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Customer-Centred Hair Color Selection Using the Analytic Hierarchy Process

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Abstract: ***This study presents a customer-centred framework for selecting hair color products using the Analytic Hierarchy Process. The study evaluates five alternatives: L'oreal Paris, Garnier Color Naturals, Godrej Expert Rich Creme, Revlon Colorsilk, and Indus Valley Organic Hair Colour. Customer preferences are assessed using five criteria: price, color variety, color durability, hair safety, and ease of application. Pairwise comparisons are used to determine the relative importance of these criteria and to prioritize the alternative products. The framework provides a systematic approach for translating customer preferences into a transparent product ranking, supporting more informed hair color selection. The study is limited to the specified products and criteria and focuses on preference-based decision analysis rather than laboratory testing of product performance***

Keywords: Analytic Hierarchy Process, multi-criteria decision-making, consumer preference, hair color selection

1. Introduction

Choosing an ideal hair color remains a multifaceted, customer-centred decision problem characterized by individual subjectivity and diverse personal requirements, particularly among customers aged 40–55 and older, who may place greater emphasis on gray-hair coverage, hair safety, durability, affordability, and ease of application than on fashion-oriented color trends (Lee & Do, 2019). Accordingly, this study aims to apply the Analytic Hierarchy Process systematically to represent the preferences of this customer group, determine the relative importance of the selected criteria through pairwise comparisons, and rank L'Oreal Paris, Garnier Color Naturals, Godrej Expert Rich Creme, Revlon Colorsilk, and Indus Valley Organic Hair Colour according to their perceived suitability. By converting customer judgments into priority weights, the framework seeks to support personalized and transparent product selection while recognizing that consumer assessments may be subjective and imprecise (Feng & Wei, 2011). This systematic evaluation framework facilitates the decomposition of complex decision goals into a hierarchical structure of criteria and alternatives, ensuring that subjective preferences are transformed into a quantitative and rational decision model (Zaizoune & Herrou, 2023). By requiring customers to compare criteria and alternatives in pairs, the method makes their judgments easier to express and converts them into priority weights and an overall ranking (Saaty, 1979). Because customer assessments may be uncertain or imprecise, the resulting priorities should be interpreted as representations of perceived suitability rather than objective measurements of product performance (Feng & Wei, 2011). The study therefore focuses on developing a transparent, customer-centered decision framework for consumers aged 40–55 and above, with the subsequent analysis examining the selected criteria, five hair color alternatives, comparison consistency, and implications of the resulting ranking.

2. Objective of the study

The objective of this study is to develop a customer-centered decision model for evaluating hair-color products using the Analytic Hierarchy Process. Specifically, the study aims to identify and prioritize the criteria customers consider when selecting hair color, distinguishing among aesthetic preferences—such as color variety and desired appearance—functional expectations, including color durability, and practical considerations, such as price, hair safety, and ease of application. The study also compares L'Oreal Paris, Garnier Color Naturals, Godrej Expert Rich Creme, Revlon Colorsilk, and Indus Valley Organic Hair Colour as meaningful alternatives. By ranking these alternatives according to customer-defined priorities, the study seeks to determine which product best satisfies the decision requirements of the target customer group. In the following section the criteria explained and provided the related literature.

3. Literature Review

Prior research demonstrates that the Analytic Hierarchy Process is well suited to customer-centred product evaluation because it decomposes complex decisions into a goal, evaluation criteria, and alternatives. Through pairwise comparisons, customers assess the relative importance of criteria and the performance of alternatives, enabling the calculation of priority weights and an overall ranking (Saaty, 1979; Zaizoune & Herrou, 2023). This approach is particularly relevant to hair-color selection, where consumers must balance aesthetic expectations, functional performance, and practical considerations rather than evaluate a product according to a single attribute.

In the context of hair-color evaluation, customers may use aesthetic criteria such as **color** variety and the attractiveness or suitability of the expected shade. Previous research on clothing and luxury fashion products shows that consumers evaluate alternatives through criteria associated with

appearance, self-expression, prestige, and other symbolic or aesthetic values (Cho, 2007; Liu et al., 2023). Similarly, research on hair-color products indicates that consumers differ in their expectations: some prioritize ease of use, technological performance, and reliability, whereas others emphasize the results delivered by the product or the information available during selection (Gabay et al., 2010). These findings support the inclusion of color variety as an aesthetic criterion while also indicating that aesthetic preferences should be examined alongside functional and practical requirements.

Functional preferences concern the performance and reliability of the coloring result. In this study, **color durability** refers to the extent to which the selected shade is expected to remain stable and retain satisfactory pigment intensity over time. Hair-color selection may also involve expectations regarding consistent color development and effective gray-hair coverage. Such expectations are important because customers may experience uncertainty about the final color outcome, and difficulty predicting the resulting shade has been identified as a significant concern in hair-color services (Lee & Do, 2019). Accordingly, durability represents more than temporary visual appeal; it reflects the perceived reliability of the product in maintaining the desired result.

Practical preferences include price, hair safety, and ease of application. **Price** represents the financial cost of purchasing and using the product, and it enables customers to compare affordability with expected performance. **Hair safety** refers to the perceived risk of damage, irritation, or undesirable effects associated with the coloring process, including concerns related to chemical sensitivity. **Ease of application** reflects the effort, time, complexity, and user skill required to achieve an acceptable result. These criteria are consistent with research showing that consumers may prioritize practical value, safety, and convenience when evaluating products and services (Cho, 2007; Lee & Do, 2019). In addition, the use of fuzzy AHP in customer-value research indicates that consumer judgments about product attributes can be imprecise because they are influenced by subjective and psychological factors (Feng & Wei, 2011). Therefore, the criteria in this study should be interpreted as measures of perceived suitability rather than laboratory-based assessments of objective product performance.

The three-dimensional structure of the model aligns the criteria with customer-centred decision requirements. The aesthetic dimension comprises color variety; the functional dimension comprises color durability; and the practical dimension comprises price, hair safety, and ease of application. This classification enables the model to represent the trade-offs that customers aged 40–55 and above may make when selecting hair color. For example, a product with a wider range of shades may be more attractive aesthetically, whereas another product may be preferred because it is less expensive, easier to apply, or perceived as safer for the hair. AHP provides a transparent means of expressing these competing priorities and determining their relative importance through structured comparison (Petiot & Yannou, 2004; Wu, 2021).

AHP Applications in Customer-Centred Product Evaluation

AHP has been applied across product-design and consumer-preference studies to identify the relative importance of criteria, compare alternatives, and support product-development decisions. In product evaluation, the method generally begins by defining the decision goal, establishing a hierarchy of criteria and sub criteria, constructing pairwise comparison matrices, calculating priority weights, and evaluating the consistency of the judgments (Saaty, 1979; Zaizoune & Herrou, 2023). This procedure allows complex and subjective customer requirements to be represented in a systematic decision model.

A central application of AHP is the prioritization of customer needs and product attributes. AHP has been used to measure consumer values and preferences in areas including luxury automobiles, travel products, smartphones, furniture, and fashion products (Liu et al., 2023). In clothing evaluation, for example, pairwise comparisons were used to determine the priority of criteria such as symbolism, practicality, economy, fashion ability, and aesthetics (Cho, 2007). These applications demonstrate how AHP can convert qualitative consumer perceptions into quantitative priorities and can identify which attributes exert the greatest influence on product choice.

AHP is also frequently integrated with product-development methods such as Quality Function Deployment. In this application, customer requirements are prioritized using AHP and then translated into technical or design requirements through the House of Quality (Asadabadi, 2016). The integration is useful for hair-color selection because customer expectations—such as affordable pricing, durable color, hair safety, and convenient application- can be connected to product characteristics and subsequently used to compare competing alternatives. AHP therefore serves not only as a ranking method but also as a mechanism for translating customer expectations into actionable product-development priorities.

Another important application is the evaluation of furniture and other consumer products in which aesthetic, functional, safety, durability, and value-related criteria must be considered simultaneously. Studies of chairs and furniture have used AHP to structure criteria, calculate comprehensive weights, and rank design or material alternatives (Chen & Sun, 2023; Liu et al., 2023). These applications are relevant to hair-color evaluation because both domains require customers to balance appearance with practical performance and safety. The same logic can be applied to hair-color products by comparing brands according to the five criteria established in this study.

AHP can also support group decision-making and preference-based design. The method allows several customer judgments to be aggregated into priority weights, while the hierarchical structure can be expanded to include additional sub criteria when a more detailed evaluation is required (Zhang et al., 2023). The reliability of AHP results depends on the consistency of pairwise judgments. Saaty's approach uses the consistency ratio to assess whether the comparisons are sufficiently coherent; a consistency ratio below 0.10 is

commonly treated as acceptable (Asadabadi, 2016). If the threshold is exceeded, the comparison matrix should be reviewed or reconstructed (Chen & Sun, 2023). This step is particularly important in hair-color selection because customers may find it difficult to compare several subjective criteria simultaneously. Consistency assessment improves the transparency of the model by showing whether the resulting priorities reflect a reasonably coherent pattern of preferences.

Overall, prior applications indicate that AHP is appropriate for the proposed hair-color decision model. It accommodates subjective customer judgments, distinguishes aesthetic, functional, and practical preferences, and produces a clear ranking of alternatives. In this study, the method is applied to compare L'Oréal Paris, Garnier Color Naturals, Godrej Expert Rich Crème, Revlon Colorsilk, and Indus Valley Organic Hair Colour according to price, color variety, color durability, hair safety, and ease of application. The resulting hierarchy provides a structured basis for identifying which criteria are most important to the target customer group and which product is perceived as the most suitable under those priorities. The following section provides the AHP methodology.

4. Methodology

The Analytical Hierarchy Process (AHP) is one of the multi-criteria-decision methods (MCDM) and the decision-support framework developed by (Saaty.TL). Its main aim is to assess the relative importance of a defined set of alternatives using a ratio scale, which is based on the decision-maker's judgment. This methodology highlights the importance of the intuitive assessments made by the decision-maker and the need for consistency when comparing alternatives during the decision-making process. Since decision-makers depend on their expertise and experience to make judgments and ultimately decisions, the AHP framework is well-suited to their behavioural tendencies. A significant benefit of this method is its capacity to systematically arrange both measurable and non-measurable factors, providing a structured yet relatively simple approach to addressing decision-making issues. Additionally, by logically breaking down a problem from a broader viewpoint to more specific details, one can create links between the smaller components and the larger context through straightforward paired comparison judgments. (Saaty.T. L) outlined the following steps for implementing the AHP:

1) Define the problem and determine its goal.
2) Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which sub- sequent levels depend) to the lowest level which usually contains the list of alternatives.
3) Construct a set of pair-wise comparison matrices (size n×n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.
4) There are n(n-1)/ 2 judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5) Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
6) Having made all the pair-wise comparisons, the consistency is determined by using the eigenvalue, λ_{max}, to calculate the consistency index, CI as follows: $CI=(\lambda_{max}-n)/(n-1)$, where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 2. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.
7) Steps 3-6 are performed for all levels in the hierarchy.

Table 1: The saaty's scale of relative importance

Relative importance	Definition	Description
1	Equally importance	Two factors equally influence the objective
3	Moderate importance	Experience and judgement slightly favour one factor over another
5	Strong importance	Experience and judgement strongly favour one factor over another
7	Very strong importance	One decision factor is strongly favoured over another, and its supremacy is established in practice
9	Extreme importance	The evidence favouring one decision factor over another is of the highest possible orders of validity
2,4,6 and 8	Intermediate values between adjacent values	When compromise is required

Fortunately, there is no need to implement the steps manually. Professional commercial software, **Expert Choice**, developed by Expert Choice, is available in the market which simplifies the implementation of the AHP's steps and automates many of its computations.

Table 2: Average random consistency (RI)

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

In this study, we identified five critical criteria for evaluation, which were considered essential for the assessment. The chosen criteria are elaborated upon below. In this study, primary data were gathered using questionnaires that were distributed to customers aged between 40 -55 and above Hyderabad, with the responses represented as pairwise comparison matrices. A structured questionnaire was utilized to aid in the data collection process for the study. The design

of the questionnaires was meticulously developed to guarantee the utmost accuracy in the information gathered and to improve the understanding of the respondents. Following this, the Analytic Hierarchy Process (AHP) was implemented on the collected data to achieve the goals of the present research. The following figure shows the proposed model.

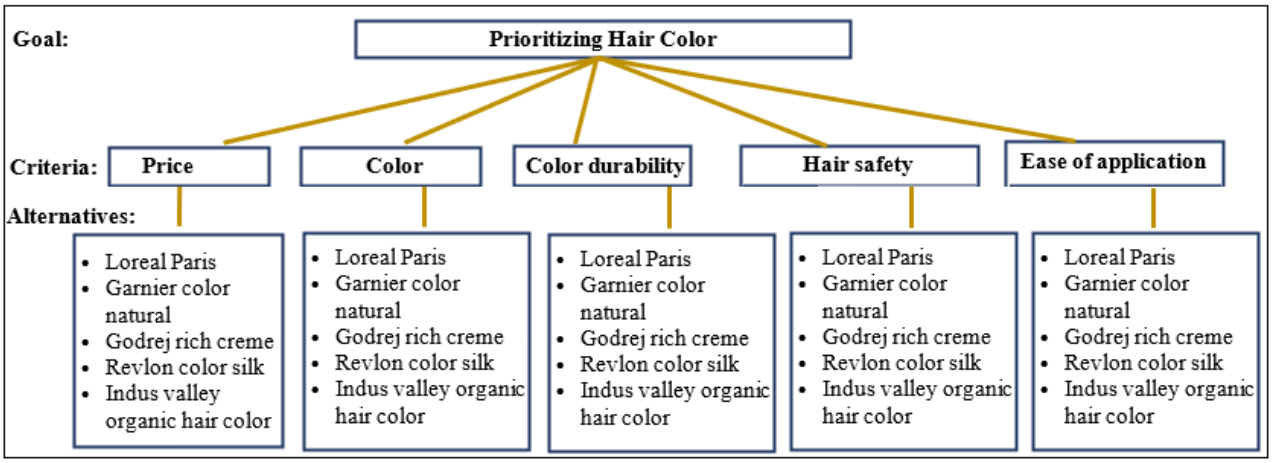

Figure 1: Proposed Model

We use the following notations Lp: Loreal paris, GN: Garnier colour Natural, GR: Godrej rich creme, RS: Revlon colour silk, IO: Indus valley organic hair color The AHP calculations are given in table 3 to 9

Table 3: Pair-wise comparison matrix for all criteria

	Price	Hair safety	Color durability	Color	Ease of application	Priority vector
Price	1	1/5	3	2	1/3	0.150
Hair safety	5	1	4	2	2	0.393
Color durability	1/3	1/4	1	1/2	1/2	0.080
Color	1/2	1/2	2	1	1/3	0.124
Ease of application	3	1/2	2	3	1	0.254
λ_{max} = 5.401 CI=0.100, CR = 0.09 < 0.1						

Table 4: Pairwise comparison matrix for "*Price* "

	LP	GN	IO	RS	GR	Priority vector
LP	1	2	3	2	5	0.370
GN	1/2	1	3	1/3	2	0.172
IO	1/3	1/3	1	1/2	1/2	0.087
RS	1/2	3	2	1	4	0.277
GR	1/5	1/2	2	1/4	1	0.095
λ_{max} = 5.328, CI=0.082, CR = 0.07<0.10						

Table 5: Pairwise comparison matrix for "*Hair safety*"

	LP	GN	IO	RS	GR	Priority vector
LP	1	2	2	4	4	0.381
GN	1/2	1	4	2	2	0.266
IO	1/2	1/4	1	2	2	0.155
RS	1/4	1/2	1/2	1	2	0.113
GR	1/4	1/2	1/2	1/2	1	0.085
λ_{max} = 5.302, CI=0.076, CR=0.07<0.1						

Table 6: Pair-wise comparison matrix for "*Color durability*"

	LP	GN	IO	RS	GR	Priority vector
LP	1	2	3	4	4	0.418
GN	1/2	1	1/2	2	2	0.173
IO	1/3	2	1	2	2	0.210
RS	1/4	1/2	1/2	1	1/2	0.114
GR	1/4	1/2	1/2	2	1	0.085
λ_{max} = 5.160, CI=0.040, CR = 0.04 < 0.1						

Table 7: Pair-wise comparison matrix for "*Color*"

	LP	GN	IO	RS	GR	Priority vector
LP	1	4	3	4	4	0.454
GN	1/4	1	3	2	2	0.193
IO	1/3	1/3	1	1/4	1/3	0.070
RS	1/4	1/2	4	1	2	0.166
GR	1/4	1/2	3	1/2	1	0.117
λ_{max} = 5.432, CI=0.108, CR = 0.096<0.1						

Table 8: Pair-wise comparison matrix for "*Ease of application*"

	LP	GN	IO	RS	GR	Priority vector
LP	1	1/2	1/4	1/4	1/3	0.072
GN	2	1	1/2	1/3	1/2	0.119
IO	4	2	1	1/2	3	0.268
RS	4	3	2	1	2	0.364
GR	3	2	1/3	1/2	1	0.177
λ_{max} = 5.184, CI=0.046, CR = 0.04< 0.1						

Table 9: Final priority table

	Price	Hair safety	Color durability	Color	Ease of application	Final priority vector	Rank
	0.150	**0.393**	**0.080**	**0.124**	**0.254**		
LP	0.370	0.381	0.418	0.454	0.072	**0.313**	**1**
GN	0.172	0.266	0.173	0.193	0.119	**0.198**	**3**
IO	0.087	0.155	0.210	0.070	0.268	**0.168**	**4**
RS	0.277	0.113	0.114	0.166	0.364	**0.216**	**2**
GR	0.095	0.085	0.085	0.117	0.177	**0.114**	**5**

5. Results

The present study focuses on the comparative assessment of five hair colors L'Oréal Paris, Garnier Color Naturals, Godrej Expert Rich Crème, Revlon Colorsilk, and Indus Valley Organic Hair Colour based on various factors including price, hair safety, color durability, color and ease of application. The findings indicate that L'Oreal Paris, (0.313) ranks highest among all evaluated products, following Revlon Colorsilk (0.216), emerges as the second most popular one, with, Garnier color naturals (0.198) in third place, Indus valley organic hair color (0.168) in fourth, and godrej expert rich creme (0.114) in last position. The results highlight that L'Oréal Paris and Revlon Color silk are the two most popular hair colors and results indicate that hair safety and ease of application are the most important criteria.

6. Conclusion

Future evaluations should incorporate fuzzy logic to better account for the inherent subjectivity in user-perceived satisfaction metrics, as current models may oversimplify nuanced linguistic variables. Furthermore, for upcoming research, multi-criteria decision-making (MCDM) techniques such as PROMETHEE, Fuzzy PROMETHEE, AHP-ANP, VIKOR, TOPSIS, Fuzzy AHP, and Fuzzy TOPSIS may be utilized.

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