Educational Research on the Application of Multiple Linear Regression Analysis to the Relationship Between Electric Vehicle Exterior Design and Affective Vocabulary

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Abstract
This study applies multiple linear regression analysis to investigate the correlation between electric vehicle exterior design and emotional vocabulary, with an emphasis on its educational application. We selected six primary automotive features as independent variables (X) and compiled consumer emotional response data toward various design features as dependent variables (Y). Multiple linear regression analysis was performed, with the F-test results showing an F-value of 5.198 and a p-value less than 0.05, indicating significant predictive ability. Some independent variables exhibited significant effects on the dependent variables based on t-test results ($p<0.05$), demonstrating that these variables significantly impact the dependent variables. The model passed normality (Shapiro-Wilk test, $p=0.976$) and independence tests (Durbin-Watson value=1.838) without issues of multicollinearity, ensuring its robustness and explanatory power. Subsequent validation of the model confirmed its significance and stability. These results indicate that the model is effective in examining the influence of design features on emotional vocabulary, offering practical insights for designers and educational applications. Additionally, it serves as a tool to enhance students' design analysis capabilities.

Keywords: Electric Vehicle Design, Emotional Vocabulary, Multiple Linear Regression Analysis, Design Education, Emotional Analysis

Introduction

With the advancement of modern technology, product design must address not only consumers' functional needs but also their emotional expectations (McDonagh, Bruseberg, & Haslam, 2002). In the evolving electric vehicle (EV) market, the exterior design of a vehicle plays a pivotal role, representing not only aesthetic expression but also consumers' emotional engagement with the product. Designers must meet both functional and technical requirements while evoking positive emotional responses through design, thereby influencing purchasing decisions.

This research, based on multiple linear regression analysis, investigates the correlation between six primary electric vehicle exterior design features and consumer emotional responses. Furthermore, the study explores the potential application of these findings in design education. As design education increasingly emphasizes the integration of theory and practice, students must learn to utilize data to inform design decisions. This can help them better understand consumer needs and enhance their data analysis skills during the design process.

Correlation Between Design Features and Emotional Vocabulary

This study selected six primary exterior design features of electric vehicles—headlights, front grille, lower grille, windshield, fog lights, and side mirrors—as independent variables (X). Consumer emotional response data regarding these design features were collected as dependent variables (Y), specifically focusing on two emotional vocabularies: "modern and sleek" and "robust and comfortable." These design features directly influence consumers' visual perception and may shape their emotional response to the overall vehicle image. By understanding these responses, designers can optimize the design process to elicit positive reactions from target audiences.

According to the results of the multiple linear regression analysis, the model's F-test showed significant predictive power ($F\text{-value}=5.198$, $p<0.05$), indicating that these design features play a statistically significant role in shaping emotional responses. The t-test results revealed that some independent variables had a significant impact on the dependent variables ($p< 0.05$). Furthermore, the model passed the Shapiro-Wilk normality test ($p=0.976$), confirming that the data distribution met the normality assumption, while the Durbin-Watson value of 1.838 indicated no autocorrelation issues. Additionally, no multicollinearity problems were detected, further supporting the model's robustness.

These results demonstrate that our regression model has strong explanatory and predictive power, enabling designers to make more informed design decisions during the design process. At the same time, this model highlights the value of data-driven design, providing a foundation for future research.

Application in Design Education

In the field of design education, data-driven design thinking is becoming increasingly important. With the widespread adoption of data analysis techniques, design is no longer solely reliant on designers' intuition or creativity; data analysis provides a scientific basis for design. This study’s multiple linear regression model offers empirical support for design education, allowing students to understand the data underlying design decisions.

Through this model, students can learn how to translate design features into measurable variables and apply data analysis techniques to quantify the impact of design features on consumer emotional responses. This not only enhances students' data analysis skills but also promotes their understanding of the scientific basis of decision-making in the design process.

Additionally, the model serves as a practical case study for evaluating and optimizing design solutions. By incorporating data-driven design into education, students can improve their design capabilities and enhance their ability to solve real-world design problems, which is crucial for their future professional development.

Cultivating Data-Driven Design Thinking

Data-driven design thinking is an integrated approach that combines creative design with data analysis. As the design industry evolves, data analysis has become an essential skill for designers. The multiple linear regression model serves as a tool for quantifying design decisions, helping students gain insights into the subtle correlations between design features and consumer emotional responses through data.

Data-driven design thinking requires students to adopt critical thinking during the design process, using data to validate design assumptions and adjust designs based on analysis results. This skill is particularly important in today's fast-changing market environment, where consumer needs often shift, and designers must quickly adapt their design strategies based on the latest market feedback and data. Data-driven design thinking is not just about using numbers to support design decisions but also about developing a mindset that actively seeks out and integrates data throughout the design process. This approach empowers designers to make informed decisions, rather than relying solely on intuition or aesthetic preferences. As designers begin to prioritize data in their decision-making, they are able to identify patterns and correlations that may not be immediately obvious. For example, designers can analyze consumer feedback data to better understand how specific design features resonate emotionally with their target audience, enabling them to fine-tune their work for greater impact. Furthermore, this approach encourages continuous improvement by allowing designers to assess the effectiveness of their designs through the collection and analysis of real-world data. The ability to iterate quickly based on data-driven insights not only enhances the design's relevance and appeal but also improves the efficiency of the design process, reducing the time and resources spent on designs that do not meet consumer expectations. As the design industry moves forward, integrating data analysis into creative thinking is becoming an essential skill, enabling designers to stay competitive and respond to emerging trends more effectively. By integrating data-driven design thinking into their workflow, designers can foster a culture of innovation that is both creative and analytical. This mindset encourages designers to explore new possibilities while grounding their decisions in real-world insights. As a result, they can create products that not only meet functional needs but also resonate emotionally with consumers. Moreover, data-driven approaches enable designers to predict future design trends by analyzing consumer preferences and market behaviors. This predictive capability allows them to stay ahead of competitors and develop products that align with evolving consumer expectations. Additionally, the incorporation of data analytics tools and artificial intelligence can further enhance the design process by automating repetitive tasks and providing deeper insights into consumer behavior. With these advancements, designers can focus more on the creative aspects of their work while leveraging data to optimize their designs. Ultimately, embracing data-driven design thinking helps bridge the gap between creativity and science,

ensuring that design decisions are not only aesthetically pleasing but also strategically sound and aligned with user expectations.

Conclusion

This study explored the correlation between electric vehicle exterior design features and emotional vocabulary through multiple linear regression analysis, highlighting its potential application in design education. The results demonstrate that the model effectively explains the relationship between design features and consumer emotional responses, providing concrete data support for both designers and design education.

Future research could build upon this framework to further explore the impact of other design features on various emotional responses. For example, whether different interior design elements, such as seats and dashboards, have similar effects on consumer emotions is a question worth investigating. Additionally, with the advancement of artificial intelligence, future studies could integrate these technologies into design decision-making, making the design process more intelligent and efficient.

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