TELKOMNIKA Telecommunication, Computing, Electronics and Control
Vol. 18, No. 3, June 2020, pp. 1343~1353
ISSN: 1693-6930, accredited First Grade by Kemenristekdikti, Decree No: 21/E/KPT/2018
DOI: 10.12928/TELKOMNIKA.v18i3.14778

Application of recommendation system with AHP method and sentiment analysis

Ira Prasetyaningrum[1], Kholid Fathoni[2], Tri Tangguh Jiwo Priyantoro[3]
[1,3]Computer and Informatic Engineering Department, Politeknik Elektronika Negeri Surabaya, Indonesia
[2]Creative Multimedia Technology Department, Politeknik Elektronika Negeri Surabaya, Indonesia

Article Info

Article history:

Received Sep 1, 2019
Revised Jan 19, 2020
Accepted Feb 25, 2020

Keywords:

Analytical hierarchy process (AHP)
Decision-making system
Sentiment analysis

ABSTRACT

Over time, people needs are increasing. Needs that must be met, often cause problems in the people in determining a choice. People must make the right choice and according to their needs. Not an easy thing for people to make these choices. Therefore, a recommendation system is needed to support people in making decisions that fit their criteria. This research provides a system that can provide recommendations for decision support people according to their criteria, which are web-based. The decision-making system in this research uses the analytical hierarchy process (AHP) method. AHP is a multi-criteria decision-making method, which in this research one of the criteria is using sentiment analysis. Sentiment analysis is the process of understanding, extracting, and processing textual data to get sentiment information from an opinion sentence. The opinion sentiment value of each alternative will be included in the AHP calculation to get the best alternative recommendations according to the criteria of people. The result of this research is that the system can provide recommendations to people or users according to their criteria and alternatives as well as public opinion about each alternative.

Corresponding Author:

Ira Prasetyaningrum,
Department of Computer and Informatic Engineering,
Electronic Engineering Polytechnic Institute of Surabaya,
ITS Road, Keputih, Surabaya 60111, Indonesia.
Email: ira@pens.ac.id

1. INTRODUCTION

The needs of people increase with time. To meet their needs, people are often faced with conditions where people have to make a decision. In making a decision, the community needs supporters to make decisions beyond their ability to think. One that can be used by the community to support decision making is a recommendation. Recommendations can be simply referred to as suggestions that encourage, justify, or reinforce something or someone. This recommendation is very important to convince others that something or someone is right. Recommendations are the result of decision making. Decision making is a selection process from various alternative actions that might be chosen by mechanism certain, with the aim to produce the best decision [1]. Another definition that is almost the same also states that decision making is an act of choosing from the alternatives faced which are based on facts and carried out through a mathematical approach that can provide the best solutions made by managers [2]. Decision support system is a computer-based information system that do approach to produce various alternatives decision to help certain parties in dealing with problems using data and model [3]. Decision support systems are

made by applying high competency adaptations so that they can be used as alternatives in making a decision [4]. Model that describes the process decision making consists of four phases [5], namely: intelligence, design, selection and implementation. Some studies related to decision support systems in general include [6] that examines a system analysis design for the assessment of vocational students' soft skills as prospective workers. Research [7] applies a decision support system to predict stock of goods. Meanwhile research [8] uses DSS for housing selection and research [9] applies an expert system to diagnose telecommunication service disruptions on an Indonesian telecommunications operator. Whereas research [10] produced a system to deal with additional teaching and learning specialization in accordance with the activity of learning needed.

Many recommendation systems have been developed to support decision making in certain cases. However, people have different needs or cases, so the needs in making a decision are different. Many people's needs or cases are different from the existing recommendation system cases, so they do not get recommendations for decision support in their case. People also need a recommendation from the topic that they have determined based on the opinions of people. Information derived from people (in the form of opinions) can also be used as a decision support with several other considerations, including criteria according to the person himself.

From some of the problems described above, it is very supportive to make the application of a dynamic recommendation system as a supporter of people's decisions based on their case. In this study, the authors are interested in making a dynamic recommendation system application using analytical hierarchy process (AHP) calculations combined with sentiment analysis calculations. Analytical hierarchical process (AHP) is a hierarchy with the main input in the form of human views, developed by Prof. Thomas Lorie Saaty from Wharton Business School in the early 1970s and this method is used to find the order or ranking of priorities from various alternatives in problem solving [11]. Sentiment analysis value will be one of the criteria in AHP calculation to get the best recommendation according to user criteria. Previous studies regarding the recommendation system as a reference for this research include research from kholid Fathoni, Ira Prasetyaningrum and chairunisa. This research is a research on a recommendation system for child care in East Surabaya by using the AHP method. The results of this study can provide information about where daycare in East Surabaya and provide recommendations regarding the selection of daycare [12]. Several other studies related to AHP-based decision support system (DSS) include: DSS for employee soft skill competency assessment [13], DSS for determination of land use conformity (case study: Semarang Regency) [14], DSS for motorcycle selection [15], DSS for employee performance appraisal at Serang Hospital [16], and DSS for the selection of outstanding students [17]. While research related to sentiment analysis methods, namely research conducted by Gaurav Kumar, this study aims to recommend the best products based on the opinions expressed in customer reviews. Researchers use methods such as machine learning and sentiment classification to analyze customer reviews to summarize them. Researchers analyze customer reviews from various online platforms and use an effective multi-criteria decision-making approach to evaluate and recommend the most suitable products [18]. The results of this study are that can help users in the decision-making process.

Research from Desheng Dash Wu, Lijuan Zheng, and David L. Olson, this study developed a new sentiment ontology to conduct context-sensitive sentiment analysis of online opinion posts on the stock market. The methodology in this study integrates popular sentiment analysis into a machine learning approach based on support vector machines and modeling general autoregressive conditional heteroscedasticity. [19] Sentiment analysis of online opinion posts can facilitate investor investment decision making and stock company risk perception. Research from Zaoli Yang, Guanming Xiong, Zehong Cao, Yuchen Li, and Lucheng Huang. This research proposes a method based on the classification of sentiment orientation and discrete DIFWA operators (DDIFWA) for online purchasing decisions by considering dynamic information preferences [20]. The results of this study are able to obtain alternative product ratings and features to support consumer purchasing decisions using intuitionistic fuzzy valuation functions and the "vertical projection distance" method. Research from Justin Eko Soelisto. Text mining can be applied to various fields. One application uses text mining in digital newspapers to do political sentiment analysis. In this sentiment analysis is applied to obtain information from news articles about digital positive or negative sentiments about certain politicians [21]. Research from Anastasia Dewanti Pratama Putri which discusses the design of a recommendation system for East Java tourism objects. Data collected in this study consisted of East Java tourist attraction data and public opinion about each tourist attraction. In this study using Sentiment Analysis for the process of evaluating public opinion about East Java tourism objects on social media. This research proposes a new modeling by providing recommendations on tourism in East Java from existing comments to be able to help tourists find information about attractions in East Java that are expected to realize the Sapta Pesona Wisata in East Java [22]. Some other studies using sentiment analysis are sentiment analysis of television shows based on opinion the public uses the k-nearest neighbor method [23],

sentiment analysis system of customer comments of the xyz hotel customer using the naive bayes classifier method [24], and hotel review sentiment analysis using a particle swarm optimization support algorithm [25]. This research provides a system that can provide recommendations for decision support people according to their criteria, which are web-based. The decision-making system in this research uses the analytical hierarchy process (AHP) method. AHP is a multi-criteria decision-making method, which in this research one of the criteria is using sentiment analysis.

2. RESEARCH METHOD

The system process flow in this study is shown in Figure 1. From Figure 1. users can input criteria and alternative data and pairwise comparison values according to their case to get recommendations. Admin has the authority to process the system database.

Step 1. AHP design

After users decide goal, we can go to design AHP:

a) Determine the AHP Variable: in the AHP calculation process, there are two important variables that must be present, namely criteria and alternatives. Criteria variable is candidate criteria expected by user. Alternative variables are alternatives that will be calculated in the AHP process to get the best alternative as a recommendation.

b) Hierarchy design: this hierarchy of AHP contains criteria and alternatives that will be taken into account in the AHP process. In this study, sentiment analysis becomes a mandatory criterion that must be present in AHP calculations. This sentiment analysis is the value of sentiment analysis of public opinion on social media Twitter about each alternative. After users decide goal, than they must decide criteria and alternative. The hierarchy in the AHP process in this study is as Figure 2.

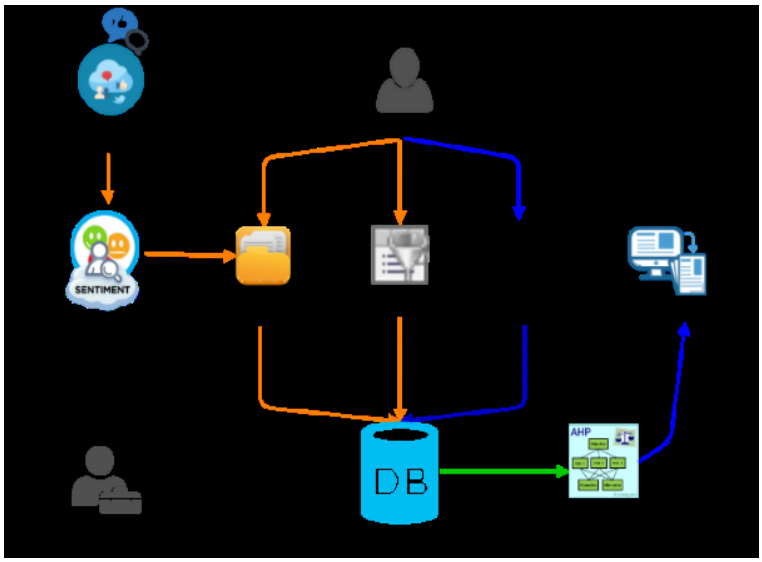


Figure 1. Design system

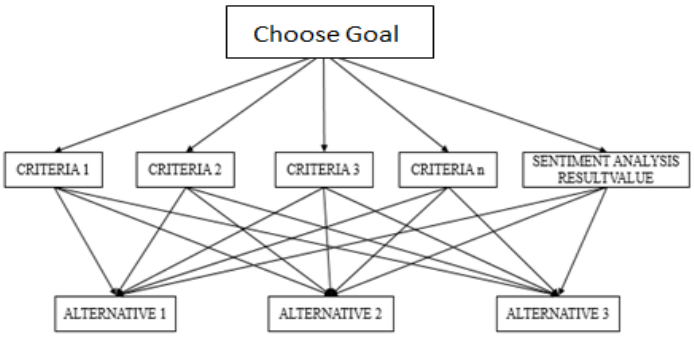


Figure 2. Hierarchy AHP

Step 2. Opinion scraping from Twitter

This research utilizes Twitter's open API to get public opinion about each alternative entered by the user. With the Twitter API, the system can take p*ublic opinion about alternatives based on a keyword. Keyword to get an opinion from Twitter in the form of an alternative name. Examples of opinion scraping with the keyword "KFC Mulyosari" using the Twitter API are as Figure 3.


```
{
    "status": 200,
    "data": [
        {
            "text": "@askmenfess Daerah mulyosari ada posto, kedai 27, mcd, kfc, richeese banyak colokan",
            "time": 1560946511,
            "user": "Sirup Marjan"
        },
        {
            "text": "RT @NafiaIlmi_: apalah saya yang cuma lulusan diploma kfc mekdi mulyosari 😭",
            "time": 1560860711,
            "user": "Era"
        },
        {
            "text": "RT @NafiaIlmi_: apalah saya yang cuma lulusan diploma kfc mekdi mulyosari 😭",
            "time": 1560819826,
            "user": "dinar sukma dewi"
        },
        {
            "text": "apalah saya yang cuma lulusan diploma kfc mekdi mulyosari 😭",
            "time": 1560790808,
            "user": "afi"
        }
```


Figure 3. Opinion scraping

Step 3. Sentiment analysis

There are five stages in the text mining process, namely tokenizing, filtering, stemming, tagging, and analyzing. In this study, the analyzing process is not needed because the text mining process is only used to search for important words that can represent the text.

a) Tokenizing is the process of cutting text into collections of words. The process of cutting text is done based on spaces in each word.
b) Filtering is the process of removing unnecessary words or stoplists. Words not representing can be in the form of conjunctions, auxiliary words, conjunctions, etc.
c) Stemming is the process of removing affixes to a word so that the content contains basic words that can represent the content.
d) Tagging is the process of justifying words that are not properly written. In addition, the tagging process is also used to replace non-standard words into standard.
e) Keywords are important words that can represent the text, so during the opinion analysis process, these keywords will be used as a reference.

After opinions are processed in text mining, they can be processed in sentiment analysis. Sentiment analysis refers to the classification of opinions into 3 classes, namely positive, negative, and neutral. To do sentiment analysis, it is necessary to have word and rule degree data. The degree of the word is used as a reference for word sentiment and the rule used as a sentiment calculation technique.

a) Degree of word the degree of the word is used to give value to each word. This value is in the form of numbers 1, -1, and 0 where 1 is positive, -1 is negative, and 0 is neutral.
b) Rule is used to provide rules for commenting sentiment assessment. This process does not use a special algorithm, but rather an impression technique.

Impression techniques are more inclined to analyze the wording of a sentence. This technique analyzes the location of adjectives, verbs, and propositions in a sentence. Propositions are statements about things that can be judged right or wrong, for example not. These rules include:

a) Single adjective: if a sentence only consists of adjectives, without any verbs and propositions around it, then the sentence value follows the adjective.
b) Single verb: if a sentence consists only of verbs, without adjectives and propositions around them, the sentence value follows the verb.
c) Proposition before adjective: if there is a proposition before the adjective in a sentence, the sentiment value in the sentence follows the XOR logic rules

Example: "*saya tidak marah (*i am not angry*)*"
"*Tidak* (No)" is a negative proposition and anger is a negative adjective, so the sentiment value in the sentence is 1 (positive).

d) Proposition before Verb: as in the previous rule, if there is a proposition before the verb in a sentence, the sentiment value in the sentence follows the XOR logic rules.

Example: "*Saya tidak menolak membuka restoran baru* (I do not refuse to open new restaurant)" (value = -1)

e) Verb before Adjective: besides propositions, adjectives can also change the sentiment value of verbs. Assessment of sentiment from the meeting between the verbs before the adjective apparently does not exist in the logic of logic, but the opposite of XOR.

Example "*Dia paham dengan baik* (He/she understand well)" (value = 1)

f) Proposition + Verb + Adjective: often propositions, verbs, and adjectives appear together, so there is a need for rules to capture the sentence. The process of calculating sentiment value starts from calculating the combination of verbs and adjectives, that is, in rule c.

Example: "*Dia tidak memahami dengan baik* (He/she did not understand well)" (value = -1)

g) All symbols in comments removed, except Periods and Commas: all characters or symbols that are not needed will be deleted except for periods and commas.

h) Spelling Indonesian Words: every keyword that has been obtained must be matched with an Indonesian dictionary to correct writing errors.

i) Periods and commas break sentence: if there is a comma or period symbol in a comment, then the comment is considered to be a few sentences and sentences are calculated for each sentence. The comment value is obtained from the sum of the sentiment sentences.

j) Some English words entered in the database: regional languages will be automatically ignored, but some words in English can be detected such as: good, great, nice, wonderful, beautiful, and several other words in English.

Step 4.

The opinion sentiment value of each alternative will be included in the AHP calculation to get the best alternative recommendations according to the criteria of people. Comparative Judgement is the core of AHP, because it will influence the priority of the elements. In assessing the relative importance of the two elements a reciprocal axiom means that if element i is valued twice as important as j, then element j must be equal to ½ times as important as element i. In addition, the comparison of the same two elements will produce the number 1, meaning that it is equally important. Two different elements can be judged equally important. From each pairwise comparison matrix then the eigen vector is searched to get local priority. Because the pairwise comparison matrix exists at each level, then to get a global priority must be synthesized between local priority.

Step 5.

Logical consistency states the measure of consistency in judgment or weighting in pairwise comparisons. This test is necessary, because in actual circumstances there might be some deviations from the relationship so that the comparison matrix is not consistently perfect. The inconsistency index is based on maximum Eigenvalue, which is calculated by summing the product of each element in the Eigenvector. The calculation of the consistency index (Saaty, 2005) is given by the (1).

$$CI = \frac{\alpha_{max} - n}{n-1} \quad (1)$$

Where CI is the consistency index and n is the number of evaluated criteria. In order to verify whether the consistency index (CI) is adequate, Saaty (Saaty, 2005) suggests what has been called the consistency rate (CR), which is determined by the ratio between the consistency index and the random consistency index (RI). The matrix will be considered consistent if the resulting ratio is less than 10%.

$$CR = CI/RI \quad (2)$$

3. RESULTS AND ANALYSIS

Tests carried out to determine the suitability of the system with the expected output. The case used in this test is finding a place to eat or restaurant.

3.1. Criteria weighting

Before user inputting the criterion, comparison values and alternative, it is necessary to input the expected food criteria data first. After inputting the criteria data, the weighting of the criteria can then be done. Criteria are weighted between criteria in Table 1. The results of comparing manual calculations with the AHP system have the same value shown in Figure 4.

The test was conducted using 30 sentences dataset with positive, negative, and neutral sentiments. Dataset sentiment sentences such as Saturday night and ayam nelongso (Malam minggu dan ayam nelongso), ayam nelongso is really famous in Surabaya (terkenal banget ini ayam nelongso di Surabaya), Just smell the cooking, it makes you hungry, especially it tastes good (*Cium aroma masakannya aja bikin lapar, apalagi rasanya pasti enak*).

Table 1. Criteria weighting

	Price	Menu	Distance Location	Parking Area	Sentiment
Price (*harga makanan*)	1	0,333333	0,333333	3	5
Menu (*menu makanan*)	3	1	0,333333	3	5
Distance Location (*jarak tempat makan*)	3	3	1	3,000003	7
Parking Area (*luas parker*)	0,333333	0,333333	0,333333	1	3
Sentiment (*sentiment analisa*)	0,2	0,2	0,142857	0,333333	1

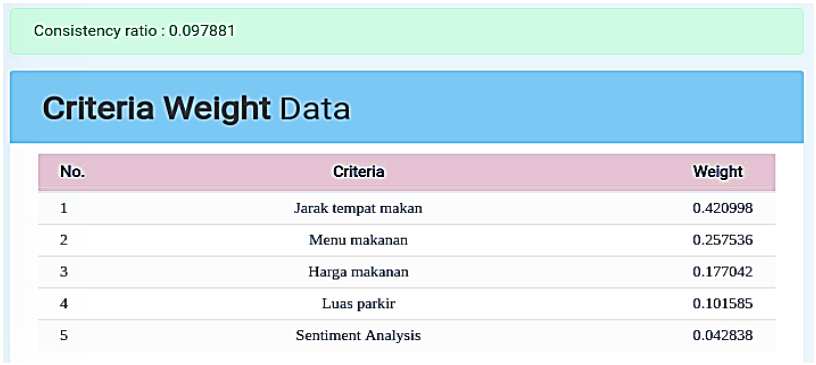


Figure 4. Criteria weighting

3.2. Response time proses scraping opinion dan sentiment analysis

Scraping is done based on alternative name keywords. Sentiment analysis process runs after the opinion scraping process is complete. The results of the response time trial opinion scraping process and sentiment analysis with several variables as in Table 2. From Table 2, the number of lines of words or opinions about alternatives can affect the speed of response time. The more opinions, the longer the opinion extraction process in the sentiment analysis process. Internet speed has an effect on the process of scraping opinions from social media Twitter because the system accesses the Twitter API directly.

Table 2. Result of response time scraping process and sentiment analysis testing

Keywords	Scraping opinions result	Response time
Depot Slamet	7 line	1.90 s
Bebek Palupi	5 line	1.44 s
Soto Cak Har	13 line	2.35 s
Ikan Bakar Keputih	4 line	1.32 s
Ayam Nelongso	7 line	1.57 s

3.3. Alternative weighting

Alternative data input "places to eat" which includes names and additional information about alternatives are also needed before weighting the alternatives. Each alternative "place to eat" that has been entered, the user can see the details along with some opinions obtained from the system scraping from social media Twitter. An alternative comparison value input is performed on each criterion except the specific criterion, sentiment analysis as shown Figures 5, 6, and 7.

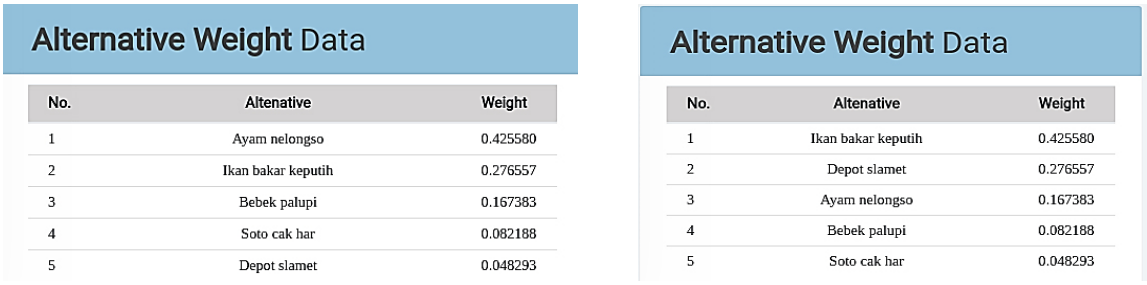
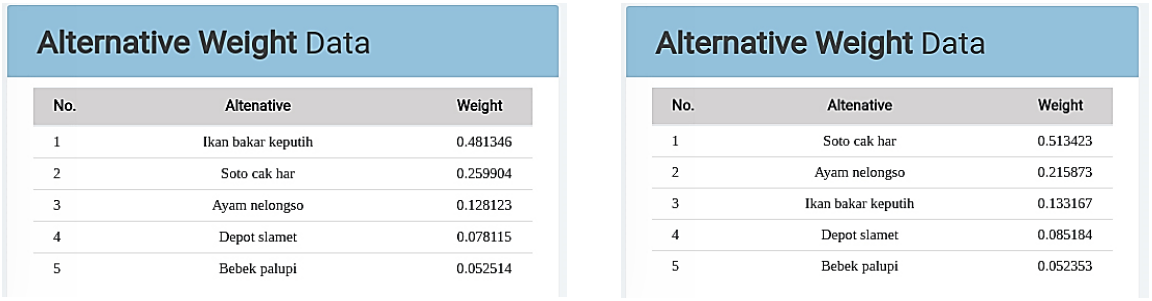


Figure 5. Alternative weight of food's price and alternative weight of food's menu



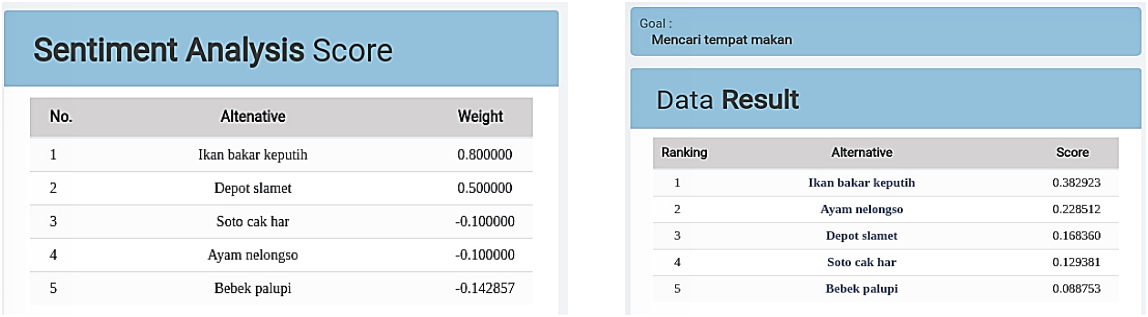
Alternative Weight Data

No.	Altenative	Weight
1	Ikan bakar keputih	0.481346
2	Soto cak har	0.259904
3	Ayam nelongso	0.128123
4	Depot slamet	0.078115
5	Bebek palupi	0.052514

Alternative Weight Data

No.	Altenative	Weight
1	Soto cak har	0.513423
2	Ayam nelongso	0.215873
3	Ikan bakar keputih	0.133167
4	Depot slamet	0.085184
5	Bebek palupi	0.052353

Figure 6. Alternative weight of distance location and alternative weight of criteria



Sentiment Analysis Score

No.	Altenative	Weight
1	Ikan bakar keputih	0.800000
2	Depot slamet	0.500000
3	Soto cak har	-0.100000
4	Ayam nelongso	-0.100000
5	Bebek palupi	-0.142857

Goal :
Mencari tempat makan

Data **Result**

Ranking	Alternative	Score
1	Ikan bakar keputih	0.382923
2	Ayam nelongso	0.228512
3	Depot slamet	0.168360
4	Soto cak har	0.129381
5	Bebek palupi	0.088753

Figure 7. Sentiment weight for each alternative and finel result

The Sentiment Analysis Accuration test was conducted using 30 sentences dataset with positive, negative, and neutral sentiments. To calculate the accuracy of sentiment analysis, a formula like the following is used:

$$Accuracy = \frac{\sum correct\ prediction}{sum\ of\ data} x\ 100\% \quad (3)$$

from this test, the number of correct predictions in sentiment sentences is 26. Calculation of sentiment analysis accuracy is as follows:

$$Accuracy = \frac{26}{30} x\ 100\% = 86.7\%$$

the accuracy of sentiment analysis reaches 86.7% in testing with 30 sentiment sentences dataset.

3.4. Response time calculation process

Response time testing of the calculation process is done with 2 variables, namely the number of criteria and the number of alternatives. The results of the response time testing of the calculation process with these 2 variables are as in Table 3. From the test results in Table 3, the average value of response time is directly proportional to the number of alternatives. In testing with a fixed number of alternatives and the number of different criteria, response time is directly proportional to the number of criteria. It can be concluded that the speed of response time calculation process depends on the number of criteria and alternatives. The more the number of criteria and alternatives, the greater the response time.

3.5. Application testing on several web browser

Testing the system on several web browsers is needed to determine the suitability and responsibility of the system in the browser Google Chrome, Mozilla Firefox, Internet Explorer, and Microsoft Edge.

3.6. System testing

System testing is done to validate each application's features in accordance with the expected output. The results of blackbox testing can be seen in Table 4. Interface testing is also performed with the usability principles of 10 heuristic evaluations developed by Jacob Neilsen resulting in several evaluations as in Table 5.

Table 3. Result of response time calculation process testing

Alternative Amount	Criteria Amount	Response Time	Average Response Time
2	2	831s	
	3	836s	874.5s
	4	890s	
	5	957s	
5	2	882s	
	3	954s	982s
	4	992s	
	5	1100s	
7	2	931s	
	3	1020s	1042.75s
	4	1100s	
	5	1120s	

Table 4. Result of validation testing

No.	Case test	Condition	Result
1.	Registration	Users can register an account with an email and username that has never been registered.	Valid
2.	Login	Users can log in with a registered username and password.	Valid
3.	CRUD Goal	Users can change and delete goals.	Valid
4.	List Criteria	Displays criteria based on the user who is logged in.	Valid
5.	CRUD Criteria	Users can add, change and delete their criteria data.	Valid
6.	Comparison value of criteria	Showing the value pairwise comparison between user criteria.	Valid
7.	Update comparison value criteria	*User* dapat mengubah value pairwise comparison antar kriteria mereka.	Valid
8.	List Alternative	Showing alternatives based on the user who is logged in.	Valid
9.	CRUD Alternative	Users can add, change and delete their alternative data.	Valid
10.	Comparison value of alternative	Display pairwise comparison values between alternatives on each user criteria.	Valid
11.	Update comparison value alternative	Users can change the value of pairwise comparison between alternatives on each of their criteria.	Valid
12.	Calculation	Showing the results of calculations in the form of alternative recommendations from the system process.	Valid
13.	History	Displays a history of the results of previous calculations.	Valid

Table 5. Heuristic testing

No.	Principles	Is there?	How?
1.	Visibility of system status	Yes	The system has given notification when successfully creating, updating, and deleting.
2.	Match between system and the real world	Yes	The system uses a global language (English) that is familiar and easy to understand.
3.	User control and freedom	Yes	Users can add, change, and delete data. But there is no system to restore deleted data.
4.	Consistency and standards	Yes	Every button, text, color, appearance on one page is the same as another page.
5.	Error prevention	Yes	There is an error message on every user that requires doing the previous steps, such as filling goals, comparison criteria, alternative comparison.
6.	Recognition rather than recall	Yes	Users do not need to remember the appearance of the page menu, because there are buttons that match their functions.
7.	Flexibility and efficiency of use	Yes	In choosing a pairwise comparison value, there is information about the meaning of each value in pairwise comparison.
8.	Aesthetic and minimalist design	Yes	Simple design not too many contrasting colors. The text and appearance of the page look smooth, not too flashy or thick.
9.	Help users recognize, diagnose, and recover from errors	Yes	An error message appears when confirming the password is incorrect and the login is incorrect. Errors outside the system are directed at the error page.
10.	Help and documentation	No	There is no help menu and documentation. Documentation is only in the form of a book.

3.7. User testing

Testing is done to the user to find out whether the system has provided output that is in accordance with the user. The test was conducted on students of several PENS 2016 informatics engineering students and general users. Users who do testing totaling 10 people including 8 students of informatics engineering and 2 general users. The results from respondents are as follows: of the 10 users who tried this application, all of them can use the application easily. Based on the results of testing with users in Figure 8, they can use the application easily. Taking the opinion by the system regarding each alternative is less than the maximum. There are alternatives that are not discussed on Twitter social media, so sentiment analysis on these alternatives is zero. It needs to be expanded regarding social media as an alternative source of opinion.

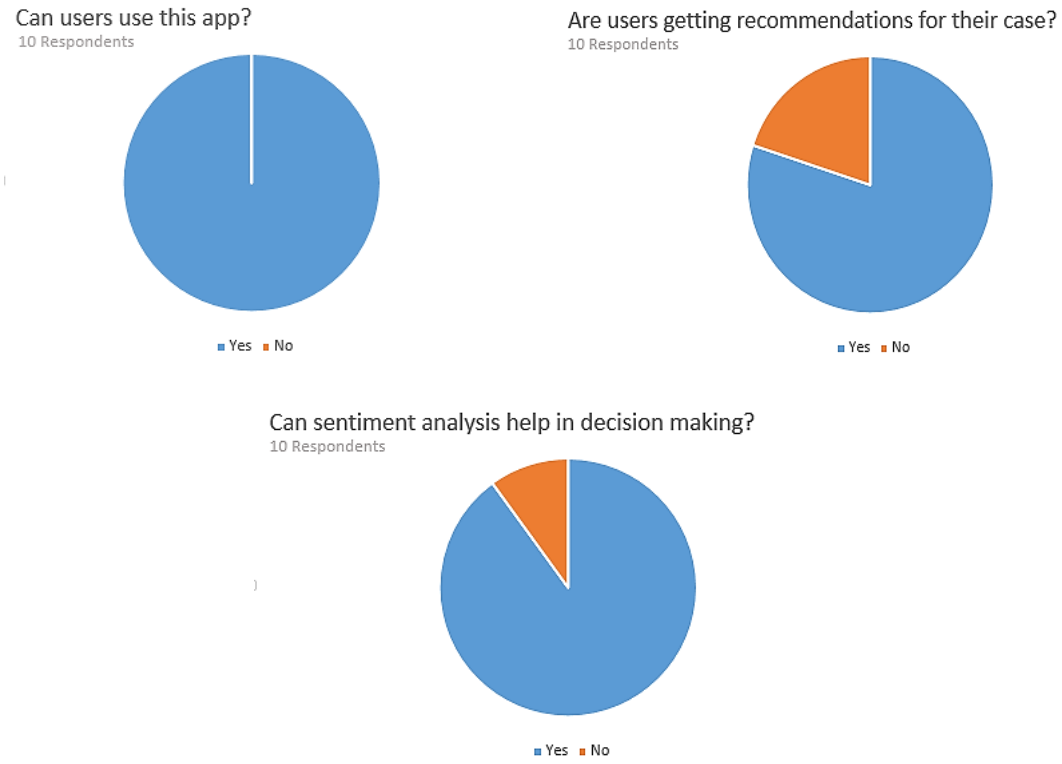


Figure 8. User survey

4. CONCLUSION

After conducting various stages starting from the design stage, making the system then proceed to the testing and analysis phase, the following conclusions can be drawn that the results of the calculation of the AHP process on the system with manual calculations are the same, so that the calculation of the AHP process is accurate. Calculation speed is influenced by the number of criteria and alternative users. Applications can provide recommendations according to user needs. Sentiment Analysis of opinions can help in user decision making. The contribution of this research is to provide one of the multi-criteria decision-making methods with one of the criteria being the results of opinions from social media about these alternatives. The combination of AHP and sentiment analysis provides user satisfaction. Users get the best recommendation from the AHP calculations with some criteria from users and public opinion about each alternative.

REFERENCES

[1] Suryadi K. and Ramadhani M. A. "Decision Support System: A Structural Discourse on Idealization and Implementation of Decision Making (in Bahasa: Sistem Pendukung Keputusan: Suatu Wacana Struktural Idealisasi dan Implementasi Pengambilan Keputusan)," Bandung: Remaja Rosda karya Offset, 1998.

[2] N. Komalasari, "Decision Support Support System (SPK2T) (in Bahasa: Sistem Pendukung Keputusan Kelaikan Terbang (SPK2T))," *Jurnal Industri Elektro dan Penerbangan*, vol. 4, no. 1, 2020.

[3] Daihani D. "Computerized Decision Making (in Bahasa: Komputerisasi Pengambilan Keputusan)," Bogor: Ghalia Indonesia, 2001.

[4] Chamid A. A. and B. Surarso, and "Implementation of AHP and Promethee Methods for Supplier Selection (in Bahasa: Implementasi Metode AHP dan Promethee untuk Pemilihan Supplier)," *Jurnal Sistem Informasi Bisnis,* vol. 5, no. 2, pp. 128–136, May 2015.

[5] Osis P. K. "Decision Support System (in Bahasa: Sistem Penunjang Keputusan)," Universitas Mercu Buana Yogyakarta, 2002.

[6] S. Utaminingsih, "Career-based Soft Skill Development at Vocational Schools in Semarang City (in Bahasa: Pengembangan Soft Skill Berbasis Karier pada SMK di Kota Semarang," *Din. Pendidik*, vol. 6, no. 2, pp. 119–133, 2011.

[7] R. Menggunakan, et al., "National Symposium on Applied Technology (SNTT) (in Bahasa: Simposium Nasional Teknologi Terapan (SNTT)," 5 2017 ISSN: 2339-028X," pp. 267–271, 2017.

[8] H. Supriyono, "Selection of Residential Using the Weighted Product Method (in Bahasa: Pemilihan Rumah Tinggal Menggunakan Metode Weighted Product," *Khazanah Informatika: Jurnal Ilmu Komputer dan Informatika*, vol. 1, no. 1, pp. 23–28, 2015.
[9] E. Lestari and E. U. Artha, "Expert System with Dempster Shafer Method for Diagnosing INDIHOME Service Disorders at PT TELKOM Magelang (in Bahasa: Sistem Pakar dengan Metode Dempster Shafer untuk Diagnosis Gangguan Layanan INDIHOME di PT TELKOM Magelang)," *Khazanah Informatika: Jurnal Ilmu Komputer dan Informatika*, vol. 3, no. 1, pp. 16–24, 2017.
[10] O. J. F. Wassalam, R. Umar, and A. Yudhana, "Implementation and Development of Web-Based E-Learning System at STIMIK Muhammadiyah Paguyangan (in Bahasa: Implementasi dan Pengembangan Sistem E-Learning Berbasis Web pada STIMIK Muhammadiyah Paguyangan)," *Proceeding SENDI*, pp. 104–107, 2017.
[11] Nugroho and S. Hartati, "AHP (Analytical Hierarchy Process) Based Decision Support System for Determining Conformity of Land Use (Case Study: Semarang Regency) (in Bahasa: Sistem Pendukung Keputusan Berbasis AHP (Analytical Hierarchy Process) untuk Penentuan Kesesuaian Penggunaan Lahan (Studi Kasus: Kabupaten Semarang)," *Jurnal Informatika*, vol. 6, no. 2, pp. 630–641, 2012.
[12] Fathoni, K. Prasetyaningrum, I. Hariyati, C.L. "Decision Support System for Choosing Daycare in Surabaya City Using Analytical Hierarchy Process (AHP)," *IEEE International Conference on Applied Science and Technology (iCAST)*, pp. 544-550, 2018.
[13] Umar R, Fadlil A, and Yuminah. "Decision Support System with AHP Method for Employee Soft Skill Competency Assessment. (in Bahasa: Sistem Pendukung Keputusan dengan Metode AHP untuk Penilaian Kompetensi Soft Skill Karyawan)," *Khazanah Informatika: Jurnal Ilmu Komputer dan Informatika*, vol. 4 no. 1, pp. 27-34, Jun 2018.
[14] S. Hartati and Nugroho A, "AHP (Analytical Hierarchy Process) Based Decision Support System for Determining Conformity of Land Use (Case Study: Semarang Regency) iIn Bahasa: Sistem Pendukung Keputusan Berbasis AHP (Analytical Hierarchy Process) untuk Penentuan Kesesuaian Penggunaan Lahan (Studi Kasus: Kabupaten Semarang)," *Jurnal Informatika* Vol 6, No. 2, Juli 2012.
[15] Supriyono, "Decision Support System (SPK) Motorcycle Selection Using the AHP Method (in Bahasa: Sistem Penunjang Keputusan (SPK) Pemilihan Sepeda Motor Menggunakan Metode AHP)," *Simetris: Jurnal Teknik Mesin, Elektro dan Ilmu Komputer,* vol. 1, no. 1, pp. 55-58, 2012.
[16] Saefudin S. and Wahyuningsih S, "Decision Support System for Employee Performance Evaluation Using Analytical Hierarchy Process (Ahp) Method in Serang District Hospital (in Bahasa: Sistem Pendukung Keputusan Untuk Penilaian Kinerja Pegawai Menggunakan Metode Analytical Hierarchy Process (Ahp) Pada RSUD Serang)," *Jurnal Sistem Informasi (JSiI)*, vol. 1, 2017.
[17] Munthafa, A. E., Mubarok, H., "Application of Analytical Hierarchy Process (AHP) Method in Decision Support System for Student Achievement Determination (in Bahasa: Penerapan Metode Analytical Hierarchy Process (AHP) dalam Sistem Pendukung Keputusan Penentuan Mahasiswa Berprestasi)," *Jurnal Siliwangi Seri Sains dan Teknologi*, vol. 3. no. 2, 2017.
[18] Gaurav Kumar, "A Multi-Criteria Decision-Making Approach for Recommending a Product using Sentiment Analysis", *2018 12th International Conference on Research Challenges in Information Science (RCIS)*, 2018.
[19] Desheng Dash Wu, Lijuan Zheng, dan David L. Olson, "A Decision Support Approach for Online Stock Forum Sentiment Analysis", *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, vol. 44, no. 8, pp. 1077-1087, 2014.
[20] Zaoli Yesng, et al., "A Decision Method for Online Purchases Considering Dynamic Information Preference Based on Sentiment Orientation Classification and Discrete DIFWA Operators", *IEEE Access,* pp. 77008-77026, 2017.
[21] Y. E. Soelistio, "Simple Text Mining for Sentiment Analysis on Political Figures Using the Naïve Bayes Classifier Method (in Bahasa: Text Mining Sederhana untuk Sentiment Analysis pada Figur Politik Menggunakan Metode Naïve Bayes Classifier)," *The Proceedings of the 7th ICTS, Bali, May 15th -16th*, 2013 (ISSN: 9772338185001).
[22] Anastasia Dewanti Pratama Putri, "Temporal Sentiment Based East Java Tourism Object Recommendation System (in Bahasa: Sistem Rekomendasi Objek Wisata Jawa Timur Berbasis Temporal Sentiment), Politeknik Elektronika Negeri Surabaya, 2018."
[23] Nurjanah, W.E., Perdana, R.S., Fauzi, M.A. "Sentiment Analysis of Television Shows Based on Public Opinion on Twitter Social Media using the K-Nearest Neighbor Method and Weighting the Number of Retweets (in Bahasa: Analisis Sentimen Terhadap Tayangan Televisi Berdasarkan Opini Masyarakat pada Media Sosial Twitter menggunakan Metode K-Nearest Neighbor dan Pembobotan Jumlah Retweet)," *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer e-ISSN*, vol. 1, no. 12, pp. 1750-1757, Desember 2017.
[24] Sipayung, E.M., Maharani and H., Zefanya, I. "Designing Customer Comment Sentiment Analysis System Using the Naive Bayes Classifier Method (in Bahasa: Perancangan Sistem Analisis Sentimen Komentar Pelanggan Menggunakan Metode Naive Bayes Classifier)," *Jurnal Sistem Informasi*, vol. 8, no. 1, April 2016.
[25] Indrayuni, E. "Hotel Review Sentiment Analysis Using the Vector Machine Support Algorithm (in Bahasa: Analisa Sentimen Review Hotel Menggunakan Algoritma Support Vector Machine)," *EVOLUSI: Jurnal Sains dan Manajemen*, vol. 4, no. 2, 2016.

BIOGRAPHIES OF AUTHORS

Ira Prasetyaningrum, She was born in Surabaya, 29 May 1980. She was the last of two children. Her fields of research are mathematics, decision support systems, data science and logistics. She started working in Politeknik Elektronika Negeri Surabaya (PENS) starting in 2008. She is a friendly person.

Kholid Fathoni, he was born in Lamongsn, 26 December 1980. he is a religious person. He started working in Politeknik Elektronika Negeri Surabaya (PENS) starting in 2008. He someone friendly and easy to get along.

Tri Tangguh Jiwo Priyantoro, he was born in Ngawi, 22 November 1998. He was the last of three children. He likes sports like football and running. He's someone friendly and easy to get along.