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Analysis of Student Specialization Recommendations in Communication Studies Using K-Means and SMART

Bambang Supperianto[1]✉, Yuhandri[2], Sarjon Defit[3]
[1, 2, 3] Master of Informatics Engineering, Faculty of Computer Science, Universitas Putra Indonesia YPTK, Padang, 25221, Indonesia
bambangs@unived.ac.id

Abstract

Student major recommendations are compiled to help students in the Communication Studies Program at the Faculty of Social Sciences, Dehasen University, Bengkulu, determine the most suitable concentration based on academic characteristics and learning data patterns. Based on this, the purpose of this study is to analyze major recommendations for students in the Communication Studies Program at the Faculty of Social Sciences, Dehasen University, Bengkulu, based on course grades.The Simple Multi-Attribute Rating Technique (SMART) was used in the process of weighting and assessing academic criteria, while K-Means was used to form major clusters based on the assessment results. This data set consists of 103 communication science students from the Faculty of Social Sciences obtained from the Dehasen Bengkulu University academic information system portal. The results of this study can recommend majors for Communication Science students at the Faculty of Social Sciences, Dehasen Bengkulu University, based on a decision support system. Based on the research results, Journalism was the most popular major with 63 students. This shows that students are more interested in journalism than in other majors. Meanwhile, Public Relations was chosen by 40 students. The contribution of this research is to improve the accuracy of student major selection in the Communication Studies Program, Faculty of Social Sciences, Dehasen University of Bengkulu. The use of the K-Means algorithm and the SMART method enables the Communication Studies Program, Faculty of Social Sciences, Dehasen University of Bengkulu to be more objective and efficient in the process of managing academic majors.

Keywords: Decision Support System, K-Means+SMART Method, student specialization.

1. Introduction

The development of Artificial Intelligence (AI) has brought about major changes in the way humans manage, analyze, and use data to support decision-making [1]. AI not only targets the automation of computational processes, but also the ability of systems to mimic the way humans think, learn, and make rational decisions based on available data [2]. In this context, AI plays an important role in assisting systematic data analysis through pattern learning, prediction processes, and data-driven decision making. [3]. The application of this technology is becoming increasingly widespread in various fields, including higher education, particularly in the development of academic information systems and decision support systems that help students and education administrators make optimal choices [4].

One of the main approaches in AI implementation is Data Mining, which is a semi-automatic process that utilizes statistical techniques, mathematics, artificial intelligence, and machine learning to extract new knowledge from large data sets [5]. Data mining is a core part of the Knowledge Discovery in Databases (KDD) process, which includes data selection, preprocessing or data cleaning, data transformation, data mining, and interpretation and evaluation of results [6]. Through this process, various hidden patterns and important information that were previously difficult to identify can be revealed and utilized as a basis for more objective and measurable decision-making [7].

One of the most widely used methods in data mining is the K-Means Clustering algorithm [8]. K-Means is an unsupervised learning algorithm that aims to group data into a number of clusters based on the degree of similarity between object characteristics [9]. The main principle of K-Means is to minimize the distance between data points within a cluster and maximize the difference between clusters, so that data with similar characteristics are in the same group [10]. This method is widely used in data segmentation, behavioral analysis, and grouping students or consumers based on specific attributes [11]. However, K-Means clustering results are generally still descriptive in nature and do not directly generate decision recommendations [12].

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To bridge the results of Data Mining analysis with decision-making needs, integration with a Decision Support System (DSS) is required [13]. DSS is a computer-based information system designed to assist decision makers by providing data, analysis models, and rational alternative solutions [14]. In the context of complex decision-making involving multiple criteria, DSS plays an important role in organizing information and presenting recommendations systematically and transparently [15].

One method widely used in DSS is the Simple Multi-Attribute Rating Technique (SMART). SMART is a multi-criteria decision-making method that evaluates each alternative based on the weight and score of a number of attributes or determining criteria [16]. The main advantages of SMART lie in the simplicity of the calculation process, the transparency of the criteria weighting, and its ability to produce objective and easily traceable recommendations [17]. In AI and Data Mining-based systems, SMART enables the results of data analysis or clustering to be further processed into targeted and measurable recommendations [18].

The integration between the K-Means algorithm and the SMART method has been applied in various previous studies [19]. Through the study Multi-Attribute Clustering for Student Entrepreneurial Potential Mapping in Indonesia, K-Means was used to form homogeneous groups of students based on a number of attributes, then a multi-attribute approach was used to interpret the cluster results as a basis for educational policy recommendations[20]. The study showed that data-based clustering was able to provide a more systematic and actionable picture of student potential [21].

The clustering approach was also applied by [22] in research on grouping prospective new students using the K-Means algorithm. Although this study did not integrate the SMART method in the calculation stage, the results confirmed the effectiveness of K-Means in assisting the educational decision-making process by reducing subjectivity and dependence on manual assessment [23].

The integration of K-Means and SMART is more explicitly demonstrated by [24] in the analysis of follow-up recommendations for fertilizer distribution among rice farmer groups. In this study, K-Means was used to form clusters of farmer groups with similar characteristics, while SMART was used to determine follow-up recommendations based on criterion weights. The results of the study show an increase in the accuracy of recommendations and a reduction in subjectivity in decision making.

On the other hand, the independent application of the SMART method is demonstrated by [25] in the decision support system for assessing the best employees at AJB Bumiputera 1912 in the Jambi region. This study confirms SMART's ability to produce transparent and measurable alternative rankings when decisions must be made based on multiple criteria. Similar findings were also demonstrated by [26] in determining disaster relief priorities using the SMART method, which emphasizes the superiority of this method in conditions of limited resources.

Based on a review of previous studies, it can be concluded that the K-Means algorithm is effective in identifying patterns and forming homogeneous data clusters, while the SMART method plays an important role in producing objective and transparent decision recommendations. Although both methods have been widely applied, either separately or in an integrated manner, research that specifically examines the application of K-Means and SMART integration in determining student major recommendations, particularly in Communication Studies Programs, is still relatively limited. Therefore, this study aims to analyze the determination of student major recommendations in the Communication Studies Program by applying the integration of the K-Means algorithm and the SMART method as an effort to produce more objective, systematic, and data-driven major recommendations.

2. Methods

The research framework is a conceptual guideline that systematically organizes the stages of research, from problem identification to drawing conclusions. Its function is to ensure that each process runs according to scientific principles, maintain consistency in the workflow, and support the achievement of research objectives in a focused and efficient manner. This series of stages is designed so that the research is conducted in a structured and focused manner. A complete visualization of this framework is shown in Figure 1.

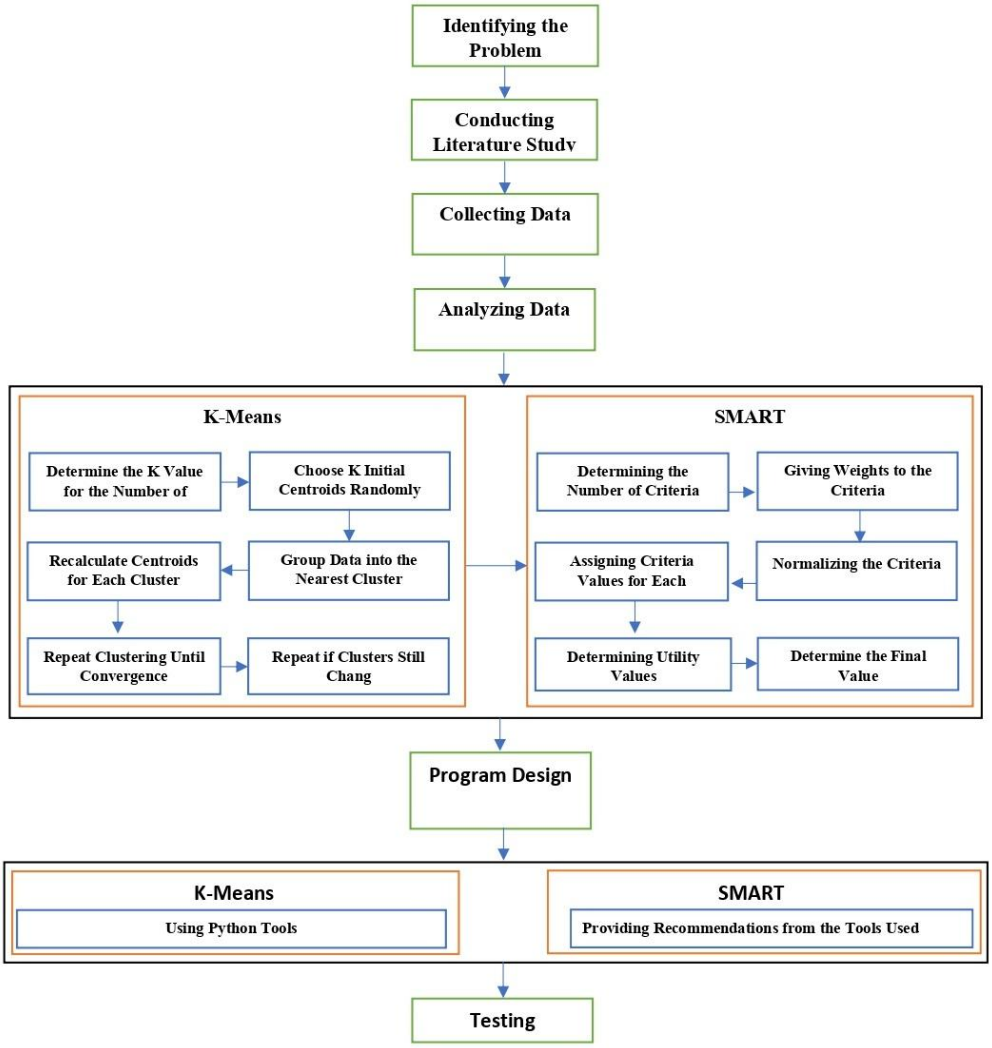

Figure 3.1 Research Framework.

Figure 1 Research Framework illustrates the stages carried out in this study. These stages were then broken down into several sub-stages to facilitate the research process. The following section will provide a detailed explanation of each stage carried out in this study.

2.1 K-Means Cluster

a. Determine the optimal K value to set the number of clusters.
b. Select K initial points as random centroids.
c. Assign each data point to a cluster by calculating the distance between the data point and each centroid, then selecting the cluster with the minimum distance. Distance calculations are performed using the Euclidean distance Equation 2.

$$D_E = \sqrt{\sum_{i=1}^{n}(A_i - B_i)^2}, \quad i = 1,2,3,\dots,n \qquad (1)$$

Description :

A_i : is the i-th data object,
B_i : indicates the i-th centroid, while
n : is the total number of features or data dimensions

d. Recalculate the previously selected centroid variations and determine a new centroid for each cluster based on the average of all data included in that cluster.

$$v_{ij} = \frac{1}{N_i}\sum_{k=0}^{N_i} X_{kj} \qquad (2)$$

Description :

v_{ij} : Average value for elements $i$and$j$.
N_i : Amount of data or dataset size for variable$i$.
X_{kj} : Data value for the element ke$k$ pada variabel$j$.
Σ : States the sum for all data values on the index from to N_i

e. Repeat step 3 to reset the clusters if necessary, based on the new centroids obtained in step 4.
f. If cluster members are still moving, return to step 4. If there are no changes, the process is complete and the model is ready to use.

2.2 SMART Method

a. Determine the number of criteria to be used.
b. Determine the weight for each criterion using a scale of 1-100, based on the priority level of each criterion.
c. Normalizing each criterion is calculated by comparing the criterion weight value to the total weight of all criteria. This calculation is performed according to Equation (2.1), where the weight value of a criterion is expressed as Wj and ∑ indicates the total weight of all criteria.

$$\text{Normalization} = \frac{Wj}{\sum Wj} \quad (3)$$

d. Assign a value to each criterion for each alternative.
e. Determine the utility value by converting the value of each criterion into standard data. The utility value is calculated using equation (2.2), where Ui(Ai) indicates the utility value for criterion i, with the maximum criterion value, minimum criterion value, and criterion i value used in the calculation.

$$\text{Ui (Ai)} = \frac{Count - Cmin}{Cmax - Cmin} \quad (4)$$

f. The final value of each criterion is determined by multiplying the normalized value of the criterion's raw data by the normalized criterion weight. The results of these multiplications are then added together, as shown in Equation (2.3), where U(Ai) is the total value of the alternative, Wj is the normalized criterion weight, and Ui(Ai) is the calculated utility value.

$$\text{U(Ai)} = \sum_{j=i}^{m} Wj\ Ui\ (Ai) \quad (5)$$

3. Results and Discussions

Analysis and design stages are carried out to form a structured system workflow. This process includes identifying requirements and creating system models. Each stage describes the logical steps in building an efficient system.

3.1 Dataset

The dataset is an important step in ensuring the validity and reliability of a study. Accurate data will produce more precise and accountable analyses. In this study, data was obtained through the Academic Information System (SIAKAD) of Dehasen University Bengkulu. The data collected was in the form of academic grades of students in the Communication Studies Program. These grades were grouped into five categories of courses, namely Journalism specialization, Public Relations specialization, core study program courses, faculty courses, and university courses. All of this data was used as the basis for the analysis and development of the recommendation system. The research dataset was then grouped into five main variables, namely X1 (Journalism major), X2 (Public Relations major), X3 (study program), X4 (faculty level), and X5 (university level). The dataset is presented in Table 1.

Table 1. Dataset

No	Name	X1	X2	X3	X4	X5
1	Tiara Natasya	3,7	3,6	3,2	3,2	3,8
2	Rebi Rhamat Ilahi	3,6	3,1	3,2	3,4	3,8
3	Niky Rahmada Ilahi	3,5	3,3	3,8	3,4	4
4	Mirza Erlangga	3,9	3,8	3,6	3,6	4
5	Wifi Viola Utama Sari	3,6	3,5	3,6	3,2	3,8
6	Iqbal Arisqi	3,9	3,5	3,8	3,6	4
7	Serly Oktaviani	1,8	1,6	2,2	2	2,8
8	Shelli Julita Puspita Sari	3,2	3,5	2,4	3,6	4
9	Rapika	2,9	2,7	2,2	2,6	3,6
10	Refal Aldiron	3,8	3,8	3,6	3,6	3,8
	....					
96	Yudi Pratama	3,8	3,6	3,6	3,4	4
97	Maula Ananda Bintang	3,7	3,7	3,8	3,8	4
98	Putra Ragil Sagiman	3,6	3,4	3,2	3,6	3,8
99	David Wibisana	3,3	2,7	3,6	3,6	3,8
100	Meliana Andraini	3,7	3,8	3,8	3,8	4
101	M. Yusuf Erianto	3,3	3,2	2,4	3,6	3,4
102	Ricko Afrianda	3,9	3,6	3,8	3,8	4
103	Alfin Fahreza	3	3,3	2,4	3	3,6

3.3 Preprocessing

The preprocessing stage was carried out to ensure that the student academic data used in this study was free from errors, duplications, and irrelevant values. The cleaning process was applied to the dataset obtained through the Academic Information System (SIAKAD) of Dehasen University Bengkulu, which contained the course grades of students in the Communication Science Study Program. The data was checked for completeness, format consistency, and consistency between academic variables. The verification results showed that all data was valid and organized, ready for further analysis without requiring additional corrections.

Table 2. Preprocessing Result

No	Name	X1	X2	X3	X4	X5
1	Tiara Natasya	3,7	3,6	3,2	3,2	3,8
2	Rebi Rhamat Ilahi	3,6	3,1	3,2	3,4	3,8
3	Niky Rahmada	3,5	3,3	3,8	3,4	4
4	Mirza Erlangga	3,9	3,8	3,6	3,6	4
5	Wifi Viola Utama	3,6	3,5	3,6	3,2	3,8
6	Iqbal Arisqi	3,9	3,5	3,8	3,6	4
7	Serly Oktaviani	1,8	1,6	2,2	2	2,8
8	Shelli Julita	3,2	3,5	2,4	3,6	4
9	Rapika	2,9	2,7	2,2	2,6	3,6
10	Refal Aldiron	3,8	3,8	3,6	3,6	3,8
				……		
94	Resi Syafitri	3,7	3,4	3,6	4	3,8
95	Dwi Ikhfani	3,8	3,5	2,6	3	3,6
96	Yudi Pratama	3,8	3,6	3,6	3,4	4
97	Maula Ananda	3,7	3,7	3,8	3,8	4
98	Putra Ragil	3,6	3,4	3,2	3,6	3,8
99	David Wibisana	3,3	2,7	3,6	3,6	3,8
100	Meliana Andraini	3,7	3,8	3,8	3,8	4
101	M. Yusuf Erianto	3,3	3,2	2,4	3,6	3,4
102	Ricko Afrianda	3,9	3,6	3,8	3,8	4
103	Alfin Fahreza	3	3,3	2,4	3	3,6

Table 2 shows the results of the data preprocessing that has been carried out. Each value generated reflects the academic performance of students in each relevant aspect. Tady to be used for statistical analysis to determine more in-depth recommendations for student majors.

3.2 K-Means Analysis

The data analysis process began with the application of the K-Means algorithm. This algorithm is used to find patterns or groups with similar characteristics. The results of the K-Means process are presented in Table 3.

Table 3. K-Means Iteration

No	C1	C2	Y
1	0,813	0,603	2
2	0,589	0,719	1
3	1,146	0,438	2
4	1,378	0,346	2
5	0,971	0,385	2
6	1,371	0,287	2
7	2,591	3,648	1
8	0,927	1,413	1
9	1,03	2,153	1
10	1,278	0,256	2
		…..	
94	1,269	0,506	2
95	0,724	1,248	1
96	1,185	0,254	2
97	1,458	0,35	2
98	0,774	0,548	2

No	C1	C2	Y
99	0,985	0,989	1
100	1,505	0,394	2
101	0,643	1,481	1
102	1,48	0,373	2
103	0,643	1,622	1

The K-Means Clustering process generates cluster labels for each data point based on the proximity of attribute values to the final centroid. This cluster assignment describes the grouping pattern that is formed after all iterations reach a stable condition. The final grouping results are displayed in full in Table 5.

Table 4. K-Means Result

No	X1	X2	X3	X4	X5	Hasil
1	3,7	3,6	3,2	3,2	3,8	Jurnalistik
2	3,6	3,1	3,2	3,4	3,8	2
3	3,5	3,3	3,8	3,4	4	2
4	3,9	3,8	3,6	3,6	4	2
5	3,6	3,5	3,6	3,2	3,8	2
6	3,7	3,6	3,2	3,2	3,8	2
7	3,6	3,1	3,2	3,4	3,8	Humas
8	3,5	3,3	3,8	3,4	4	1
9	3,9	3,8	3,6	3,6	4	1
10	3,6	3,5	3,6	3,2	3,8	2
			……			
94	3,7	3,4	3,6	4	3,8	2
95	3,8	3,5	2,6	3	3,6	1
96	3,8	3,6	3,6	3,4	4	2
97	3,7	3,7	3,8	3,8	4	2
98	3,6	3,4	3,2	3,6	3,8	2
99	3,3	2,7	3,6	3,6	3,8	2
100	3,7	3,8	3,8	3,8	4	2
101	3,3	3,2	2,4	3,6	3,4	1
102	3,9	3,6	3,8	3,8	4	2
103	3	3,3	2,4	3	3,6	1

Table 4 shows the final results of the K-Means clustering process for each data point based on five attributes. This information shows how each object has certain characteristic similarities that cause them to be grouped into the same cluster. The resulting cluster distribution also shows consistency in the clustering pattern after the centroid reaches a convergent value.

3.3 SMART Analysis

method Simple Multi-Attribute Rating Technique (SMART) to assess the available major alternatives based on students' academic scores. The SMART method is used to assign weights to each criterion and calculate a total score that reflects the level of suitability of students for each major. This process is carried out with the aim of providing objective and measurable major recommendations based on the academic data obtained. The results of the SMART analysis are presented in Table 5.

Table 5. K-Means Result

No	Recommendations humas	No	Recommendations Jurnalistik
1	Serly Oktaviani	1	Tiara Natasya
2	Shelli Julita Puspita Sari	2	Rebi Rhamat Ilahi
3	Rapika	3	Niky Rahmada Ilahi
4	Abdi Kurniawan	4	Mirza Erlangga
5	Retno Rahma Putri	5	Wifi Viola Utama Sari
6	Anisa Puspitha	6	Iqbal Arisqi
7	Edwin Jaya Ilahi	7	Refal Aldiron
8	Ririn Rama Dani	8	Alfa Tri Alfindo
9	Wulandari	9	Kerisda Lopenia
10	Ranggi Dwi Apriansyah	10	Lusi Lusmi Yanti
		………………………	
18	Rafi Zahran Adiba	67	Dania Mega Ayu
19	Matias Januar Marpaung	68	Dwi Rizqia Wati
20	Bunga Junita Dwicah Yani	69	Julio Pasa Alhadi

21	Willy Adrian	70	Resi Syafitri
22	Fardho Burenza Silman	71	Yudi Pratama
23	Bilawa Dwi Prayoga	72	Maula Ananda Bintang
24	Dwi Putri Lestari	73	Putra Ragil Sagiman
25	Dwi Ikhfani	74	David Wibisana
26	M. Yusuf Erianto	75	Meliana Andraini
27	Alfin Fahreza	76	Ricko Afrianda

With the determination of clusters, the dataset that previously had no labels now has clear attributes and label pairs, making it ready for use in the next stage. This labeled dataset will be used as the basis for calculating student interest scores using the SMART method, which will provide interest recommendations based on the academic compatibility of students with the two available majors.

4. Conclusion

Based on the results of the system evaluation testing, it can be concluded that the system output has shown a very good level of consistency. The prediction results generated by the system are fully consistent with manual calculations and data processing using Microsoft Excel. Using the K-Means method, the system successfully grouped students into two majors, namely 40 students in Public Relations and 63 students in Journalism, with identical results between the system and Excel. This similarity in results indicates that the calculation process, algorithm logic, and system implementation have been carried out correctly. Thus, the major recommendation system that has been developed can be declared valid and suitable for use as an academic decision-making tool

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Biographies of Authors

	**Bambang Supperianto** He is a student in the Master of Information Technology program at Universitas Putra Indonesia Padang. He was born on January 2, 1992, in Bengkulu. He completed his bachelor's degree in information systems at Universitas Dehasen Bengkulu in 2017. He is an Academic Staff Member in the field of academic data management at the Communication Studies Program, Faculty of Social Sciences, Dehasen University Bengkulu. He resides at Jl. Wnggano No.06 RT.03 RW. 01, Pasar Bengkulu Village, Sugai Serut District, Bengkulu City, Bengkulu Province, Indonesia. Email : Bambangs@Unived.ac.id
	**Yuhandri** was born in Tanjung Alam on May 15. He is an Assistant Professor in Faculty of Computer Science, Universitas Putra Indonesia YPTK. He received the Bachelor Degree in Informatics Management and Master Degree in Information Tecnology in 1992 and 2006 from Universitas Putra Indonesia YPTK. Moreover, he completed his Doctorate of Information Technology as Informatics Medical Image expertise from Gunadarma University in April 2017. He is a lecturer at the Faculty of Computer Science, Universitas Putra Indonesia YPTK. Scopus Id is 57193430920. E-mail: yuyu@upiyptk.ac.id.
	**Sarjon Defit** was born Padang Sibusuk/07 August 1970. He is the Chancellor of Putra Indonesia University YPTK Padang. Currently active as a lecturer in Computer Science. The educational history of SI at the College of Informatics and Computer Management (STMIK "YPTK" Padang) with a graduation in 1993. An educational history of S2 at Universiti Teknologi Malaysia, Johor Bahru, graduated in 1998. Then a Doctoral Education History at Universiti Teknologi Malaysia, Johor Bahru, graduated in 2003. The field of science consists of data mining, artificial intelligence, decision support systems, and others. Gunadi Widi Nurcahyo was born in Temanggung, 14 March 1969. He was gradua .He can be contacted at email: sarjon_defit@upiyptk.ac.id