Jurnal Info Sains : Informatika dan Sains
Volume 14 , Number 01, 2024, DOI 10.54209/infosains.v14i01
ESSN 2797-7889 (Online)
https://ejournal.seaninstitute.or.id/index.php/InfoSains

Designing a SMART algorithm-based decision support system for streamlining makeup selection through prototyping development

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Article Info
Keywords:
SMART Algorithm,
Decision Support System,
Makeup Recommendation

ABSTRACT
The research on developing a cosmetic makeup product recommendation system emerged in response to various common skin issues resulting from improper makeup usage, especially among teenagers. This study emphasizes the utilization of the Simple Multi-Attribute Rating Technique, considering criteria such as skin type, skin problems, age, price, shade, and longevity of the product. However, in testing 8 scenarios, the obtained accuracy was 62%, possibly due to the limited variations of alternatives tested. The hope is that this recommendation system can serve as a solution for the public in selecting cosmetic products that better suit their individual skin conditions, consequently aiding in reducing common skin problems resulting from inadequate product choices.

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INTRODUCTION

The use of cosmetics has now become a common habit to enhance one's appearance, ranging from applying color to the face to being part of self-exploration efforts to boost an individual's confidence [1]. According to a survey of 2830 female respondents, with a distribution percentage indicating that the majority were aged between 18-25 years (46.8%), 25-35 years (27.0%), and 36-45 years (18.9%), all respondents indicated regular use of makeup. The most commonly used makeup products are lipstick (78.0%), powder (76.6%), and foundation (40.2%) [2]

Data showed 400 instances were detected as cases affected by cosmetic dermatitis, showing a notable prevalence primarily among females aged between 20 and 39 years old [3]. The problem likely arises from a dearth of extensive awareness within our societal framework regarding the adverse repercussions associated with the use of cosmetic products, while individuals in more developed nations tend to exhibit a higher level of cognizance regarding the detrimental impacts of employing cosmetics [4].

In addressing the arising issue, there is a crucial need for a solution that facilitates users in selecting cosmetics, thereby reducing the risk of skin infections associated with their usage. One approach that proves promising is the implementation of the Simple Multi-Attribute Rating Technique (SMART). This method enhances the evaluation of various cosmetic alternatives, providing users with detailed guidance in selecting products that align with their specific needs while mitigating potential skin-related risks [5].

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Simple Multi-Attribute Rating Technique (SMART)

The decision-making framework hinges on the substantial weighting of each criterion, allowing for a comparative analysis to discern the optimal alternative. This method obviates the necessity of evaluating preferences or deeming certain hypothetical alternatives as inconsequential, thereby eschewing the elicitation process in decision-making [6].

The SMART method has been applied in various studies, such as selecting the best customers, identifying top-performing employees, assessing employee discipline levels, and even choosing treatments for customers. The results indicate that the SMART method effectively aids in providing well-founded recommendations [7], entrepreneurs can enhance their competitiveness and proficiency within the business sphere [8], facilitating the provision of guidance to those who receive evaluation results [5].

The model applied are:

$$u(a_i) = \sum_{j=1}^{m} w_j u_i(a_i), \quad i = 1,2,,,,m$$

The following is based on the above function:

1. Established the quantity of criteria utilized.
2. Assign weights to each criterion within the 1-100 interval, prioritizing the most urgent criteria.
3. Normalize the criteria by comparing their weights and dividing by the total weighted criteria, using a normalization formula. The equation are:

$$= \frac{w_j}{\sum w_j}$$

4. Specify parameter values for each criterion across alternatives.
5. Determine utility values using convert method that invers values into data using this equation:

$$u_i(a_i) = \frac{c_{out} - c_{min}}{c_{max} - c_{min}}$$

Where $u_i(a_i)$ denotes the utility value of a criterion, - I, [×] represents the criterion's value, max criteriamax criteria is the maximum value of the criterion, and min criteriamin criteria is the minimum value of the criterion.

6. Calculate the final criterion values by adjusting the normalized raw data values with weighted normalized criteria values, resulting in a total value through a multiplication function similar to function

METHOD

In this research the exploration of the value of information, contextual elements, and development prototyping in the realm of prototype development has been relatively limited [9]. This approach has been successfully applied in various studies, such as in the development of an appointment system [10], a reminder system [11], and a foundation management system [12].

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The applied method of application development follows a prototyping approach consisting of four stages. The first stage commences with swift planning and design, followed by prototype construction, delivery, feedback, and culminating in communication. The initial process involves rapid planning and application design. Upon completing the design stage, the subsequent step involves creating an application prototype. This prototype is then delivered to the client for evaluation and feedback. The prototyping approach holds advantages in intensifying communication between users and developers, aiding analysts in identifying genuine user needs, and reducing the likelihood of perceptual errors.

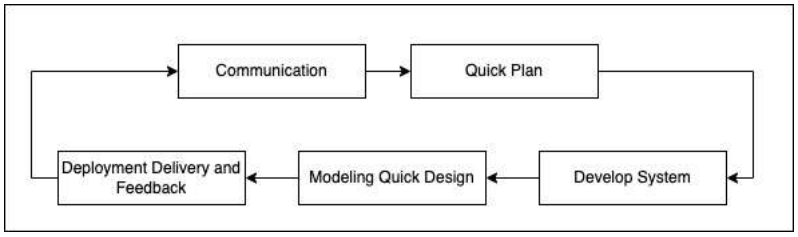

Figure 1. Research Methodology

The process for each stage includes:

- Communication This stage involves analyzing current system issues and determining system requirements by gathering questionnaire data from women as cosmetic users. Collecting questionnaire data serves as the initial reference for creating a new system. The acquired information provides a general overview of the system, including features and requirements to be developed in the software.
- Quick Plan Data obtained from the communication stage is then discussed with mentors and experts in the field.
- Modeling Quick Design Upon completing the planning, the subsequent step involves modeling the system to be developed. Modeling is done using (UML). UML is a standardized graphical language designed for the purpose of modeling business procedures, as well as for the analysis, design, and implementation of software-oriented systems [13]. The UML-based modeling includes: Use Case Diagram and Class Diagram
- Construction of Prototype The implementation of the preceding stages is then constructed through coding using the PHP Framework Laravel and MySQL Database to create a feature within the developed software.
- Deployment Delivery and Feedback Once the application is built, the testing process is initiated to evaluate or determine the quality of the developed application. In this regard, the testing conducted involves Black Box testing and User Acceptance Tests.
- This process aims to ensure a systematic and iterative approach to application development, enhancing communication, and effectively meeting user needs.

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RESULTS AND DISCUSSION

System Requirement

Data collection involves various methods sourced from multiple outlets, ensuring data validity that aligns with the research objectives. The data is categorized into two main types: primary data obtained from expert sources through interviews or questionnaires, and secondary data acquired from literature sources like journals, books, and relevant documents within the field of study. Expert interviews play a key role in establishing criteria and validating the weighting of the best cosmetic selections. Functional Requirements in this study consist of:

Table 1. Requirement Analysis

No	Fiture	Description
1	Cosmetic Recommendations	Enabling users to obtain cosmetic suggestions based on their chosen criteria, the system automatically presents fitting recommendations
2	Cosmetic Articles	Dispensing product information to users through available articles tailored to their informational needs.
3	Cosmetic Reviews	Facilitating users to provide reviews for cosmetic products, enabling comparison among products for other users
4	Criterion Management	This feature provides administrative access to manage existing criteria, including addition, modification, or deletion
5	Alternative Management	Admins have the capability to handle existing alternatives, allowing addition, modification, or removal
6	Article Management	This feature empowers admins to oversee available articles, including addition, modification, or deletion

System Modeling Design

This research employs UML use case modeling to analyze the system's functionalities. The model of this research shown in Figure 2.

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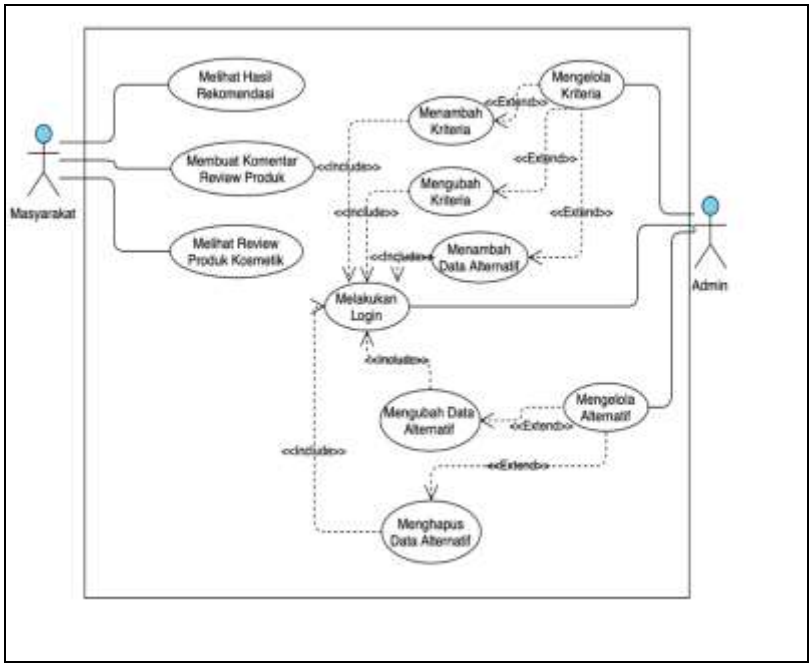

Figure 2. Use Case Diagram

Based on the analyzed requirements in Table 1, the system being developed involves two distinct actors with different roles: administrators and the public. Administrators will manage all data, comprising criteria and alternatives. Moreover, the public will be able to view recommendations for cosmetic products, provide comments, and write reviews on the products.

SMART Implementation

Defining Criteria

The preliminary stage of the SMART Algorithm focuses on defining criteria, each assigned varying weights for differentiation. In this research, the criteria are meticulously established through consultations with dermatologists specializing in skin and gender-related issues, as well as through an extensive review of pertinent literature. It is acknowledged that every individual in the public has unique skin types, specific skin concerns, and varying age brackets. Furthermore, aspects encompassing user satisfaction, pricing considerations, shareability, and product longevity are meticulously weighed and factored into the assessment process. This knowledge helps in choosing the most suitable approach, predicting potential skin reactions, and preventing complications that may arise after the procedure [14].

Table 2. Criteria

Criteria Code	Criteria Name	Weight Value (w)	Trend
C1	Skin Type	50%	Benefit
C2	Skin Problem	40%	Benefit
C3	Age	40%	Cost
C4	Price	30%	Cost

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Criteria Cod	Criteria Name	Weight Value (w)	Trend
C5	Shade	30%	Benefit
C6	Longevity	10%	Benefit
Total		200%	

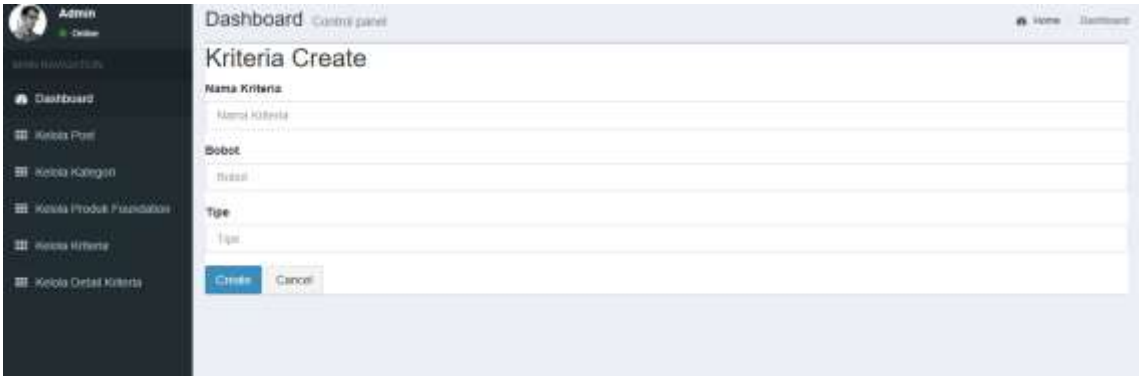

Figure 3. Create Kriteria Form

Determining Alternative

After known the criteria we determine the alternative that possible to recommend, the example of alternative is shown in Table 3. When admin have additional product alternative, they can input the product and the detail (based on criteria) on Add Product Page as shown in Figure 4.

Table 3. Product Alternative

Alternative Code	Alternative Name
A1	Lightening BB Cream Light Wardah
A2	Make It Glow Dewy Cushion Light Beige Pixy
A3	Matte Clay Foundation Savannah Pecan The Body Shop

Figure 4. Add Product Form

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Normalization

Normalization involves determining the normalization of each criterion by evaluating the weights of the criteria in relation to the total number of weighted criteria. Nomalization result is shown in Table 4.

Table 4. Normalization Process

No	Criteria Code	Weight Value	Relative Weight (Wj)
1	C1	50	0,25
2	C2	40	0,20
3	C3	40	0,20
4	C4	30	0,15
5	C5	30	0,15
6	C6	10	0,05
		200	1,00

Figure 5. Recommendation Form Page

After the normalization of the criterion value has been calculated, the subsequent step involves determining the utility value for each criterion. The method to obtain the utility value is as follows:

The table demonstrates the outcome of the utility calculation, as depicted in Table 5.

Table 5. Table Utility

Alternative	U_{C1}	U_{C2}	U_{C3}	U_{C4}	U_{C5}	U_{C6}
A1	0,5	1	0,5	0,33	0	0
A2	0	0,5	0	1	1	1
A3	1	0	1	0,66	1	0,5

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Final Value

Final result SMART algorithm decribed in Table 6, moreover example of product recomendation is shown in FIgure 6.

Table 6. Final Value

No.	$U_{(A1)}$	$U_{(A2)}$	$U_{(A3)}$
1	0,362	0,45	0,724
2	0	0,5	0
3	1	0	1

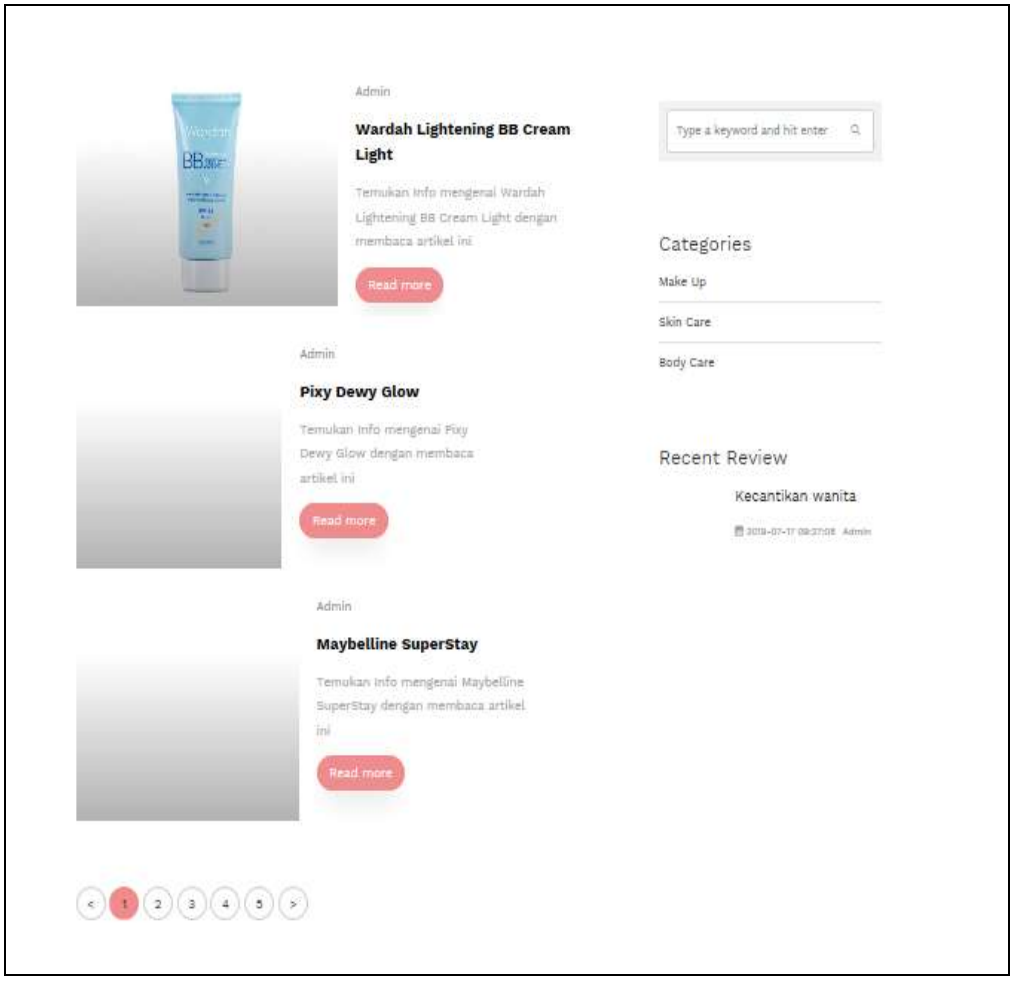

Figure 6. Recommendation Result

Testing

To ensure the readiness of the website program, testing was conducted using several scenarios. This testing involved comparing the analysis of product recommendations manually versus recommendations generated by the smart program.

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Table 7. Accuration Testing

No.	Result using SMART Alternatif	Result Manual Alternatif	Summarize	
			True	False
1	Wardah Exclusive Liquid Foundation	Wardah Exclusive Liquid Foundation	√	
2	Wardah Lightening BB Cream Natural	Maybelline Superstay Foundation 24H Full Coverage Foundation Warm Nude		√
3	Pixy Make It Glow Dewy Cushion Light Beige	Pixy Make It Glow Dewy Cushion Light Beige	√	
4	Purbasari Brightening Cool BB Cream Hydra Series honey beige	The Body Shop Fresh Nude Foundation 030		√
5	Pixy BB Cream Bright Fix Orche	Pixy BB Cream Bright Fix Orche	√	
6	Wardah Everyday BB Cream Light	Wardah Everyday BB Cream Light	√	
7	Purbasari Brightening Cool BB Cream Hydra honey beige	The Body Shop Matte Clay Foundation		√
8	Liquid Foundation Wardah Exclusive 01	Liquid Foundation Wardah Exclusive 01	√	

From 8 testing experiments conducted, it was observed that five out of the eight scenarios produced accurate outcomes, while the remaining three scenarios generated recommendations incongruent with the manual product analysis. Subsequently, accuracy was computed by tallying the correct values across all scenarios [15]. The accuracy calculation results are outlined below:

$$DSS\ Accuration = \frac{Correct\ Scenarios}{Total\ Scenarios}\ x\ 100\%$$

$$DSS\ Performance = \frac{5}{8}\ x\ 100\%$$

$$= 0{,}62\ x\ 100\%$$

$$= 62\%$$

Following the accuracy assessment, the cosmetic recommendation website employing the SMART method demonstrates a 62% accuracy rate, precisely reflecting 5 correct out of 8 total values. This underscores the imperative need for supplementary testing on select additional alternatives to conduct a more comprehensive evaluation.

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CONCLUSION

The utilization of smart algorithms has been implemented for the calculation of cosmetic product recommendations, aiming to mitigate the skin health issues frequently encountered among the community, particularly teenage girls. Based on the implemented deployment, the accuracy achieved stands at 62%. This is primarily due to the limited variety of products available and the multitude of testing scenarios.

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