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TOTAL COST OF OWNERSHIP OF ELECTRIC CAR AND INTERNAL COMBUSTION ENGINE CAR WITH PERFORMANCE NORMALIZATION

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Abstract:
In this research, we will present a calculation model for the TCO of electric cars and the TCO of conventional internal combustion engine (ICE) cars as a comparison. The cars analyzed in this research consist of several electric cars and ICE cars according to their respective performance levels, where for each electric car, an analysis of several battery ownership schemes is also attempted, namely those owned by the car owner, rental batteries and those owned by the car owner. However, some components can be repaired. The calculation model will consist of capital and operational costs, namely the purchase price, resale value, government subsidies, retailer discounts, battery replacement costs, maintenance, insurance, vehicle tax and energy consumption costs. All data was obtained from literature studies and information from vehicle distributors in Indonesia. The TCO model is analyzed based on the average distance traveled, namely 20,000 km/year for 10 years of driving. The research results show that the TCO of BEVs with a rental battery scheme is cheaper than that of ICEs for cars with 93, 167 and 210 hp, namely 2,961, 6,227 and 5,633 (USD) and the TCO of ICE is cheaper than that of BEV with a rental battery scheme on cars with 40 & 95 hp, namely 796 & 5,793 USD. Several components that make up TCO costs will later be proposed to be considered for adjustment so that vehicle purchases can grow significantly. Knowledge from this research can be useful for consumers, product manufacturers, planners, and government policy makers.

Keywords: Electric vehicle, Total cost of ownership, Indonesia, Energy Consumption, Electric Car

INTRODUCTION

Global warming and climate change are difficult human problems and have become a significant global concern in this decade. Efforts to find more sustainable solutions in various matters and aspects have been proposed to overcome this problem, such as teaching and transmitting alternative energy to surrounding communities and encouraging through research the transition to more sustainable materials to encourage the determination of transition policies to control greenhouse gases. glass. Many countries currently have set ambitious targets for controlling GHG problems, especially carbon dioxide (CO2) emissions. The transportation sector as a whole accounts for more than a quarter of global CO2 emissions (International 2020). Therefore, advocates for environmental conversations from every level of society in the world are promoting the electrification of transportation to decarbonize the transportation sector, which mostly uses fossil fuel energy such as gasoline and diesel. Promoting electric vehicles (EVs) towards the immediate phase of reducing the number of conventional internal combustion engine (ICE) vehicles is an important strategy for countries around the world. Based on the results of an existing review or outlook, by 2025, Norway plans to place only electric vehicles in all new car markets, while China targets to make electric vehicles account for one-fifth of the domestic new car market (Chen et al.

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2020). The European Union is committed to reducing CO_2 emissions by 40% by 2030 (United 2020). The United Kingdom and California in the United States plan to end sales of ICE vehicles by 2040 (Hertzke 2018). Automotive manufacturers in many countries predict that electric vehicles will become the main power generator in the car market within a decade. In response to the rapid growth of electric vehicles in the future, many researchers around the world are paying attention to studying electric vehicles in various aspects, such as CO_2 emissions (Palencia, 2017), energy consumption, and total cost of ownership (TCO).

The number of discussions related to EVs has existed since the oil embargo era in 1973, then continued with the number of studies on EVs increasing significantly since 2018 because EVs are used in transportation practices, as private vehicles and also public transportation. In the electric car market, there are several electric vehicle technologies, consisting of hybrid electric vehicles (HEV), plug-in hybrid vehicles (PHEV), and battery electric vehicles (BEV). The impact of electric cars on CO_2 emissions and energy consumption of each type of EV has been widely analyzed in countries that have metropolitan cities and EV promotion policies. Based on the data, in Beijing, the CO_2 emissions and energy consumption of EV private vehicles and EV taxis were studied (Hu 2017; Tu 2019). EV taxi travel patterns in New York have also been analyzed to optimize EV feasibility (Hu 2018).

Most researchers pay direct attention to studying the environmental impact, energy efficiency and the total costs that must be paid for an electric vehicle. It plays an important role in buyers' decisions in purchasing electric vehicles, and the government's encouragement in determining the most appropriate policies. If comprehensive information on the overall costs over the lifetime of electric vehicles is provided, this could be useful for consumers, government policy makers in each country and product planners. In recent years, with the increasingly rapid growth of electric vehicles, the total cost of ownership of electric vehicles has been studied in countries that want to use electric vehicles as the main vehicle in their transportation sector soon (Ouyang 2021), (Letmathe 2017), (Danielis 2018). Various TCO models have been proposed to provide more comprehensive information to Decision makers in understanding the lifetime costs of EVs. Expenditures, such as purchase price, battery costs, maintenance, insurance, vehicle tax and energy consumption costs are used in the TCO calculation model.

Several TCO studies have been conducted in countries with a high share of electric vehicles, such as China, the European Union, the United States, and Japan (Ouyang 2021), (Letmathe 2017), (Danielis 2018), (Palmer 2018). Because the costs and support of EVs will vary in each vehicle from a country, a TCO analysis is needed with a specific context for the conditions in that country. Apart from that, the conditions and assumptions of the TCO model will vary depending on the perspective of the research being proposed. For example, TCO research works in Italy, Germany and Sweden have presented case scenarios of government subsidized TCO models with different assumptions (Danielis 2018), (Scorrano 2020), (Letmathe 2017), (Hagman 2016).

For countries taking the initiative to encourage electric vehicles in the automotive market, such as Indonesia, TCO analysis will help stakeholders to understand the total cost of electric vehicles better. To the best of our knowledge, no comparison of TCO models based on different performance (EV and ICE) in Indonesia has been reported. This study proposes a comparative TCO model between Electric cars and conventional ICE vehicles. The EVs considered in this research include BEV cars with performance ratings of 40, 93, 95, 167 and 210 hp. TCO analysis consists of capital and operational costs such as vehicle purchase price, battery costs, maintenance, insurance, vehicle taxes, energy consumption costs and residual value. In this research, energy consumption costs are sourced or obtained from calculations of data on electric charging rates per kWh of electric car

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batteries in Indonesia and the assumed distance traveled in 1 year (20,000 km), according to the efficiency of the electric motor of each car. All expenditure data is considered appropriate to Indonesian conditions. Finally, the battery ownership case scenario is proposed as a recommendation for the government as a policy maker and manufacturer planner to encourage electric vehicles in the Indonesian car market.

METHODS

Total Cost of Ownership. The core concept of TCO is to summarize all current and future costs of a product. When purchasing a vehicle with new technology, such as an EV, the results of the TCO analysis are very important for prospective buyers to make a decision because there are several other cost variables besides the purchase price that will be charged during the use of the vehicle. TCO can be thought of as a decision-making tool in purchasing; the TCO model can help customers understand the true costs of owning a vehicle over its lifetime. At the same time, manufacturers and governments that better understand TCO can create much better planning and appropriate policies to support electric vehicles. The TCO model is very important because this method contains accurate estimates, assumptions and empirical data. The general equation for the TCO of a vehicle can be written as follows:

$$TCO = CC + OC$$

Where CC shows capital costs, while OC shows operational costs. Please note that the TCO unit used is US Dollars (USD). CC is the total cost of vehicle ownership, which is paid once at the beginning, and can be expressed as

$$\boldsymbol{CC = MSRP - S_G - D_R + C_B}$$

Where MSRP is the manufacturer's suggested retail price, SG is the government subsidy, DR is the retailer's discount, and CB is the cost of the battery. The CC formula, as referred to in (2), is only for calculations in the first year of electric car ownership, and the CB value is assumed to be 0, because the battery replacement will only be in the eighth year.

In the second year to the seventh year and the tenth year, CC is no longer taken into account. One of the CC parameters, which is calculated again in the eighth year of electric car ownership, is CB or battery cost, where the scenario used is that there is a battery replacement in the eighth year, so that CC in the eighth year can be expressed as

$$\boldsymbol{CC = C_B}$$

In the tenth year, it is assumed that the car owner will sell his used vehicle, so the CC formula in the tenth year can be expressed as

$$\boldsymbol{CC = MSRP - R_V - S_G - D_R + C_B}$$

Where there is one additional parameter for RV, namely resale value, in the calculation of the ten other parameters forming CC besides RV, it is assumed to have a value of 0, because both the car price, government subsidies, retailer discounts and battery costs appear outside the tenth year.

OC, which represents the accumulated annual recurring costs over the lifetime of vehicle ownership, can be expressed as

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$$OC = C_M + C_I + T_V + C_E$$

where CM is maintenance costs, CI is insurance costs, TV is vehicle tax, and CE is energy consumption costs. The OC formula, as intended in (4), is calculated every year.

In this research, we will try to analyze the TCO value of the 3 existing battery ownership schemes, which consist of: (scheme 1) owned by the car owner, (scheme 2) rented battery, and (scheme 3) owned by the car owner but can be partially repaired. component.

The CC formula, as intended in (3), only applies to analysis in (scheme 1) and (scheme 3), whereas for (scheme 2), the CC value is considered 0, because there is no battery replacement in the eighth year.

Model Parameters and Assumptions. In this study, the ownership period is assumed to be 10 years from 2024 to 2034. In addition, it is also assumed that the battery will be replaced in the 8th year of ownership. The model assumptions will be explained as follows:

Capital Costs. The total one-time costs of purchasing a vehicle are accumulated in CC. The component of the price forming CC that experiences depreciation is the RV value, namely the resale value in the tenth year and the CB or battery cost in the eighth year when the battery is replaced, where the battery price has decreased in the year of replacement compared to the year the car was purchased (this happens in the entire scheme).

Depreciation on the value of an RV with a performance of 40 hp can be expressed as follows:

$$1st - 4th\ year = 33.89\%$$
$$\boldsymbol{5th - 10th\ year = 51.9\% * (6)}$$

Depreciation on the value of an RV with a performance of 167 hp can be expressed as follows:

$$1st - 4th\ year = 3.07\%$$
$$\boldsymbol{5th - 10th\ year = 51.9\% * (8)}$$

Depreciation on the value of an RV with a performance of 95 hp can be expressed as follows:

$$\boldsymbol{1st - 10th\ year = 71.83\%}$$

Depreciation on the value of an RV with a performance of 93 hp can be expressed as follows:

$$1st - 4th\ year = 21.1\%$$
$$5th - 10th\ year = 51.9\% * (11)$$

Depreciation on the value of an RV with a performance of 210 hp can be expressed as follows:

$$1st - 4th\ year = 18.55\%$$
$$\boldsymbol{5th - 10th\ year = 33.89\% * (13)}$$

Vehicle MSRP is obtained from the selling price of new Indonesian cars in 2024, as shown in the Appendix. SG is included in the TCO model to propose promotional options that policy makers, in this case the government, can provide for EVs. It needs to be pointed out that, because electric vehicles are still relatively new in the Indonesian commercial car market, with unclear annual

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operating costs, the government's subsidy policy is very important for buyers. SG in the UK, France and Italy ranges from 20% to 27% of the purchase price (Scorrano et al. 2020), (Hagman et al. 20), (Levay et al. 2017), (Rusich et al. 2015). In this study, real data is presented on government subsidies given to several electric car brands according to their respective performance, which can also be influenced by the value of domestic component levels (Iom 2023).

DR is included in the TCO model to propose options to manufacturers to provide discounts to attract buyers and boost EV sales (Panna et al. 2022). In this study, CB had a depreciation of 11.83% per year (Irena 2021).

Operation Costs. All recurring costs during the ownership period, such as annual fixed costs and other variable costs, have been included in the OC as shown in equation (5) (Panna et al. 2022). The CM model in this research presents the required maintenance costs.

Annual recurring costs represent scheduled maintenance costs based on years of use or distance traveled. Some of these maintenance costs derived from data provided by the manufacturer are included in the CM model. BEV CM is lower than that of ICE vehicles for electric cars over 40 hp, but for electric cars with a performance of 40 hp, the CM value is higher than that of ICE vehicles.

CI depends on vehicle factors such as the model. There are two types of CI considered in the TCO model of this research, namely: Total loss only and all risk liability insurance, where the availability of these 2 types of insurance can vary from the car model that we represent, based on the performance value (Lifepal 2024).

TV shows motor vehicle tax from cars, which is charged annually. The TV is based on the type of car.

In this study, actual energy consumption obtained from the assumed driving distance of ICE and EV in each year by taking into account the values of liters and watt-hours per kilometer, respectively, is used to estimate CE. CE represents the cost of energy consumption based on the annualized vehicle mileage, which can be expressed as:

$$CE = AD \times EC \times EP$$

Where AD indicates the average distance traveled (km), EC is the energy consumption (L/km or Wh/km) obtained from manufacturer information, and EP is the energy price (USD/L or USD/Wh). Annual vehicle AD is assumed to be 20,000 km/year (Panna et al.). Fuel prices are based on the retail price of RON 90 in the metropolitan city of Jakarta from 2024 (Pertamina 2024) and are projected to increase until 2034 based on the average increase in USA fuel prices over the last 45 years (US 2024). Electricity costs are based on the SPKLU (public electric vehicle charging station) tariff, which is 0.161 USD/kWh (Kementerian 2023)

The data used in this study uses five EV vehicles and one ICE vehicle, EV vehicles represent 5 different performances 40 hp (Wuling.id 2024), (Olx 2024), (Bounche 2024), (Selma et al. 2024), (Antam 2024), (Ahmad 2023), (Dina 2022), (Bertold 2023), (Wuling.id 2023), (Oto 2024), 93 hp (Neta 2024), (Olx .co 2024), (Rangga 2024), (Manuel 2023), (Neta.co 2024), (Redaksi 2023), (Neta.co.id 2024), (Carmudi 2024), 95 hp (BYD 2024), (Gemilang 2023), (Haa 2024), (Dicky 2024), (Oto 2024), (Oto.com 2024), 167 hp (Id-hyundai 2024), (Olx.co.id 2024), (Hyundai 2023), (Ferry 2023), (Dina 2023), (Ryh 2023), (Hyundai 2023), (Hyundai 2024) and 210 hp (Chery 2024), (Mobil123 2024), (Fea 2024), (CNN 2024), (Radityo 2024), (Cermati 2024), (Redaksi 2023), (Aries 2024), (Mik 2024) and for ICE vehicles the cost parameters were normalized following the EV comparator at each performance value. Characteristics of the six cars with BEV and ICE powertrains are shown in the Appendix.

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Table 1. Samples Criteria

No	Samples Criteria	Total
1.	Manufacturing companies that were not listed in three consecutive years from 2017 to 2019.	168
2.	Manufacturing companies that were not listed in three consecutive years from 2017 to 2019.	(23)
3.	Manufacturing companies whose financial statements are not presented in the rupiah currency.	(40)
4.	Manufacturing companies registered as State-Owned Enterprises.	(14)
5.	Manufacturing company registered in the cigarette industry sub-sector	(4)
6.	Manufacturing company registered in the plastic industry sub-sector	(10)
7.	Manufacturing company registered in the wood industry sub-sector	(2)
	Number of samples of manufacturing companies	75
	Number of samples of manufacturing companies in 3 years, / during 2017-2019	75 x 3 = 225

RESULT AND DISCUSSION

To compare TCO between EV and conventional ICE vehicles, ICE TCO is normalized according to the performance of each existing EV. In this study, a sensitivity analysis was carried out to estimate the influence of several parameters on the TCO model. Three case schemes to be researched and proposed, namely Scheme-1: battery ownership is owned by the car owner; Scheme-2: battery ownership is owned by the battery lessee; and Scheme-3: ownership of the battery is owned by the car owner, but the battery can be repaired only if some of the components are damaged.

Scheme-1. Figures 1, 2, 3, 4 and 5 show the TCO model of 5 electric cars with different performance and 1 ICE car, which is normalized to the performance of the electric car for the battery scheme owned by the car owner. The TCO of the battery is seen to have a high value in the first year in the 5 existing electric cars from ICE, because the MSRP of electric cars is still higher than ICE, in the second year to the seventh year it shows that the TCO of electric cars is 40 hp higher than ICE (Figure 1) this is inversely proportional to 4 other electric cars that have performance above 40 hp which have a lower TCO than ICE in the second to seventh years (Figures 2, 3, 4, 5). BEV TCO for cars with a performance of 40 hp to 167 hp jumped again in the 8th year due to battery replacement (Figures 1, 2, 3, 4), and cars with a performance of 210 hp only jumped in the ninth year due to the manufacturer's warranty for the battery during 8 years (Figure 5). After that, the TCO in the tenth year drops due to the appearance of a deduction, namely resale value, which arises because of the assumption that the car will be sold in the tenth year. The important point in this scenario is that the TCO of BEV is lower than that of ICE from the 2nd year until the year of battery replacement for cars with performance above 40 hp. In this context, customers can continue using the car by replacing the battery or stop investing and reselling in the eighth or ninth year.

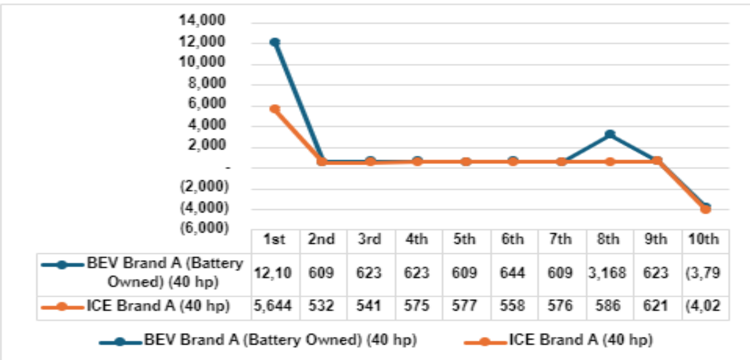

Figure 1. TCO BEV 40 hp (Battery Owned) v.s. ICE Normalized follows BEV

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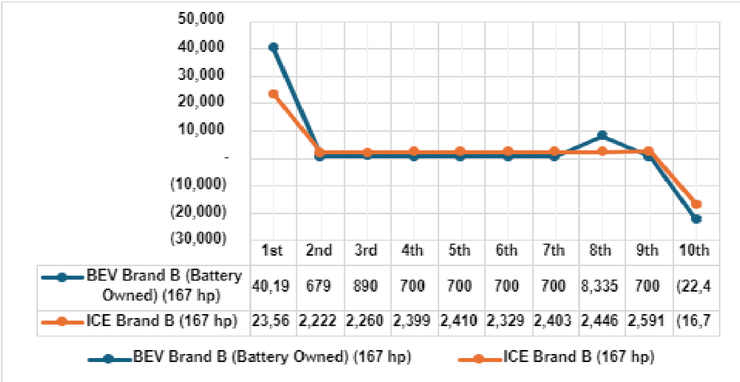

Figure 2. TCO BEV 167 hp (Battery Owned) v.s. ICE Normalized follows BEV

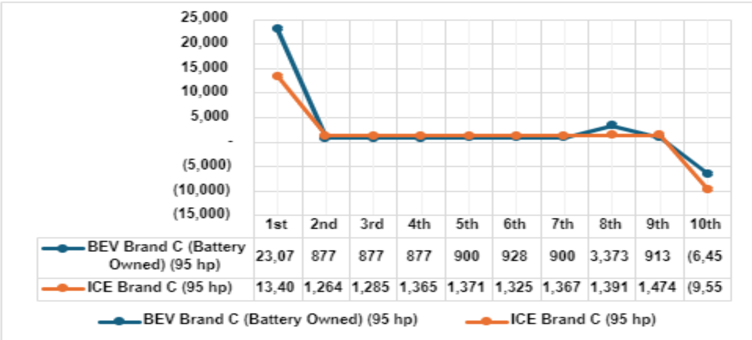

Figure 3. TCO BEV 95 hp (Battery Owned) v.s. ICE Normalized follows BEV

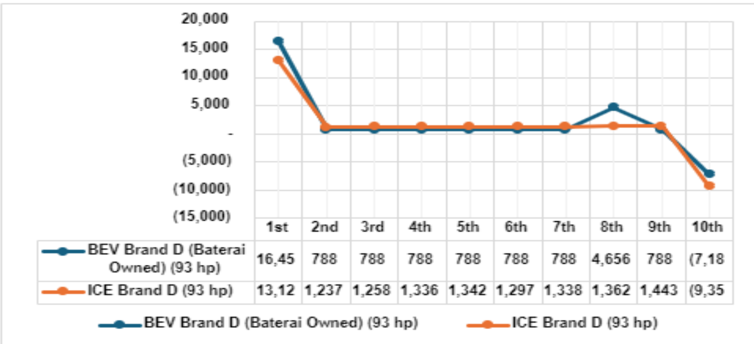

Figure 4. TCO BEV 93 hp (Battery Owned) v.s. ICE Normalized follows BEV

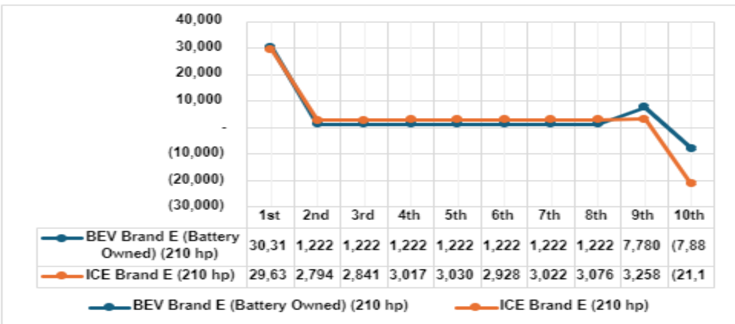

Figure 5. TCO BEV 210 hp (Battery Owned) v.s. ICE Normalized follows BEV

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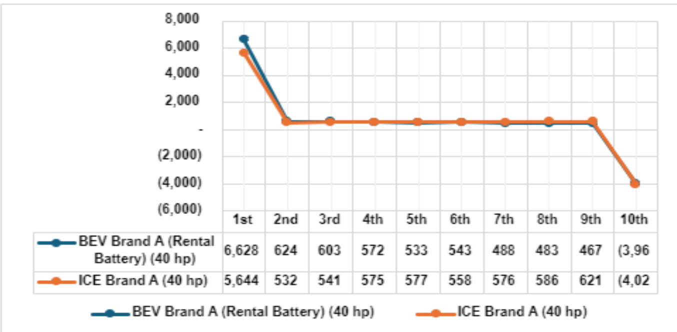
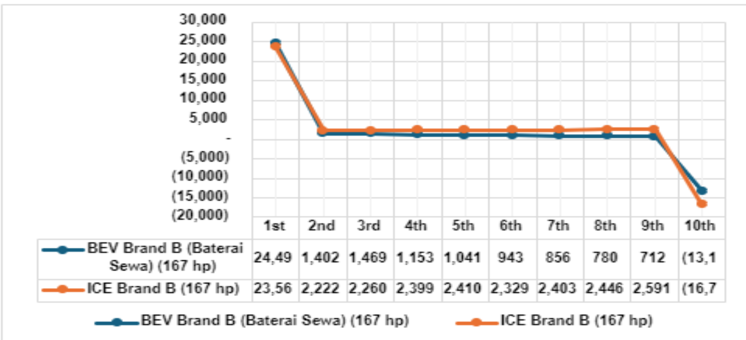
Scheme-2. Figures 6, 7, 8, 9 and 10 show the TCO model of 5 electric cars with different performance and 1 ICE car, normalized to the performance of the electric car for the battery scheme owned by the battery lessee. The TCO of rental batteries is seen to have a high value in the first year in 3 electric cars (brands A, B, C) and lower (brands D & E) than ICE, this higher value is because the MSRP of electric cars is still higher than ICE However, in the case of D & E brand cars there are subsidies from retailers which cause the TCO value to be lower than ICE in the first year, 4 electric cars (brands B, C, D, E) in the second to ninth year show that the TCO of electric cars above 40 hp is smaller than ICE (Figures 7, 8, 9, 10) this is different from 1 electric car which has a performance of 40 hp, the new TCO value drops lower than ICE starting in the 4th year, this is because in the second year and This third thing is because ICE cars with 40 hp performance can provide cheaper maintenance costs than BEVs (Figure 6). There is no BEV TCO displayed for cars with performance from 40 hp to 210 hp in either the eighth or ninth year because there is no battery replacement in this second phase (Figures 6, 7, 8, 9, 10). After that, the TCO for that year fell due to the emergence of a deduction, namely resale value, which appeared because of the assumption that the car would be sold that year. The important point in this scenario is that the TCO of BEVs is lower than that of ICEs from the 2nd to the ninth year for cars with performance above 40 hp and from the 4th to the ninth year for cars with a performance of 40 hp. In this context, customers can continue using the phone without changing the battery.



	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
BEV Brand A (Rental Battery) (40 hp)	6,628	624	603	572	533	543	488	483	467	(3,96
ICE Brand A (40 hp)	5,644	532	541	575	577	558	576	586	621	(4,02

Figure 6. TCO BEV 40 hp (Rental Battery) v.s. ICE Normalized follows BEV



	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
BEV Brand B (Baterai Sewa) (167 hp)	24,49	1,402	1,469	1,153	1,041	943	856	780	712	(13,1
ICE Brand B (167 hp)	23,56	2,222	2,260	2,399	2,410	2,329	2,403	2,446	2,591	(16,7

Figure 7. TCO BEV 167 hp (Rental Battery) v.s. ICE Normalized follows BEV

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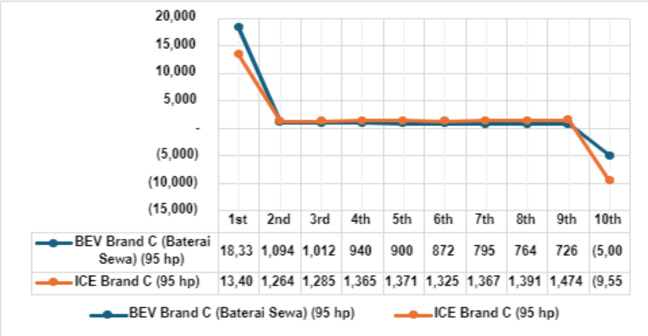

Figure 8. TCO BEV 95 hp (Rental Battery) v.s. ICE Normalized follows BEV

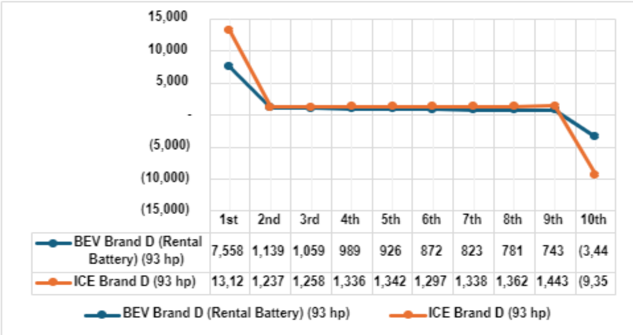

Figure 9. TCO BEV 93 hp (Rental Battery) v.s. ICE Normalized follows BEV

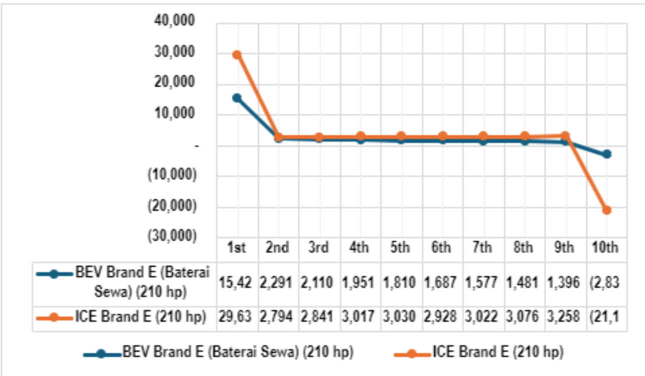

Figure 10. TCO BEV 210 hp (Rental Battery) v.s. ICE Normalized follows BEV

Scheme-3. Figures 11, 12, 13, 14 and 15 show the TCO model of 5 electric cars with different performance and 1 ICE car, which is normalized to the performance of the electric car for the battery scheme owned by the car owner, but the battery can be repaired in part. TCO in this scheme is seen to have a high value in the first year for 5 electric cars (brands A, B, C, D & E) from ICE, this higher value is because the MSRP of electric cars is still higher than ICE, TCO for 4 electric cars (brands B, C, D, E) in the second to seventh years shows that the TCO of electric cars over 40 hp is smaller than ICE (Figures 12, 13, 14, 15) this is different from 1 electric car which has a performance of 40 hp, the TCO value from the second year to the ninth year is still higher than ICE (Figure 11), this is because ICE cars with 40 hp performance can provide cheaper maintenance costs than BEVs (Figure 11). BEV TCO for cars with a performance of 40 hp to 167 hp jumped again in the 8th year due to battery

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replacement (Figures 11, 12, 13, 14), and cars with a performance of 210 hp only jumped in the ninth year due to the manufacturer's warranty for the battery during 8 years (Figure 5). After that, the TCO in the tenth year drops due to the appearance of a deduction, namely resale value, which arises because of the assumption that the car will be sold in the tenth year. The important point in this scenario is that the TCO of BEVs is lower than that of ICEs from year 2 to the year of battery replacement for cars with performance above 40 hp, and also in this scheme, the TCO value in the year of battery replacement has a smaller value than scheme-1, where Batteries can be repaired only on damaged packs. In this context, customers can continue using the car by replacing the battery or stop investing and reselling in the eighth or ninth year.

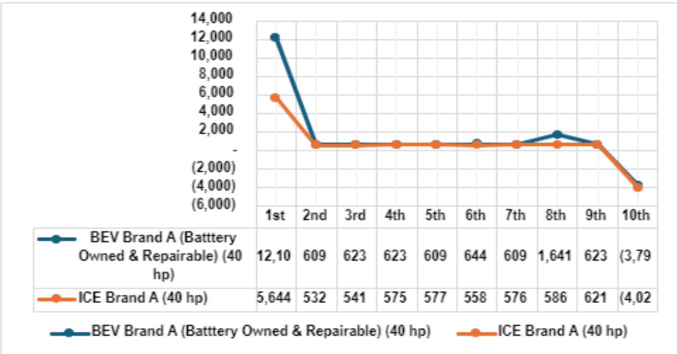

Figure 11. TCO BEV 40 hp (Battery Owned & Repairable) v.s. ICE Normalized follows BEV

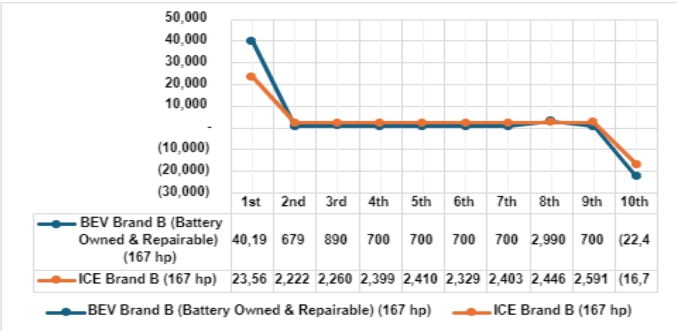

Figure 12. TCO BEV 167 hp (Battery Owned & Repairable) v.s. ICE Normalized follows BEV

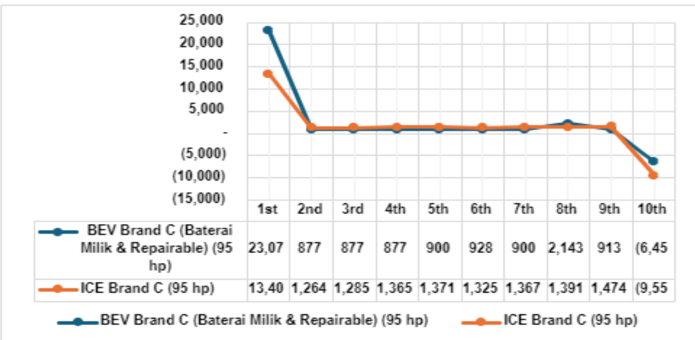

Figure 13. TCO BEV 95 hp (Battery Owned & Repairable) v.s. ICE Normalized follows BEV

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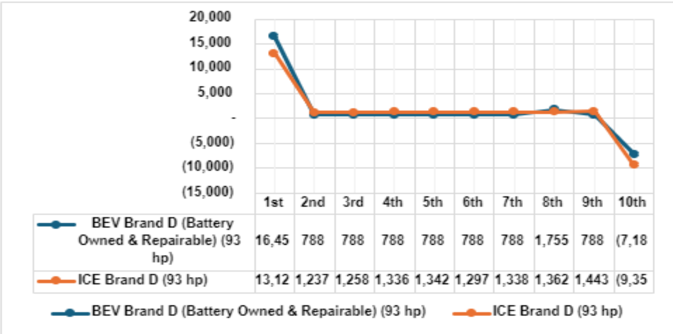

Figure 14. TCO BEV 93 hp (Battery Owned & Repairable) v.s. ICE Normalized follows BEV

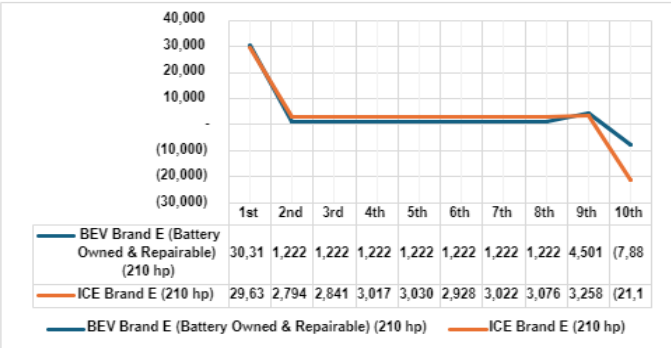

Figure 15. TCO BEV 210 hp (Battery Owned & Repairable) v.s. ICE Normalized follows BEV

Table 2. xxxx

Variable	Coefficient	Standard Error	t statistic	Probability
Constanta (C)	5.56E-16	0.052493	2.23E-14	1.0000
XXX	0.174535	0.071761	0.432191	0.0244
XXX	0.452535	0.035242	0.252082	0.0467
XXX	0.357635	0.052431	0.432191	0.0152
XXX	0.142711	0.072563	0.588706	0.0360
R squared	0.272466			
Prob (F-statistic)	0.000236			

Source: Data Processed 2021

CONCLUSION

This research can be concluded as follows:

- The order of the most efficient TCO values over a period of ten years, in order of the 10 most efficient is as follows: ICE 40 hp, BEV (Rental Battery) 40 hp, BEV (Rental Battery) 93 hp, BEV (Battery Owned & Repairable) 40 hp, ICE 93 hp, ICE 95 hp, BEV (Battery Owned) 40 hp, BEV (Battery Owned & Repairable) 93 hp, BEV (Battery Owned) 93 hp, BEV (Battery Rental) 167 hp.
- The comparison of TCO values for cars with 40 hp performance between ICE and BEV battery rental schemes (scheme-2) is in: cheaper MSRP value, higher retailer discounts, cheaper maintenance costs, cheaper insurance, and Cheaper energy consumption, making ICE cars 13 USD cheaper than BEVs.
- Comparison of TCO values for cars with a performance of 93 hp between the BEV battery rental scheme (scheme-2) and the ICE is: no burden on battery replacement in the eighth year, cheaper

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MSRP value, higher retailer discounts, cheaper maintenance and cheaper vehicle tax, making BEV cars 48 USD cheaper than ICE.

- Comparison of TCO values for cars with 40 hp performance between ICE and BEV battery owned & repairable scheme (scheme-3) is in: no expensive part replacement costs in the eighth year, lower MSRP value, higher retailer discount, cheaper maintenance and cheaper insurance costs, making an ICE car 132 USD cheaper than a BEV.
- Comparison of TCO values for cars with 40 hp performance between ICE and BEV battery owned scheme (scheme-1) is in: no expensive part replacement costs in the eighth year, lower MSRP value, higher retailer discounts, costs Cheaper maintenance and cheaper insurance, making an ICE car 156 USD cheaper than a BEV.
- Comparison of the TCO value for a car with a performance of 93 hp between a BEV with a battery rental scheme (scheme-2) and a BEV with a battery owned scheme (scheme-1) is that there is no charge for battery replacement in the eighth year and the MSRP is lower because the initial purchase price is not take into account the price of the battery.
- With the current policy support for BEV (battery owned), the TCO value cannot yet match that of ICE cars; ICE TCO is still 61% lower than BEV.
- The policy support needed if scheme-1 is chosen is to genericize batteries that will be used in the eighth year, government subsidies to reduce the MSRP value, encourage retailers to provide more discounts, and reduce maintenance and insurance costs.
- The policy support needed if scheme-2 is chosen is to provide subsidies in an effort to reduce the MSRP value, encourage retailers to provide more discounts, reduce maintenance costs, insurance and energy consumption costs for battery renters.
- The policy support needed if scheme-3 is chosen is to genericize batteries that will be used in the eighth year, increase capacity in the form of a battery repair industry, government subsidies to reduce the MSRP value, encourage retailers to provide more discounts, and reduce maintenance and insurance costs.
- Supporting electric vehicles directly against MSRP, such as government subsidies or retailer discounts, can have a significant impact on reducing TCO from the first year of ownership. Scheme-2 has more sensitivity and efficiency than Scheme-3 and Scheme-1.

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