

Comparative Analysis of Operational and Investment Costs Between Diesel Trucks and Electric Trucks in Coal Transportation Activities in West Kutai Regency

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ABSTRACT

This study aims to compare investment and operational costs between electric trucks (Electric Vehicles/EV) and diesel trucks (Internal Combustion Engine/ICE) in coal transportation activities in Kutai Barat Regency. The main issue addressed is the high investment cost of electric vehicles and their suboptimal operational productivity compared to conventional vehicles. A quantitative approach was employed using descriptive statistics and the non-parametric Mann–Whitney U test. Data were collected from actual operational measurements of both vehicle types. The results show that electric trucks have significantly higher investment costs than diesel trucks. However, in terms of energy efficiency, electric trucks offer significant savings—up to 72.9% in energy costs. Meanwhile, operational and total costs between the two truck types were not statistically different. In terms of productivity and daily output capacity, diesel trucks were significantly superior. This study contributes to the existing body of research on coal transportation and electric vehicle adoption by providing the first comprehensive cost-benefit analysis in the Indonesian mining context, specifically addressing the economic viability and operational performance of electric trucks under challenging mining conditions in remote areas. The findings offer critical insights for mining companies and policymakers navigating the transition toward sustainable transportation technologies while maintaining operational efficiency and profitability. These findings suggest the adoption of a mixed-fleet strategy and underscore the importance of developing supporting infrastructure such as swap charging stations to optimize the role of electric vehicles in the mining sector.

KEYWORDS

Electric truck, Diesel truck, Operational cost, Investment cost, Mann–Whitney U, Coal transportation



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INTRODUCTION

In recent years, climate change has become one of the biggest global challenges facing humanity today. The impacts of climate change, such as rising global temperatures, rising sea levels, and extreme weather, have affected various aspects of life, including the economic, social, and environmental sectors (Augusta et al., 2023). One of the main causes of climate change is greenhouse gas (GHG) emissions resulting from the burning of fossil fuels, such as petroleum, natural gas, and coal. The transportation and industrial sectors, including the mining industry, are significant contributors to these GHG emissions (Al-Yaqoobi et al., 2021; Pranata, 2023).

As one of the largest coal-producing countries in the world, Indonesia faces unique challenges in the coal mining industry, which serves as both a critical economic pillar and a significant environmental concern (Patriawan et al., 2021; Pranata et al., 2023; Romi, 2019). The coal mining sector in Indonesia not only supports the national economy through substantial contributions to state revenue, exports, and employment generation, but it also bears considerable responsibility for managing the environmental impacts of extraction and

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transportation activities (Horngren et al., 2018). This dual role creates a complex tension between economic development imperatives and environmental sustainability obligations that require careful navigation through evidence-based policy and operational decision-making (Garrison et al., 2021).

Based on data from the Central Statistics Agency (BPS), Indonesia's coal production in 2023 will reach more than 700 million tons, with around 70% of production output exported to various countries, resulting in an export value of USD 25.2 billion. This sector also provides employment for more than 1.2 million people throughout Indonesia, both directly and indirectly. As one of the largest coal-producing countries in the world, Indonesia has a great responsibility in managing the environmental impact of mining activities (Mukmin & Gusprasetyo, 2017; Nugroho, 2020).

Indonesia, as an archipelagic country with a long coastline, is very vulnerable to the impact of climate change (Gibbons & Chakraborti, 2010).

. Rising sea levels threaten coastal areas and small islands, while changes in rainfall patterns can lead to floods and droughts that are detrimental to the agricultural and infrastructure sectors (Mantik & Sukadana, 2022). GHG emissions from various sectors, including energy, transportation, and industry, are the main cause of this problem. Data from the Ministry of Environment and Forestry (MoEF) shows that the energy sector, including coal-fired power plants, is one of the largest contributors to GHG emissions in Indonesia (Habib et al., 2023).

In West Kutai Regency, East Kalimantan, the coal mining sector operates under particularly challenging conditions that amplify the economic pressures facing transportation operations. The region's hilly terrain, suboptimal road conditions, and remote location create operational inefficiencies that significantly impact fuel consumption and vehicle maintenance costs for diesel-powered fleets (Rahmawati et al., 2021; Saputra & Yulhendra, 2024). These geographic and infrastructural challenges, combined with volatile global fuel prices and increasing regulatory pressure to reduce emissions, have intensified the urgency for mining companies in the region to explore alternative transportation technologies. However, the transition to electric vehicles in such remote mining areas presents unique obstacles, including limited access to reliable electrical grid infrastructure and the absence of established charging networks, making West Kutai an especially critical case study for evaluating the economic viability of electric truck adoption in Indonesia's coal transportation industry.

The Indonesian government has shown its commitment to reducing carbon emissions through various policies and programs, such as the National Energy General Plan (RUEN) and the Net Zero Emission (NZE) target by 2060. Behind its crucial role, the sector faces various challenges, especially in terms of operational cost efficiency, environmental sustainability, as well as government regulatory pressure to reduce carbon emissions. One of the strategic steps taken is to encourage the transition from the use of fossil fuels to cleaner and more environmentally friendly energy, including through the electrification of heavy equipment used in the mining sector.

Within the global context of energy transitions, the shift from diesel to electric vehicles represents a critical component of decarbonization strategies across multiple industries. International experiences from countries such as Norway, China, and Sweden demonstrate that the successful adoption of electric vehicles in industrial settings requires not only technological readiness but also comprehensive policy frameworks, substantial infrastructure investments, and carefully designed economic incentives. However, the existing literature on electric vehicle

adoption in mining operations remains predominantly focused on developed economies with mature infrastructure and favorable policy environments. There is a notable research gap concerning the economic feasibility and operational performance of electric trucks in developing countries, particularly in remote mining regions characterized by limited infrastructure, challenging terrain, and unstable power supply. This study addresses this gap by examining the specific case of coal transportation in West Kutai Regency, providing critical insights into the real-world challenges and opportunities of electric vehicle adoption in resource-constrained settings that are representative of many mining operations across Southeast Asia and other developing regions.

Although coal is an energy source that produces significant GHG emissions, coal is still the main source of energy in Indonesia for several reasons. First, coal is a relatively cheap and abundant source of energy, making it an attractive choice to meet the ever-increasing energy needs. Second, the infrastructure for renewable energy is still inadequate, making it difficult to replace coal quickly. Third, the coal industry makes a significant economic contribution to the country, including state revenue, exports, and job creation. Therefore, the transition from coal to renewable energy requires careful planning and large investments.

One of the main challenges in coal mining operations is transportation, which relies largely on a fleet of diesel-fueled trucks. Dependence on diesel trucks is a challenge in itself, considering the fluctuations in fuel oil (BBM) prices that continue to increase, which contributes to the high operating costs of mines. Since 2022, industrial fuel prices in Indonesia have increased significantly due to global market instability and world energy policies that increasingly suppress the use of fossil fuels. In addition, the use of diesel trucks has a significant impact on the environment, with exhaust emissions being one of the main contributors to air pollution and greenhouse gases. Data from Climate Watch shows that the transportation sector accounts for about 23% of total global carbon emissions, which has also prompted the Indonesian government to issue regulations to reduce emissions, such as the implementation of a carbon tax and the Net Zero Emission 2060 target.

Coal companies have a significant role as GHG contributors through their various operational activities. Starting from the mining process, processing, to coal transportation, all produce GHG emissions. The use of diesel-fueled heavy equipment, such as trucks and excavators, is one of the main sources of GHG emissions in the mining sector. In addition, burning coal in power plants also produces significant GHG emissions. Therefore, coal companies have a great responsibility to reduce GHG emissions through various efforts, such as improving energy efficiency, using cleaner technologies, and switching to renewable energy.

Based on BPS analysis, the use of electric trucks in Indonesia's transportation sector is expected to grow by 15% per year in the 2025–2030 period, driven by government policies that support the clean energy transition. The use of electric trucks in the mining industry, while still limited, has the potential to reduce operational costs by up to 40% compared to diesel trucks, as it requires no fossil fuels and has lower maintenance costs. However, the adoption of electric trucks still faces major obstacles, such as high initial investment costs and limited charging infrastructure. Until 2023, the number of charging stations for electric vehicles in Indonesia has only reached 1,000 units, with uneven distribution, especially in remote or mining areas (Mustakim, 2023).

From an economic perspective, although the initial investment cost of electric trucks is higher compared to diesel trucks, the long-term operating costs are lower. The average price of an electric truck is 1.5 to 2 times the price of a conventional diesel truck, but with higher energy efficiency and lower maintenance costs. Several international studies show that the implementation of electric trucks in the mining industry can be effective if supported by the right policies and adequate infrastructure, as has been done in Norway and China (Kurniawan, 2019).

In Indonesia, East Kalimantan Province, West Kutai Regency is one of the largest coal-producing areas, with very intensive mining activities and quite challenging transportation routes, including hilly terrain and road conditions that are not always optimal. Therefore, it is important to conduct a comprehensive analysis of the *comparative operational and investment costs between diesel trucks and electric trucks* in the context of coal transport in the region.

This study will compare the two types of trucks by taking into account factors such as energy efficiency, maintenance costs, truck life, and environmental impact, so that mining companies can make more effective investment decisions.

In addition, reliance on fossil fuels such as diesel also contributes to the increasingly alarming global energy crisis. Countries around the world, including Indonesia, have begun to look for renewable energy alternatives to reduce their dependence on fossil fuels and address their adverse impact on the environment. In response to these challenges, the Indonesian government has targeted greater use of renewable energy, with a commitment to achieve Net Zero Emissions by 2060. In this regard, the transition to electric vehicles in the transportation sector, including in the mining sector, is an important step that must be considered by mining companies to support the government's efforts to achieve this goal.

Mining companies in Indonesia, especially those located in coal-producing areas, often face challenges in updating their transportation fleets, both in terms of technology and infrastructure. The high initial investment cost for electric vehicles, especially electric trucks, which are more expensive compared to diesel trucks, is one of the factors hindering the adoption of this technology. However, lower operating costs in the long run, such as not requiring fossil fuels and fewer maintenance needs, can provide significant benefits for companies in terms of cost savings. Therefore, although the initial investment cost of electric trucks is higher, the long-term gains can offset those expenses over time.

Another factor to consider is the potential long-term economic impact that can be gained by switching to electric trucks. As one of the largest coal-producing countries, Indonesia has a great opportunity to increase competitiveness in the global market by reducing operational costs and optimizing transportation processes in the mining sector. In addition, the use of electric trucks can help reduce carbon emissions generated by the transportation sector, which not only benefits the environment but also improves the company's image in terms of sustainability and compliance with increasingly stringent government regulations related to carbon emissions. Therefore, the adoption of electric trucks in Indonesia's mining sector can have a positive impact on the national economy while supporting the sustainable development goals set by the government.

In addition to the economic and environmental impacts, the use of electric trucks can also improve operational efficiency. Electric trucks have more stable performance compared to

diesel trucks in acceleration, energy use, and engine maintenance. The fewer engine components in electric trucks make them simpler to maintain and reduce the risk of damage that can occur in more complicated conventional machines. This reduction in maintenance costs can improve overall operational efficiency, especially in the mining sector, which faces challenging road and terrain conditions. On the other hand, the operation of electric trucks can also reduce noise generated by diesel trucks, improving working comfort for operators and reducing environmental disturbances around mining areas.

Along with the increasing demand for transportation in coal activities, operational cost efficiency and sustainability are the main factors considered in fleet selection. Based on data, diesel trucks, which still dominate coal transportation, have an operational cost of USD 0.194 per ton per kilometer, while electric trucks only require USD 0.058 per ton per kilometer. This difference shows that electric trucks offer significant efficiencies in operating costs. However, electric trucks require a higher initial investment cost—USD 80,000 compared to diesel trucks at USD 50,000. This phenomenon raises fundamental questions regarding the trade-off between high initial investment costs and long-term operational cost savings.

In addition, the global trend towards the use of environmentally friendly technologies drives this consideration. The use of electric trucks not only reduces operational costs but also contributes to carbon emissions reduction. This aligns with efforts to maintain environmental sustainability, especially in a mining sector often scrutinized for its environmental impact.

Given the significant difference between operational costs and initial investment, this phenomenon forms the basis for analyzing the *comparison of operational and investment costs between diesel trucks and electric trucks in coal transportation activities*. The study is also expected to provide insights into long-term efficiencies and encourage the use of more sustainable transportation technologies.

It is also important to recognize that while the transition to electric vehicles has the potential to bring positive change, the mining sector in Indonesia still faces major challenges related to adopting this technology. One is the lack of infrastructure supporting electric vehicles, such as limited charging stations and uneven distribution throughout the region, especially in remote areas like West Kutai Regency—East Kalimantan—which still lacks sufficient power supply from PLN. This infrastructure limitation can hinder widespread electric truck implementation in the mining sector. Therefore, further support from the government and private sector is needed to accelerate charging infrastructure development so the transition to electric vehicles can proceed effectively.

Based on this situation, this study aims to evaluate the feasibility of using electric trucks in coal transportation operations in West Kutai Regency. The study results are expected to provide recommendations for mining companies on more efficient and sustainable investment strategies and offer insights for policymakers to support the adoption of environmentally friendly technology in mining.

The world's energy needs are still dominated by fossil energy, including coal, which has a strategic role in supporting the industrial sector and power plants. In Indonesia, East Kalimantan is one of the largest coal-producing regions, with various mining companies operating there. One of these companies supporting mining processes is PT XYZ, engaged in mining contractor services (Supriadi & Syahidah, 2018).

PT XYZ is a subsidiary of PT ABC Tbk, focusing on various mining services ranging from exploration, construction, mining operations, coal transportation, to reclamation. Established in 2013, PT XYZ currently runs several projects owned by PT ABC Tbk, including one in West Kutai Regency, East Kalimantan. PT XYZ's ownership structure is within the larger PT ABC Tbk group in Indonesia. PT ABC itself is part of PT 123 Tbk, a Thailand-based integrated energy company operating globally. PT 123 Tbk has a long-term vision to become a leader in the energy transition, targeting Net Zero Emissions by 2050.

PT 123 Tbk's vision encourages all its business entities, including PT ABC and PT XYZ, to support decarbonization, including plans to use 100% electric trucks as a coal transportation fleet. Operationally, the use of electric trucks is expected to reduce carbon emissions from hauling activities, representing a tangible step toward the company's sustainability goals.

Currently, however, PT XYZ still relies on a diesel truck fleet as the primary tool in coal transportation. This poses challenges, especially since diesel trucks incur high operating costs, particularly for fuel and maintenance. Furthermore, global trends toward sustainable mining practices are motivating companies to consider energy transition measures.

The urgency of this research lies in understanding and comparing the operational and investment costs between diesel trucks and electric trucks in coal hauling activities at PT XYZ. Besides contributing to Net Zero Emission goals, this analysis is essential for data-driven investment decisions regarding cost efficiency and long-term benefits. This aligns with PT XYZ's vision to develop efficient, competitive, and environmentally friendly operations. By conducting this cost comparison analysis, the results can offer strategic recommendations supporting the energy transformation agenda in mining, addressing environmental sustainability and financial feasibility.

Based on the background outlined, this research focuses on answering two main questions: First, what is the operational cost comparison between diesel trucks and electric trucks in coal transportation activities? Second, how do investments compare between diesel trucks and electric trucks in the same context? These questions aim to provide a comprehensive overview of the economic aspects of using both truck types.

This research has two main objectives: first, to analyze the *comparison of operational costs between diesel trucks and electric trucks in coal transportation activities in West Kutai Regency*; second, to analyze the investment comparison between the two truck types to determine long-term efficiency and feasibility.

This research is expected to benefit several parties. For mining companies, it can serve as a reference for investment decisions based on operational and investment cost comparisons. For the government, the findings can inform policy related to energy transition and electric truck adoption in mining. For academics, the study adds to the literature on operational costs and investment analysis of diesel and electric vehicles in the coal mining sector.

METHOD RESEARCH

This research is a case study with a descriptive-comparative approach and time series. The descriptive method is used to describe the variable status of investment and operational costs, while the comparative method aims to compare the two types of costs (Sugiyono, 2020).

The time series approach allows the analysis of the pattern of relationships between variables within the same period, in accordance with the concept of Sekaran & Bougie (2016) about case studies that collect specific information on specific organizational units. This study analyzes coal transportation activities using diesel trucks (SINOTRUK-SITRAK) and electric trucks (SINOTRUK-HOWO) at PT. XYZ, West Kutai Regency, East Kalimantan. The main objective is to compare operational and investment costs between the two types of trucks to achieve cost efficiency and support the Net Zero Emission 2050 target (Field, 2017).

The population includes all SITRAK (diesel) and HOWO (electric) trucks used in coal transportation operations at PT XYZ, including operational aspects such as carrying capacity, energy consumption, frequency of use, vehicle age, and maintenance costs.

The sample was selected using purposive sampling techniques with the following criteria: (1) Trucks active in coal transportation operations with similar specifications, (2) Age of the vehicle in the productive range with similar usage rates, (3) Frequency of regular use for accurate comparison, and (4) Availability of complete operational data including energy consumption, maintenance costs, and initial investment.

Table 1. Variable Operational Definition

Variable	Definition	Formula
Investment Cost	The cost of purchasing a vehicle converted to depreciation over the economical life	Investment Cost : Operation Period : Production : Distance
Operating Costs	Total cost of operating coal transport vehicles	Total Operating Cost : Production : Distance
Energy Cost	Cost to drive the truck (diesel or electric)	Energy Cost : Production : Distance
Total Cost	Combined operational and investment costs	(Operational Cost + Investment Cost) : Production : Distance
Transport Capacity	Total load that a truck can transport	Load Load – Empty Load
Productivity	Time required for a single production cycle	Empty travel time + Loaded travel time
Production Capacity per Day	Total truck production in one day	The production amount of each truck per day

Primary Data: Fleet operational data, actual fuel consumption, maintenance and repair costs, and vehicle productivity. **Secondary Data:** Technical specifications from manufacturers, component price data from suppliers, electricity tariffs and fuel prices from official sources, and previous research literature.

Data obtained from PT. XYZ (operational reports, consumption and cost records, procurement documents, financial statements), vehicle manufacturers and distributors (specification catalogs, performance data, spare parts information), and public sources (PLN electricity tariffs, Pertamina fuel prices).

Data collection was carried out through four main techniques. Documentation includes analysis of financial and operational statements as well as the study of historical data on costs and usage patterns. Interviews are conducted with management to understand electric vehicle

usage strategies and investment decision factors, as well as with operators to understand differences in field performance. Field observations collect data on actual operational conditions, consumption patterns, maintenance procedures, and supporting infrastructure. The literature study conducted a literature search of scientific journals and official publications on vehicle efficiency as well as an analysis of previous research on cost comparisons in industrial transportation.

Data Analysis Methods

Statistics Descriptive

Used to provide an overview of data through minimum, maximum, average, and standard deviation sizes. This analysis identifies and compares the average value of operating and investment costs between diesel and electric trucks, providing an initial understanding of the distribution of the data before hypothesis testing.

Normality Test

Ensure near-normal data distribution using Kolmogorov-Smirnov, Shapiro-Wilk, and histogram visualizations. The data is considered to be normally distributed if the p-value > 0.05 . This test is important for the validity of parametric statistical analysis according to Ghazali (2018).

Differential Test

Evaluate the significant difference between the operating costs and investment of diesel versus electric trucks. The selection of methods is tailored to the distribution of data: Independent Sample t-Test for normal distributed data, and Mann-Whitney U Test for abnormal data.

Research hypothesis:

- H_1 : There is a significant difference in operational/investment costs between diesel and electric trucks
- H_0 : There is no significant difference in operational/investment costs between diesel and electric trucks

Test criteria: H_0 is rejected if the p-value < 0.05 (there is no significant difference), H_0 is accepted if the p-value is > 0.05 (no significant difference).

RESULTS OF RESEARCH AND DISCUSSION

Descriptive Research Variables

Descriptive analysis aims to provide an overview of the data characteristics of each research variable before further testing is carried out. In this study, the variables analyzed include investment costs, operational costs, energy costs, total costs, transportation capacity, productivity, and production capacity per day. All of these variables are compared based on two groups of vehicles, namely electric trucks (*electric vehicle* or EVs) and diesel-fueled trucks (*internal combustion engine* or ICE).

The data were analyzed using descriptive statistical measures, including the mean value (*Mean*), middle value (*median*), minimum values, maximum values, and standard deviations (*standard deviation*). The mean value provides a general indication of the magnitude of each

variable, while the median is used to see the central distribution of the data, which is often more representative when there are outliers (*outliers*). Minimum and maximum values indicate the range of data distribution, while standard deviation indicates the rate of value spread within that data group.

The use of descriptive statistics is also intended to support the interpretation of the results of different tests carried out at a later stage. Before concluding whether there are significant differences between the two types of trucks, it is important to first understand the general trends and distribution of each variable in a data set. The following table 2 presents a summary of the results of the descriptive analysis of each research variable.

Table 2. Descriptive Statistics of Research Variables

Variabel	Truck Type	Mean	Median	Min	Max	Std. Dev
Investment Cost (million IDR)	EV	708,98	603,06	294,67	2.002,43	332,50
	ICE	225,29	180,64	79,29	589,89	139,75
Operating Costs (million IDR)	EV	1.019,66	867,33	423,80	2.879,92	478,20
	ICE	809,66	649,20	284,94	2.119,96	502,25
Energy Cost (million IDR)	EV	108,90	107,15	46,51	229,93	33,64
	ICE	401,87	373,76	113,35	1.140,86	161,99
Total Cost (million IDR)	EV	1.837,55	1.579,63	804,85	5.040,49	819,06
	ICE	1.436,82	1.184,10	670,95	3.375,32	664,62
Transport Capacity (tons)	EV	80,76	80,76	49,15	107,65	4,73
	ICE	80,62	80,53	75,17	88,00	2,15
Productivity (rit/day)	EV	3,55	3,50	1,33	8,07	0,96
	ICE	3,78	3,62	0,89	7,97	0,92
Production Capacity per Day (tons)	EV	166,13	163,20	49,15	334,00	63,61
	ICE	258,12	247,85	75,90	564,70	110,62

Source: Processed Researcher (2025)

Based on the results in Table 2, it can be seen that the average investment cost for electric trucks reaches IDR 708.98 million, much higher than diesel trucks which is IDR 225.29 million. This difference is also reflected in the median value, where the middle value of the investment cost of electric trucks is recorded at IDR 603.06 million, while diesel trucks are only IDR 180.64 million. A larger standard deviation in the EV group (332.50) indicates that the variation in investment costs in the electric truck group is higher than in diesel trucks. This indicates a greater value irregularity in the EV group, which can be caused by variations in torque and technology.

In the variables of operating costs and total costs, the electric truck group also showed a higher average value than diesel trucks. The operational cost of EV is IDR 1,019.66 million, while ICE is IDR 809.66 million. The total cost in the EV group even reached IDR 1,837.55 million, while in ICE it was only IDR 1,436.82 million. The median values and standard deviations on the two variables also reinforce the finding that electric trucks have a wider cost spread and a relatively higher median value. In contrast, in the variable production capacity per day, diesel trucks show a higher value with an average of 258.12 tons per day, while electric

trucks are only 166.13 tons per day. These findings suggest that although electric trucks require higher investment and operational costs, their production levels are not necessarily superior to diesel trucks in the current operational context.

In addition, on the variables of carrying capacity and productivity, the two types of trucks show relatively comparable values. The carrying capacity of electric trucks is recorded at 80.76 tons and productivity is 3.55 rits per day, while diesel trucks have a carrying capacity of 80.62 tons and productivity of 3.78 rits per day. This suggests that the significant difference is more apparent in the cost and output aspects of daily output, rather than in the carrying capacity or number of daily operating cycles. All of these descriptive results will be used as a starting point for further analysis of the significance of the differences between the two groups of vehicles.

Based on the results shown in Table 2, the electric truck group showed a higher average value on almost all cost variables than the diesel truck group. This can be seen in the variables of investment costs, operational costs, energy costs, and total costs. The striking difference is mainly in the variable investment cost, where the average investment in electric trucks is almost three times greater than that of diesel trucks. In addition, larger standard deviation values in the EV group indicate a wider spread of data, which may be due to variations in capacity, technology, or age of the vehicles in the group.

On the other hand, in the variable production capacity per day, the diesel truck group showed a higher average value, which was 258.12 tons per day, compared to electric trucks which only reached 166.13 tons per day. This difference is also reflected in the median values, which show a consistent distribution tendency between groups. This shows that although electric trucks have a higher cost value, their production effectiveness in the context of daily transport volume is still lower than diesel trucks. This comparison is the initial basis for further examining the differences between the two types of vehicles based on the inferential statistical test presented in the next subchapter.

Table 3. Comparison of Average Investment Costs between Electric Trucks and Diesel Trucks

Cost Investment	Electric Trucks (EV)	Truk Diesel (ICE)	Difference Results (%)
Mean (IDR million)	708,98	225,29	214,67%

Source: Processed Researcher (2025)

The average investment cost for electric trucks was recorded at IDR 708.98 million, while for diesel trucks it was IDR 225.29 million. Based on the calculation of the relative difference, the investment cost of electric trucks is higher around 214,67% compared to diesel trucks. This difference shows that the initial investment for the procurement of electric trucks is still relatively high, which is likely due to the price of batteries, vehicle technology, as well as the cost of supporting infrastructure such as *charging station*. This difference in cost is one of the main considerations in assessing the economic feasibility between the two types of vehicles.

Table 4. Comparison of Average Operating Costs between Electric Trucks and Diesel Trucks

Cost Operational	Electric Trucks (EV)	Truk Diesel (ICE)	Difference Results (%)
Mean (IDR million)	1.019,66	809,66	25,93%

Source: Processed Researcher (2025)

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The average operating cost for electric trucks is recorded at IDR 1,019.66 million, while diesel trucks have an average of IDR 809.66 million. The difference between the two shows that the operating costs of electric trucks are higher by 25,93%. This increase in costs can be attributed to new technological factors that require special maintenance, as well as network limitations *charging* which can have an impact on daily operational efficiency.

Table 5. Comparison of Average Energy Costs between Electric Trucks and Diesel Trucks

Cost Energy	Electric Trucks (EV)	Truk Diesel (ICE)	Difference Results (%)
Mean (IDR million)	108,90	401,87	-72,89%

Source: Processed Researcher (2025)

The average energy cost for electric trucks was recorded at IDR 108.90 million, much lower than diesel trucks of IDR 401.87 million. Negative difference of -72.89% It shows that the use of electrical energy is much more financially efficient than fossil fuels. This efficiency is one of the main advantages of electric vehicles in the context of long-term cost savings.

Table 6. Average Comparison of Total Cost between Electric Trucks and Diesel Trucks

Total Cost	Electric Trucks (EV)	Diesel Truck (ICE)	Difference Results (%)
Mean (IDR million)	1.837,55	1.436,82	27,89%

Source: Processed Researcher (2025)

The average total cost of electric trucks was recorded at IDR 1,837.55 million, while diesel trucks were IDR 1,436.82 million. Difference of 27,89% indicates that overall, electric trucks require higher financing to operate in a given unit of time or volume. This indicates that despite higher energy efficiency, the total cost burden is still influenced by the investment and operational components.

Table 7. Comparison of Average Carrying Capacity between Electric Trucks and Diesel Trucks

Capacity Transport	Electric Trucks (EV)	Diesel Truck (ICE)	Difference Results (%)
Red (ton)	80,76	80,62	0,17%

Source: Processed Researcher (2025)

The average carrying capacity of electric trucks and diesel trucks shows almost equal values, which are 80.76 tons and 80.62 tons, respectively. Difference of 0,17% shows that the two types of vehicles have relatively identical carrying capacity, so this aspect is not the main differentiator in the consideration of transportation efficiency based on the type of engine.

Table 8. Average Productivity Comparison between Electric Trucks and Diesel Trucks

Productivity	Electric Trucks (EV)	Diesel Truck (ICE)	Difference Results (%)
Mean (rit/hari)	3,55	3,78	-6,08%

Source: Processed Researcher (2025)

The average productivity of electric trucks was recorded at 3.55 rits per day, slightly lower than diesel trucks which reached 3.78 rits per day. Negative difference of -6,08% Showing that diesel trucks still have an advantage in terms of daily ritase frequency. This factor can be related to charging duration, limitations of EV infrastructure, or shorter mileage in electric vehicles.

Table 9. Comparison of Average Production Capacity per Day between Electric Trucks and Diesel Trucks

Production Capacity (tons/day)	Electric Truck (EV)	Truk Diesel (ICE)	Result (% Selisih)
Red (tons/day)	166,13	258,12	-35,66%

Source: Processed Researcher (2025)

The average daily production capacity of electric trucks is 166.13 tons, while diesel trucks reach 258.12 tons. Difference of $-35,66\%$ Reflecting that the daily production capability of diesel trucks is still quantitatively superior to electric trucks. This finding is important in the context of operational needs that demand high transport volumes in a short period of time.

Normality Test

The normality test was carried out to find out whether the data from each group (electric trucks and diesel trucks) were distributed normally. Normal distribution is one of the prerequisites in the selection of statistical methods to be used to test the difference between the two groups. In this study, normality tests were carried out on all research variables, namely investment costs, operational costs, energy costs, total costs, transportation capacity, productivity, and production capacity per day.

The test was carried out using two approaches, namely the Kolmogorov–Smirnov test and the Shapiro–Wilk test. The Kolmogorov–Smirnov test is used when the sample count is more than 50, while the Shapiro–Wilk test is more recommended for small samples (< 50). The decision-making criteria are based on the significance value (Sig.): if the Sig. value > 0.05 , then the data is considered to be normally distributed, while if the Sig. value is < 0.05 , then the data is not normally distributed (Sugiyono, 2020). The results of the normality test showed that most variables had significance values below 0.05, both in the Kolmogorov–Smirnov and Shapiro–Wilk tests. This indicates that the data from both groups are not normally distributed. The following table 10 presents a summary of the normality test results for each variable.

Table 10. Normality Test Results (Kolmogorov–Smirnov and Shapiro–Wilk)

Variabel	Truck Type	Kolmogorov–Smirnov (Sig.)	Shapiro–Wilk (Sig.)
Investment Cost	EV	0.000	0.000
	ICE	0.000	0.000
Operating Costs	EV	0.001	0.000
	ICE	0.000	0.000
Energy Costs	EV	0.000	0.000
	ICE	0.000	0.000
Total Cost	EV	0.000	0.000
	ICE	0.000	0.000
Transport Capacity	EV	0.000	0.000
	ICE	0.024	0.000
Productivity	EV	0.000	0.000
	ICE	0.000	0.000
Production Capacity per Day	EV	0.000	0.000
	ICE	0.000	0.000

Source: Processed Researcher (2025)

All significance values in both types of tests showed a number below 0.05, so it can be concluded that all variable data in both groups did not meet the assumption of normal distribution. Therefore, non-parametric statistical analysis techniques are more appropriate in this study. One of the relevant non-parametric tests for comparing two independent groups is the Mann–Whitney U test, which will be used in the next subchapter.

Differential Test (Mann–Whitney U)

The Mann–Whitney U test was used to find out if there was a significant difference between the two independent groups, in this case an electric truck (*electric vehicle*) and diesel trucks (*internal combustion engine*), against each research variable. Because the results of the normality test in the previous subchapter show that the data is not normally distributed, this non-parametric method is the appropriate approach to test the comparative hypothesis in this study.

This test evaluates the difference in the distribution of values between the two groups based on data ranking, rather than based on averages as in the parametric test. Therefore, the results of the Mann–Whitney U test are more robust when the data does not meet the assumption of normality. Significance value (*Asymp. Sig.*) was compared with a significance level of 0.05 to determine whether or not differences between groups were statistically significant.

Table 11. Results of the Mann–Whitney U Test between Electric Trucks and Diesel Trucks

Variabel	Asymp. Sig. (2-tailed)
Investment Cost	0.000
Operating Costs	0.246
Energy Costs	0.000
Total Cost	0.194
Transport Capacity	0.775
Productivity	0.016
Production Capacity per Day	0.001

Source: Processed Researcher (2025)

The test results showed that the variables of investment cost, energy cost, productivity, and production capacity per day had a significance value below 0.05, which means that there is a significant difference between electric trucks and diesel trucks in these four variables. The difference in investment costs indicates that the procurement of electric trucks still requires a much larger initial allocation of funds than diesel trucks, which is likely due to battery prices, vehicle technology, and the need for charging infrastructure.

On the energy cost variable, significant differences show that electric trucks have much better energy cost efficiency. This reflects the advantages of electric vehicles in reducing fuel consumption, considering that the price of electricity is more stable and generally cheaper than diesel or gasoline. Meanwhile, in the variables of productivity and production capacity per day, significant differences show that diesel vehicles still have an advantage in terms of the number of rirates and daily transportation volume. This can be attributed to the speed of refueling and the infrastructure that is more prepared for conventional vehicles.

On the other hand, the variables of operating costs, total costs, and transport capacity showed a significance value above 0.05, which means that there is no significant difference

between the two types of trucks. Although descriptively electric trucks appear to have higher operating costs, this difference is not statistically significant. This shows that operationally, both types of vehicles can be said to have relatively equal cost performance in practice. Similarly, the total cost and carrying capacity do not show any real difference, indicating that the efficiency and carrying capability of the two types of trucks are in a comparable range.

These findings confirm that the switch from diesel trucks to electric trucks does not necessarily result in efficiencies across all cost and operational aspects. Some of the advantages of electric trucks mainly lie in energy efficiency, while diesel vehicles still excel in terms of productivity and daily working capacity. Therefore, strategic decision-making regarding the type of vehicle should consider the priority of operational needs and the readiness of the available infrastructure.

Discussion

The discussion was carried out to interpret the results of statistical tests that have been carried out on the research variables. The main objective of this study was to compare the cost-effectiveness and operational efficiency between electric trucks (*electric vehicle* or EVs) and diesel trucks (*internal combustion engine* or ICE) in coal transportation activities. Therefore, the discussion is prepared based on each variable that has been analyzed, including aspects of investment, operational costs, energy, and vehicle performance.

Investment Costs

Investment costs are one of the main indicators in the analysis of the economic feasibility of vehicles. Based on the results of the descriptive analysis, it is known that the average investment cost of electric trucks is IDR 708.98 million with a standard deviation of IDR 332.50 million, indicating a fairly high level of variation. Meanwhile, the average investment cost of diesel trucks is IDR 225.29 million with a standard deviation of IDR 139.75 million. This difference shows that the use of electric trucks requires a much larger initial capital expenditure than diesel trucks. In addition, the maximum value in the EV group of more than IDR 2 billion strengthens the evidence that the procurement of electric vehicles requires a significant budget.

The results of the differential test using the Mann–Whitney U showed that there was a significant difference between the electric truck and diesel trucks groups in terms of investment costs, with a significance value of 0.000 ($p < 0.05$). This means that statistically, the type of vehicle has a real effect on the size of the investment cost. These findings indicate that initial costs are one of the main obstacles in the process of adopting electric vehicles, especially in industrial sectors with large scale vehicle use such as mining.

This difference in investment costs is also in line with several literature findings that state that electric vehicles require higher procurement costs because they involve large-capacity battery technology, advanced electronic control systems, and supporting infrastructure such as charging stations. However, the amount of initial investment can be considered as a form of *capital expenditure* that can be compensated in the long run through lower energy and maintenance cost efficiency. Thus, although electric trucks may seem more expensive in terms of initial cost, the potential long-term economic benefits remain an important consideration in investment decision-making.

Operating Costs

Operating costs reflect expenses incurred on a regular basis during the time of the vehicle's use, including maintenance, labor, and supporting logistics. Based on the results of descriptive statistics, the average operating cost of electric trucks was recorded at IDR 1,019.66 million with a standard deviation of IDR 478.20 million. Meanwhile, diesel trucks showed an average operating cost of IDR 809.65 million with a standard deviation of IDR 502.24 million. Although the nominal operational costs of electric trucks look higher, the variation in both types of vehicles is quite large and needs to be tested further statistically.

The results of the Mann–Whitney U test on the operational cost variable showed a significance value of 0.246. This value is above the significance threshold of 0.05, which indicates that there is no significant difference between the operating costs of electric trucks and diesel trucks. Thus, statistically, both types of vehicles have relatively equivalent operational cost performance. It can be interpreted that differences in maintenance components or technical consumption do not significantly affect the overall total operating costs in the context of use in the field.

These findings show that the operation of electric vehicles does not always result in direct savings in terms of operational costs, especially in the early transition period of the use of new technologies. On the other hand, the mining sector generally has relatively standard internal maintenance facilities, so both electric and diesel vehicles will face similar operational handling systems. In this context, the operational cost efficiency of electric vehicles may only be seen noticeably after going through a long cycle of use, where the potential for reduced maintenance frequency and technological efficiency begins to dominate the total costs incurred.

Energy Costs

Energy costs are an important component in assessing the efficiency of operational vehicles, especially in the transportation sector that is intensive on fuel consumption. Based on the results of the descriptive analysis, it is known that the average energy cost of electric trucks is IDR 108.90 million with a standard deviation of IDR 33.64 million. Meanwhile, diesel trucks recorded an average energy cost of IDR 401.87 million with a standard deviation of IDR 161.99 million. This difference reflects that electric trucks consistently show efficiency in terms of energy consumption in terms of financing, with a more controlled rate of value spread than diesel trucks.

The results of a statistical test using the Mann–Whitney U show that the energy cost between electric trucks and diesel trucks has a statistically significant difference, with a significance value of 0.000. This value is well below the threshold of 0.05, which indicates that there is a real difference in energy financing between the two types of vehicles. The low energy cost of electric trucks can be explained by the price difference between industrial electricity and diesel, as well as the efficiency of electric engines that are able to convert energy more optimally than internal combustion engines.

These findings reinforce the argument that electric vehicles offer advantages in fuel cost efficiency in the long run. In addition, the use of electricity as an energy source is also more stable and less volatile than fossil fuels, thus providing advantages in terms of certainty of daily operational costs. In the context of coal transportation that requires repeated ritase in large volumes, energy cost efficiency can make a significant contribution to the cumulative savings

of a company's operating budget. Therefore, although the initial investment of electric trucks is higher, efficiency in the energy cost component is one of the important economic justifications in making decisions on fleet use.

Total Cost

Total costs are the accumulation of all major cost components, namely investment costs, operational costs, and energy costs. This variable provides a comprehensive picture of the cost burden that the company must bear for the procurement and operation of trucks in a certain period of time. Based on the results of the descriptive analysis, electric trucks have an average total cost of IDR 1,837.55 million with a standard deviation of IDR 819.06 million. On the other hand, diesel trucks showed an average total cost of IDR 1,436.82 million with a standard deviation of IDR 664.62 million. Although electric trucks have a higher average total cost, it is necessary to further analyze whether this difference is statistically significant.

The results of the Mann–Whitney U test on the total cost variable showed a significance value of 0.194. Since this value is above the significance threshold of 0.05, it can be concluded that statistically there is no statistically significant difference between the total cost of electric trucks and diesel trucks. In other words, although the nominal difference seems large descriptively, in terms of data distribution, the two are not significantly different. This may be due to the high variation in the cost components of each vehicle type, which causes the data ranges in both groups to overlap.

These findings provide perspective that the decision to switch from diesel trucks to electric trucks will not necessarily significantly increase or decrease total costs. This suggests that the use of electric vehicles is not necessarily more expensive overall, especially when energy efficiency and long-term maintenance are taken into account. In the context of financial planning and operational strategy, these results can be a consideration that investment in electric vehicles can still be compensated by cost savings in other aspects, so as not to cause an aggregate cost spike (Kurniawan, 2019).

Transport Capacity

The carrying capacity reflects the vehicle's ability to transport coal material in one trip. This variable is important for assessing logistics efficiency, as larger capacity has the potential to lower the amount of ritase required. Based on the results of the descriptive analysis, electric trucks have an average carrying capacity of 80.76 tons, with a standard deviation of 4.73 tons. Meanwhile, diesel trucks show almost the same average of 80.62 tons, with a smaller standard deviation of 2.15 tons. The relatively similar median and 5% trimmed mean values in both groups also indicate that the data distribution is fairly balanced.

The results of the Mann–Whitney U test showed a significance value of 0.775, which is well above the limit of 0.05. This shows that there is no significant difference between electric trucks and diesel trucks in terms of carrying capacity. This means that both types of vehicles have equal performance in the ability to transport loads per ride. This fact is quite interesting considering that there is a common assumption that diesel trucks are superior in terms of carrying capacity because of their more mature and tested mechanical systems in the mining sector.

These findings provide the basis that in terms of technical capacity, electric trucks are already able to compete with diesel trucks in the context of heavy transportation in the industrial

sector. The absence of this significant difference also reinforces that the capabilities of the vehicle are no longer determined only by the type of energy source, but by the design and technical engineering of the manufacturer. With equivalent transport capacity, the determination of the choice of vehicle type can be focused on cost efficiency, sustainability, and environmental policies that apply in the operating area.

Productivity

Productivity in the context of this study is measured based on the number of ritase or transportation volume that vehicles can achieve in a certain unit of time. This variable is a direct performance indicator that is very important in transportation operations, because it determines the level of efficiency and output of the vehicle. Based on descriptive analysis, the average productivity of electric trucks was recorded at 3.55 units, with a standard deviation of 0.96. Meanwhile, diesel trucks showed a higher average productivity, which was 3.78 with a standard deviation of 0.92. This difference indicates that diesel trucks have nominally superior daily transportation performance compared to electric trucks.

The results of the Mann–Whitney U test showed a significance value of 0.016, which was below the threshold of 0.05. Thus, there is a statistically significant difference between the productivity of electric trucks and diesel trucks. This means that diesel trucks show a noticeably higher level of productivity than electric trucks in daily operations. This can be due to faster energy recharging times in diesel trucks, as well as the availability of supporting infrastructure such as petrol stations that are much more evenly distributed than electric vehicle charging stations.

This difference in productivity is an important note for companies in considering vehicle technology transition. Although electric vehicles have advantages in energy efficiency and emission reduction, infrastructure limitations and longer downtime can impact work productivity. In the context of the mining industry that demands continuity and high transportation rhythms, productivity performance is a strategic factor that cannot be ignored. Therefore, the use of electric vehicles needs to be accompanied by adjustments to operational systems and infrastructure support so as not to sacrifice the efficiency of daily ritase (Tokac et al., 2025).

Production Capacity per Day

Production capacity per day describes the total actual transport volume achieved by each vehicle in a single operational day. This variable is an indicator of final output which is influenced by the combination of transport capacity and daily ritase productivity. Based on the results of the descriptive analysis, the average production capacity per day of electric trucks is 166.13 tons, while diesel trucks have a much higher average, which is 258.12 tons. In addition, diesel trucks showed a larger standard deviation (110.62) than electric trucks (63.61), indicating a fairly high output variation in the diesel truck group.

The results of the Mann–Whitney U test on this variable showed a significance value of 0.001, which means that there is a significant difference between the production capacity of electric trucks and diesel trucks. This difference reflects that diesel vehicles statistically have the ability to produce a larger daily haul volume. This can be influenced by higher productivity factors, refueling speeds, and more mature operational support in diesel vehicles.

These findings have important implications for fleet procurement planning. Although

electric vehicles have advantages in energy cost efficiency, the actual performance in the field in terms of daily production output is still lower than that of diesel trucks. Therefore, companies need to consider the trade-off between cost efficiency and production targets when formulating fleet replacement strategies. In the long run, improving charging infrastructure and improving battery technology can be key to reducing this gap, so that electric vehicles can compete more optimally in terms of daily output.

CONCLUSION

The study found that electric trucks have significantly higher investment costs than diesel trucks (Rp708.98 million vs. Rp225.29 million; sig. 0.000), while their operational costs and total overall costs showed no significant difference. Electric trucks demonstrated much lower energy costs (Rp108.90 million vs. Rp401.87 million; sig. 0.000) and similar transport capacity, but diesel trucks outperformed in productivity and daily production capacity. Companies should weigh the trade-off between electric trucks' higher initial investment and greater energy efficiency by calculating the Total Cost of Ownership and consider adopting a mixed fleet to leverage both trucks' advantages. Enhancing charging infrastructure is crucial to boosting electric truck productivity, and their energy efficiency supports sustainability amid emissions and ESG regulations. It is advised that companies create a gradual transition roadmap focusing on short-haul routes, while the government should provide incentives and infrastructure support for mining-sector EV adoption. Future research should explore environmental impacts, including carbon emissions and Life Cycle Cost (LCC) analysis.

REFERENCES

- Al-Yaqoobi, A. M., Al-Rikabey, M. N., & Al-Mashhadani, M. K. H. (2021). Electrochemical harvesting of microalgae: Parametric and cost-effectivity comparative investigation. *Chemical Industry & Chemical Engineering Quarterly*, 27(2), 121–130. <https://doi.org/10.2298/CICEQ191213031A>
- Augusta, R., Gaol, H. L., Rahardian, S., Aditya, W., & Dwipayana, A. D. (2023). Analysis Comparison of the operational costs of electric cars and internal combustion engine cars. *Scientific Journal of Mechanical Engineering*, 11(1), 581–590.
- Horngren, Datar, & Rajan (2018) in the book *Cost Accounting: A Managerial Emphasis* Garrison, Noreen, & Brewer (2021)
- Habib, S., Kamarposhti, M. A., Shokouhandeh, H., Colak, I., & Barhoumi, E. M. (2023). Economic dispatch optimization considering operation cost and environmental constraints using the HBMO method. *Energy Reports*, 10, 1718–1725. <https://doi.org/10.1016/j.egy.2023.08.032>
- Mantik, K. B., & Sukadana, I. W. (2022). Comparative analysis of the cost and sale of carbon emissions, maintenance costs of electric car purchases, electric car operating costs and transitions with conventional cars. *E-Journal of University Development Economics Udayana*, 13(7), 452–460.
- Mukmin, M. N., & Gusprasetyo. (2017). The Effect of Fixed Asset Investment and Operating Costs to operating income at PT. Sanshiro Hope Makmur. *Journal Accounting*, 3(1), 21–30.

- Nugroho. (2020). Study of electric vehicle development in Indonesia: Prospects and Obstacles. *Economic Paradigm*.
- Patriawan, D. A., Putra, J. H., & Setyono, B. (2021). Comparative analysis of operational costs between electric vehicles, gasoline and diesel. National Seminar on Industrial Technology Sustainable (SENASTITAN I), Faculty of Industrial Technology, Institute of Technology Adhi Tama Surabaya.
- Ahmad Zaki Romi. (2019). The use of electrification technology in mining operational excavation equipment.
- Pranata, S. E., Tjahjaningsih, Y. S., & Mustakim. (2023). Comparative analysis of values Economical electric cars and conventional cars with a total cost of ownership (TCO). *Journal of Transportation & Logistics Management*, 10(2), 163–175.
- Rahmawati, F., Sari, Y. K. E., & Sopian, D. (2021). The effect of operating costs on profits clean (case study on Perum Jasa Tirta II Jatiluhur Purwakarta for the period 2012-2019). *Journal of Business*, 9(1), 75–86.
- Saputra, R., & Yulhendra, D. (2024). Study of the effect of the slope of the transport road on consumption of truck fuel in coal production in the West Pit of PT. AIC Jaya, Kec. Talawi Sawahlunto, West Sumatra. *Journal of Mining Development*, 6(2), 245–248.
- Sugiyono. (2020). *Quantitative, Qualitative, and R&D Research Methods*. Bandung: Alfabet.
- Supriadi, Y., & Syahidah, H. (2018). Analysis of the influence of investment policy, growth sales and operating cost efficiency to profitability. *Scientific Journal of Management Unity*, 6(1), 67–77.
- Tokac, B., Zhang, Q., & Sari, Y. A. (2025). Environmental and economic comparison of diesel and electric trucks in open-pit mining operations. *Transportation Engineering*, 13, 100220. <https://doi.org/10.1016/j.treng.2025.100220>
- Andrie Kurniawan, (2019). Feasibility study on the replacement of operational vehicles of PT. VI from energy-based to electric vehicles (Thesis). Sepuluh Nopember Institute. https://repository.its.ac.id/62370/1/02311650022027-Master_Thesis.pdf
- Setya Edi Pranata, (2023). Comparative analysis of the economic value of electric cars and Conventional cars with a total cost of ownership (TCO) approach
- Field, A. (2017). *Discovering Statistic Using IBM SPSS Statistic 5th. Dk*, 53(9).
- Gibbons, J. D., & Chakraborti, S. (2010). *Nonparametric Statistical Inference*. Nonparametric Statistical Inference. <https://doi.org/10.1201/9781439896129>