (Rochaety et al., 2009). The test confirms that the instrument can consistently capture accurate data.

**Data Analysis Techniques**

Data analysis in this study was performed after collecting data related to logistical infrastructure, tariff policies, and technological innovations affecting air cargo cost efficiency in Papua. The analysis process involved simplifying the raw data, organizing it systematically, and interpreting it to gain meaningful insights. Through this process, the researcher aimed to identify potential patterns or relationships between the variables in the study. Additionally, regression analysis was used to predict changes in the dependent variable based on independent variables. This involved estimating the regression coefficients, assessing statistical significance, and interpreting the results to understand the relative influence of each predictor variable on air cargo cost efficiency (Sugiyono, 2019).

**Multiple Linear Regression Analysis and Classical Assumption Testing**

The multiple linear regression analysis aimed to determine the relationship between one dependent variable (air cargo cost efficiency) and multiple independent variables (logistical infrastructure, tariff policies, and technological innovations). The equation used was $\hat{Y} = a + b1\ X1 + b2\ X2 + b3\ X3 + e$, where each coefficient represented the influence of its corresponding predictor (Creswell & Creswell, 2018). Classical assumption tests, including normality (Kolmogorov-Smirnov), linearity (ANOVA), multicollinearity (VIF), and heteroskedasticity (scatterplot), ensured the model's reliability. These tests confirmed that the regression model met the necessary assumptions, making it suitable for interpreting the relationships between variables.

## RESULTS AND DISCUSSION

**Results**

**Research Data Description**

The following is a description of the data that can be collected and analyzed in the context of this research.

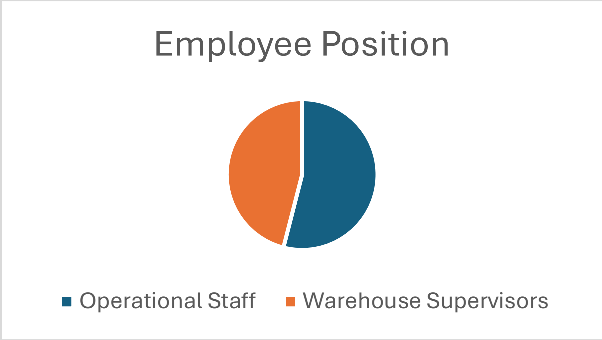


**Figure 1. Respondent Position**
Source: Processed data (2024)

From the research results, the majority of respondents are Operational Staff with a total of 27 people, while Warehouse Supervisors number 23 people. This shows that the views of the two job groups are quite balanced, providing a comprehensive perspective on warehouse operations and management.

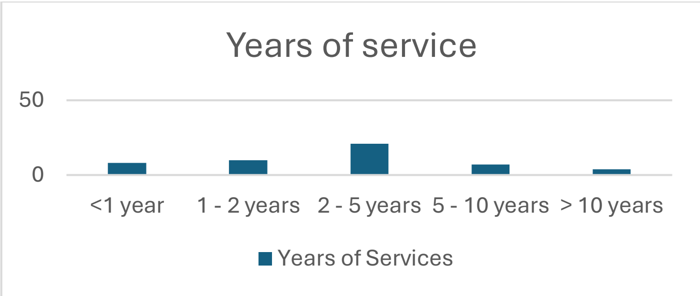


**Figure 2. Respondents' work period**
Source: Processed data (2024)

Based on the analysis of employee tenure data at Sentani Papua Airport, namely logistics staff, operational staff and warehouse supervisors. The distribution of employees according to tenure shows that 8 people have a tenure of less than 1 year, 10 people between 1 to 2 years, 21 people between 2 to 5 years, 7 people between 5 to 10 years, and 4 people with a tenure of more than 10 years, both for logistics staff, operational staff and warehouse supervisors.

## Validity and Reliability Test

**Table 1. Results of Validity Test of Logistics Infrastructure Variable (X1)**

| Instrument Items | r count | Description |
|---|---|---|
| 1 | 0.617 | Valid |
| 2 | 0.686 | Valid |
| 3 | 0.802 | Valid |
| 4 | 0.759 | Valid |
| 5 | 0.565 | Valid |
| 6 | 0.472 | Valid |
| 7 | 0.802 | Valid |
| 8 | 0.686 | Valid |
| 9 | 0.827 | Valid |
| 10 | 0.460 | Valid |
| 11 | 0.617 | Valid |
| 12 | 0.827 | Valid |
| 13 | 0.565 | Valid |
| 14 | 0.759 | Valid |

Source: Processed data (2024)

Based on the results of calculating the validity of the items using SPSS, the results of the validity test of the Logistics Infrastructure variable (X1) above show that of the 14 Instrument Items statements, all Instrument Items are declared valid.

**Table 2. Results of Validity Test of Tariff Policy Variable (X2)**

| Instrument Items | r count | Description |
|---|---|---|
| 1 | 0.755 | Valid |
| 2 | 0.473 | Valid |
| 3 | 0.476 | Valid |
| 4 | 0.638 | Valid |
| 5 | 0.681 | Valid |
| 6 | 0.675 | Valid |
| 7 | 0.480 | Valid |
| 8 | 0.591 | Valid |
| 9 | 0.477 | Valid |
| 10 | 0.777 | Valid |

Source: Processed data (2024)

Based on the results of calculating the validity of the items using SPSS, the results of the validity test of the Tariff Policy variable (X2) above show that of the 10 Instrument Items, the statements and all Instrument Items of the X2 variable are valid.

**Table 3. Results of the Validity Test of the Technological Innovation Variable (X3)**

| Instrument Items | r count | Description |
|---|---|---|
| 1 | 0.757 | Valid |
| 2 | 0.634 | Valid |
| 3 | 0.254 | Invalid |
| 4 | 0.603 | Valid |
| 5 | 0.267 | Invalid |
| 6 | 0.543 | Valid |
| 7 | 0.624 | Valid |
| 8 | 0.768 | Valid |
| 9 | 0.860 | Valid |
| 10 | 0.506 | Valid |
| 11 | 0.724 | Valid |
| 12 | 0.153 | Invalid |

Source: Processed data (2024)

Based on the results of the calculation of item validity using SPSS version 25 which can be seen in the table above, the results of the validity test of the Technological Innovation variable (X3) above show that of the 12 statement Instrument Items, there are 9 valid questions and 3 invalid questions.

**Table 4. Results of the Validity Test of the Air Cargo Cost Efficiency Variable (Y)**

| Instrument Items | r count | Description |
|---|---|---|
| 1 | 0.457 | Valid |
| 2 | 0.474 | Valid |
| 3 | 0.554 | Valid |
| 4 | 0.530 | Valid |
| 5 | 0.254 | Invalid |
| 6 | 0.543 | Valid |
| 7 | 0.464 | Valid |
| 8 | 0.468 | Valid |
| 9 | 0.160 | Invalid |
| 10 | 0.526 | Valid |
| 11 | 0.724 | Valid |

| Instrument Items | r count | Description |
|---|---|---|
| 12 | 0.543 | Valid |

Source: Processed data (2024)

Based on the results of the calculation of item validity using SPSS version 25, the results of the validity test of the Air Cargo Cost Efficiency variable (Y) above show that of the 12 statement instrument items, there are 10 valid questions and 2 invalid questions.

**Table 5. Results of Variable Reliability Test**

| Variable | Cronbach's Alpha | N of Items |
|---|---|---|
| Logistics Infrastructure (X1) | .932 | 14 |
| Tariff Policy (X2) | .817 | 10 |
| Technology Innovation (X3) | .700 | 9 |
| Air Cargo Cost Efficiency (Y) | .713 | 10 |

Source: Processed data (2024)

The reliability test results indicate that most variables exhibit good internal consistency, based on the obtained Cronbach's Alpha values. The Logistics Infrastructure variable (X1) has a very high reliability with a Cronbach's Alpha of 0.932 for 14 items. The Tariff Policy variable (X2) also shows good reliability, with a value of 0.817 for 10 items. However, Technological Innovation (X3) has a Cronbach's Alpha of 0.700 for 9 items, indicating high reliability. Air Cargo Cost Efficiency (Y) has an acceptable reliability value of 0.713 for 10 items, though it is close to the minimum threshold. Overall, these results suggest that the instrument used is sufficiently reliable, with most variables showing high reliability according to Guilford's classification, where a value greater than 0.8 indicates very high reliability and values above 0.700 indicate high reliability.

## Prerequisite Test (Classical Assumption)

**Table 6. Normality Test with Kolmogorov-Smirnov**

| Tests of Normality | | | | | | |
|---|---|---|---|---|---|---|
| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
| | Statistic | Df | Sig. | Statistic | df | Sig. |
| Logistics Infrastructure | ,103 | 50 | ,200* | ,962 | 50 | ,196 |
| Tariff Policy | ,116 | 50 | ,093 | ,952 | 50 | ,086 |
| Technology Innovation | ,115 | 50 | ,122 | ,925 | 50 | ,011 |
| Air Cargo Cost Efficiency | ,125 | 50 | ,074 | ,950 | 50 | ,073 |
| *. This is a lower bound of the true significance. | | | | | | |
| a. Lilliefors Significance Correction | | | | | | |

Source: Processed data (2024)

This data normality test was conducted with the help of the IBM SPSS program. The results of the normality test of Logistics Infrastructure (X1) data obtained a significance value of 0.200 which means it is greater than 0.05 or 0.200> 0.05, so it can be concluded that the data of the Logistics Infrastructure Variable (X1) is normally distributed. Furthermore, the significance value of the Tariff Policy Variable (X2) is 0.093 and greater than 0.05, which means that this variable is also normally distributed. This also occurs in Technology Innovation (X3) where the results of the Kolmogorov Smirnov test are more than 0.05, namely 0.122. While the significance value of the Air Cargo Cost Efficiency (Y) Variable is 0.074> 0.05, which means that the Y Variable is also normally distributed.

**Table 7. Linearity Test Results**

| | | | Sig. |
|---|---|---|---|
| Air Cargo Cost Efficiency* Logistics Infrastructure | Between Groups | (Combined) | ,014 |
| | | Linearity | ,000 |
| | | Deviation from Linearity | ,276 |
| Air Cargo Cost Efficiency* Tariff Policy | Between Groups | (Combined) | ,043 |
| | | Linearity | ,000 |
| | | Deviation from Linearity | ,384 |
| Air Cargo Cost Efficiency* Technology Innovation | Between Groups | (Combined) | ,012 |
| | | Linearity | ,000 |
| | | Deviation from Linearity | ,521 |

Source: Processed data (2024)

The results of the linearity test show that there is a significant linear relationship between Air Cargo Cost Efficiency and Logistics Infrastructure, Tariff Policy, and Technology Innovation. This is indicated by the Deviation from Linearity value for the three variables, namely 0.276, 0.384, and 0.521 for Logistics Infrastructure, Tariff Policy, and Technology Innovation, respectively, all of which have results greater than 0.05 indicating that there is no significant deviation from linearity. Thus, it can be concluded that the relationship between Air Cargo Cost Efficiency and the three variables is linear, meaning that an increase or decrease in one variable will be followed by consistent changes in the other variables.

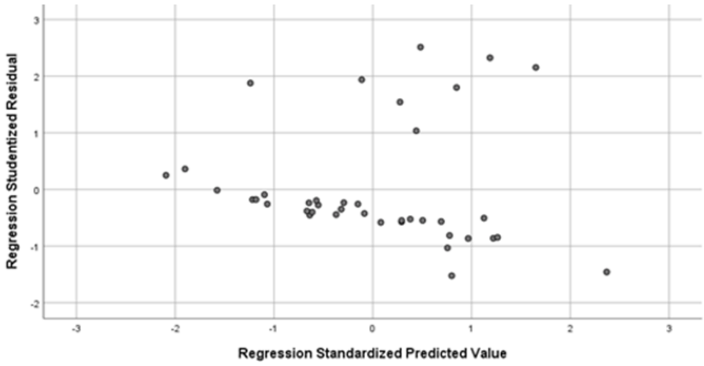


**Figure 3. Heteroscedasticity Test Diagram**
Source: Processed data (2024)

From the SPSS output, it is known that the points do not form a clear pattern or a certain pattern, and the points are spread above the X and Y axes, so from this it can be concluded that there is no heteroscedasticity, which means that this regression model is good.

**Table 8. Multicollinearity Test Results**

**Coefficients[a]**

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Tolerance | VIF |
| (Constant) | 12,197 | 6,552 | | 1,862 | ,071 | | |
| Logistics Infrastructure | ,336 | ,031 | ,522 | 6,774 | ,000 | ,969 | 1,052 |
| Tariff Policy | ,474 | ,047 | ,585 | 9,972 | ,003 | ,983 | 1,146 |
| Technology Innovation | ,005 | ,356 | ,219 | 1,239 | ,079 | ,931 | 1,021 |

a. Dependent Variable: Air Cargo Cost Efficiency

Source: Processed data (2024)

The results of the multicollinearity test show that the three independent variables Logistics Infrastructure, Tariff Policy, and Technology Innovation do not experience serious multicollinearity problems. The tolerance for all variables is above 0.1 and the VIF (Variance Inflation Factor) for all variables is well below 10. The tolerance values range from 0.931 to 0.983, and the VIF values range from 1.021 to 1.146, indicating that there is no high correlation between the independent variables. This means that each independent variable can contribute uniquely in explaining the variation in the dependent variable, namely Air Cargo Cost Efficiency, without significant redundancy.

## Hypothesis Testing

**Table 9. Multiple Linear Regression Analysis**

| Coefficients[a] | | | | | |
|---|---|---|---|---|---|
| Model | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
| | B | Std. Error | Beta | | |
| (Constant) | 12,197 | 6,552 | | 1,862 | ,071 |
| Logistics Infrastructure | ,336 | ,031 | ,522 | 6,774 | ,000 |
| Tariff Policy | ,474 | ,047 | ,585 | 9,972 | ,003 |
| Technology Innovation | ,005 | ,356 | ,219 | 1,239 | ,079 |

a. Dependent Variable: Air Cargo Cost Efficiency

Source: Processed data (2024)

The regression equation derived from the results is: $Y = 12.197 + 0.336X1 + 0.474X2 + 0.005X3$. The intercept value of 12.197 indicates that if all independent variables (X1, X2, and X3) are zero, the predicted air cargo cost efficiency (Y) would be 12.197. The coefficient of 0.336 for X1 (Logistics Infrastructure) suggests that a one-unit increase in X1 increases Y by 0.336 units. The coefficient of 0.474 for X2 (Tariff Policy) indicates that a one-unit increase in X2 raises Y by 0.474 units. Meanwhile, the coefficient of 0.005 for X3 (Technological Innovation) shows a minimal impact, with a one-unit increase in.

**Table 10. t-test**

| Coefficients[a] | | | | | |
|---|---|---|---|---|---|
| Model | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
| | B | Std. Error | Beta | | |
| (Constant) | 12,197 | 6,552 | | 1,862 | ,071 |
| Logistics Infrastructure | ,336 | ,031 | ,522 | 6,774 | ,000 |
| Tariff Policy | ,474 | ,047 | ,585 | 9,972 | ,003 |
| Technology Innovation | ,005 | ,356 | ,219 | 1,239 | ,079 |

b. Dependent Variable: Air Cargo Cost Efficiency

Source: Processed data (2024)

The hypothesis testing results showed that for the Logistics Infrastructure (X1), the t-value was 6.774 with a significance of 0.000, exceeding the t-table value of 2.011, thus rejecting Ho and accepting Ha, indicating that Logistics Infrastructure significantly influences Air Cargo Cost Efficiency. For Tariff Policy (X2), the t-value was 9.972 with a significance of 0.003, also greater than the t-table value, leading to the conclusion that Tariff Policy has a significant effect on Air Cargo Cost Efficiency. However, for Technological Innovation (X3), the t-value was 1.239 with a significance of 0.079, which was lower than the t-table value, resulting in Ho being accepted and Ha being rejected, meaning Technological Innovation does not significantly impact Air Cargo Cost Efficiency.

**Table 11. F Test**

| ANOVA[a] | | | | | |
|---|---|---|---|---|---|
| Model | Sum of Squares | Df | Mean Square | F | Sig. |
| Regression | 567,843 | 2 | 328,571 | | |
| Residual | 234,132 | 47 | 8,637 | 40,635 | ,002[b] |
| Total | 801,975 | 49 | | | |

a. Dependent Variable: Air Cargo Cost Efficiency
b. Predictors: (Constant), Logistics Infrastructure, Tariff Policy, dan Technology Innovation

Source: Processed data (2024)

Based on the results, the hypothesis (H4) can be formulated as follows: H0 states that there is no simultaneous effect of Logistics Infrastructure, Tariff Policy, and Technological Innovation on Air Cargo Cost Efficiency, while H1 suggests that these factors do have a simultaneous effect. The F-test result showed an F-value of 40.635 with a significance level of 0.002, which is greater than the F-table value of 2.81 and below the significance threshold of 0.05. Therefore, Ho is rejected, and Ha is accepted, indicating that Logistics Infrastructure, Tariff Policy, and Technological Innovation collectively have a significant effect on Air Cargo Cost Efficiency.

**Table 12. Correlation Coefficient Test**

| | | Logistics Infrastructure | Tariff Policy | Technology Innovation | Air Cargo Cost Efficiency |
|---|---|---|---|---|---|
| **Logistics Infrastructure** | Pearson Correlation | 1 | ,146* | ,055 | ,224** |
| | Sig. (2-tailed) | | ,149 | ,523 | ,026 |
| | N | 50 | 50 | 50 | 50 |
| **Tariff Policy** | Pearson Correlation | ,146* | 1 | ,171** | ,470* |
| | Sig. (2-tailed) | ,149 | | ,142 | ,000 |
| | N | 50 | 50 | 50 | 50 |
| **Technology Innovation** | Pearson Correlation | ,055 | ,171** | 1 | ,041 |
| | Sig. (2-tailed) | ,523 | ,142 | | ,717 |
| | N | 50 | 50 | 50 | 50 |
| **Air Cargo Cost Efficiency** | Pearson Correlation | ,224** | ,470* | ,041 | 1 |
| | Sig. (2-tailed) | ,026 | ,000 | ,717 | |
| | N | 50 | 50 | 50 | 50 |

Source: Processed data (2024)

The Pearson correlation analysis revealed significant relationships between the studied variables. Logistics Infrastructure showed a positive and significant correlation with Air Cargo Cost Efficiency ($r = 0.224$, $p = 0.026$), indicating that improvements in logistics infrastructure are associated with increased cost efficiency. Tariff Policy had a stronger positive correlation with Air Cargo Cost Efficiency ($r = 0.470$, $p < 0.001$), suggesting that better tariff policies contribute to higher efficiency. However, Technological Innovation had a very weak and non-significant correlation with Air Cargo Cost Efficiency ($r = 0.041$, $p = 0.717$). Tariff Policy also showed positive, though statistically insignificant, correlations with both Logistics Infrastructure ($r = 0.146$, $p = 0.149$) and Technological Innovation ($r = 0.171$, $p = 0.142$). Overall, the data indicate that Tariff Policy and Logistics Infrastructure are key factors correlated with Air Cargo Cost Efficiency.

**Table 13. Determination Coefficient Test**

| Model Summary[b] | | | | |
|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| | ,794[a] | ,721 | ,668 | 2,332 |

Source: Processed data (2024)

The results of the coefficient of determination test from the Model Summary show an R value of 0.794, indicating a strong correlation between the independent variables (Logistics Infrastructure, Tariff Policy, and Technological Innovation) and the dependent variable (Air Cargo Cost Efficiency). The R Square value of 0.721 suggests that approximately 72.1% of the variation in Air Cargo Cost Efficiency is explained by the model, which includes these three independent variables. The Adjusted R Square, at 0.668, indicates that the model remains effective in explaining the variation even after adjusting for the number of predictors and sample size. The Standard Error of the Estimate is 2.332, indicating a relatively small average prediction error, demonstrating that the model is fairly accurate in predicting Air Cargo Cost Efficiency. Overall, the model shows a good fit and the chosen variables significantly explain the variation in Air Cargo Cost Efficiency.

### Discussion

The t-test results for the Logistics Infrastructure variable (X1) showed a t-value of 6.774 with a significance level of 0.000, indicating a significant effect on Air Cargo Cost Efficiency at Sentani Airport in Papua. This means that the hypothesis (Ha) is accepted, confirming that improving logistics infrastructure positively impacts air cargo cost efficiency. This finding aligns with Sugiyanto (2021), who emphasized that effective logistics infrastructure, including road access, cargo handling facilities, and information technology, plays a crucial role in enhancing operational efficiency and reducing costs.

The t-test results for the Tariff Policy variable (X2) yielded a t-value of 9.972, greater than the t-table value of 2.011, with a significance level below 0.05, indicating a significant influence on Air Cargo Cost Efficiency. Thus, the hypothesis (Ha) is accepted. This supports previous research by Piadi et al. (2021), which demonstrated that transparent and well-planned tariff policies can help reduce operational costs, increase logistical efficiency, and create cost predictability for air cargo users, improving overall cost management.

For the Technology Innovation variable (X3), the t-value was 1.239 with a significance level of 0.079, indicating that it does not have a significant impact on Air Cargo Cost Efficiency at Sentani Airport. Therefore, the hypothesis (Ha) is rejected, meaning that current technological innovations have not yet substantially improved efficiency. Alayida et al. (2023) suggest that factors like high initial investments and inadequate infrastructure hinder the effective implementation of new technologies in air cargo operations.

The F-test results show that all three independent variables (Logistics Infrastructure, Tariff Policy, and Technology Innovation) simultaneously have a significant effect on Air Cargo Cost Efficiency, with an F-value of 40.635 and a significance level of 0.002. This means the hypothesis (Ha) is accepted. These findings align with research by Priyajati (2020), Agustini & Yarlina (2019), and Purbasari et al. (2023), emphasizing that a combined approach integrating logistics infrastructure, transparent tariff policies, and appropriate technological innovations can lead to optimal operational efficiency in air cargo services.

## CONCLUSION

The research concludes that logistics infrastructure has a significant impact on air cargo cost efficiency at Sentani Airport in Papua. With a t-value of 6.774 and a significance of 0.000, the study highlights the importance of good infrastructure, including road access, cargo handling facilities, information technology, and support services, in improving the speed and efficiency of cargo operations. Investing in infrastructure should be a priority for stakeholders to enhance operational efficiency, competitiveness, and regional economic development.

Additionally, the study shows that tariff policies significantly affect air cargo cost efficiency, with a t-value of 9.972 and a significance below 0.05. Effective tariff policies can reduce operational costs and improve logistics efficiency by enhancing cost transparency, utilizing information technology, and minimizing administrative expenses. Clear policies also help businesses plan their logistics budgets more accurately, leading to economic, social, and environmental benefits.

On the other hand, technological innovation did not have a significant effect on air cargo cost efficiency, with a t-value of 1.239 and a significance level greater than 0.05. The lack of significant impact may be due to challenges in technology implementation, high initial investment, infrastructure constraints, and workforce resistance to change. Despite this, technology still holds potential for future operational improvements if implemented effectively.

Overall, the study found that logistics infrastructure, tariff policies, and technological innovation collectively have a significant influence on air cargo cost efficiency, with an F-value of 40.635 and 72.1% of the variation explained by the model. An integrated and effective management approach across these areas is essential for optimizing cost efficiency in air cargo operations at Sentani Airport.

## REFERENCES

Aboda, M., Manakane, S. E., & Lasaiba, M. A. (2023). Pengembangan Objek Wisata Teluk Triton di Desa Lobo Kabupaten Kaimana Provinsi Papua Barat Monika. *Jurnal Pendidikan Geografi Unpatti*, *2*(2), 131–143.

Adenigbo, A. J., Mageto, J., & Luke, R. (2023). Adopting Technological Innovations in the Air Cargo Logistics Industry in South Africa. In *Logistics* (Vol. 7, Issue 4). https://doi.org/10.3390/logistics7040084

Agustini, E. D., & Yarlina, L. (2019). Efektifitas dan Efisiensi Biaya Logistik Angkutan Udara di Bandar Udara Soekarno- Hatta Effectiveness and Efficiency of Air Transport Logistic in Soekarno-Hatta International Airport. *Warta Ardhia: Jurnal Perhubungan Udara*, *41*(2), 97–110.

Alayida, N. F., Aisyah, T., Deliana, R., & Diva, K. (2023). Pengaruh Digitalisasi Di Era 4.0 Terhadap Para Tenaga Kerja Di Bidang Logistik. *Jurnal Economina*, *2*(1), 1290–1304. https://doi.org/10.55681/economina.v2i1.286

Anggraeni, S. M., & Rachmawati, D. (2022). Analisis Penanganan Kargo Pt. Angkasa Pura Logistik Bandar Udara Internasional Juanda Surabaya Jawa Timur. *Jurnal Multidisiplin Ilmu*, *1*(4), 681–685. https://journal.mediapublikasi.id/index.php/bullet/article/view/931%0Ahttps://journal.mediapublikasi.id/index.php/bullet/article/download/931/403

Bachtiar, J., Jandhana, P., & Siahaan, T. (2023). Peran Bandar Udara Dalam Meningkatkan Efektivitas Distribusi Logistik Industri Pertahanan. *Nusantara: Jurnal Ilmu Pengetahuan Sosial*, *10*(7), 3375–3383.

Badarudin, Mi., Marasabessy, I., & Sareo, F. P. (2021). Keadaan Sosial dan Ekonomi Nelayan Ikan Karang Kampung Malaumkarta Distrik Makbon Kabupaten Sorong Papua Barat. *(Jrpk) Jurnal Riset Perikanan Dan Kelautan*, *3*(2), 370–384.

Bunahri, R. R. (2023). Factors Influencing Air Cargo Business: Business Plan and Strategy, Professional Human Resources, and Airlines' Performance. *Journal of Accounting and Finance Management*, *4*(2), 220-226.

Bunahri, R. R., Supardam, D., Prayitno, H., & Kuntasi, C. (2023). Determination of Air Cargo Performance: Analysis of Revenue Management, Terminal Operations, and Aircraft Loading (Air Cargo Management Literature Review). *DJIMS: Dinasti International Journal of Management Science*, *4*(5), 833–844. https://www.dinastipub.org/DIJMS/article/view/1822%0Ahttps://www.dinastipub.org/DIJMS/article/download/1822/1252

Caetano, M., & Pinto Alves, C. J. (2019). Innovation System in Air Transport Management. *Journal of Information Systems and Technology Management*, *16*. https://doi.org/10.4301/s1807-1775201916010

Creswell, J. W., & Creswell, J. D. (2018). *Research Defign: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE publications.

Fajar, M. N., Fikri, A., Arkan, M. T., & Sahara, S. (2023). Lemahnya Mutu Kualitas Infrastruktur Logistik Di Indonesia Berdampak Pada Perekonomian Nasional. *Cross-Border*, *6*(1), 389–399.

Fredrian, R., Caturadi, R., & Rizaldy, W. (2020). Air Transport Policy & Regulation about Live Animal on Pandemic Season. *Advances in Transportation and Logistics Research*, *3*(Huri), 8–14.

Gavrilova, I. S., & Gyazova, M. M. (2021). Analysis of the market for the air transportation of bulky and heavy cargo: trends and prospects. *Journal of Revenue and Pricing Management*, *20*(1), 66–75. https://doi.org/10.1057/s41272-020-00252-4

Giban, A. (2019). *Pengembangan Bandara Udara Nop Goliat Dekai Di Yahukimo Papua*. Universitas Atmajaya Yogyakarta.

Heiets, I., La, J., Zhou, W., Xu, S., Wang, X., & Xu, Y. (2022). Digital transformation of airline industry. *Research in Transportation Economics*, *92*, 101186. https://doi.org/https://doi.org/10.1016/j.retrec.2022.101186

Hidayanto, R. A. (2022). *Pengaruh Inovasi Teknologi, Faktor Organisasi, dan Lingkungan Bisnis Pada UKM Terhadap Praktik Kelestarian Lingkungan Kota Yogyakarta*. Universitas Islam Indonesia.

Johnson Kennedy, P. S. (2019). Analisis Tingginya Biaya Logistik di Indonesia Ditinjau dari Dwelling Time. *Jurnal Economic Resource*, *1*(2), 136–145.

Lesmini, L., & Rizaldy, W. (2021). Studi Perbandingan Prosedur Penanganan Barang Perishable untuk Cold Storage di Pelabuhan dan Bandara Internasional di Jakarta. *Jurnal Manajemen Bisnis Transportasi Dan Logistik*, *7*(1), 53–64. https://doi.org/10.54324/j.mbtl.v7i1.638

Magfirah, O. S., & Fitri, Y. (2019). Analisis Efisiensi Biaya Produksi Dengan Penggunaan Biaya Standar Dalam Meningkatkan Rasio Net Profit Margin (Studi Empiris Pada Umkm Dendeng Sapi Di Banda Aceh). *Jurnal Ilmiah Mahasiswa Ekonomi Akuntansi*, *4*(2), 334–343. https://doi.org/10.24815/jimeka.v4i2.12262

Maharani, K. (2021). Analisis Faktor Yang Mempengaruhi Tingkat Ketercapaian Angka Partisipasi Sekolah Di Papua (Studi Kasus Di Kabupaten Merauke). *Borneo Journal of Islamic Education*, *I*(1), 2021.

Mahasyahputra, B. A., Wulandari, P., Maharani, E. D., Rahman, A. H., & Sahara, S. (2023). Analisis Perbandingan Sistem Logistik Jakarta dengan Papua. *Jurnal Ilmiah Wahana Pendidikan*, *9*(14), 208–216.

Munim, Z. H., & Schramm, H.-J. (2018). The impacts of port infrastructure and logistics performance on economic growth: the mediating role of seaborne trade. *Journal of Shipping and Trade*, *3*(1), 1–19. https://doi.org/10.1186/s41072-018-0027-0

Nurkhamid, M., & Rahayu, S. T. (2020). Efisiensi Biaya Logistik Dengan Fasilitas Kepabeanan Pusat Logistik Berikat: Impian Atau Kenyataan? *Jurnal Perspektif Bea Dan Cukai*, *4*(1), 36–50. https://doi.org/10.31092/jpbc.v4i1.763

Paais, M. W. (2019). Analisis Kapasitas Terminal Penumpang Bandar Udara Sentani Di Jayapura. *Prosiding Seminar Intelektual Muda*, *1*, 290–294. https://doi.org/10.25105/psia.v1i1.5963

Pereira, B. A., Lohmann, G., & Houghton, L. (2022). Technology trajectory in aviation: Innovations leading to value creation (2000–2019). *International Journal of Innovation Studies*, *6*(3), 128–141. https://doi.org/https://doi.org/10.1016/j.ijis.2022.05.001

Piadi, A. A., Ari, B., Sugiarto, R., & Nurullah, P. (2021). Biaya Logistik Sektor Transportasi Laut Dan Pengaruhnya Terhadap PDB Nasional. *Jurnal Transportasi Multimoda*, *19*(2).

Priyajati, H. A. (2020). *Pengaruh Infrastruktur Logistik Terhadap Pertumbuhan Ekonomi : Studi Kasus 9 Negara Emerging Markets Asia*. Universitas Airlangga.

Purbasari, R., Jamil, N., Novel, A., & Kostini, N. (2023). Digitalisasi Logistik Dalam Mendukung Kinerja E-Logistic Di Era Digital: A Literature Review Logistic Digitalization in Support of E-Logistics Perfomance in the Digital Era: A Literature Review. *Management, Business and Logistics (JOMBLO)*, *01*(02), 177–196.

Sarmauli, S. M. (2021). Analisis Kebijakan Tarif Bayar Bawah (Tbb) Dan Tarif Bayar Atas (TBA) Dalam Angkutan Udara. *E-Journal Fatwa Hukum*, *4*(2).

Sudarto. (2023). Analisa Rekayasa Transportasi Untuk Distribusi Logistic Di PT ABC Transportation Engineering Analysis For Logistic Distribution At PT ABC. *JSNu : Journal of Science Nusantara*, *3*(1), 13–21.

Sudira, I. N., & Feneteruma, L. (2022). Pembangunan, Marginalisasi dan Integrasi Papua. *Jurnal Masyarakat Indonesia*, *48*(1), 147–152.

Sugiarti, Gusmali, J., & Asriati, S. (2022). Tantangan Pengembangan Jembatan Udara di Provinsi Papua. *Jurnal Mitra Manajemen*, *13*(2), 69–76.

Sugiyanto. (2021). Analisis Kualitas SDM dan Layanan Keagenan Perusahaan Pelayaran Nasional di Indonesia. *Jurnal Manajemen Bisnis Transportasi Dan Logistik (JMBTL)*, *7*(2), 173–180. https://doi.org/10.54324/j.mbtl.v7i2.659

Sugiyono. (2019). *Metode Penelitian Kualitatif, Kuantitatif, dan R&D*. Alfabeta.

Szymczyk, K., & Kadłubek, M. (2019). Challenges in general cargo distribution strategy in urban logistics - comparative analysis of the biggest logistics operators in EU. *Transportation Research Procedia*, *39*(2018), 525–533. https://doi.org/10.1016/j.trpro.2019.06.054

Teti, Y. N., Nurhayati, S., Widiyantoro, M. R., Umalekhoa, I., Habibi, S. W., Ndala, S., Stella, S., & Sumba, M. (2020). Sistem Informasi Geografis Destinasi Tempat Wisata Provinsi Papua. *Journal Technology and Information System (J-TIS) ISSN*, *1*(2), 71–82. http://jurnal.uniyap.ac.id/uyp/index.php/jtis/article/view/291%0Ahttp://jurnal.uniyap.ac.id/uyp/index.php/jtis/article/download/291/271

Trisnawan, Y. L., & Yuliarmi, N. N. (2022). Pengaruh Infrastruktur, Investasi, Biaya Transportasi terhadap Jumlah UMKM dan Pertumbuhan Ekonomi Daerah yang Dilalui Tol Batang – Semarang. *E-Jurnal Ekonomi Pembangunan Universitas Udayana*, *11*(1), 55. https://doi.org/10.24843/eep.2022.v11.i01.p03

Turienzo, J., Blanco, A., F. Lampón, J., & del Pilar Muñoz-Dueñas, M. (2023). Logistics business model evolution: digital platforms and connected and autonomous vehicles as disruptors. *Review of Managerial Science*. https://doi.org/10.1007/s11846-023-00679-0

Vidyatmoko, D., Rosadi, H. Y., Susetyanto, S., Hastuti, P., & Zubair, M. (2019). Analisis Faktor Penentu Inovasi Teknologi Di Industri Pangan. *Jurnal Sains Dan Teknologi Indonesia*, *14*(1), 29–37. https://doi.org/10.29122/jsti.v14i1.902

Vikaliana, R., Raza, E., & Sutandi, S. (2022). Logistik Perkotaan Pintar di Provinsi DKI Jakarta: Sebuah Pendekatan Causal Loop Diagram. *Jurnal Ilmiah Ilmu …*, *6*, 1–10. https://online-journal.unja.ac.id/JIITUJ/article/view/19326%0Ahttps://online-journal.unja.ac.id/JIITUJ/article/download/19326/13752

Widiastono, A., & Angriani, L. (2018). Analisis Dan Evaluasi Sistem Informasi Geografis Pariwisata Propinsi Papua. *ILKOM Jurnal Ilmiah*, *10*(1), 33–37. https://doi.org/10.33096/ilkom.v10i1.199.33-37

Widodo, A., Widyastuti, R., & Hendrawan, S. A. (2024). Prediksi Biaya Logistik Menggunakan Metode K-Means. *1*(1), 19–27.

Wirabrata, A., & Silalahi, S. A. F. (2012). Hubungan Infrastruktur Transportasi dan Biaya Logistik. *Jurnal Ekonomi & Kebijakan Publik*, *3*(1), 79–90. http://www.bisnis.com/articles/

Yuliana, D., Subekti, S., Kusumawati, D., Alwi, M., & Windrasari, S. (2019). Kajian Angkatan Udara Perintis Kargo di Provinsi Papua. *Warta Ardhia: Jurnal Perhubungan Udara*, *44*(2), 107–122.

Zhao, H., Zhang, N., & Guan, Y. (2018). Safety assessment model for dangerous goods transport by air carrier. *Sustainability (Switzerland)*, *10*(5), 1–16. https://doi.org/10.3390/su10051306