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Replacement Analysis of Official Vehicles at Universitas Negeri Padang with Electric Vehicles

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ABSTRACT

Indonesia's growing dependence on fossil fuels, especially in the transportation sector, has prompted policy interventions promoting Electric Vehicles (EVs) as a sustainable alternative. This study evaluates the economic feasibility of replacing conventional Internal Combustion Engine (ICE) vehicles with Battery Electric Vehicles (BEVs) in the official vehicles of Universitas Negeri Padang. Employing the Equivalent Uniform Annual Cost (EUAC) method, the analysis compares purchase costs, taxes, energy consumption, maintenance, market value, and salvage value of eight vehicle types. Findings indicate that only two electric vehicles demonstrate lower EUAC values than their ICE counterparts, suggesting limited economic advantage under current cost structures. Although electric vehicles offer environmental benefits, their adoption remains economically viable only under specific operational and fiscal conditions. These insights support data-driven policy and procurement decisions in the public sector.

Keywords
Electric Vehicles, EUAC Analysis, Replacement Decision, Economic Feasibility

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INTRODUCTION

The global shift toward sustainable energy has heightened interest in electric vehicles (EVs) as a solution to environmental degradation and energy dependency [1][2]. In Indonesia, the transportation sector is a major contributor to greenhouse gas emissions, due to the heavy reliance on fossil fuels such as gasoline and diesel [3][4]. Compounding this, national oil and gas production has steadily declined over the last decade, further emphasizing the urgency for alternative energy sources [5].

The economic impact is also severe. In 2023, Indonesia’s fuel import costs exceeded IDR 396 trillion, with nearly 49% consumed by the land transportation sector [6]. Projections suggest that by 2025, these imports could surpass IDR 550 trillion, worsening the country’s Current Account Deficit [7]. In response, the government has initiated a national strategy to accelerate EV adoption [8][9], formalized in Government Regulation No. 79/2014, which promotes renewable energy development and reduction of fossil fuel dependency [10].

Further commitment is demonstrated in Presidential Regulation No. 55/2019, mandating higher education institutions to contribute through research and innovation in battery electric vehicle (BEV) technologies [11]. This aligns with national goals to reduce emissions, enhance energy efficiency, and lower operational costs in the transportation sector [12][13]. To support this agenda, the government offers fiscal incentives such as import duty exemptions, luxury tax reductions, and tax breaks for manufacturers meeting domestic component thresholds [14]. These policies aim to build a robust local EV ecosystem while simultaneously reducing environmental and economic vulnerabilities.

To ensure the success of electric vehicle (EV) adoption, infrastructure readiness and a resilient supply chain are essential. One critical aspect is the expansion of Public Electric Vehicle Charging Stations (PEVCS), which must be accelerated to support increasing EV usage across Indonesia. In parallel, mineral downstreaming is necessary to secure the raw materials for battery production. Several strategic projects in this area, including domestic battery manufacturing, are expected to commence between 2025 and 2026 [15].

The Ministry of Energy and Mineral Resources (ESDM) has outlined four key strategies for developing EV charging infrastructure: (1) constructing 1,558 charging units nationwide by 2024; (2) placing chargers in strategic locations such as gas stations, government offices, malls, and highway rest areas; (3) establishing a reliable and safe recharging system; and (4) ensuring compatibility with standardized charging connectors such as Mennekes Type 2 (AC), CHAdeMO (DC), and CCS (AC/DC hybrid) [16][17]. Operational cost comparisons between internal combustion engine (ICE) vehicles and EVs also support the transition. While conventional vehicles generally incur lower maintenance costs, EVs offer greater savings in energy consumption and overall service expenses, making them more economical in the long term [18][19].

Although prior studies—such as those conducted by Augusta and Pranata—focused primarily on comparing operating costs between ICE and EVs, this study introduces a new dimension by integrating a structured decision-making framework for vehicle replacement, specifically targeting official (government-owned) vehicles. The proposed framework not only examines economic feasibility but also offers practical insights for institutional policy-making, thereby advancing the field of vehicle transition analysis. Official vehicles, defined as government assets used for administrative and operational purposes, include both ICE and EV variants [20]. ICE vehicles rely on gasoline or diesel engines. Gasoline engines operate through spark-ignited combustion of air–fuel mixtures, converting thermal energy into mechanical work via piston movement [21][22]. In contrast, diesel engines use high-pressure air compression to ignite fuel, enabling combustion without spark plugs [23]. On the other hand, EVs utilize batteries as energy sources, with electric motors controlled by dedicated systems to regulate power delivery to the drivetrain [24].

This research aims to evaluate the economic feasibility of replacing Universitas Negeri Padang's official ICE vehicles with EVs. By adopting a cost-benefit perspective, the study seeks to provide evidence-based recommendations for sustainable vehicle fleet management within public institutions.

METHOD

This study employs a quantitative methodology, enabling an objective analysis through the utilization of numerical data to substantiate evidence-based decision-making. Quantitative methods demonstrate significant efficacy in assessing financial feasibility, as they offer a systematic analysis of the measurable results derived from observed phenomena [25]. This study primarily aims to evaluate the economic viability of transitioning Universitas Negeri Padang's official vehicles from conventional internal combustion engine (ICE) vehicles to electric vehicles (EVs) by conducting a thorough financial analysis. The research is based on secondary data gathered during the years 2024 to 2025. Secondary data denotes datasets that have been previously compiled and are sourced from reputable entities, including institutional records and government publications [26]. This study employs comprehensive operational cost reports pertaining to the current official fleet of Universitas Negeri Padang, alongside benchmark cost data for similar electric vehicles present in the Indonesian market. The vehicle fleet of the university under examination comprises eight units, specifically two diesel-powered vehicles and six gasoline-powered vehicles. The financial implications of transitioning to electric vehicles are assessed through the application of a cash flow analysis as the principal methodology. The analysis of cash flow facilitates the visualization and quantification of economic transactions over time, thereby elucidating both the magnitude and timing of cash inflows and outflows throughout the vehicle life cycle [27]. This framework is critical for evaluating the total cost of ownership associated with internal combustion engine (ICE) vehicles and electric vehicle (EV) alternatives, encompassing aspects such as acquisition, operation, maintenance, and residual value. Figure 1 provides a summary of the research flow, illustrating the sequential methodological framework adhered to during the course of the study.

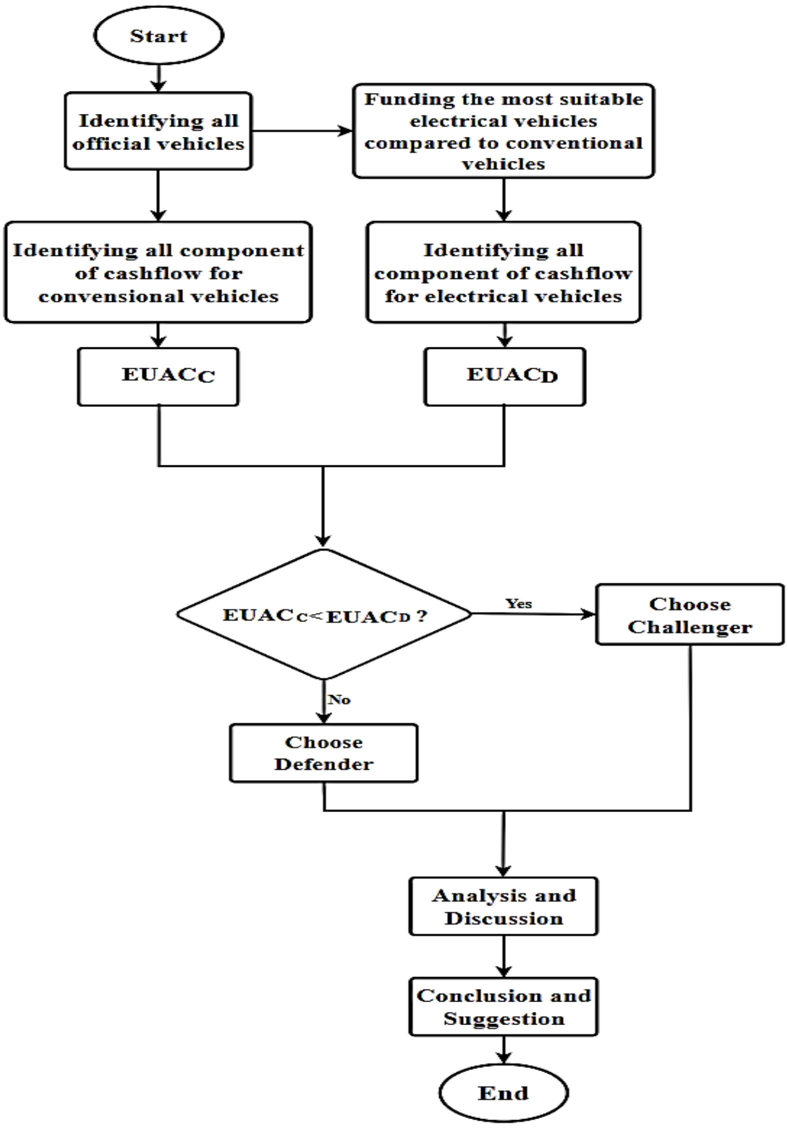

Figure 1. Research Flow Diagram

This research employs a quantitative methodology to assess the economic viability of substituting traditional official vehicles with electric vehicles at Universitas Negeri Padang. The research methodology employs the Equivalent Uniform Annual Cost (EUAC) approach, enabling a systematic cost comparison between current assets (conventional vehicles, designated as "defenders") and potential substitutes (electric vehicles, termed "challengers") [25][27][28].

The initial phase of the research process involves the identification and systematic documentation of all officially designated service vehicles that are presently in operation. This phase is critical for establishing a foundational comprehension of vehicle profiles, encompassing aspects such as type, fuel system (gasoline or diesel), operational lifespan, and usage characteristics. Subsequently, a technically and functionally comparable electric vehicle is identified to act as a challenger, thereby ensuring consistency in service function and capacity. Following the identification of the defender and challenger units, the analysis advances by gathering and structuring the requisite economic data pertinent to both vehicle categories. The data encompasses initial acquisition costs, yearly maintenance expenditures, fuel or electricity usage, vehicle taxation, salvage values, anticipated market values, and the relevant interest rate. This phase delineates a thorough cash flow framework applicable to both alternatives [26].

The core analysis involves calculating the EUAC for each vehicle over the defined analysis period. For the conventional vehicle, the result is referred to as the Equivalent Uniform Annual Cost of the Defender (EUACD), while for the electric vehicle, it is termed the Equivalent Uniform Annual Cost of the Challenger (EUACC). The EUAC is computed using the standard uniform series formula:

$$A = P\left(\frac{A}{P}, i\%, N\right)$$

In this formula, A represents the annual equivalent cost incurred uniformly over the analysis period, P denotes the initial capital investment or present value, i indicates the applicable annual interest rate, and N refers to the number of years considered in the investment horizon [27]. This formulation enables the conversion of all relevant cost components into a consistent annual value, facilitating a direct comparison between alternatives.

In assessing the economic feasibility of substituting a conventional vehicle with an electric alternative, the decision-making criterion is clear: the replacement is warranted if the Equivalent Uniform Annual Cost of the challenger (EUACC) is less than that of the defender (EUACD). In contrast, when the EUACC is equal to or surpasses the EUACD, the replacement is considered economically disadvantageous [28]. This evaluative framework guarantees that decisions are based on rational, long-term financial projections, thus enhancing efficiency in asset management and procurement planning.

RESULT AND DISCUSSION

Data Collection

The data for this study were gathered based on several key factors pertinent to the economic analysis of vehicle replacement. A comprehensive explanation of each factor is provided in the following section to clarify their significance in the overall analytical framework.

1. Vehicle Purchase Cost and Specifications

At Universitas Negeri Padang, the fleet of official service vehicles comprises six gasoline-powered units and two diesel-powered units. The analysis encompasses all of these vehicles.

To facilitate a clear and concentrated comparison, this study analyzes one representative gasoline vehicle alongside one electric vehicle, in addition to one diesel vehicle paired with one electric vehicle. The choice of these vehicles is predicated upon their technical specifications and operational characteristics. The purpose of this information is to provide a foundational understanding of the functional and economic feasibility of each vehicle in relation to the replacement analysis. The analysis focuses on a comparative assessment of the conventional Kijang Innova G 2.0 A/T in relation to the electric BYD M6 Superior, alongside an evaluation of the All New Pajero 4x4 A/T compared to the electric Chery J6 IWD Phantom, as detailed in Table 1 and Table 2.

Table 1. Specifications Kijang Innova G 2.0 A/T and BYD M6 Superior

Vehicle Specifications	Vehicle Name and Type	
	Kijang Innova G 2.0 A/T (Gasoline)	**BYD M6 Superior (Electric)**
Length x Width x Height	4.735 x 1.830 x 1.795 mm	4.710 x 1.810 x 1.690 mm
Wheelbase	2.750 mm	2.800 mm
Drivetrain	Rear Wheel Drive (RWD)	Front wheel Drive (FWD)
Ground Clearance	185 mm	170 mm
Engine Type	1TR-FE 4 Cylinders in-line, 16 valve DOHC with Dual VVT-i	-
Motor Type	-	AC Permanent Magnet Synchronous Motor
Displacement	1.998 cc	-
Bore x Stroke	86.0 x 86.0 mm	-
Max Power	139 PS/5.600 rpm	150 kW
Max Torque	18.7 kgm/4.000 rpm	250 N.m
Fuel Tank Capacity	55 Litre	-
Battery Capacity	-	71,8 kWh
Battery Type	-	BYD Blade Battery
Charging Type		Charging Type DC: CCS2 115 kW and AC: 27 kW
Charging Time	-	DC: 1 hr 10 mins and AC: 13 hrs
Driving Range	-	530 Km
Tire & Wheel Size	205/65 R16	225/55 R17
Seating Capacity	7	7

Table 1 provides a comparative overview of the specifications between the conventional gasoline-powered government vehicle, the Kijang Innova G 2.0 A/T, and the electric alternative, the BYD M6 Superior. Both vehicles accommodate up to seven passengers, indicating functional parity in terms of passenger capacity. However, notable distinctions exist in their technical characteristics, particularly those that influence operational performance and suitability for replacement.

The primary factors that facilitate the interchangeability between the Kijang Innova and the BYD M6 encompass overall vehicle dimensions, drivetrain configuration, propulsion system, and energy storage capacity. The Kijang Innova exhibits a slightly larger overall body size, in contrast to the BYD M6, which is characterized by a longer wheelbase. This distinction may have implications for ride comfort and stability. The Kijang Innova features a rear-wheel drive system, which is powered by a gasoline engine and is equipped with a 55-liter fuel tank.

In contrast, the BYD M6 features a front-wheel drive electric motor system, which is supported by a 71.8 kWh battery, indicating a significant transformation in energy source and drivetrain technology.

Table 2. Specifications All New Pajero 4x4 A/T and Chery J6 IWD Phantom

Vehicle Specifications	Vehicle Name and Type	
	All New Pajero 4x4 A/T (Diesel)	**Chery J6 IWD Phantom (Electric)**
Length x Width x Height	4.785 x 1.815 x1.805 mm	4406 x 1910 x 1715 mm
Wheelbase	2.800 mm	2715 mm
Drivetrain	Four Wheel Drive (4WD)	Intelligent All Wheel Drive (IWD)
Ground Clearance	218 mm	200 mm
Engine Type	4N15 2.4L MIVEC Turbocharged and Intercooled (EURO II)	-
Displacement	2.422 cc	-
Bore x Stroke	86.0 x 105.1 mm	-
Max Power	181 PS/3.500 rpm	205 kW
Max Torque	43.8 kgm/2.500 rpm	165/220 N.m
Fuel Tank Capacity	68 Litre	-
Battery Capacity	-	69,77 kWh
Battery Type	-	Lithium Iron Phosphate Battery
Charging Type	-	Ultra Fast Charging
Charging Time	-	30% - 80% in 30 Minutes
Driving Range	-	418 Km
Tire & Wheel Size	265/60 R18	225/55 R19
Seating Capacity	7	5

Table 2 provides a comparative analysis of the specifications for the All New Pajero 4x4 A/T (Diesel) and the Chery J6 IWD Phantom (Electric), highlighting several significant differences between the two models. The All New Pajero exhibits dimensions of 4,785 mm in length, 1,815 mm in width, and 1,805 mm in height, making it marginally larger than the Chery J6, which has dimensions of 4,406 mm in length, 1,910 mm in width, and 1,715 mm in height. The Pajero is characterized by a longer wheelbase measuring 2,800 mm, in contrast to the 2,715 mm wheelbase of the Chery J6. The Chery J6, characterized by its wider stance, presents a shorter overall length that may enhance maneuverability, especially within urban settings.

The analysis of the All New Pajero and the Chery J6 reveals a significant degree of interchangeability, which is primarily substantiated by their comparable drivetrain configurations, propulsion systems, and energy storage capacities. The Pajero features a four-wheel drive system, a diesel engine, and a fuel tank capacity of 68 liters. In contrast, the Chery J6 utilizes an intelligent all-wheel drive electric powertrain, which is complemented by a 69.77 kWh lithium iron phosphate battery that supports fast charging capabilities. Furthermore, the specifications of the tires and wheels exhibit notable differences, as the Pajero utilizes 265/60 R18 tires, whereas the Chery J6 is fitted with 225/55 R19 tires. This discrepancy suggests that the electric vehicle possesses marginally larger wheel dimensions and a wider tire profile.

Moreover, the Pajero has the capacity to accommodate seven passengers, in contrast to the Chery J6, which provides seating for five individuals. Notwithstanding the variance in seating capacity, the comparison retains its validity owing to the commonalities in drivetrain type, vehicle body proportions, wheelbase, and ground clearance, all of which are pertinent to operational feasibility and performance.

2. Vehicle Operational Costs

Table 3 presents a comparative overview of the operational costs associated with the conventional gasoline-powered Kijang Innova G 2.0 A/T and the electric vehicle BYD M6 Superior. The analysis includes key financial parameters such as vehicle purchase price and acquisition year, annual tax obligations, yearly energy consumption costs (fuel or electricity), and service expenses. The Kijang Innova was purchased in 2016 for Rp332,000,000, while the BYD M6 Superior was acquired in 2024 at a cost of Rp429,000,000. In terms of annual vehicle tax, the Kijang Innova incurs a significantly higher rate of Rp1,005,800 compared to just Rp143,000 for the BYD M6.

Energy costs reveal a pronounced disparity. The Kijang Innova, utilizing fossil fuel, consumes approximately Rp29,418,605 annually in gasoline expenses. Conversely, the BYD M6, as a fully electric vehicle, does not consume fossil fuel. Its annual electricity cost is considerably lower, amounting to Rp6,692,823. When total operational costs—comprising taxes, energy usage, and service expenditures—are considered over the full period of analysis, the cumulative cost for the Kijang Innova reaches Rp411,116,046. In contrast, the BYD M6 registers a significantly lower total cost of Rp70,071,012.

Maintenance cost trends also reflect substantial differences between the two vehicles. The Kijang Innova exhibits notable fluctuations, particularly during the fifth and tenth years of operation, with service costs peaking at Rp10,241,000 in both instances. The overall service expenditure over a 10-year period is considerably high. In contrast, the BYD M6 displays a more stable and lower maintenance profile. Service costs rise moderately only during the third and fifth years—recorded at Rp1,586,477 and Rp9,586,477, respectively—while remaining steady at approximately Rp525,000 in other years.

Table 3. Vehicle Operational Cost Innova G 2.0 A/T and BYD M6 Superior

Vehicle Name and Type	Kijang Innova G 2.0 A/T (Gasoline)		BYD M6 Superior (Electric)	
Price on year of purchasing	Rp332.000.000 (2016)		Rp429.000.000 (2024)	
Tax (Per Year)	Rp1.005.800		Rp.143.000	
Fossil Fuel (Per Year)	Rp29.418.605		-	
Vehicle Name and Type	Kijang Innova G 2.0 A/T (Gasoline)		BYD M6 Superior (Electric)	
Electric Fuel (Per Year)	-		Rp6.692.823	
Service (Per Year)	1	Rp3.505.000	1	Rp525.000
	2	Rp3.979.000	2	Rp525.000
	3	Rp3.505.000	3	Rp1.586.477
	4	Rp5.488.000	4	Rp525.000
	5	Rp10.241.000	5	Rp9.586.477
	6	Rp3.505.000	6	Rp525.000
	7	Rp3.979.000	7	Rp525.000
	8	Rp3.505.000	8	Rp1.586.477
	9	Rp5.488.000	-	
	10	Rp10.241.000	-	

Total Vehicle Operational Costs	Rp411.116.046	Rp70.071.012

A similar operational cost comparison was conducted between the All New Pajero 4x4 A/T and the Chery J6 IWD Phantom. The resulting data, summarized in Table 4, provides a foundational basis for further evaluation of each vehicle's operational efficiency and long-term maintenance implications.

Table 4. Vehicle Operational Cost All New Pajero 4X4 A/T and Chery J6 IWD Phantom

Vehicle Name and Type	All New Pajero 4X4 A/T (Diesel)	Chery J6 IWD Phantom (Electric)
Price on year of purchasing	Rp672.000.000 (2018)	Rp608.000.000 (2024)
Tax (Per Year)	Rp2.567.500	Rp.143.000
Fossil Fuel (Per Year)	Rp28.800.000	-
Vehicle Name and Type	All New Pajero 4X4 A/T (Diesel)	Chery J6 IWD Phantom (Electric)
Electric Fuel (Per Year)	-	Rp7.602.012
	1 Rp4.560.990	1 Rp525.000
	2 Rp7.523.580	2 Rp525.000
	3 Rp3.266.730	3 Rp1.586.477
	4 Rp7.523.580	4 Rp525.000
Service (Per Year)	5 Rp17.413.590	5 Rp14.086.477
	6 Rp4.560.990	6 Rp525.000
	7 Rp7.523.580	7 Rp525.000
	8 Rp3.266.730	8 Rp1.586.477
	9 Rp7.523.580	-
	10 Rp17.413.590	-
Total Vehicle Operational Costs	Rp394.251.940	Rp81.844.528

Table 4 presents a comparative analysis of the operational costs between a conventional diesel-powered vehicle—the All New Pajero 4x4 A/T—and an electric vehicle, the Chery J6 IWD Phantom. Key cost components evaluated include the purchase year and price, annual taxation, energy consumption (diesel or electricity), and yearly maintenance costs. The All New Pajero 4x4 A/T was procured at a price of Rp672,000,000, whereas the Chery J6 was purchased for a slightly lower price of Rp608,000,000. The annual tax burden for the Pajero is considerably higher at Rp2,567,500, compared to just Rp143,000 for the Chery J6.

The annual expenditure for diesel fuel associated with the Pajero is approximately Rp28,800,000. Conversely, the Chery J6, which operates on electricity, incurs a notably reduced annual energy cost of Rp7,602,012. Upon evaluating the total operational expenses, which encompass taxes, energy, and maintenance throughout the analysis period, it is observed that the Pajero incurs costs totaling Rp394,251,940, in contrast to the Chery J6, which amounts to only Rp81,844,528. The findings unequivocally indicate a significant long-term cost benefit associated with the electric vehicle.

The trends in maintenance costs further substantiate this conclusion. The Pajero exhibits significant cost increases during the fifth and tenth years of operation, with service expenses amounting to Rp17,413,590 for each of these years. This leads to a significant cumulative maintenance burden. Conversely, the Chery J6 exhibits a more stable and cost-effective maintenance profile. The peak service cost is observed in the fifth year, amounting to Rp14,086,477. This is succeeded by moderate increases in the third and eighth years, each recorded at Rp1,586,477. Throughout the subsequent years, maintenance expenses are projected to remain consistent at approximately Rp525,000. The maintenance schedule of the Chery J6 demonstrates enhanced cost efficiency and predictability over an extended period.

3. Cash Flow

The computation of the Equivalent Uniform Annual Cost (EUAC) in this analysis is predicated on an interest rate of 6%, consistent with the Bank Indonesia benchmark rate effective from September 18 to December 18, 2024 [29]. The cash flow representation in this research is categorized into two primary components. The initial component is a horizontal line representing the temporal scale or analysis duration, whereas the subsequent component comprises vertical lines depicting the direction and volume of cash flows.

The temporal scale is articulated in annual units, aligning with the enduring nature of vehicle use and replacement assessment. Vertical arrows represent specific transactions and are positioned along the timeline according to their occurrence. The length of each arrow indicates the magnitude of the transaction, with longer arrows representing more monetary values. The orientation of the arrows differentiates between expenditures and revenues: downward arrows signify expenses, whereas upward arrows denote income or financial returns [27]. Figure 2 illustrates the cash flow diagrams for the Kijang Innova G 2.0 A/T and the BYD M6 Superior.

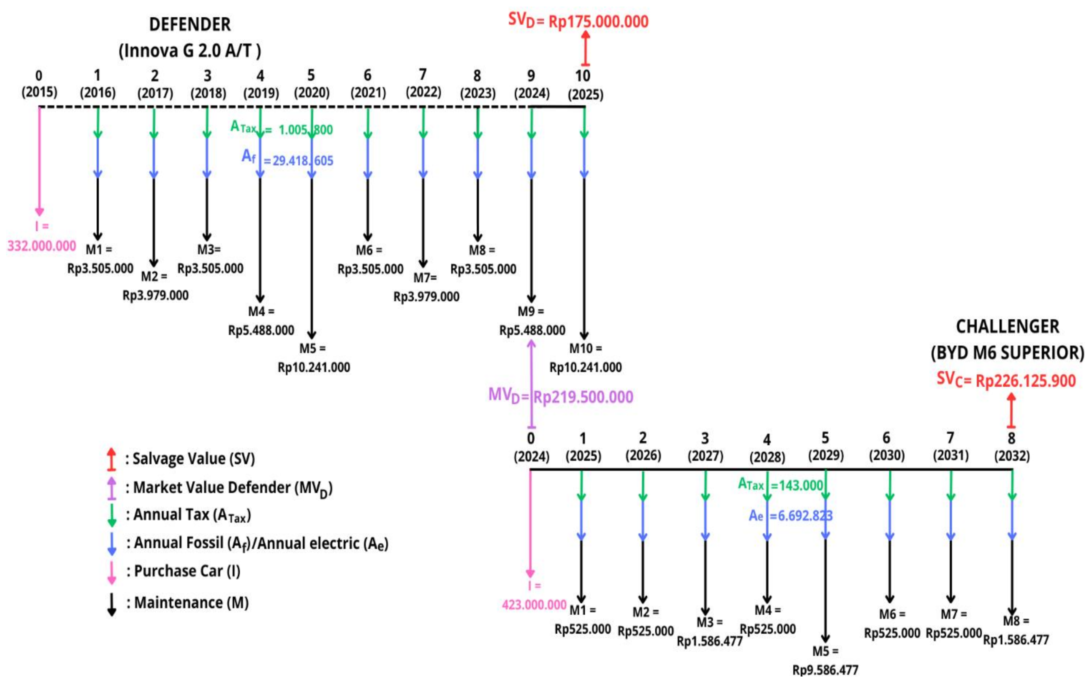

Figure 2. Cash Flow of Innova G 2.0 A/T and Cash Flow of BYD M6 Superior

Figure 2 depicts the comparative cash flow characteristics of the traditional Kijang Innova G 2.0 A/T (defender) and the electric BYD M6 Superior (challenger) over their designated service durations. The illustration includes essential cost elements such as vehicle acquisition cost, annual taxes, energy usage, maintenance expenses, projected market value, and salvage value. Colored arrows depict the yearly expenditure for each component, facilitating a visual analysis of total operational expenditures. The Kijang Innova required an initial capital investment of Rp332,000,000, with yearly recurrent expenses comprising Rp1,005,800 in taxes, Rp29,418,605 in gasoline, and variable maintenance costs, which reached a maximum of Rp10,241,000 in the fifth and tenth years. The vehicle's residual value is projected to be Rp219,500,000 in the ninth year and Rp175,000,000 at the conclusion of its service life in the tenth year.

In contrast, the BYD M6 Superior has a higher initial price of Rp423,000,000 but has significantly lower operating costs. Annual taxes amount to Rp143,000, electricity bills total Rp6,692,823 per annum, and maintenance costs exhibit considerable stability, with significant rises occurring solely in the third and fifth years. The anticipated salvage value at the conclusion of its eight-year service life is Rp226,125,900. The comparison analysis distinctly demonstrates the enduring economic benefit of the electric vehicle. Decreased energy and maintenance expenses substantially lower total lifecycle costs, hence enhancing the economic feasibility of shifting from fossil-fueled to battery-powered official vehicles.

Figure 3 likewise illustrates the cash flow comparison between the All New Pajero 4x4 A/T (diesel) and the Chery IWD Phantom (electric), adhering to the same analytical framework to further corroborate the outcomes across diverse vehicle categories.

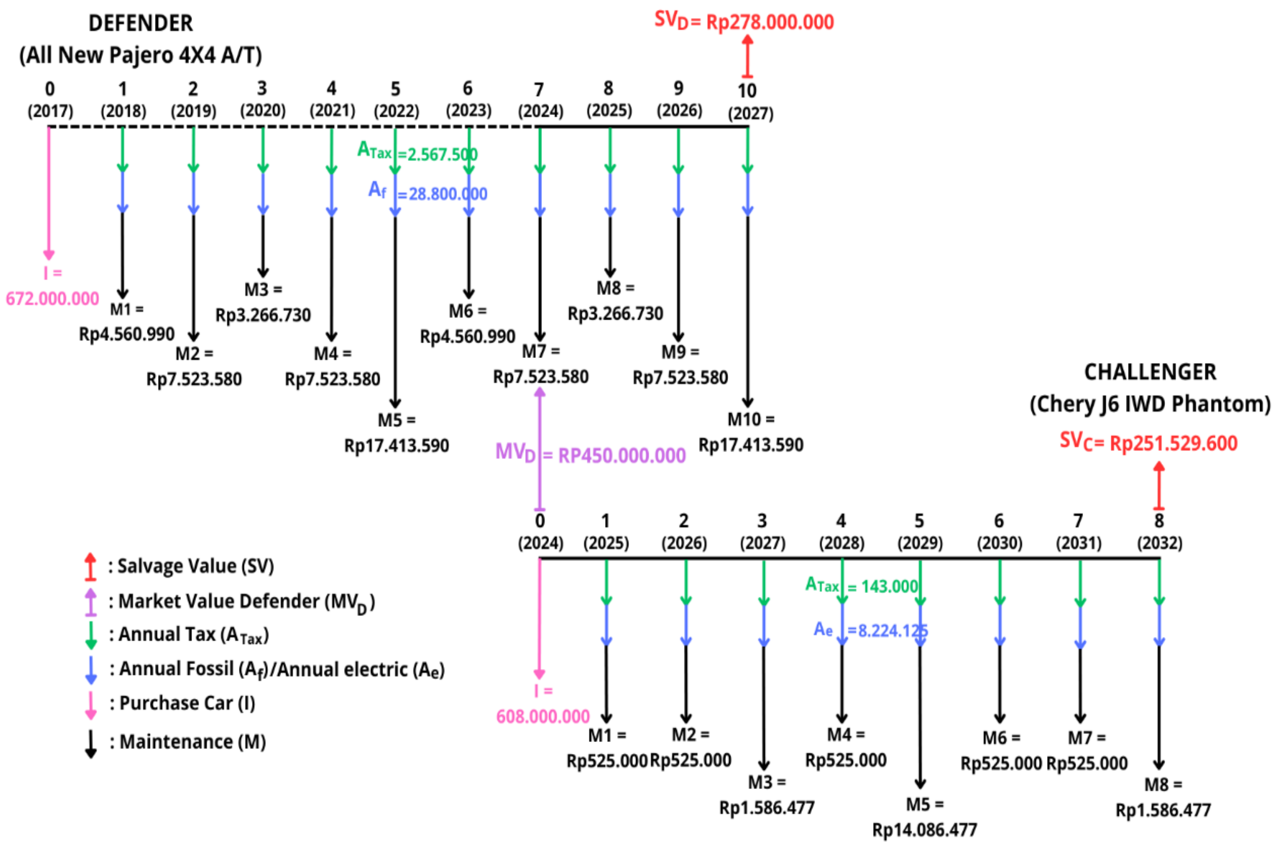

Figure 3. Cash Flow of All New Pajero 4X4 A/T and Cash Flow of Chery IWD Phantom

Figure 3 illustrates the comparative cash flow analysis between the All New Pajero 4x4 A/T (diesel, defender) and the Chery J6 IWD Phantom (electric, challenger), furthering the economic evaluation framework developed in the prior comparison. The analysis includes key cost components throughout the vehicles' operational lifespans, such as acquisition cost, annual tax liabilities, fuel or power expenditures, maintenance expenses, and anticipated market and salvage values.

The All New Pajero was acquired for Rp672,000,000 and utilized over a decade. Throughout this period, the vehicle accumulated annual tax liabilities of Rp2,567,500 and diesel fuel expenditures of Rp28,800,000 per annum. Maintenance expenses exhibited significant volatility, with considerable increases in the fifth and tenth years, each amounting to Rp17,413,590. In its seventh year of operation (2024), the Pajero's market value is estimated at Rp450,000,000, while its predicted end-of-life salvage value (2027) is Rp278,000,000. In comparison, the Chery J6 IWD Phantom was obtained at a reduced beginning price of Rp608,000,000. This electric car provides a significant decrease in operational costs, with an annual tax of about Rp143,000 and electricity expenses of approximately Rp8,224,125 per annum. Maintenance costs exhibit considerable stability during the service duration, with slight increments in the third and eighth years (Rp1,586,477 each) and a maximum in the fifth year (Rp14,086,477). Upon the conclusion of its eight-year operational lifespan in 2033, the vehicle is anticipated to possess a salvage value of Rp251,529,600.

The analysis reaffirms the long-term economic advantage of electric vehicles through reduced operating and maintenance costs, which collectively contribute to a more favorable lifecycle cost profile when compared to their conventional counterparts.

Discussion

The core objective of this study is to assess the economic feasibility of replacing conventional internal combustion engine (ICE) official vehicles with electric vehicles (EVs) at Universitas Negeri Padang, using the Equivalent Uniform Annual Cost (EUAC) method. The EUAC framework facilitates long-term cost comparisons by annualizing the total expenditures—including purchase price, taxes, energy consumption, maintenance costs, and salvage value—across the vehicle's operational lifetime.

The summary of the EUAC analysis results is presented in Table 5, which displays cost outcomes for each pair of vehicles under evaluation (defender vs challenger) and the corresponding decision.

Table 5. EUAC Analysis Results and Replacement Decisions

No	Vehicle Name and Type	The result of the EUAC analysis	Decision
1	Kijang Innova G 2.0 A/T BYD M6 Superior	–Rp133,720,135 Rp19,592,439	Choose Defender (Kijang Innova G 2.0 A/T)
2	All New Pajero 4X4 A/T Chery J6 Phantom IWD	–Rp236,081,420 Rp10,807,887	Choose Defender (All New Pajero 4X4 A/T)
3	Avanza Veloz 1.5 M/T BYD M6 Superior	Rp5,066,887 Rp19,421,941	Choose Defender (Avanza Veloz 1.5 M/T)
4	All New Pajero 4X2 A/T Chery J6 Phantom RWD	–Rp187,081,420 Rp15,170,146	Choose Defender (All New Pajero 4X2 A/T)
5	Expander Ultimate A/T BYD M6 Superior	Rp19,365,279 Rp14,094,245	Choose Challenger (BYD M6 Superior)
6	Camry 2.5 V A/T BYD Seal Performance AWD	–Rp137,830,561 Rp64,519,462	Choose Defender (Camry 2.5 V A/T)
7	Corolla Altis 1.8 V A/T BYD Seal Premium	–Rp116,035,071 Rp64,419,681	Choose Defender (Corolla Altis 1.8 V A/T)
8	Alphard G 2.5 A/T BYD Denza D9	Rp4,213,940 -Rp28.726.031	Choose Challenger (BYD Denza D9)

The analysis reveals that in 6 out of 8 vehicle pairs, the existing ICE vehicles (defenders) are more economically efficient than their electric counterparts. This result is driven by the lower salvage value, higher initial cost, and sometimes shorter service life of EVs, which counterbalance their operational advantages such as lower electricity and maintenance costs.

For example, in Pair 1, the Kijang Innova G 2.0 A/T recorded an EUAC of –Rp133,720,135, significantly lower than the BYD M6 Superior's Rp19,592,439. Despite the EV's lower running costs and tax benefits, the financial outlay associated with acquisition and replacement cycle remains a limiting factor.

Nonetheless, two competing electric vehicles had distinct economic advantages: the BYD M6 as a substitute for the Expander Ultimate A/T (Pair 5), and the BYD Denza D9 as a replacement for the Alphard G 2.5 A/T (Pair 8). These instances highlight particular situations in which electric vehicles become economically feasible, especially when the defending car incurs substantial operational expenses or possesses a diminished resale value. The electric vehicles chosen in these two instances provide a competitive equilibrium among capital expenditure, maintenance efficiency, and energy usage.

Beyond numerical outcomes, this analysis underscores the contextual importance of vehicle utilization intensity, maintenance trends, and fuel price volatility. For instance, while diesel vehicles like the Pajero have higher initial costs, they may still be more efficient over time due to better residual values and longer expected lifespan. On the other hand, EVs—though more predictable in maintenance and operational costs—suffer from slower depreciation recovery in the absence of widespread resale markets. In terms of sustainability, the potential environmental benefit of EV adoption—such as reduced emissions and energy diversification—is not directly quantified in this analysis. However, if future policies provide stronger fiscal incentives (e.g., tax relief, subsidies, infrastructure development), the EUACC could decline significantly, tipping the balance toward more widespread EV replacement feasibility.

Finally, this study represents an economic decision for the year 2025. Continuous reassessment is essential as macroeconomic factors, such as fuel price changes, regulatory adjustments, and EV technology development, evolve rapidly. Incorporating dynamic models and scenario analysis in future research will enable more adaptive fleet management strategies.

CONCLUSION AND RECOMMENDATION

Conclusion

This research utilized the Equivalent Uniform Annual Cost (EUAC) method to assess the economic viability of substituting conventional official vehicles at Universitas Negeri Padang with electric alternatives. The analysis revealed that decisions regarding vehicle replacement can be systematically informed by a comparative evaluation of the Equivalent Uniform Annual Cost (EUAC) associated with current (defender) vehicles in relation to that of proposed electric (challenger) vehicles. The results indicate that, in the majority of instances, the defender vehicles—including the Kijang Innova G 2.0 A/T, All New Pajero 4X4 A/T, All New Pajero 4X2 A/T, Avanza Veloz 1.5 M/T, Camry 2.5 V A/T, and Corolla Altis 1.8 V A/T—exhibited reduced annual costs, thus categorizing them as more cost-effective options for retention. Nonetheless, exceptions were identified in the Alphard G 2.5 A/T and Expander Ultimate A/T, wherein the electric alternatives—BYD Denza D9 and BYD M6, respectively—demonstrated enhanced economic performance characterized by reduced annual costs. The results emphasize the effectiveness of EUAC analysis as a pragmatic and data-informed instrument for institutional decision-making in the context of fleet management. Furthermore, these factors illustrate the increasing competitiveness of electric vehicles within specific market segments, propelled by diminished maintenance costs and reduced energy expenditures. The analysis was conducted based on the 2025 financial outlook; however, periodic reassessment is essential to account for dynamic variables, including fuel price volatility, technological advancements, and changing government incentives.

Recommendation

The current findings provide essential insights for policymakers, university administrators, and procurement planners in the efficient management of vehicle assets. It is recommended that future research builds upon this study by integrating environmental externalities, including carbon emission factors, to assess the ecological advantages associated with the transition to electric vehicles. Furthermore, an examination of the lifecycle costs associated with electric vehicle batteries, anticipated resale values, and national subsidy policies may yield a more comprehensive economic assessment. It is advisable that decisions regarding vehicle replacement be incorporated into a comprehensive strategic framework that encompasses technology foresight, energy security factors, and sustainability goals. As the technology surrounding electric vehicles advances and associated costs decrease, the periodic reapplication of EUAC analysis will guarantee that decisions are economically viable and consistent with national energy and environmental objectives.

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