Men's Perfume Recommendation System Using Analytic Hierarchy Process (AHP) And Technique For Order Of Preference By Similarity To Ideal Solution (TOPSIS) Method

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***Abstract**.*

Perfume has been a product used for thousands of years by human civilization. Rapid growth of perfume products creates a problem especially for men to choose the best perfume to fit their personality. This research aims to help men find out which perfume suits each individual's personality by inputting a comparison of four main criteria, namely quality, price, aroma and durability. In this research, the research team built a perfume recommendation system specifically for men using the application of the Analytic Hierarchy Process (AHP) & Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) algorithm. The research resulted in an 89.17% usefulness score, 89.34% ease of use, 89.34% ease of learning, and 91.61% satisfaction, resulting in an overall score of 90.07%. The research results demonstrate that the AHP and TOPSIS algorithm can assist men in choosing appropriate perfume through its implementation in the system built by the research team, which was tested using a questionnaire.

Keywords: *Recommendation System, Analytic Hierarchy Process, Technique for Order of Preference by Similarity to Ideal Solution and Men's Perfume.*

I. INTRODUCTION

Perfume has been a commodity used to provide a pleasant aroma to the body for more than 3000 years. This is proven by the oldest perfume formula in the world which was created by Tapputi on a tablet found in Mesopotamia which is thought to date from 1200 BC [1]. As time progresses towards the modern era, the number of perfume varieties has experienced rapid growth. Currently there are more than 62,131 perfume brands all over the world. This might make things difficult for users [2]. The research team expects that the recommendation system would be helpful to assist people choosing the appropriate perfume needs quickly and accurately.Several previous studies regarding perfume selection systems for women using the AHP algorithm have been found such as [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], and [13]. Unfortunately, there has been no men's perfume recommendation system that has been created using the AHP & Topsis algorithm.Recommendation systems are software, which are used to recommend items of interest to users [14]. The use of the AHP & TOPSIS algorithm in creating a men's perfume recommendation system is an innovative step in developing a recommendation system. The AHP algorithm helps in measuring and comparing the importance of various criteria in perfume selection, such as quality, price, aroma, and durability, in a structured and objective way. Meanwhile, TOPSIS allows selecting the best solution that is closest to user preferences by considering the similarity score with the ideal solution and the worst solution.

The use of the AHP & TOPSIS algorithm is suitable because it is efficient and fast, so it can be implemented later on various platforms [15]. The development of the men's perfume recommendation system, the research team used the *Software Development Life Cycle* (SDLC) method, where later the perfume criteria will be divided into 4, namely based on quality, price, aroma and durability. The SDLC method was chosen because it can provide a structured and organized approach to building this complex recommendation system.The purpose of building this recommendation system is to make it easier for men to determine which perfume is suitable for them based on their personality. Apart from the goals the research team wants to achieve, building this system also provides several benefits, such as reducing the time needed to carry out the research individually regarding perfumes that are suitable for men, as promotional media and also branding for listed perfume brands, and perfume purchasing references for users [16].It is hoped that this research can provide significant benefits for the development of science and innovation, especially in men's perfume products.

II. METHODS

In this research, the SDLC *(Software Development Life Cycle*) concept is used in the system development process. SDLC is a model used for systematic development and can ensure all user needs are met. This method ensures that product development runs efficiently and with quality and in accordance with user needs [17]. The steps of the SDLC development model applied are as follows:

1. **Literature Study**
   Literature studies are carried out through reading and analyzing research that is relevant to the research topic and the algorithms used. This approach was applied to gain an in-depth understanding of the context surrounding this research.
2. **Data collection**
   Data collection was carried out quantitatively through questionnaires distributed regarding the preferences of the majority of targets for the perfumes provided.
3. **System Planning**
   The system planning process is presented in flowchart and DFD (Data Flow Diagram).

3.1. Flowchart

Below is presented a flowchart which describes the process in outline in the decision support system that has been designed.

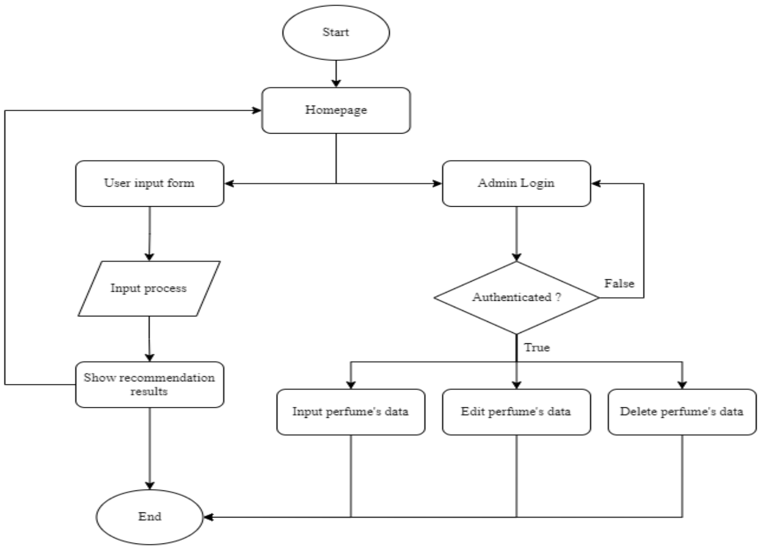

Fig 1. Flowchart of Men's Perfume Recommendation System

Figure 1 is the flowchart of the overall system that includes the role user and admin. Users are capable of carrying out two activities, namely determining men's perfume decisions and viewing the list of men's perfumes. When deciding on a perfume, users carry out the process of filling in pairwise comparison weights against the specified criteria. This comparison data is then calculated with AHP and TOPSIS algorithms to display perfume prediction results that match the user. Admin role, on the other hand, needs to login to carry out the 3 available activities, which are adding, editing and deleting men's perfume data.

3.2. DFD (*Data Flow Diagram*)

Data flow diagram used in designing this system is divided into two diagrams, namely context diagram and DFD level 1 shown in figures 2 and 3 respectively.

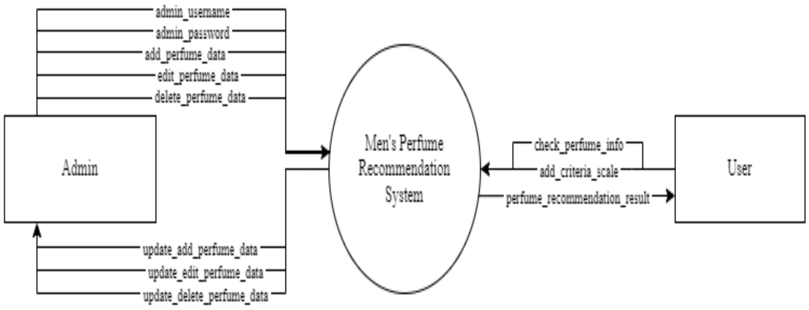

Fig 2. Context Diagram of Men's Perfume Recommendation System

The context diagram presented in figure 2 has two entities that play an important role, namely user and admin. The entity user can carry out the activity check_perfume_info,add_criteria_scale, and receive perfume_recommendation_results. Meanwhile, admin entity can do three main activities and login by filling username and password. The admin can also see the latest results after doing one of the three activities.

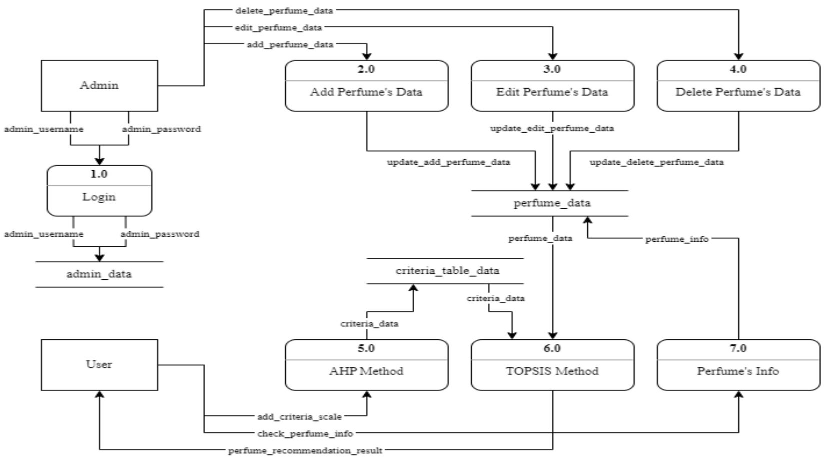

Fig 3. Level 1 DFD of Men's Perfume Recommendation System

Figure 3 shows the first level of data flow diagram which explains the subsystems in the decision support system for selecting men's perfume. Activities that can be carried out on the system are create, read, update, delete operations, and the AHP & TOPSIS methods processes. In addition, there are several database tables which are used to store data.

4. Implementation

The men's perfume decision making system that has been designed is then implemented in the form of a website. Implementation results can be accessed at [3]. The following figures are some of the displays of the interface of the system that has been created.

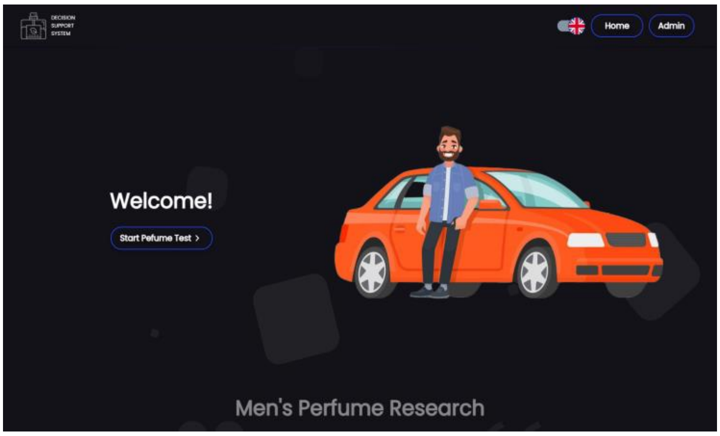

Fig 4. Homepage

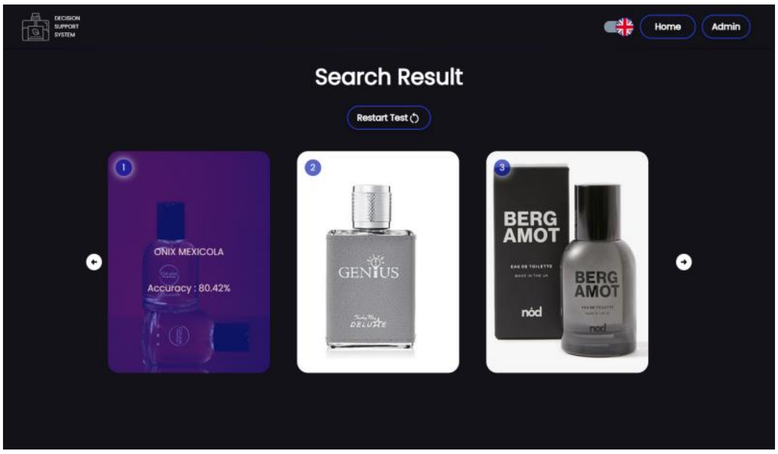

Fig 5. Perfume recommendation results page

The results of the website interface that has been made are shown in figures 4 and 5. Figure 4 is the main display that welcomes users, while figure 5 refers to the page display that will be found after carrying out tests to determine the results of recommendations that are suitable for the user.

5. Evaluation

The system evaluation stage is carried out by distributing USE questionnaires (Usability, Satisfaction, and Ease of use) to 30 respondents. This questionnaire contains 30 questions with values represented by the answers ranging from "strongly disagree" to "strongly agree". This method was chosen so that the product can be evaluated based on the three-dimensional aspects that most dominate usability testing of an application, namely usefulness, satisfaction, and ease of use [4]. Based on the results of the questionnaire, it was found that the product evaluation was at a very good level, with a satisfaction percentage of 90.07%.

III. RESULT AND DISCUSSION

Result

In this system, four criteria are used for calculation, which are quality, aroma, price and durability. Users will enter 6 inputs in a system with a value range from 1 to 7 with a neutral limit at 4.

Table 1. Visualization of user input mapping

	Quality	*Scent*	*Price*	*Durability*
Quality	1	$input[0]$	$input[1]$	$input[2]$
Scent	$\frac{1}{input[0]}$	1	$input[3]$	$input[4]$
Price	$\frac{1}{input[1]}$	$\frac{1}{input[3]}$	1	$input[5]$
Durability	$\frac{1}{input[2]}$	$\frac{1}{input[4]}$	$\frac{1}{input[5]}$	1

The inputs from users will be processed in matrix form of *n* x *n*, where *n* is the number of variables or calculation criteria in the system. In the programming paradigm, input will be entered in an array of dimensions 2 x 2. Each sub-array represents one criteria while each column or index on each sub-array shows the mapping of relations between criteria from the values located in that index.

Table 2. Output of AHP calculation

λ_{max}	*Consistency Index*	*Consistency Ratio*
1.349992883	-0.8833357058	-0.9814841175

The table above shows three outputs from the AHP calculation obtained through the initial matrix normalization calculation of the user's input and eigenvalue of the normalized matrix. The matrix normalization results will then be processed by adding up all the results of the multiplication between the eigenvalues in each row of criteria with the total number in each row of the normalized matrix as the maximum lambda value.

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

$$CR = \frac{CI}{IR}$$

Consistency index and consistency ratio values are obtained through the formula above, where *n* is the number of criteria and IR is the random index value adjusted to the number of criteria. The IR value used for calculations with 4 criteria is 1.12. The consistency ratio will be used to validate the consistency of the given input. If CR > 0.1, then the user's input would be considered as inconsistent. The output of the AHP algorithm that will be used to calculate the TOPSIS algorithm is stored as a table consisting the eigenvalues of each criteria

Table 3. Sample alternative index

Sample Name	*Quality*	*Durability*	*Scent*	*Price*
Perfume Extract - SAFF	4	3	5	3
No Ordinary Day Bergamot Eau de Toilette	5	2	4	2
Male	1	4	3	2
SENOPARTY	4	4	3	5
Scuderia Black Man	4	4	3	5
NATA Perfume - Matteo	5	3	1	2
MEXICOLA	5	3	4	5
Alpha	4	4	3	4
No Ordinary Day Amber	4	3	3	3
X Limited EDT	4	2	5	4
Mural In Black Edt	3	2	4	2
The Perfection	3	3	1	4
Affair Man	3	4	3	1
Evaflor Whisky Men Sport	1	4	4	2
Armaf Ventana For Men	4	3	5	5
Extrait De Parfum - CASCAVEL	1	4	2	2
Armaf Tag Him	4	4	3	4
JUSTIN PAUL CLEAR DAY	4	3	4	2
Romano Grandiose Eau De Parfum	1	1	1	1
LINN YOUNG CROSS COUNTRY	2	4	5	2
Wild	2	4	1	2

FWB	4	4	4	5
SHIRLEY MAY DELUXE GENIUS	4	5	5	1
Brusco	4	4	3	1

Perfume data samples as a calculation object was obtained by conducting a survey in one of the perfume communities in Twitter (@ohmybeautybank) [5]. Respondents were asked to fill in a scale from one to five for each criteria with profit attributes for the quality, durability, aroma criteria and cost attributes for the price criteria. The survey results obtained 23 perfume samples which were then processed for scale measurements in relation to each test criteria.TOPSIS calculations will use eigenvalues columns obtained from the previous AHP calculations together with index data from survey results to process the normalized matrix in the alternative sample index list. Normalization is carried out by mapping each index in the survey data into a matrix or array with the same dimensions and dividing it by the root of the sum of the squares of the values in all columns of the survey data.

After that, each cell in the matrix will be multiplied by the eigenvalue from the previous AHP calculation, according to the bound column. This matrix will then be used to obtain the ideal distance of positive and negative solutions for each research sample by finding the root of the square of the difference between each cell in the normalized matrix with the positive and negative ideal points according to the bound column. The positive ideal point is obtained by finding the maximum value of each criteria column, and the negative ideal point is obtained by finding the minimum value in each criteria column. If the attribute or criteria used is the profit attribute, then the positive ideal point will use the maximum value. If the criteria is classified as a cost attribute, then the positive ideal point will use the minimum value. This process also applies in reverse for the ideal negative point.

Table 4. Top 10 sorted preference results in descending order

Rank	Sample Name	Preference Value
1	SHIRLEY MAY DELUXE GENIUS	0.8135130498
2	Brusco	0.7449426341
3	Born Perfume - Matteo	0.7127337738
4	MEXICOLA	0.7074774268
5	Alpha	0.7068288428
6	Armaf Tag Him	0.7068288428
7	FWB	0.6957304580
8	SENOPARTY	0.6863891263
9	Scuderia Black Man	0.6863891263
10	JUSTIN PAUL CLEAR DAY	0.6639636358

The calculation of the ideal distance of positive and negative solutions for each sample will be processed by finding the percentage ratio of the distance of negative ideal solutions to the total number of ideal solutions. This calculation is the final result of all processes in the system.

Table 5. Questionnaire data results

Aspect	Percentage Calculation	Statement
Usefulness	89.17%	Very good

Ease of Use	89.34%	Very good
Ease of Learning	89.34%	Very good
Satisfaction	91.61%	Very good
Overall	90.07%	Very good

The high percentage result of the questionnaire has shown that the majority of the users are satisfied by the system with an 90.07% overall satisfaction. This proves that the algorithms used behind the system together along with the interface successfully provided usable system for public usage.

Discussion

The overall success of this research comes with several limitations. The limitations of this dataset arise because the research team has limited time and resources to collect more datasets. An example of bias that occurs, if there is a perfume that has a weight of all criteria worth 5 points (full). The system will always recommend the perfume to the user due to its high preference evaluation value. Furthermore, high computing facilities are needed to serve users if the system is published to the public. The research team believes that when more datasets are used, although it will reduce bias in the results, on the other hand it will also increase computational requirements. The research team also believes that the AHP and TOPSIS methods used by this system have low scalability. This is because the more criteria used in the system, the more questions asked to users will increase. This refers to the arithmetic series formula $\frac{n(n-1)}{2}$.

IV. CONCLUSION

Based on the system and final survey result, this research has successfully provided a web-based recommendation system with *Analytic Hierarchy Process (AHP) & Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)* algorithm, which gives 90.07% of overall satisfaction. It helps men to determine which perfume is suitable for them based on their personality amongst numerous perfume choices spread all over the world. Even though the methodology and approach used to achieve the purpose has several limitations, it is highly open and possible for improvement in terms of scope and accuracy.

V. SUGGESTION

The research team has found results and conclusions related to the development of "Men's Perfume Recommendation System Using the Analytic Hierarchy Process (AHP) Algorithm & Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)". The research team would like to convey several suggestions regarding further system development:

1. Further system development uses other algorithms to increase the accuracy of the recommended perfume results.
2. System optimization to reduce resources used by the server, so it can serve more users.
3. Increasing the number of datasets used to reduce the possibility of bias in the results that appear in system calculations.

VI. ACKNOWLEDGMENTS

The research team would like to thank all related parties who have helped carry out this research, and the community Ohmybeautybank for their willingness to be a research respondent, to Universitas Multimedia Nusantara, which has funded this research.

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