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Principal Components Analysis and Brand Mapping for Infinity

This report analyzes brand competition using Principal Components Analysis (PCA) and Principal Components Regression (PCR). The objective is to visualize how different car brands are perceived based on consumer attributes and to provide strategic suggestions for Infinity.

PCA was performed to reduce dimensionality, interpret principal components, and construct brand maps to identify Infinity's market position.

Data Overview

The dataset contains 13 consumer perception attributes for car brands, including:

- Performance-related: Attractiveness, Sporty, Prestige
- Comfort & Quality: Quietness, Roominess, Uncomfortable, Poorly Built
- Practicality & Economy: Easy Service, Economical, Common
- Brand Positioning: Avant-Garde, Poor Value, Overall Preference

Principal Components Analysis (PCA)

PCA was performed on the standardized dataset, and we obtained the following eigenvalues :

First Component	7.74
Second Component	2.80
Third Component	2.06
Fourth Component	1.29
Fifth Component	0.43

From this, we retained 4 values for further analysis.

After factor loadings, the following names were assigned:

Factor 1: Brand Appeal

- Influenced by Attractiveness, Quietness, Prestige, Successful.

Factor 2: Luxury & Comfort

- Influenced by Unreliable, Sporty, Easy Service.

Factor 3: Economy & Value

- Influenced by Economical, Unreliable, Poor Value.

Factor 4: Innovation

- Influenced by Avant-Garde, Uncomfortable, Common.

Brand Mapping

The brand map was generated using Factor 1 (Z1) vs. Factor 3 (Z3) as they were found to be statistically significant (p-value < 0.05).

Key Observations from the Brand Map:

- Infinity is positioned high on Factor 1, thus it is perceived as a high-prestige, appealing brand.
- BMW is close to Infinity, suggesting a similar perception in terms of brand appeal and luxury.
- Audi and Toyota cluster together, indicating they share consumer perceptions.
- Ford and Pontiac are positioned much lower on Factor 1 (Z1), suggesting they may be a bit less prestigious brands.

Iso-Preference Line vs. Regression Line

The key difference between the iso - preference line and regression line is that in the iso - preference line, the line shows a combination of theoretical variables producing the same outcomes, like cost or utility. Additionally, the fixed slope which in iso - preference line is derived from models, not the data. On the other hand, the regression line which is derived from the data depicts the best-fit relationship between the variables. The regression line also minimizes errors and depends on observed data patterns, commonly used for trends and forecasting. An example for iso-preference line could be cars offering equal attractiveness and quietness ratings (e.g. Infinity: 5.6 and 6.3) and for a regression line example: analyze how attractiveness predicts prestige ratings across brands.

The Ideal Vector

An ideal vector is a line that is perpendicular to iso-preference lines. It serves as the benchmark for the perfect or optimal combination of attributes. The ideal vector points towards the direction of increasing

preference because as we move closer to the vector in the space, attribute values align more with the desired levels, indicating higher preference. That means, the closer a brand is to the ideal vector, the more preferred that brand is.

Using PCA regression, the computed values for the angles of iso-preference line and ideal vector are:

- **Iso-Preference Line Angle = -56.21°**
- **Ideal Vector Angle = 33.79°**

95% confidence interval for the angle of the ideal vector

The confidence interval interval was computed using data bootstrapping method and these are the ranges

- **Lower: -28.11443**
- **Upper: 28.39938**

Recommendations to improve product design

Some suggestions that might help Infinity managers to improve their product design are:-

- Identifying which attribute contributes most to the growth of a product based on the consumer preference. For example, if a customer prefers the attractiveness of a car and luxury setting more than other parameters then these features are highlighted in Infinity's product design.
- Managers should consider redesigning products or improving certain features that customers value the most.
- Managers may look out for competitors if they are closer to the ideal vector, it might indicate a need for Infinity to adjust its strategy in order to align with consumer preferences.
- These are some of the key takeaways a manager at Infinity should focus in order to improve their product design.