NOVA SCHOOL OF BUSINESS & ECONOMICS

AI-Driven Pricing for Used Cars: Startup Strategy Report

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1. Executive Summary

The used car market is highly competitive and prices fluctuate based on supply, demand, vehicle condition and economic trends. Traditional pricing methods are time consuming, subjective and inefficient. This analysis explores the implementation of AI-driven pricing models to provide accurate and competitive price estimates for used cars in real time.

The analysis found that the neural network model provided the highest accuracy with an R^2 value of 0.8338, outperforming traditional methods. AI-assisted pricing offers significant benefits, including increased profitability, greater customer confidence and optimised inventory turnover. However, challenges remain in dealing with extreme outliers, ensuring interpretability and adapting to market fluctuations.

The proposed implementation plan consists of three phases. The first phase includes data collection, model training and the development of an API for automatic pricing. The second phase focuses on providing AI-driven pricing via a user-friendly web and mobile interface. Finally, continuous model updates and integration into retailers' management systems will ensure the long-term scalability of the solution.

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2. 2. Dataset and Exploratory Data Analysis

The dataset used for this study consists of historical data on used car sales, including features such as price, mileage, fuel type, transmission type, accident history, and model year. The dataset was first examined to assess its structure, identify missing values, and understand variable distributions.

2.1 Data Processing

To ensure consistency and accuracy, the data was cleaned and edited in pre-processing steps. Missing values in categorical variables were replaced using the method of most frequent values, while numerical outliers were identified and treated by outlier caps. The dataset was then standardized to ensure that the features were on the same scale, which improves the stability of the machine learning models.

2.2 Exploratory Data Analysis (EDA)

The EDA was conducted to uncover patterns and relationships within the data set. Initial descriptive statistics revealed key trends and data distributions. Visualization techniques such as box plots and density plots showed that mileage had a right skewed distribution, indicating that most vehicles in the dataset had low mileage. A second peak indicated a

possible bimodal distribution, possibly due to the presence of newer and older vehicles. Price was also right-skewed, with most vehicles in the lower price segment and a small number of high-end vehicles forming a second peak, suggesting different price groups between budget and luxury vehicles. In contrast, the "model year" variable was left-skewed, indicating that most of the vehicles in the dataset were relatively new models, with only a small proportion of older vehicles. In addition, the accident history analysis showed that vehicles with previous accidents generally had lower prices, which was in line with expected market behaviour.

2. Business Problem & Market Opportunity

Traditional methods of pricing used cars are slow and inconsistent, as different valuers can set different prices for similar vehicles. In addition, market volatility affects the accuracy of pricing as vehicle prices fluctuate due to economic conditions and regional demand. Competitors such as Carvana and AutoTrader have already introduced AI-based pricing models, giving them a strategic advantage in the market.

The global used car market is estimated to be worth around $1.2 trillion, with AI-driven pricing models increasingly being used. AI models can analyse thousands of transactions and pricing trends, enabling the creation of accurate, data-driven price estimates. Startups that use AI-driven pricing strategies can gain a competitive advantage by offering transparent and optimised prices.

By eliminating human bias and automating pricing decisions based on historical trends and real-time data, AI-powered pricing increases profitability and ensures that vehicles are priced optimally to maximise sales. Integrating AI into pricing models offers the opportunity to modernise the used car industry and dynamically adapt to changes in supply and demand.

3. Machine Learning Model Evaluation

Several machine learning models were tested for their suitability for predicting used car prices. Measures such as R^2 (coefficient of determination), RMSE (Root Mean Squared Error) and MAPE (Mean Absolute Percentage Error) were taken into account in the evaluation. The following table shows the results:

Model	R^2	RMSE ($)	MAPE (%)	Strengths	Weaknesses
Neural Network	0.83	11,316	24.74	Best accuracy, good generalization	Harder to interpret
XGBoost	0.76	13,614	**24.70**	Good performance, interpretable	Higher RMSE

Linear Regression	0.79	12,468	32.66	Simple & explainable	High percentage error
Random Forest	0.67	15,861	33.00	Good for small datasets	Worst performance

The neural network model had the best accuracy, with an R^2 value of 0.83, meaning that it explained 83% of the variation in vehicle prices. It also achieved the lowest RMSE of $11,316, indicating a higher accuracy compared to other models. This model is particularly effective for mid-range and luxury vehicles, where pricing accuracy has a significant impact on profitability.

Challenges associated with neural networks include their lack of interpretability and the need to regularly retrain them to account for market changes. In addition, extreme price outliers require pre-processing techniques or alternative treatment strategies to improve the robustness of the model.

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4. Business Implementation Strategy

The successful introduction of AI-driven pricing requires a structured approach that includes data collection, system development, implementation and market expansion.

The first phase focuses on gathering historical sales data, vehicle attributes and competitor pricing information. Feature engineering techniques are used to extract relevant variables such as mileage, accident history, make and model year. Machine learning models, in particular neural networks, are then trained and optimised by tuning the hyperparameters.

Following model development, an API is created that provides instant price estimates for cars based on AI predictions. This API will be integrated into a web and mobile application that allows users to enter vehicle data and receive accurate price recommendations. In addition, dynamic price updates will be implemented using real-time data sources to continuously refine price estimates.

To ensure a successful launch, the model will be tested as part of a pilot programme in collaboration with a small car dealership or an online car marketplace. Based on feedback from users and dealers, refinements will be made to improve performance and usability. In the long term, the service may be expanded to include regional pricing models, demand forecasting and personalised offers to improve user engagement and business scalability.

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5. Business Impact & Competitive Advantage

The integration of AI-driven pricing offers several decisive advantages. Optimised pricing improves conversion rates, ensures faster stock turnover and maximises sales potential. By reducing reliance on manual pricing, the system improves operational efficiency and enables businesses to make data-driven pricing decisions. In addition, AI-driven pricing promotes customer confidence by ensuring transparent and fair pricing strategies.

Compared to traditional retailer pricing models, AI-driven systems enable faster and more accurate price estimates. Real-time price adjustments ensure that vehicles are neither overpriced nor underpriced, allowing companies to remain competitive. AI-powered trade-in valuations also improve negotiations at the dealership, enhancing both the customer experience and the company's profitability.

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6. Future Enhancements & Scalability

To improve the effectiveness and scalability of AI-supported pricing models, various enhancements can be made. In the short term, the system can make regional price adjustments to take account of fluctuations in local demand. User-specific pricing mechanisms can also be developed that offer AI-driven discounts based on customer preferences and purchasing behaviour.

Long-term growth opportunities include the integration of AI pricing solutions into dealer management systems and online car marketplaces. In addition, AI-powered demand forecasting can be used to predict fluctuations in vehicle prices, allowing companies to proactively make price adjustments. The pricing model can also be extended to car financing and insurance prices, further enhancing its value proposition.

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7. Conclusion

The implementation of AI-driven pricing strategies offers a significant competitive advantage for companies in the used car industry. The neural network model offers the highest accuracy, making it the best choice for predicting car prices. AI-assisted pricing increases efficiency, transparency and profitability, making it a valuable tool for startups looking to optimise their pricing strategies.

Future developments should focus on refining model performance, improving interpretability and expanding the system's ability to adapt to dynamic market conditions. By continuously updating and optimising the AI pricing model, companies can ensure sustainable success in an increasingly competitive market.