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Unlocking the Potential of EV Insurance in Indonesia:

Actuarial Solutions and Data-Driven Insights

role player

a consulting firm

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OTORITAS JASA KEUANGAN

Insurance Regulator

Interest with Electric vehicle (EV) in the motor industry

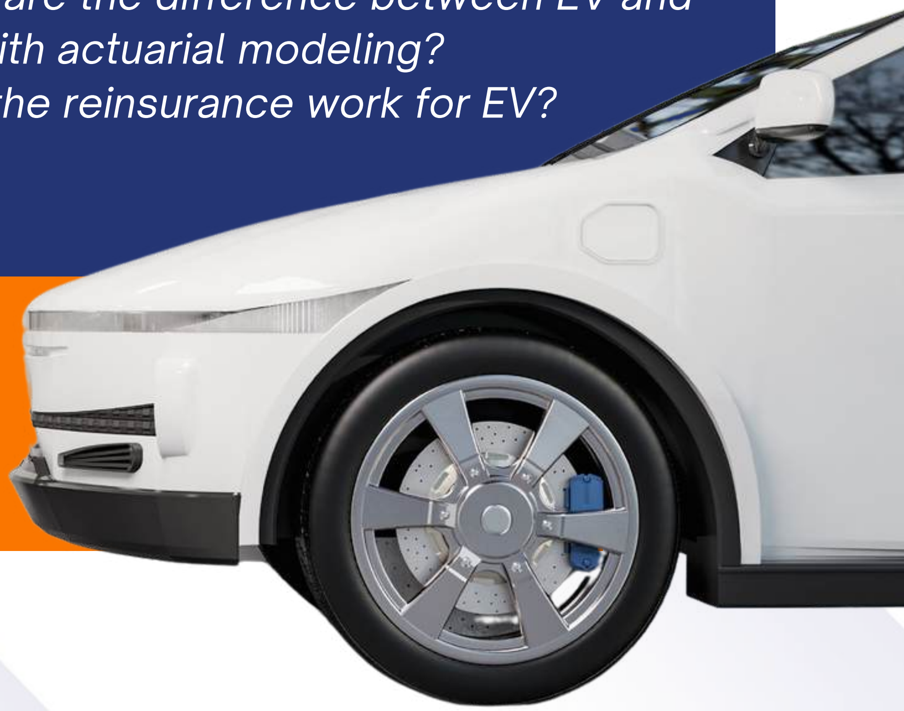
Target Audience #3

Objective: *To produce a comprehensive research report on the impact of electric vehicles (EVs) on the motor insurance industry.*

Outcome: *Provide actionable insights and recommendations to help the regulator and insurers adapt to the EV landscape.*

Key Questions :

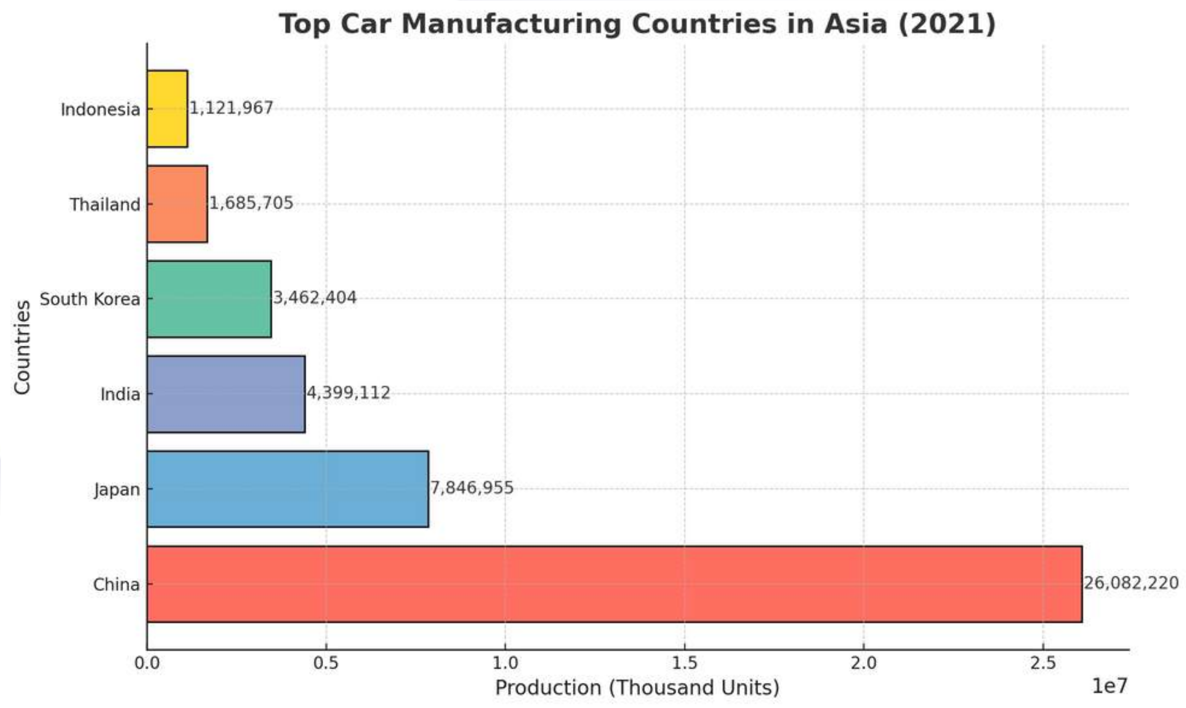
- *How is the EV market evolving in Indonesia?*
- *What are the difference between EV and ICE with actuarial modeling?*
- *How the reinsurance work for EV?*

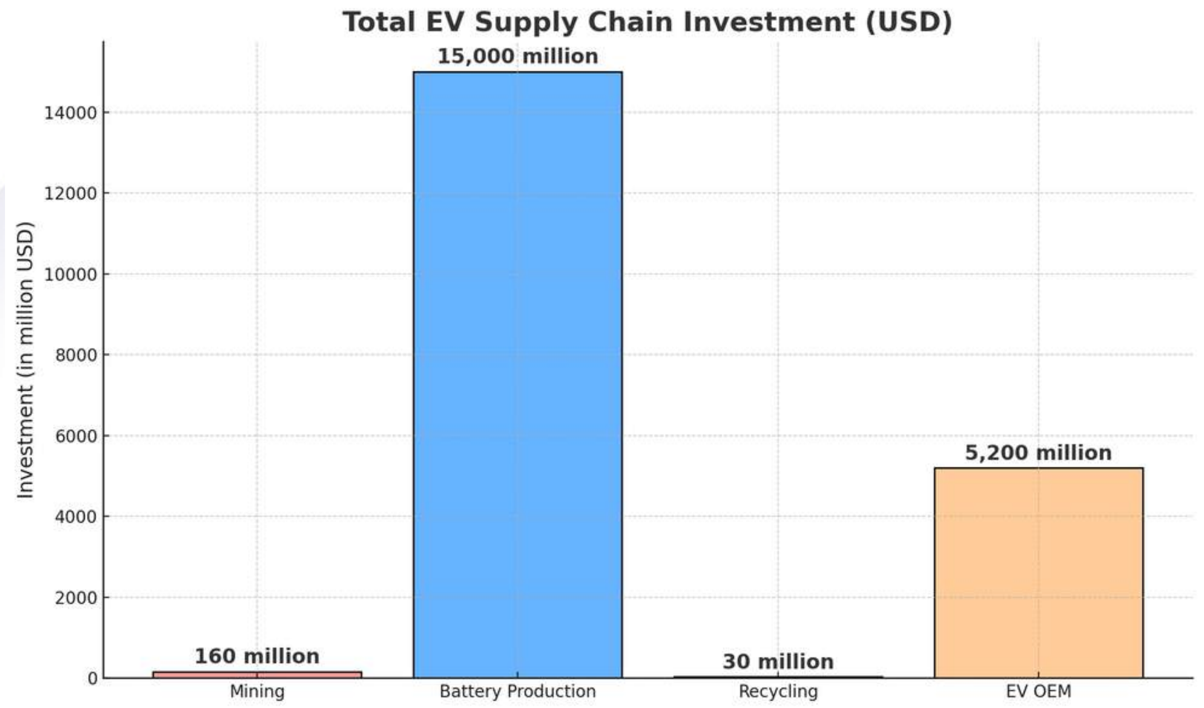


ps : If I advance to **the second round, i will give the best storyteller about this great ideas.*

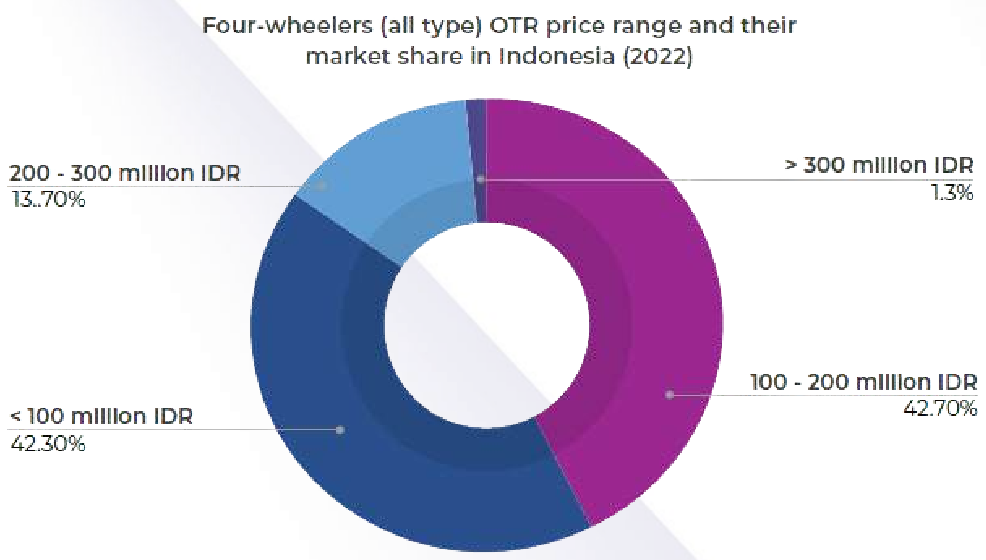
Market Growth and Sales Figures in Indonesia

According to the Gabungan Industri Kendaraan Bermotor Indonesia (Gaikindo), the wholesale sales of electric cars in Indonesia reached 23,045 units from January to August 2024, marking a substantial 177.32% increase compared to the same period in 2023. This surge indicates a growing acceptance and demand for EVs among Indonesian consumers.





The battery production's dominant role in the EV ecosystem. These figures highlight Indonesia's potential to become a hub for EV manufacturing, especially with the development of an integrated supply chain.



Sources: Gaikindo, 2022

The Role of Strengthened Fiscal Policy in Driving Indonesia's EV Future

Indonesia's lower EV purchasing power, reflected in its GDP per capita, underscores the need for either more substantial price reductions or other supportive measures.

Compared to more developed EV markets, Indonesia's EV policy lacks sufficient cost-reduction incentives. While other markets offer 15–25% price cuts for EVs based on type and performance, Indonesia plans to reduce E2W prices by 20–40% (IDR 7 million) and E4W prices by 10% (IDR 80 million) in 2023.

Now,
Let's beggin with story..

Start with a real-world scenario
a family considering their first EV purchase in Jakarta but unsure about insurance coverage.

EVs introduce unique risks that differ from Internal Combustion Engine (ICE) vehicles, including:

- Higher Repair Costs - EVs have specialized components like batteries and advanced electronics, which are costly to repair or replace.
- Unpredictable Claim Patterns - EVs may have different accident frequencies due to emerging technologies such as autonomous driving features.
- Technology and Battery-Related Risks - Risks such as battery fires, degradation, and high replacement costs can skew individual loss profiles.

Pooling risks allows the family to mitigate these uncertainties by distributing the costs of claims across a broader base, reducing the financial burden of high-cost events.

Why does this family require insurance for their electric vehicle?

How the difference EV vs ICE?

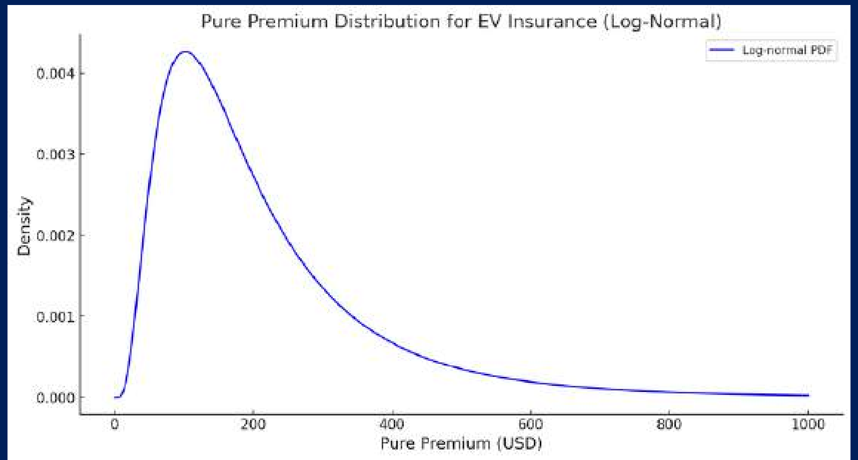
EVs have unique characteristics and risks compared to ICE vehicles, including high repair costs, specialized battery risks, and cyber vulnerabilities. These factors necessitate tailored insurance products to protect owners against unforeseen losses.

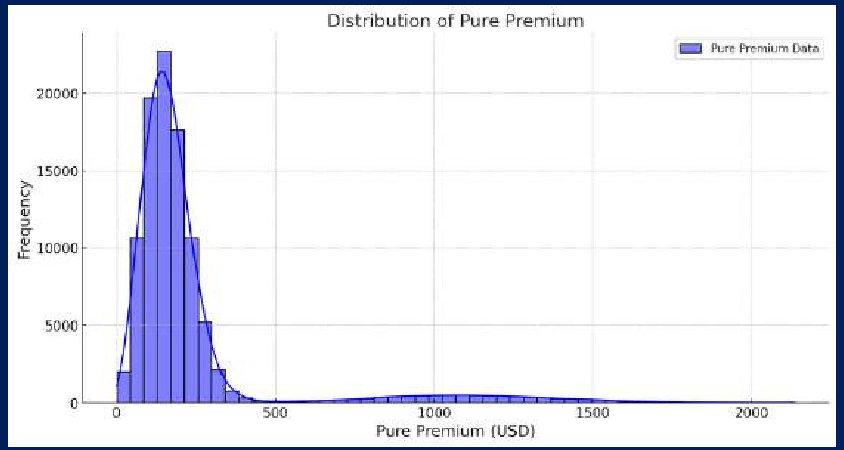
Category	Electric Vehicles (EVs)	Internal Combustion Engine (ICE)	Implications for Insurance
Purchase Cost	Higher upfront cost (e.g., EVs often priced > IDR 200M for E4Ws)	Lower upfront cost (most ICE cars in Indonesia priced < IDR 200M)	Higher asset value increases premiums to protect the investment.
Claim Frequency	Lower due to fewer moving parts and advanced safety features (e.g., ADAS).	Higher due to engine issues and accidents.	EVs have lower frequency but require ongoing monitoring via telematics to reduce risk further.
Claim Severity	Higher, especially for battery-related repairs (30%-50% of vehicle value).	Moderate, with most claims related to engine repairs or accidents.	EV premiums must reflect high battery replacement costs.
Battery Risks	Degradation, high replacement costs, and fire risks unique to lithium-ion.	Not applicable.	Insurers must cover risks like thermal runaway (battery fires) and degradation.
Cybersecurity	High risk due to connectivity and over-the-air updates in smart vehicles.	Low to no risk.	EV insurance requires coverage for hacking and cyberattacks.
Maintenance Costs	Lower (fewer moving parts, no oil changes), but specialized repair costs.	Higher (engine maintenance, oil changes, etc.).	Specialized EV repair facilities may lead to higher downtime costs.
Range Anxiety	High reliance on charging infrastructure; limited range increases risks.	None.	Policies may include roadside assistance for charging issues.
Charging Infrastructure	Dependent on SPKLU availability, increasing roadside risks if unavailable.	Refueling infrastructure is widespread.	Insurers should provide add-ons for charging-related risks (e.g., flat battery roadside help).
Environmental Impact	Low emissions and eligibility for green incentives.	High emissions and subject to carbon taxes in the future.	Insurers can offer discounts for EVs to support ESG goals.
Residual Value	Depreciates faster due to rapid battery degradation.	Slower depreciation over time.	Policies must account for varying depreciation rates in premium calculations.

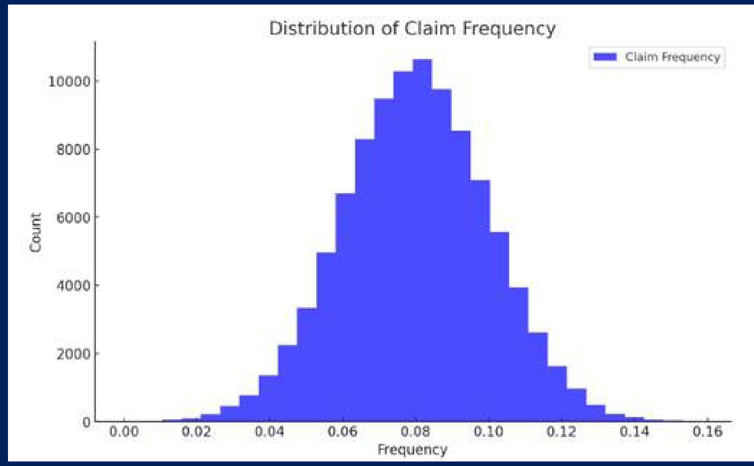
we practiced with the data!

Variable	Type	Description	Impact
Vehicle_Age	Numeric	The age of the electric vehicle (in years).	Older vehicles might have higher maintenance costs and lower replacement values, impacting premiums.
Battery_Age	Numeric	The age of the EV's battery (in years).	Older batteries may have higher failure risks or reduced efficiency, influencing claims and replacement costs.
Driver_Age	Numeric	The age of the driver.	Younger drivers may have higher claim frequencies due to inexperience, while older drivers might have lower risks.
Annual_Mileage	Numeric	The total distance driven annually (in kilometers or miles).	Higher mileage increases exposure to potential accidents and wear, impacting claim frequency.
Claim_Frequency	Numeric	The average number of claims made per policy in a given period.	Higher frequencies indicate higher risk, directly affecting premium calculations.
Repair_Cost	Numeric	The average cost of repairs per claim.	Significant driver of claim severity and total costs, closely linked to 'Battery_Replacement_Cost.'
Battery_Replacement_Cost	Numeric	The cost to replace the EV battery.	As one of the most expensive components, it heavily influences premium and severity calculations.
Telematics_Score	Numeric	A score based on driver behavior, often measured via telematics devices.	Higher scores usually correlate with safer driving, potentially lowering claim frequency and premiums.
Cyber_Risk_Score	Numeric	A measure of the risk associated with cybersecurity vulnerabilities in connected EVs.	Although crucial for EVs, it may not show direct correlations with claims unless linked to specific incidents like hacking.
Claim_Severity	Numeric	The average cost of claims per event.	Determines the magnitude of individual claims, which contributes to premium calculations.
Pure_Premium	Numeric	The actuarial premium calculated to cover expected claims, excluding additional loadings.	Directly derived from claim frequency and severity; used as the base rate for pricing insurance products.

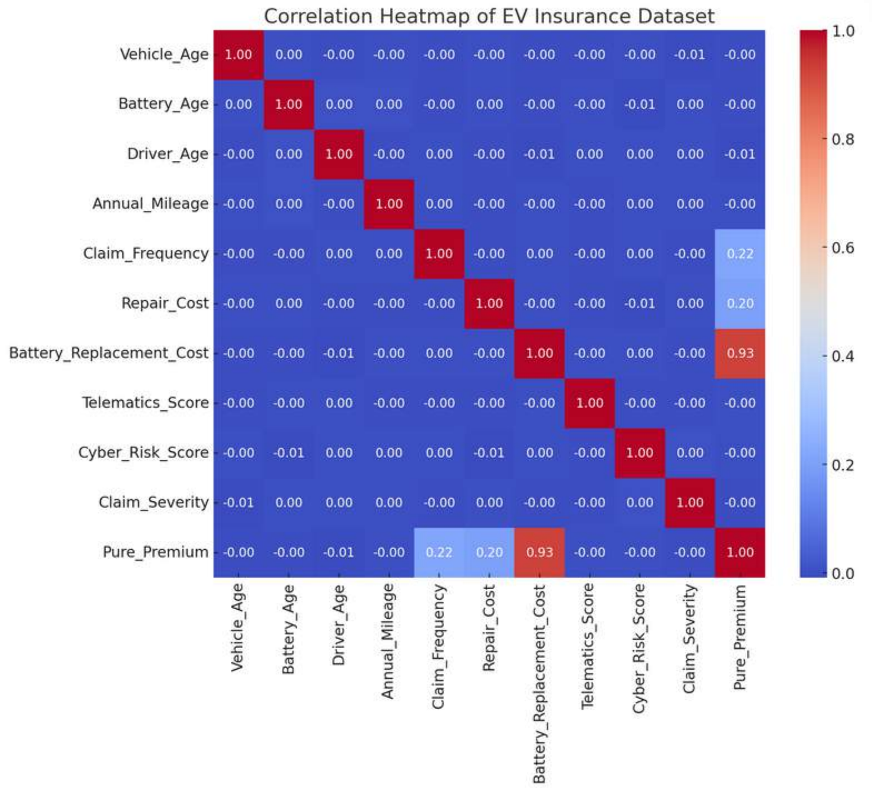
Begin with a data-driven approach..





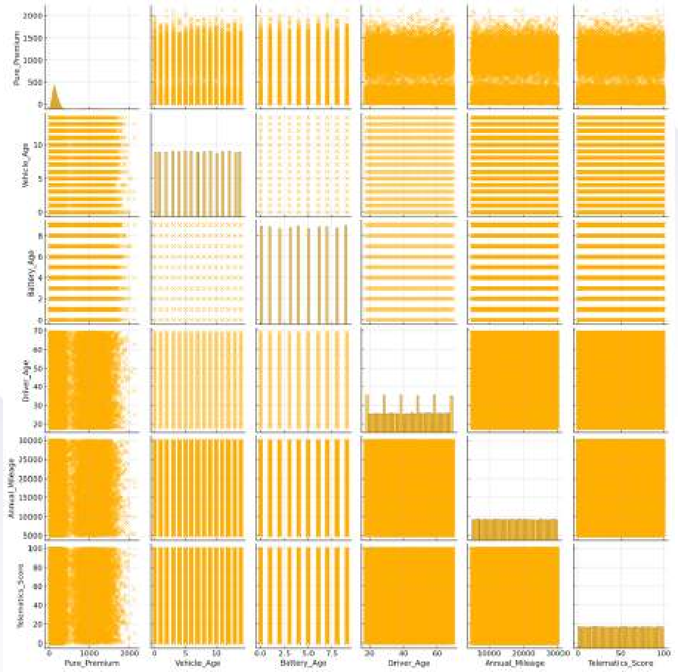


The best-fitting distribution for the Pure Premium data is the log-normal distribution. This indicates that the Pure **Premium values are positively skewed,** with the log-normal distribution capturing the variability effectively. The Kolmogorov-Smirnov (KS) test confirms the fit, with the log-normal distribution outperforming other candidate distributions **like gamma, Weibull, and normal.**

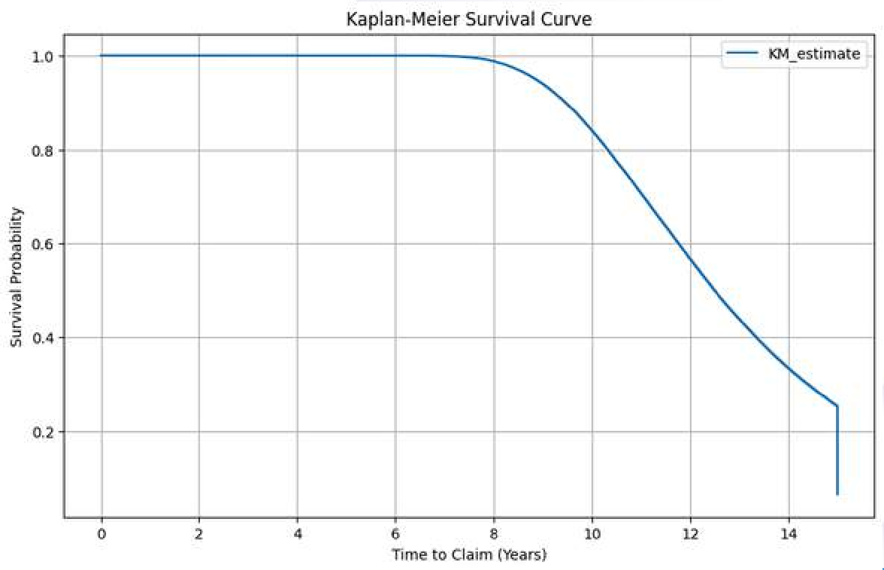


Notably, there is a **high correlation (0.93)** between Battery Replacement Cost and Repair Cost, indicating these costs are closely linked. Similarly, Pure Premium is strongly influenced by Battery Replacement Cost (0.93) and Repair Cost (0.92), suggesting that these **two variables are major drivers of insurance premium calculations.**

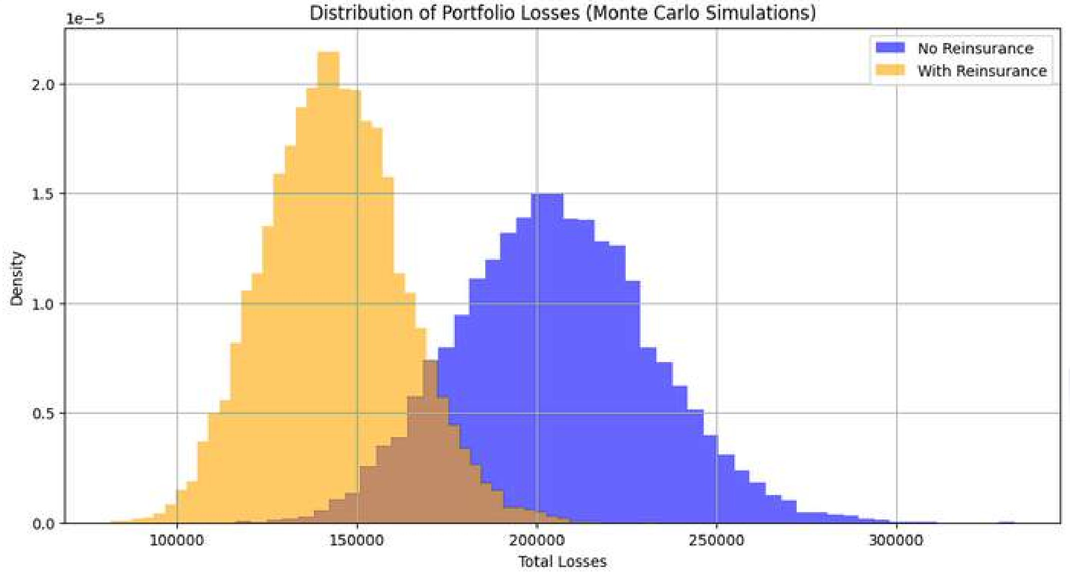
The pairplot shows key patterns in the EV insurance dataset. Pure Premium is right-skewed, indicating most policyholders pay lower premiums, while a few pay significantly more. **Driver Age is more evenly distributed,** with clusters in younger and middle-aged drivers. Annual Mileage spans a wide range, with a weak **positive relationship to premiums,** suggesting higher mileage slightly increases risk.



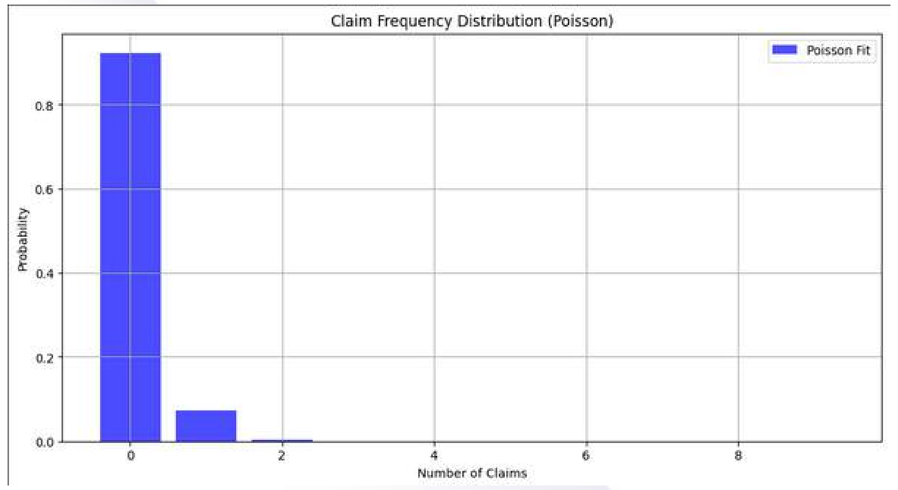
What the result models?



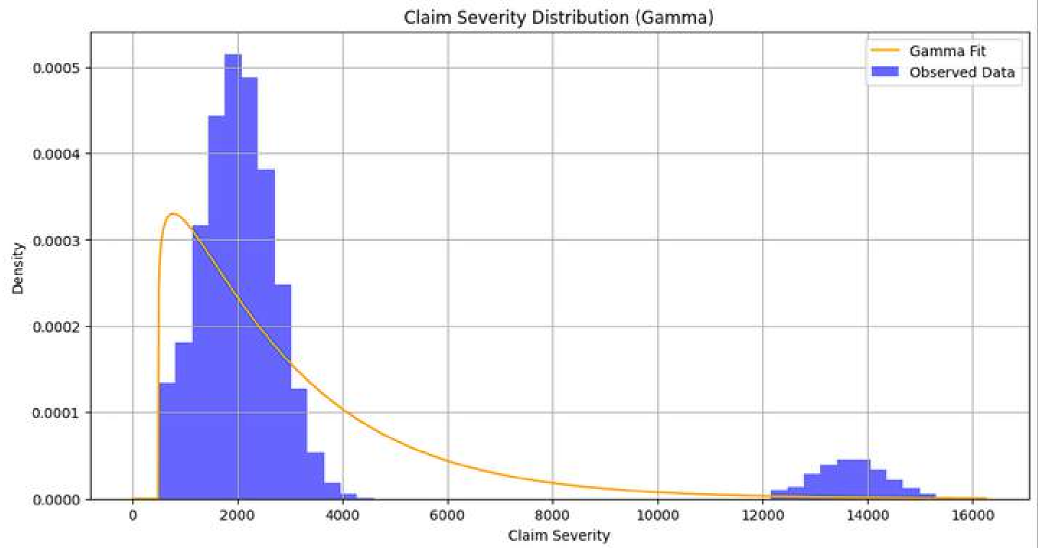
This plot shows the survival probability of policyholders over time until a claim occurs. Initially, all policyholders have a survival probability of 1, which decreases as claims are made. **By the 12th year, survival probability sharply declines,** indicating a higher likelihood of claims over longer periods.



The "No Reinsurance" distribution (yellow) has a broader range and higher tail risks, indicating higher potential losses. The "With Reinsurance" distribution (blue) shows reduced variability and lower losses, **highlighting the effectiveness of reinsurance in mitigating risk.**



Most policyholders have zero or one claim, **with a sharp drop-off for higher claim counts.** This aligns with typical insurance portfolios where frequent claimants are rare.



The observed data (blue bars) fits well with the Gamma curve (orange line). Most claims are small to moderate, but there are some outliers with very high severities, reflecting rare but costly incidents.

after we have the models..

Model	Target	MSE	R^2 Score
Poisson GLM	Frequency	4.014895e-04	0.000049
Gamma GLM	Severity	1.007311e+07	0.000164
Gradient Boosting	Frequency	4.019035e-04	-0.000982
Gradient Boosting	Severity	1.015497e+07	-0.007961
XGBoost	Severity	1.107503e+07	-0.099283

- Best Model for Frequency is Poisson GLM with the lowest MSE and highest R^2 Score.
- Best Model for Severity is Gamma GLM with the lowest MSE and highest R^2 Score.
- Non-linear Models (Gradient Boosting, XGBoost). But, struggled to outperform GLMs for both frequency and severity predictions.

Simulation Summary

- **Claim Frequency**
  - Average frequency parameter (λ) varies by customer segment
    - Low-risk drivers: $\lambda=0.3$ (e.g., older drivers, low mileage).
    - High-risk drivers: $\lambda=0.8$ (e.g., young drivers, high mileage).
- **Claim Severity**
  - Modeled with a Gamma distribution parameters (α, β), with severe claims
    - Battery replacement costs ($5,000–$15,000).
    - Cyber risks (e.g., hacking of connected systems).
- **Pure Premium**
  - Ranges from **$540 to $2,800**, depending on driver and vehicle profiles.

Recommended Reinsurance Structures

Metric	No Reinsurance	With Reinsurance
Total Losses	$2,500,000	$1,200,000
Retained Losses	$2,500,000	$800,000
Reinsurance Premium	$0	$400,000
Net Cost (Losses + Premiums)	$2,500,000	$1,200,000

- **Protects the insurer** against high-severity claims and aggregate losses.
- **Stabilizes financial performance** in a growing EV market.
- **Optimizes cost-effectiveness** through tailored quota share and excess of loss structures.

Adds loadings for expenses, profit, and risk:

- Expense Loading: 20%
- Profit Margin: 10%
- Risk Loading: 15%

Now,

Recommendations for Policy Makers (OJK) to Foster EV Insurance Growth in Indonesia

based on simulation before, here's the best recommendations.

1. **Incentivize EV Insurance Products**
   - Offer tax incentives or subsidies to insurers who develop specialized EV insurance products, such as coverage for battery replacement, cybersecurity risks, and charging station protection.
2. **Standardize Risk Assessment**
   - Develop guidelines for EV-specific actuarial modeling, including risk factors like battery age, telematics data, and repair costs, to ensure accurate premium pricing and sustainable profitability.
3. **Promote Public Awareness**
   - Collaborate with insurers to launch educational campaigns about EV-specific risks and the benefits of tailored insurance products, encouraging both adoption and trust in EV insurance.
4. **Strengthen Reinsurance Framework**
   - Partner with global reinsurers to mitigate high-severity risks associated with EV insurance, ensuring financial stability for local insurers entering the EV market.

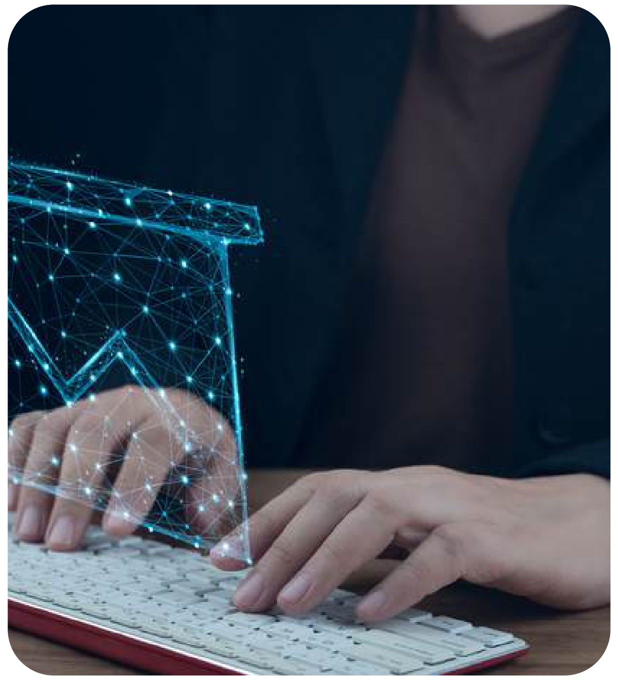
what the conclutions?

Growing EV Potential

Indonesia has significant potential to become an EV manufacturing hub, supported by its large automotive market and natural resources for battery production.

Challenges in Affordability

Limited purchasing power and insufficient fiscal incentives hinder EV adoption, particularly for four-wheelers, highlighting the need for stronger policies.



Need for Advanced Modelingbility

Accurate actuarial and data science modeling is crucial for designing effective EV insurance products and mitigating risks, ensuring profitability and market sustainability.

Conclusions

Indonesia's EV market holds immense **potential,** driven by its automotive capacity and abundant resources. However, affordability **challenges and weak fiscal incentives slow adoption**, especially for four-wheelers. Advanced **actuarial and data science modeling** can play a pivotal role in developing tailored insurance solutions and supporting sustainable market growth.

THANK YOU!

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