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Business Intelligence for Determining Promotional Media

In 2021-2022, SMK Dirgantara Putra Bangsa experienced a decrease in the number of prospective students who registered. This condition encourages schools to innovate and be creative in choosing effective promotional media in disseminating information on New Student Admissions (PPDB) to the public widely and routinely, with the aim of attracting more new students. This promotional effort involves the use of various types of promotional media. Business intelligence plays a role in processing organizational data into useful information to improve performance, by analyzing historical data which is then used to support decision making and planning. The K-Means algorithm is one of the clustering methods that is often used because of its ease of implementation and its ability to minimize the sum of squared error (SSE) value between data and the specified centroid. The collaboration between Business Intelligence and K-Means clustering is expected to help SMK Dirgantara Putra Bangsa in choosing the right promotional media and creating new innovations in disseminating PPDB information to the public.

***KeyWords**: PPDB, Business intelligence, K-Means clustering, Promotional Media*

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1 Introduction

SMK Dirgantara Putra Bangsa offers a vocational program in the field of Travel and Tourism Business with specifications for Airlines Staff and Flight Attendants. In the 2020-2022 academic year, the COVID-19 pandemic that limited various human activities had a significant impact on the education sector, including a decrease in the number of applicants to schools, one of which was SMK Dirgantara Putra Bangsa. This impact affected the learning process, reduced teacher teaching hours, and reduced school income used for operational needs. To overcome this situation, schools made various efforts to promote new student admissions (PPDB) through various media, such as promotional letters to junior high schools, television advertisements, billboards, banners, social media, and others. Business intelligence plays a role in converting data into valuable information by analyzing historical data to support decision making and organizational planning [1]. On the other hand, data mining is the process of extracting data to find hidden, implicit, or considered useless information, which is then processed into information or knowledge [2]. The collaboration between business intelligence and the K-Means clustering method is expected to improve organizational performance through more effective data analysis. Due to the importance of this collaboration in supporting decision making, this study was conducted to optimize the application of this method.

The integration of business intelligence and the K-Means clustering method can help schools like SMK Dirgantara Putra Bangsa better understand patterns and trends in student enrollment. By analyzing historical data on student demographics, application trends, and program preferences, schools can segment potential applicants into specific clusters. This segmentation allows for targeted promotional strategies that align with the interests and needs of each cluster, maximizing the effectiveness of marketing campaigns. For instance, promotional efforts for clusters showing interest in airline staff training could focus on showcasing the school's success stories and alumni achievements in that field, while clusters inclined toward flight attendant training could be targeted with campaigns emphasizing soft skills and international career opportunities[3].

Additionally, the insights gained through business intelligence can also aid in resource allocation and operational planning. By predicting enrollment trends and identifying factors influencing applicant choices, schools can make data-driven decisions to adjust teaching resources, optimize class sizes, and develop curriculum improvements that resonate with market demands. These measures not only help mitigate the financial challenges caused by declining applicant numbers but also position the school as a competitive and adaptive institution in the field of vocational education. With this approach, SMK Dirgantara Putra Bangsa can strengthen its resilience against external challenges and improve its overall organizational performance[4].

2 Method

2.1 Data Mining. Students are individuals who are part of a society who seek to develop their potential through the learning process available on certain paths, levels, and types of education [5]. Business Intelligence (BI) is a series of techniques used to acquire and transform data into useful and meaningful information for business analysis. BI has the ability to handle structured

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and unstructured data to identify, develop, and create new business opportunities through innovative strategies [6]. Data mining is a step in the analysis process in data-based knowledge discovery. This method can be used to find patterns that explain data characteristics (descriptive) or to make predictions (predictive) [7]. Clustering is the process of grouping objects based on similarities so that these objects are in similar groups. The application of clustering can be found in various fields, such as machine learning, pattern recognition, image analysis, bioinformatics, data compression, and computer graphics [6]. The K-Means clustering method begins with determining the value of K as the number of clusters to be formed. After that, the cluster center value is determined, followed by the stage of calculating the distance between each data and the centroid using the Euclidean distance formula (1).

$$d(x_i, \mu_j) = \sqrt{\sum (x_i - \mu_j)^2} \tag{1}$$

After calculating the distance between each data and the centroid, the next step is to group the data into clusters based on their proximity to the nearest centroid. Then, the new centroid value is calculated by taking the average of all the data in each cluster.

$$\mu_i(t+1) = \frac{1}{N_{sj} \sum_{j \epsilon sj} x_j} \tag{2}$$

Description
μ_i is the new centroid value at iteration $t+1$
N_{sj} is the amount of data in cluster S_j

Determining the number of the best clusters can use the elbow method where the best cluster will be taken from the sum of square error (SEE) value that decreases significantly and is elbow-shaped using the formula (3), y_i is the predicted value, $\bar{y}$ is the actual value and n is the number of clustering.

$$\sum_{j}^{n} (y_i - \bar{y})^2 \tag{3}$$

2.2 Decision support system (DSS). In the decision-making process, we are often faced with a large amount of information and data originating from daily activities. Decision Support Systems (DSS) are designed to help select the best alternative from the various options available. However, this decision-making process often involves conflict and sacrifice, because there are various goals and objectives that must be achieved simultaneously by decision makers [8].

One of the DSS methods based on weighted summation is the Simple Additive Weighting (SAW) method. This method aims to determine the best alternative by calculating the sum of the weighted values of the performance of each alternative against all attributes. The main process in this method is the normalization of the decision matrix to change the attribute values into a form that can be compared between alternatives [9]. The stages in the SAW method include:

a. Determining the Type of Value Classify the attribute values into cost or benefit categories
b. Normalization of the Decision Matrix

Normalization is done by changing the value of each attribute into a uniform number, according to the type of cost or benefit value.

$$R_{ij} = \begin{cases} \frac{X_{ij}}{\max X_{ij}} & \text{if } j \text{ is a profit attribute (benefit)} \\ \frac{\min X_{ij}}{X_{ij}} & \text{if } j \text{ is a cost attribute (cost)} \end{cases} \tag{4}$$

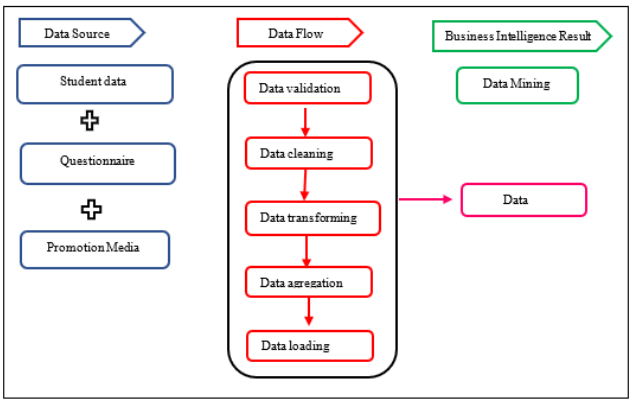

Fig. 1 Business intelligence scheme

R_{ij} : normalize performance rating
$Max\ X_{ij}$: maximum value each row and column
$Min\ X_{ij}$: minimum value each row and column
X_{ij} : matrix row and columns

Ranking is done by multiplying all attribute values by the criteria weights on all alternatives

$$V_{ij} = \sum_{j=1}^{n} W_j R_{ij} \tag{5}$$

V_{ij} : preference value
W_j : ranking weight
R_{ij} : normalized performance rating

3 Results

3.1 Business Intelligence. Business Intelligence (BI) using Tableau Public has been applied in research [3] to overcome the problem of recording patient data which is still done manually. This manual recording causes a decrease in the effectiveness and efficiency of work in the clinic. The study used data on deliveries at the Ani Clinic in 2015-2016. The results show that information on delivery trends at the Ani Clinic Padang can be analyzed by comparing the number of births by gender.

Other studies also highlight the problem of customer segmentation, which aims to understand buyer behavior, predict needs, and determine business strategies. This problem affects aspects of pricing, product demand forecasting, and business strategy formulation. The data used comes from online retail shopping customers, and the methods applied include K-Means Clustering, Hierarchical Clustering, and DBSCAN Clustering. The results of the study show that artificial intelligence is able to solve customer segmentation problems using the appropriate methodology [10].

3.2 Work Procedure. This study begins with data collection, both internal and external. Furthermore, the data is processed using Business Intelligence (can be seen in Figure 1) with the K-Means Clustering approach and the Simple Additive Weighting (SAW) method. This process is used to support decision making by the PPDB chairman, so that it can increase efficiency and effectiveness in the PPDB promotion and management strategy.

4 Discussion

4.0.1 Data Presentation. The research location is SMK Dirgantara Putra Bangsa, the research aims to determine the right promotional media to use for PPDB activities. This research will later conduct clustering on promotional media that will be collaborated with business intelligence for decision making. The results

Table 1 Data Tabulation

Data	Region	Source of Information	Assessment
1	Mlati, Sleman	Pamflet di SMP	Baik
2	Mlati, Sleman	Brosur	Cukup
3	Mlati, Sleman	Sosialisasi	Baik
4	Mlati, Sleman	Instagram	Baik
5	Mlati, Sleman	Alumni	Cukup
6	Mlati, Sleman	Baliho	Cukup
7	Mlati, Sleman	Web SMK	Cukup
...	...	...	...
39	Luar DIY	Alumni	Baik
40	Luar DIY	Alumni	Sangat Baik

Table 2 Regional Data Transformation Process

No	Region	Conversion
1	Mlati, Sleman	1
2	Sleman, DIY	2
3	Luar Sleman, DIY	3
4	Luar DIY	4

of this study can provide input to the PPDB executive chairman to determine the promotional media used for PPDB activities(see Tabel 1).

The data that has been collected will then be validated, data cleaned when there is unnecessary data, qualitative data will be changed into quantitative data (data conversion, see Table 2 and 3) so that it can be implemented in k-means, data unification and processing using k-means clustering.

The data that has been collected will then be validated, data cleaned when there is unnecessary data, qualitative data will be changed into quantitative data (data conversion) so that it can be implemented in k-means, data unification and processing using k-means clustering.

4.1 K-means Clustering. In calculating clustering using k-means which aims to group data based on data similarity and minimize the emergence of data variations. Implementation of K-means clustering calculation with the euclidean distance formula (6):

$$De = \sqrt{(x_i - S_i)^2 + (y_i - t_i)^2} \tag{6}$$

The object coordinates are the x and y values and the centroid values are s and t, and i is the number of objects. Before calculating k-means, we must first determine the number of clusters. In determining the number of clusters, we can use the help of R studio with the principle of applying the elbow method to determine the number of clusters by looking at the decrease in the sum of square error (SSE) value which is visualized in the shape of an elbow, see on Figure 2

Visualization of determining the number of clusters can be seen that the number of clusters suggested is 3 where the first elbow is

Table 3 Promotional Media Data Transformation Process

No	Promotion Media	Conversion
1	Web SMK	1
2	Pamflet di SMP	2
3	Brosur	3
4	Sosialisasi	4
5	Instagram	5
6	Rontek	6
7	Baliho	7
8	Alumni	8

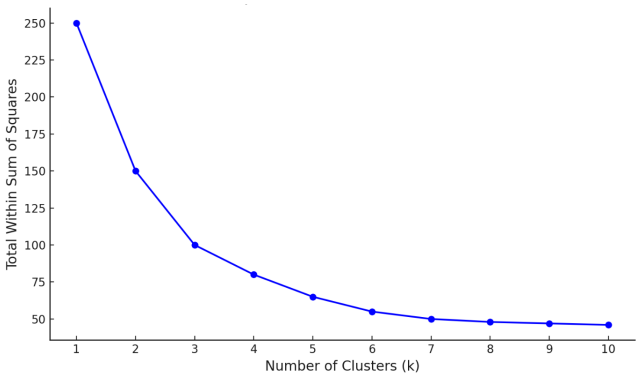

Fig. 2 Visualization of determining the number of clusters

Table 4 Data

Data	x	y
1	1	2
2	1	3
3	1	4
4	1	5
5	1	8
6	1	7
7	1	1
:	:	:
39	4	8
40	4	8

formed at k = 3 and after that in a stable decline. Clustering calculation. The initial process in k-means is determining the number of clusters and determining the centroid or distance of the data center to determine the position of the data. The centroid determination process is taken randomly from the data, see on Table 4.

The centroid value will be collaborated with the data variable value for the K-means calculation as follows: K-means calculation using the Euclidean distance formula:

Data-1$(1, 2)$

Clustering 1 : $\sqrt{(1-4)^2 + (2-1)^2} = 3.162$

Clustering 2 : $\sqrt{(1-2)^2 + (2-4)^2} = 2.236$

Clustering 3 : $\sqrt{(1-3)^2 + (2-2)^2} = 2$

Calculation of the distance of the 1st data (1,2) in Table 5 with each centroid obtained clustering results 3 has the smallest value and it is from this smallest value that is used as the basis for determining the location of the data grouping. This calculation applies to all

Table 5 Initial Centroid Values

Cluster	Region	Resources
C1	4	1
C2	2	4
C3	3	2

Table 6 K-means calculation

Data	x	y	C1	C2	C3	Clustering
1	1	2	3.162	2.236	2	3
2	1	3	3.605	1.414	2.236	2
3	1	4	4.242	1	2.828	2
4	1	5	5	1.414	3.605	2
5	1	8	7.615	4.123	6.324	2
6	1	7	6.708	3.162	5.385	2
7	1	1	3	3.162	2.236	3
:	:	:	:	:	:	:
39	4	8	7	4.472	6.082	2
40	4	8	7	4.472	6.082	2

Table 7 Clustering Results

Data	x	y	Start	The iteration						
				1	2	3	4	5	6	7
1	1	2	3	3	3	3	3	1	1	1
2	1	3	2	3	3	3	3	3	3	3
3	1	4	2	2	3	3	3	3	3	3
4	1	5	2	2	2	2	2	3	3	3
5	1	8	2	2	2	2	2	2	2	2
6	1	7	2	2	2	2	2	2	2	2
7	1	1	3	3	3	3	1	1	1	1
:	:	:	:	:	:	:	:	:	:	:
39	4	8	2	2	2	2	2	2	2	2
40	4	8	2	2	2	2	2	2	2	2

data that we use in the study.

Data-2(1, 3)

$$\text{Clustering 1} : \sqrt{(1-4)^2 + (3-1)^2} = 3.605$$

$$\text{Clustering 2} : \sqrt{(1-2)^2 + (3-4)^2} = 1.414$$

$$\text{Clustering 3} : \sqrt{(1-3)^2 + (3-2)^2} = 2.236$$

Data-3(1, 4)

$$\text{Clustering 1} : \sqrt{(1-4)^2 + (4-1)^2} = 4.242$$

$$\text{Clustering 2} : \sqrt{(1-2)^2 + (4-4)^2} = 1$$

$$\text{Clustering 3} : \sqrt{(1-3)^2 + (4-2)^2} = 2.828$$

The clustering process using k-means in the first stage will find the location of the data in a particular cluster. To ensure the location of the cluster, after the first calculation, a recalculation will be carried out by applying the Euclidean distance formula again so that the location of the cluster will not change, see Table 7.

The results of this clustering can be visualized in the form of a Scatter Plot diagram as follows on Figure 3:

4.2 Simple Additive Weighting. DSS method that uses the concept of finding a weighted sum of the performance value rankings on an alternative from all attributes. The SAW method requires a decision matrix normalization process so that it can be compared with all available alternative rankings (Table 8).

The decision support system process using SAW begins by entering data from each promotional media, then looking for alternative

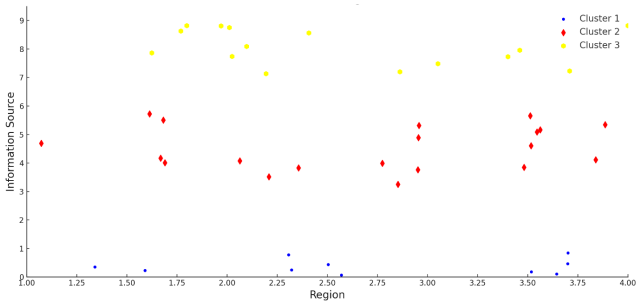

Fig. 3 Clustering Visualization Results

promotional service providers and determining the criteria that can be included in the benefits and costs. In determining the criteria, we can weight each of these criteria, the total weight of the criteria is 1. The calculation of SAW for promotional media is by applying the formula (7):

$$R_{ij} = \begin{cases} \dfrac{X_{ij}}{\max\limits_{i} X_{ij}} & \text{if } j \text{ is a profit attribute (benefit)} \\ \dfrac{\min\limits_{i} X_{ij}}{X_{ij}} & \text{if } j \text{ is a cost attribute (cost)} \end{cases} \quad (7)$$

R_{ij} : Normalized performance rating value
$Max\ X_{ij}$: The largest value of each performance
$Min\ X_{ij}$: The smallest value of each performance
X_{ij} : The attribute value owned by each Criteria

The prioritized value for each alternative choice given is (Formula (8))

$$V_i = \sum_{i=1}^{n} W_j r_{ij} \quad (8)$$

V_{ij} : rank of each alternative
W_j : weight value of each criterion
r_{ij} : normalized performance order value

In the process of determining alternative choices, if the V_i value is greater, it indicates that the alternative will be selected.

The application of SAW calculations to data to determine alternatives for decision making can be done as follows: SMK Dirgantara Putra Bangsa uses 5 brochure making service providers (Table 9)that offer prices and color choices as listed in table9 regarding data on brochure making service providers.

The SAW method begins with determining alternative choices and then determining the criteria that will be used as a basis for making decisions, these criteria are included in the cost if it offers a low cost or benefit if it offers the most color choices. The weighting of the cost and benefit criteria if totaled will contain a value of 1 so that the weighting for the cost criteria is 0.5 and the color choice is 0.5. Implementation of decision making for selecting a brochure making service provider by applying the SAW method, namely

Service 1

$$Normalization :$$

$$\text{Cost} : \frac{200}{200} = 1$$

$$\text{Benefit} : \frac{1}{3} = 0.333$$

$$AlternativeValue :$$

$$V_i = (1 * 0.5) + (0.33 * 0.5)$$

$$= 0.5 + 0.167 = 0.667$$

Table 8 Promotional Media Data and Alternatives

No	Promotion Media	Alternative	Benefit	Cost
1	Brosur	Vendor 1-5	Warna	Harga
2	Pamflet	Vendor 1-5	Warna	Harga
3	Direct mail	-	-	Harga
4	Sosialisasi SMP	-	-	Harga
5	Guru BK	-	-	Harga
6	Sosial media Sekolah	Instagram, youtube,web sekolah		Harga
7	Rontek	Vendor 1-5	Durasi	Harga
8	Baliho	Vendor 1-5	Durasi	Harga
9	Running text	Chanel TV 1-5	Durasi	Harga
10	Berita televisi	Chanel TV 1-5	Durasi	Harga
11	Berita media cetak	Koran 1-5	Luasan tampilan	Harga
12	Talk show	Chanel tv/radio	durasi	Harga
13	Iklan di radio	Chanel radio	durasi	Harga

Table 9 Data on brochure making service providers.

Alternative	Cost	Color
	Cost	Benefit
Jasa 1	200	1
Jasa 2	300	3
Jasa 3	1500	3
Jasa 4	300	2
Jasa 5	400	3

This matrix normalization process is used to determine alternative criteria to enter the cost or benefit value. Alternative criteria will become cost if the cost or value is smaller then it will provide a benefit and vice versa if the criteria become benefit then if the value or benefit increases then the benefit value will be good. The benefit value is obtained from the data benefit value divided by the maximum benefit value offered while the cost is obtained from the minimum criterion value divided by the criterion value. After determining the benefit and cost values, the next step is to determine the value of the alternative from each service provider which will later be compared to be used as a basis for determining decision making. The alternative value is obtained from the result of multiplying the benefit value multiplied by the criteria weight added to the cost value multiplied by the criteria weight.

Service 2

$$Normalization:$$

$$\text{Cost}: \frac{200}{300} = 0.667$$

$$\text{Benefit}: \frac{3}{3} = 1$$

$$AlternativeValue:$$

$$V_i = (0.667 * 0.5) + (1 * 0.5)$$

$$= 0.333 + 0.5 = 0.833$$

Service 3

$$Normalization:$$

$$\text{Cost}: \frac{200}{1500} = 0.133$$

$$\text{Benefit}: \frac{3}{3} = 1$$

$$AlternativeValue:$$

$$V_i = (0.133 * 0.5) + (1 * 0.5)$$

$$= 0.067 + 0.5 = 0.567$$

Service 4

$$Normalization:$$

$$\text{Cost}: \frac{200}{300} = 0.667$$

$$\text{Benefit}: \frac{2}{3} = 0.667$$

$$AlternativeValue:$$

$$V_i = (0.667 * 0.5) + (0.667 * 0.5)$$

$$= 0.333 + 0.333 = 0.667$$

Service 5

$$Normalization:$$

$$\text{Cost}: \frac{200}{400} = 0.5$$

$$\text{Benefit}: \frac{3}{3} = 1$$

$$AlternativeValue:$$

$$V_i = (0.5 * 0.5) + (1 * 0.5)$$

$$= 0.25 + 0.5 = 0.75$$

From the results of the DSS SAW calculation on promotional media brochures from 5 service providers with cost criteria as cost and color as benefit, the results obtained were that the 2nd vendor provided a profitable offer at a price of 300 per sheet to be printed in 3 colors (Figure 4). For the decision-making process for other promotional media, calculations can be carried out as in the calculations for the type of brochure to get the best alternative with a good price and profit offer.

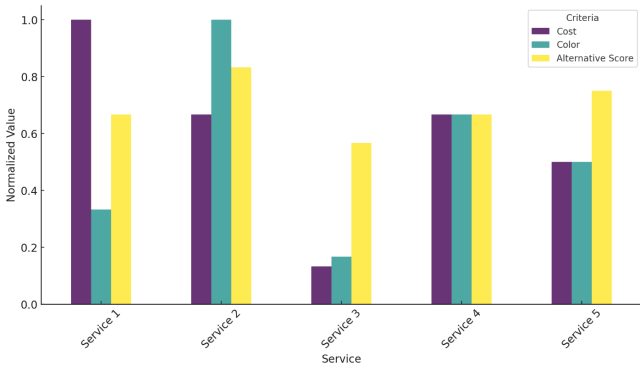

Fig. 4 Normalization and Ranking of Brochure Making

5 Conclusion

From the results of the implementation of business intelligence to determine the promotional media for PPSD SMK Dirgantara Putra Bangsa, it can be concluded that the k-means algorithm can be used to group data with the same characteristics so that it can provide input on the form of promotional media that has the same character and for decision making in determining the promotional media for PPDB SMK Dirgantara Putra Bangsa, the Simple additive weighting (SAW) method can be used which provides alternative choices with advantages for each promotional media.

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