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Clustering of Lecturer Performance Using K-Means

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Abstract

A lecturer is a professional educator and a scientist whose main task is to transform knowledge, develop knowledge and disseminate knowledge, technology and art through education, research, namely compiling scientific work and community service, and teaching staff or lecturers play an important role in educating the nation's generation. Therefore, lecturers must have high integrity in the world of education. The higher a lecturer's academic position, the more certain the lecturer has carried out research, community service and a number of scientific outputs or publications. In this way, lecturers are considered to have extensive knowledge. The data taken is secondary data from the Community Service Research Institute, UPT Academic Positions and Lecturer Certification and UPT Publications. The method used in this research is non-hierarchical with the k-means method. Cluster 1 has the most members, namely 26 lecturers, cluster 2 has 6 lecturers and cluster 3 has 20 lecturers. Based on this grouping, universities need to pay attention to the productivity of lecturers in fulfilling the tri dharma of higher education because in cluster 1 the majority of members in cluster 1 lack productivity in fulfilling the tri dharma of higher education so it is hoped that in the future universities will have lecturers with academic, research, community service and publication positions. better scientific work.

Keywords: Clustering, Lecturer Performance, K-Means

INTRODUCTION

Lecturers are professional educators and scientists with the main task of transforming knowledge, developing knowledge and disseminating science, technology and art through education, research, namely compiling scientific work and community service (*"Kamus Hukum Indonesia," Dosen Menurut PP No. 14 Tahun 2021.*, n.d.) lecturers play an important role in the world of education with the main goal being to educate the nation's next generation, with professional teaching staff in their knowledge, the teaching and learning process in higher education will be able to achieve an intelligent generation of the nation.

In this case, lecturers are required to have academic qualifications, competencies, educational certificates, be physically and spiritually healthy and meet other qualifications which are supporting requirements for the creation of professional lecturers (*UU 14-2005 Guru Dan Dosen*, n.d.). In creating quality education, lecturers are also required to carry out the tri dharma of higher education, including education and teaching, research, community service and supporting elements. Apart from that, lecturers are very important in assessing study program accreditation and higher education accreditation. Universities or study programs that have lecturers with functional position qualifications will give grades according to the number of lecturer functional position qualifications in the university (*Dunia Dosen, "Jabatan Akademik Dosen Berpengaruh Pada Nilai Akreditasi Program Studi.,"* n.d.).

Apart from that, in higher education lecturers are required to have a functional position as low as an expert assistant (*PANGKAT DAN JABATAN AK Dosen Oktober 2019 (1)*, n.d.), functional positions or what are called academic positions are regulated in Minister of Education and Culture Regulation Number 92 of 2014 (*Permendikbud92-2014JafungDosen*, n.d.). The academic position of lecturer is a position that indicates the duties, responsibilities, authority and rights of a lecturer in a higher education unit whose implementation is based on certain skills and is independent, therefore to become a professional teaching staff and have scientific work published in journals so that can increase lecturers' insight and provide up-to-date knowledge. In monitoring teaching staff in a tertiary institution, there needs to be data on lecturers who do not yet have a functional position or academic position as a lecturer, therefore it is necessary to group together lecturers who do not yet have a functional position and lecturers who already have a position functional by creating groupings or clusters it can help lecturers resolve obstacles in the progress of applying for functional positions. In this grouping, the k-means algorithm is used for use in data mining. This algorithm is included in the non-hierarchical method which begins by first determining the desired number of clusters, then the clustering process is carried out. The term k-means was proposed by James McQueen in 1967

(Nico Ardimas Putra, n.d.). This algorithm was first used and introduced by Stuart Lloyd in 1957 as the pulse code modulation technique. The k-means algorithm is a partition-based cluster analysis method (Vora, 2013). The k-means working system is a method that can be used to partition objects into groups based on the closeness of the characteristics of each data, so that objects that have the same characteristics are grouped in one cluster and objects that have different characteristics will be grouped into different clusters. others (R.A Jhonson, 2007).
Research that uses this algorithm to group lecturer data based on data on lecturers who have functional positions, research and community service. Data was obtained from the Institute for Research and Community Service, Institute Technology and Business of Widya Gama Lumajang.

METHOD

The data obtained as the basis for data processing from this research is secondary data obtained from the Community Service Research Institute, Widya Gama Lumajang Institute of Technology and Business, which consists of the number of research studies and the number of community service services in 2022 - 2023, then data on lecturer academic positions was obtained. from the UPT Academic Positions and Lecturer Certification of the Widya Gama Lumajang Institute of Technology and Business, and data on the number of publications of scientific articles during 2022 – 2023 obtained from the UPT Publications of the Widya Gama Lumajang Institute of Technology and Business.

K-means will work by grouping objects or data into several desired groups, where one object is similar to other objects (Fitri et al., 2023), the k-means algorithm will continue to work with the same pattern by grouping data that is similar to other data according to groups determined into several parts. K-means will try to group lecturers with the criteria of having an academic position, conducting research in the last 2 years, doing community service in the last 2 years, having a number of publications in the last 2 years, with these criteria k-means will form clusters (Sartika & Jumadi, 2019) by producing members whose characteristics are similar to each other. In this research, the method used to group is non-hierarchical.

Non-hierarchical methods are approach methods used in various contexts such as grouping that do not rely on layered structures or hierarchies. In general, non-hierarchical methods emphasize dividing or grouping data or objects according to the characteristics of these objects (R.A Jhonson, 2007). The advantage of the k-means method is that it is very efficient for use in large amounts of data, the weakness of the k-means method is that the number or number of clusters can be determined in advance by the researcher.

The k-means algorithm is a method used in data clustering (unsupervised learning) which works to divide a number of data into groups or what are called clusters which are mutually exclusive based on the similarity or closeness of the values which are based on these features. In general, this algorithm tries to minimize the distance between points and the center of the object or what is called the centroid. The way k-means works starts by first randomly selecting k objects within D or centroids which initially represent the average or cluster center. For the remaining objects, a new cluster will be formed for each object according to the similarity of the object's character based on the distance between the object and the cluster average. Then k-means iteratively increases the variance into clusters. each cluster, will be calculated using the objects assigned to the cluster in the previous iteration (*Data Mining*, n.d.). This iteration is carried out continuously until it is stable, and the clusters formed at this time are the same as the previous process.

Pada penelitian ini menggunakan analisis kluster yang merupakan metode untuk mengolah data dan bertujuan untuk mengelompokkan berbagai objek-objek berdasarkan kemiripan karakteristik objek-objek tersebut. Sp
Algoritma k-means bekerja dengan tahap sebagai berikut:

1. Input
   k : Number of clusters
   D : Collection of (n) objects
2. Determine the number of clusters k
3. Determine the initial position of the centroid for each cluster randomly
4. Assign each data point to a cluster based on the distance closest to the centroid
5. Recalculate the newly formed centroid
6. Repeat this iteration until you get a stable value

Calculating the distance between objects in the centroid continues by inserting objects into clusters based on their closest distance to the centroid. In this case, generally calculate the distance with the following equation:

$$dist = \sqrt{\sum_{j=1}^{k} \sum_{i=c_j} (x_i - z_j)^2}$$

Where, cj is the jth cluster and zj is the centroid of cluster cj and xi is the object value (Eliyanto & Surono, 2022).

RESULTS AND DISCUSSION

In cluster analysis using the no-hierarchy method with k-means as the method. Researchers can determine the number of clusters as many as 3 clusters, therefore cluster analysis uses the k-means method with k divided by 3 clusters. The results of cluster analysis using the k-means method are as follows:

Table 1. Initial Cluster Center

Initial Cluster Centers

	Cluster		
	1	2	3
Jabatan Akademik	0	2	1
Penelitian	0	2	2
Pengabdian Kepada Masyarakat	0	3	1
Jumlah Publikasi	0	20	10

Source: Processed data (2024)

The results of table 1 describe information about the selected initial cluster center. This process requires multiple iterations of 5 iterations to get 3 clusters. The results can be seen in the table below.

Table 2. Iteration History

Iteration History[a]

	Change in Cluster Centers		
Iteration	1	2	3
1	2.164	2.920	1.071
2	.707	.000	.682
3	.651	.000	.752
4	.168	.000	.219
5	.000	.000	.000

Source: Processed data (2024)

In table 2 it can be seen that in getting 3 clusters, the k-means method carried out an iteration process 5 times. This process produces the results of the closest distance between objects as follows.

Table 3. Distance Between Final Cluster Centers

Distances between Final Cluster Centers

Cluster	1	2	3
1		14.015	7.655
2	14.015		6.370
3	7.655	6.370	

Source: Processed data (2024)

In table 3 you can see the final results of distance calculations in determining clusters from centroids. From the results of k-means, all variables used have a significant effect.

Tabel 4. Anova

ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Jabatan Akademik	4.002	2	.322	47	12.442	.000
Penelitian	6.671	2	.354	47	18.821	.000
Pengabdian Kepada Masyarakat	7.519	2	.380	47	19.808	.000
Jumlah Publikasi	594.642	2	4.313	47	137.868	.000

Source: Processed data (2024)

Table 4 Anova shows that the clustering results for all variables are still below the significant fair value of 0.05, indicating that all variables (Academic Position, Research, Community Service, Number of Publications) have a significant effect on grouping.

Table 5 Observations for Each Cluster

Cases in each Cluster

Cluster	1	24.000
	2	6.000
	3	20.000
Valid		50.000
Missing		.000

Source: Processed data (2024)

In table 5 you can see the clustering process using the k-means method, this clustering system is able to work optimally so that 50 data are read as valid while the missing error from the process is 0.00.

CONCLUSION

From the research results, it was found that the clustering of lecturers based on academic position, research and number of publications at the Widya Gama Lumajang Institute of Technology and Business College in 2022-2023 was divided into 3 clusters. Cluster 1 has at most 24 members, with an average of academic positions, teaching staff, expert assistants, conducting research on average once in the last 2 years, carrying out community service once in the last 2 years, and having an average number of publications. 3 to 7 articles in the last 2 years, in cluster 2 there are 6 members, namely the lowest position is expert assistant to associate professor, conducted research 2 to 3 times in the last 2 years, carried out community service 2 to 3 times in the last 2 years, and has the lowest number of publications of 15 articles and the maximum of 20 articles, while cluster 3 has the second largest number of members with 20 people who on average have academic positions, the lowest being expert assistant and the highest being lecturer, conducted research 1 to 2 times in the last 2 years, carried out community service 1 to 2 times in the last 2 years and had a minimum number of publications of 6 articles to 13 articles in the last 2 years. In this grouping or cluster, hierarchical methods such as simple linkage, complete linkage and others can also be used and the level of accuracy produced between hierarchical and non-hierarchical methods can be compared.

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