Jurnal Teknik Informatika C.I.T Medicom, xx (x) (20xx) xx-xx

Published by: Institute of Computer Science (IOCS)

Jurnal Teknik Informatika C.I.T Medicom

Journal homepage: www.medikom.iocspublisher.org

IMPLEMENTATION OF SIMPLE MULTY-ATTRIBUTE RATING TECHNIQUE (SMART) METHOD IN SMARTPHONE RECOMMENDATION

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Article Info

Article history

Received : diisi oleh editor
Revised : diisi oleh editor
Accepted : diisi oleh editor

Kata Kunci:

Decision Support System;
SMART Method;
Smartphone Recommendation;
Smartphone Selection.

Abstract

The advancement of information technology has had a significant impact on multiple facets of human existence, notably the widespread use of smartphones, which have now become an essential requirement for the majority of individuals. Choosing a smartphone can be difficult because of the extensive range of options and the diverse interests of users. The objective of this study is to create a web-based Decision Support System (DSS) that utilizes the Simple Multi-Attribute Rating Technique (SMART) method to provide personalized smartphone recommendations based on user preferences. The research stages encompass: Planning: Strategizing the development system. Data Collection: Gathering data on the technical specs of smartphones. Data Selection: Choosing pertinent data for research purposes. Data Implementation: Incorporating data into the system utilizing the SMART methodology. Data Ranking: Organizing data according to the outcomes of the SMART method analysis.The study discovered that incorporating the SMART technique into a decision support system can yield smartphone recommendations that are more accurate and aligned with user preferences. The technique additionally aids in mitigating consumer perplexity and discontentment following the acquisition of a smartphone. The research concludes that the SMART technique is highly effective in the smartphone purchase recommendation system. The recommendations given are more accurate and aligned with the user's preferences. Future research should investigate the application of the SMART technique in different circumstances and broaden the criteria for making recommendations.

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1. Introduction

In the present age, the advancement of information technology has led to numerous varied breakthroughs that enhance the availability of information and promote industrial advancement in human society. Smartphones are devices that have been influenced by technological advancements. The development of smartphones has had several positive effects on human life. They serve as a tool for expanding knowledge and providing easy access to the latest information, such as educational resources, news, and entertainment. Nowadays, tasks that were once exclusive to laptops or PCs may be accomplished with a smartphone[1]. Smartphones have become an essential requirement in the context of lectures in this contemporary day. Without owning a smartphone, students will significantly lag behind in accessing the necessary information[2].

Smartphones have become the prevailing telecommunications device among the younger generation, with approximately 82% of individuals who already possess a mobile. The versatile functionalities of smartphones have significantly influenced the behaviour of their users, particularly among the younger generation who exhibit a tendency to utilise cellphones with high frequency. Furthermore, when it comes to buying smartphones, the connection between product knowledge and the inclination to make a purchase is impacted by the extent of consumer familiarity with the product[3]. When selecting a smartphone, customers frequently encounter the difficulty of identifying a product that aligns with their interests. With a wide range of brands, models, features, and pricing, the process of selecting a smartphone can be hard and perplexing for some users. Consequently, it is not uncommon for customers to feel disappointed after purchasing a smartphone[4][5]. In choosing a smartphone in the current era has many determining factors. In determining the purchase of a smartphone, there are several influences, including product design, brand image, product quality, country of origin of the product, corporate identity, and purchase intention, even age also affects buying certain brand products[6]. The determining factor in purchasing decisions is not only in terms of technical specifications and price. Product quality on smartphones technically has many things to consider, not just from the capacity of RAM, ROM, battery, and camera megapixels alone[7].

Extracted from the publication "Decision Support System" authored by Hutahaean[8]. A Decision Support System (DSS) is an information system that utilises data, mathematical algorithm models, and technological analysis to aid in decision-making. Hutahaean and his colleagues elucidated various techniques in Decision Support Systems (DSS), such as Additive Ratio Assessment (ARA), Preference Ranking Organisation Method for Enrichment Evaluation (PROMETHEE), Multy-Object Optimazation On The Basis by Ratio Analysis (MOORA), Multy-Attribute Rating Technique (MAUT), Simple Multy-Attribute Rating Technique (SMART), and Bayes. The primary objective of DSS is to offer valuable support to users in the process of decision-making. Gorry and Scott Morton introduced the concept of DSS to the literature on information systems and computing systems in 1971. DSS employs artificial intelligence methodologies, including expert systems, data analysis (Data Analyst), machine learning, artificial neural networks, logical reasoning, and other techniques, to model human decision-making functions[9]. The primary objective of DSS is to offer valuable support to users in the process of decision-making. The notion of Decision Support Systems (DSS) was first introduced to the literature on information systems and computing systems by Gorry and Scott Morton in 1971. DSS employs artificial intelligence methodologies, including expert systems, data analysis (Data Analyst), machine learning, artificial neural networks, logical reasoning, and other techniques, to model human decision-making functions[10][11].

The Simple Multy-Attribute Rating (SMART) is a comprehensive decision-making approach that takes into account both qualitative and quantitative factors. Saragih further elucidated that in this methodology, metrics possess diverse values and weights, and serve as crucial components in the decision-making process. These ideals serve as the foundation for making the decision[12]. The SMART method is a multi-criteria decision-making approach that assigns a value to each criterion and determines their relative influence through a weightage system[13].

2. Methodology

2.1 Decision Support System (DSS)

A Decision Support System (DSS) is an information system that aids in decision-making by utilizing data, mathematical algorithm models, and technical analysis. The objective of SPK is to create decisions that are highly accurate, efficient, and intricate by utilizing the available facts and adhering to predetermined preferences. DSS has versatile applications in domains including education, healthcare, business, government, and other sectors. DSS can be characterized by its ability to provide help to users, particularly in circumstances involving both structured and unstructured data that require a combination of human judgment and automated data. Assistance provided to all levels of management, ranging from top executives to field managers, as well as support offered to individuals or groups. Assistance in making independent or recurring decisions, assistance across all stages of the system process: design, selection, analysis, and execution. Support within each process is also a form of decision-making system. The SDM system will consistently demonstrate its ability to adjust and evolve as time progresses. The decision system processing should consistently demonstrate flexibility and continuous evolution, ensuring adaptability to any alterations. The system should provide a user-friendly interface. When designing an interface, system structure, and graphics, it is crucial to prioritize user comfort. Utilizing language that is suitable and readily comprehensible to humans can enhance the efficacy of DSS. Emphasizing the improvement of decision-making efficacy, which includes accuracy, quality, and timeliness, rather than focusing on efficiency, which involves system development expenses and computer usage costs. Users possess complete autonomy over all decision-making processes[8].

2.2 Smartphone

The history of smartphones: It was first created by IBM in the United States, a company that manufactures electronic devices, in 1992. But back then smartphones were not as sophisticated as they are today, the first smartphones were equipped with features such as a calendar, phone book, world clock, note-taking section, email, and also the ability to send faxes and play games. However, one thing to know about the smartphone made by IBM at the time is that it was equipped with touchscreen technology. However, the typing method was still using a stylus stick[14]. The development of technology is now increasingly rapid, one of the impacts is the rapid development of smartphones that have used advanced technologies. Smartphones or often referred to as smartphones are cell phones that have capabilities and also uses that resemble computers[1][15].

2.3 SMART Method

In the book made by Hutahaean[8] explained that, Simple Multi-Attribute Ratio Technique (SMART) is a method of making multiple attribute decisions made in 1971 by Edward as a simplification in applying Multy-Attribute Utility Theory (MAUT). The SMART method has evolved over time, and was refined by Edward and Barron in 1994 and resulted in the Simple Multi-Attribute Ratio Technique Swing (SMARTS) and Simple Multi-Attribute Ratio Technique Exploiting Rank (SMARTER) methods. SMART allows decision makers to choose between several alternatives based on a set of attributes and associated values. This method uses a weighting scale between 0 and 1, which simplifies the calculation and comparison of values between alternatives. The model in SMART is based on adaptive linear to predict the value between alternatives, with a weighting procedure that can be adjusted by the decision maker.

The difference between SMART, SMARTS, and SMARTER lies in the way they are weighted. SMART and SMARTS are weighted directly by the user. While SMARTER adds the Rank Order Centroid (ROC) weighting formula which aims to overcome disproportionality in weighting. The steps used in this SMART method are as follows:

1. Determine Criteria
   In determining what criteria will be used in SPK, it is required from users or parties who are competent or responsible for the problem.
2. Determining Criteria Weights
   Determining the weight of each criterion by using a rating ratio of 1 to 100 of the level of importance.
3. Normalization of Criteria Weights
   Normalize all criteria weights to 0 to 1, using the formula:

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

Description:

nw_j : Normalization of the jth weight

w_j : Weight of the jth criterion

$\sum w_j$: Total weight of criteria

4. Provide Parameter Value for Each Criterion
In providing parameter values for each criterion, it is not only changing each criterion data from qualitative to quantitative. for example, the level of satisfaction (very satisfied, satisfied, quite satisfied, ordinary, dissatisfied) becomes the level of satisfaction (100, 80, 60, 40, 20), but providing parameter values also aims to standardize each criterion value, determine relative performance, and facilitate relevant comparison values. For example, the smartphone price criterion is given value changes such as < 1 million = 0, 1 million - 3 million = 10, 3 million - 4.5 million = 20, 4.5 million - 7 million = 30, 7 million - 10 million = 50, 10 million - 15 million = 70, 15 million - 20 million = 80, 20 million - 25 million 90, > 25 million = 100.
5. Determining Utility Value
After converting the ultility value after the parameter value data for each criterion is changed, each criterion will be calculated based on its priority, there are two types of formulas used as follows:
   - Criteria Cost
   This criterion is usually used if prioritizing smaller is better, such as in price, operational criteria, and so on. Criteria Cost has the following formula:
   $$u_i(a_i) = 100\ \frac{(c_{max} - c_{out\ i})}{(c_{max} - c_{min})}\%$$
   Description:
   $u_i(a_i)$: utility value of the i-th criterion for the i-th alternative
   c_{max} : maximum criterion score
   c_{min} : minimum criterion score
   $c_{out\ i}$: i-th criterion value
   - Criteria Benefit
   This criterion is the opposite of Cost, this criterion is used if prioritizing bigger is better, such as in discount criteria, version, value, quality, and others. Criteria Benefit has the following formula:
   $$u_i(a_i) = 100\ \frac{(c_{out\ i} - c_{min})}{(c_{max} - c_{min})}\%$$
   Description:
   $u_i(a_i)$: utility value of the i-th criterion for the i-th alternative
   c_{max} : maximum criterion score
   c_{min} : minimum criterion score
   $c_{out\ i}$: i-th criterion value
6. Determining the Final Grade
After doing all the normalization and conversion of utility values, the final value will be determined by multiplying the normalization value by the utility value. The formula used is as follows:
$$u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)$$
Description:
$u(a_i)$: Total value of alternative criteria
$\sum_{j1}^{m} w_j$: The result of normalizing the weight of the jth criterion
$u_i(a_i)$: The result of the i-th utility value
After determining the overall final value, then add up each criterion on each data, then perform ranking.

3. Result and Discussion

3.1 Data Collection Methods

Data collection in this study requires a number of data from various parties, this is due to the need for data on smartphone technical specifications, prices, and seeing the release time of the product. The need for technical specifications and current prices of the latest smartphone products requires in-depth research into these data. This data collection method involves various available documents, without direct interaction with the object of research. In collecting data on technical specifications and smartphones that have been released in Indonesia, researchers collect data from the official websites of Indonesian regional manufacturers, get prices from official Indonesian e-commerce, collect data from www.gsmarena.com. Quoted from the official GSMArena website, GSMArena is one of the leading sources in the field of cellphones established since 2000, GSMArena also has the most complete source of technical specification data in the world..In this data collection, various criteria are obtained that affect the technical specifications of a smartphone, from various criteria broken down into several sub-criteria, here are examples of the data used:

Table 1 Sample Data

No	Product		Body		Price
	Brand	Merk	*Dimension*	...	
1	ASUS	Zenfone 10	146.5 x 68.1 x 9.4 mm	...	8.999.000,00
2	APPLE	Iphone 15 Pro Max	159.9 x 76.7 x 8.3 mm	...	22.999.000,00
.....	....	....	....	....	....
....	...	...	...	...	...
28	SAMSUNG	Galaxy S23	146.3 x 70.9 x 7.6 mm	...	13.999.000,00

3.2 SMART Algorithm Calculation Process

1. Weight Calculation
   the determination of the weight is calculated as follows with detailed results in table 2

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

Body = $\frac{50}{420} = 0{,}119047619$

Display = $\frac{10}{420} = 0{,}023809524$

Table 2 Determination of Criteria Weight

No	Criteria	Weight	Normalization	Final Weight
1	*Body*	50	0,119047619	12%
2	*Display*	10	0,023809524	2%

3	*System*	95	0,226190476	23%
4	*Memory*	90	0,214285714	21%
5	*Front Camera*	0	0	0%
6	*Main Camera*	0	0	0%
7	*Battery*	80	0,19047619	19%
8	*Price*	95	0,226190476	23%
Total		420	1	100%

In the calculation of weights to determine the normalization value by means of the weight value divided by the total weight value. To find the final weight, the normalized value is multiplied by 100%. Weights are determined by general users, according to their preferences. The table above is an example of determining the weight of a general user.

2. Data Conversion

Table 3 Data Conversion

Smartphone	**Dimenssion**	**Weight**	***Build***	**Type LCD**	**Size LCD**	**...**	**Price**
ASUS Zenfone 10(8/128 gb)	40	20	90	70	10	...	26
APPLE Iphone 15 Plus(8/128 gb)	40	40	150	100	100	...	49
...	...	...	...	...	...	...	...
INFINIX INFINIX HOT 30i(8/128 gb)	60	40	20	30	100	...	2

The data conversion as described will be implemented in this conversion with the conversion values as specified. In data conversion, each parameter in the sub-criteria will be converted into a value, the better/larger/higher each parameter, the higher the conversion value.

Example of conversion calculation

Dimensions 146.5 x 68.1 x 9.4 mm = 93780,51 mm^3

The following are the criteria (Attributes) and sub-criteria used, and are represented by this symbol. IN DATA COLLECTION METHOD. each criterion has its own sub-criteria, for example the BODY criterion has sub-criteria Dimensions, Weight, Build. LCD criteria, sub Type LCD, Size, Resolution. intine criteria ki not represent B, L, S, etc.

B_1 = BODY(DIMENSION)

B_2 = BODY(WEIGHT)

B_3 = BODY(BUILD)

L_1 = LCD(TYPE LCD)

L_2 = LCD(SIZE)

L_3 = LCD(RESOLUSI)

S_1 = SYSTEM(OS)

S_2 = SYSTEM(CHIPSET)

S_3 = SYSTEM(CPU)

M_1 = MEMORY(RAM)

M_2 = MEMORY(ROM)

MC_1 = MAIN CAMERA(MEGA PIXEL CAMERA)

MC_2 = MAIN CAMERA(TYPE CAMERA)

MC_3 = MAIN CAMERA(VIDEO)

FC_1 = FRONT CAMERA(MEGA PIXEL CAMERA)

FC_2 = FRONT CAMERA(VIDEO)

BTR_1 = BATTERY(USB TYPE)

BTR_2 = BATTERY(CAPACITY)

P = PRICE

Table 4 After the data is converted into symbols

Smartphone	**B1**	**B2**	**B3**	**L1**	**L2**	**L3**	**S1**	**S2**	**S3**	**...**	**P**
ASUS Zenfone 10(8/128 gb)	40	20	90	70	10	40	60	84	80	...	26
ASUS Zenfone 10(16/512 gb)	40	20	90	70	10	40	60	84	80	...	36
ASUS ROG Phone 7 Ultimate(16/512 gb)	100	100	150	65	100	40	60	84	80	...	73
...	...	...	...	...	...	...	...	...	...	...	...
INFINIX INFINIX NOTE 30(8/128 gb)	60	80	80	30	100	40	60	61	80	...	5
INFINIX INFINIX HOT 30i(8/128 gb)	60	40	20	30	100	20	60	46	80	...	2

3. Data Normalization

In the normalization calculation, it must be determined whether the criteria are costs or benefits. In this case, only the price criterion is a cost,
Example of benefit criteria calculation

$$\boldsymbol{u_i(a_i) = 100\ \frac{(c_{out\ i} - c_{min})}{(c_{max} - c_{min})}}\%$$

B1(ASUS Zenfone 10(8/128 gb) = $\mathbf{100}\ \frac{(40-20)}{(100-20)}\% =\ 0{,}25$

Kriteria cost

$$\boldsymbol{u_i(a_i) = 100\ \frac{(c_{max} - c_{out\ i})}{(c_{max} - c_{min})}}\%$$

P (ASUS Zenfone 10(8/128 gb) = $\mathbf{100}\ \frac{(1-26)}{(100-1)}\% = \mathbf{0,74}$

Table 5 Data Normalization

Smartphone	**B1**	**B2**	**B3**	**L1**	**L2**	**L3**	**S1**	**S2**	**S3**	**...**	**P**
ASUS Zenfone 10(8/128 gb)	0,25	0	0,46	0,57	0	0,25	0,33	0,75	0,5	...	0,74
ASUS Zenfone 10(16/512 gb)	0,25	0	0,46	0,57	0	0,25	0,33	0,75	0,5	...	0,64
ASUS ROG Phone 7 Ultimate(16/512 gb)	1	1	0,86	0,5	1	0,25	0,33	0,75	0,5	...	0,27
...	...	...	...	...	...	...	...	...	...	...	...
INFINIX INFINIX NOTE 30(8/128 gb)	0,5	0,75	0,4	0	1	0,25	0,333	0,308	0,5	...	0,960
INFINIX INFINIX HOT 30i(8/128 gb)	0,5	0,25	0	0	1	0	0,333	0,019	0,5	...	0,990

4. Final Results

Table 6 Final Results

Smartphone	**Dimenssion**	**Weight**	***Build***	**...**	**Price**
ASUS Zenfone 10(8/128 gb)	0,029761905	0	0,055555556	...	0,169071669
ASUS ROG Phone 7 Ultimate(16/512 gb)	0,119047619	0,119047619	0,103174603	...	0,061688312
APPLE Iphone 15 Pro Max(8/256 gb)	0,029761905	0,089285714	0,119047619	...	0,066257816

APPLE Iphone 15 Pro Max(8/512 gb)	0,029761905	0,089285714	0,119047619	...	0,027417027
APPLE Iphone 15 Pro Max(8/1000 gb)	0,029761905	0,089285714	0,119047619	...	0
...	...	...	...	...	...
INFINIX INFINIX HOT 30i(8/128 gb)	0,05952381	0,029761905	0	0,023809524	0,223905724

After the data is normalized and the utility is determined, the final result will be calculated by multiplying the weight value given by the normalized data.

5. Rangking
   Final score calculation formula
   Body Ranking Criteria
   B1 or Body(Dimension) ASUS Zenfone 10(8/128 gb)
   $\boldsymbol{u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)}$ = 0,25 * 0,119 = 0,0297
   Body(Weight) ASUS Zenfone 10(8/128 gb)
   $\boldsymbol{u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)}$ = 0 * 0,119 = 0
   Body(Build) ASUS Zenfone 10(8/128 gb)
   $\boldsymbol{u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)}$ = 0,46 * 0,119 = 0,0555
   Body = $\boldsymbol{\frac{Dimenssion+Weight+Build}{Total\ subcriteria} = 0,0284}$
   Criteria LCD
   L1 ASUS Zenfone 10(8/128 gb)
   $\boldsymbol{u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)}$ **= 0,057 * 0,0238 = 0,0136**
   L2 ASUS Zenfone 10(8/128 gb)
   $\boldsymbol{u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)}$ **= 0 * 0,0238 = 0**
   L3 ASUS Zenfone 10(8/128 gb)
   $\boldsymbol{u(a_i) = \sum_{j1}^{m} w_j\, u_i(a_i)}$ **= 0,25 * 0,0238 = 0,0059**

   LCD = $\frac{L1+L2+L3}{Total\ subkriteria}$ =0,0065

Table 7 Rangking

Rank	Smartphone	Body	LCD	System	Memory	...	Total
99	ASUS Zenfone 10(8/128 gb)	0,0284	0,0065	0,1194	0,0357	...	0,4147
36	ASUS Zenfone 10(16/512 gb)	0,0284	0,0065	0,1194	0,1786	...	0,5347
10	ASUS ROG Phone 7 Ultimate(16/512 gb)	0,1138	0,0139	0,1194	0,1786	...	0,6248
9	ASUS ROG Phone 7(12/256 gb)	0,1138	0,0139	0,1194	0,1071	...	0,6265

12	ASUS ROG Phone 7(16/512 gb)	0,1138	0,0139	0,1194	0,1786	…	0,5997
56	APPLE Iphone 15 Pro Max(8/256 gb)	0,0794	0,0198	0,1232	0,0714	…	0,5030
62	APPLE Iphone 15 Pro Max(8/512 gb)	0,0794	0,0198	0,1232	0,1071	…	0,4999
…	…	…	…	…	…	…	…
79	INFINIX INFINIX HOT 30i(8/128 gb)	0,0298	0,0079	0,0643	0,0357	…	0,4648

The calculation on this ranking is summed up for each sub-criteria that has been determined and divided by the number of sub-criteria for each existing criterion. After getting the value of each criterion, it will be totaled for each smartphone data.

4. Conclusion

Based on the research that has been done, conclusions can be drawn from the implementation of the SMART method in smartphone purchase recommendations as follows:

1. The application of the SMART method to the smartphone recommendation system is carried out by giving weight to each criterion, normalizing the weight of each criterion, converting alternative data, normalizing alternative data, calculating the final value, and ranking each total alternative. The SMART method has proven effective in providing smartphone recommendations based on predetermined criteria. By considering attributes such as body, system, screen, memory, camera, battery, and price, this method is able to provide recommendations that match user preferences.
2. The analysis shows that the weight of an attribute has a significant influence on the recommendations given. Attributes that are given a higher weight will be more dominant in determining the final choice, so it is important to determine the weight of the criteria in accordance with user preferences.

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