K-Means Analysis in Sharia Banking Intellectual Capital

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ABSTRACT

Purpose: This research aims to assess the need to manage and increase Intellectual Capital efficiently in the context of Sharia BPR.

Methodology: Using secondary data to categorize BPR Sharia banks in East Java Province based on the level of the intellectual model using the K-Means method.

Findings: The k-means method with a two-group configuration is the best approach for clustering. The second group has a high amount of Intellectual Capital, while the first group has a low amount of Intellectual Capital. Managing Intellectual Capital to increase added value for the company is a challenge for 10 Sharia BPRs in East Java Province.

Research limitations/implications: Data collection is limited to 2022 and focuses on 10 Sharia BPRs in East Java Province, which can provide a limited picture of the dynamics of change over a longer period or at the national level.

Practical implications: The results of clustering BPR Syariah using the K-Menas method provide a basis for practitioners to group BPR Syariah based on the level of intellectual capital so as to help banks identify intellectual capital management and use this information to design more targeted strategies.

Originality/value: This research involves the application of the K-Means technique in classifying intellectual capital in the context of sharia banking so as to provide more accurate and structured insight into the potential and utilization of intellectual capital in the context of sharia finance.

Paper type: Research paper

Keyword: *Sharia BPR, Intellectual Capital, Clustering, K-Means*

I. INTRODUCTION

The presence of intellectual capital can be explained by Resource-Based Theory (RBT), which centers on organizational resources that produce value and are managed strategically to gain competitive advantage, which ultimately influences company performance. Armstrong & Shimizu (2007) asserts that resource-based theory argues that to achieve lasting competitive advantage, organizations must possess specialized resources that have qualities that are valuable, rare, difficult to imitate, and challenging to replace. Resource-based theories largely emphasize the internal dynamics of an organization, namely the resources it has, to formulate strategies that create value and lead to competitive advantage. According to (Wernerfelt, 1984; Barney, 1991) Resource-based theory asserts that intangible assets play an important role in maintaining competitive advantage. Resource-based theory posits that businesses' economic activities are sequential processes in which value is generated based on their capacity to define and organize input variables (resources), execute them with efficiency, and deliver desired outcomes (Galabova and Ahonen, 2011). Therefore, companies, like the research banks in this study, are required to formulate powerful and proficient strategies to generate value, which will give them a competitive advantage. These strategies should be based on the resources they have and the competencies they have to utilize those resources effectively. Resource-based theory highlights the need to utilize a company's internal resources, including tangible physical assets and intangible assets that have been internalized and successfully utilized, to

achieve competitive and profitable activities. Therefore, it is important for organizations to position themselves strategically according to their resources and capabilities, rather than just focusing on the goods and services that come from those capabilities(Galabova and Ahonen, 2011; Kamaluddin and Rahman, 2013). In a corporate climate that changes rapidly and relies on information, it cannot be denied that intellectual capital (IC) plays an important role in providing competitive advantages for companies, especially banks. IC, as a valuable resource, is closely related to the ability to innovate in the creation of products, processes and practices. Resource-based theory considers intellectual capital (IC) as a strategic resource because of the competitive advantage a company gains by using it efficiently (Ousama, Hammami and Abdulkarim, 2020).

Recognition of the importance of IC in a company's performance and competitiveness brings with it the need to manage it effectively. Identifying and assessing IC is a challenge in successful management (Chang and Hsieh, 2011). In this case, companies definitely need a certain methodology to determine and measure IC use. One of these methodologies, developed by Pulic (2000) is the value added (VA) intellectual coefficient (VAIC). The VAIC method, as described by Shiu is a standard and easy-to-use approach to measuring IC efficiency that is based on logical principles. Measuring the efficiency of a company's value creation is facilitated by utilizing financial data taken from financial reports. This approach allows comparison of companies with each other, as highlighted by (Maditinos et al., 2011). The VAIC technique emphasizes the quantification of added value (VA) generated by the capital used (CE) and intellectual capital (IC) owned by the organization (Pulic, 2008).

According to Bontis, Janošević & Dženopoljac (2015) it can be said that banks, especially Islamic banks (IB), can be classified as knowledge-intensive organizations. This classification is based on the fact that their main resources consist of intangible assets, and their operations largely depend on the utilization of intellectual capital (IC). Banks rely heavily on the use of information technology to facilitate the creation and provision of products and services. Additionally, they rely on human resources to develop complex products and maintain close relationships with clients. According to Ahuja & Ahuja (2012) successful bank performance in a competitive landscape depends on the effective allocation and deployment of intellectual capital (IC), which includes several elements such as human resources, integrated information technology, brand image and business processes.

Multivariate cluster analysis groups objects with comparable features. Clusters contain significant object similarity but low object characteristic similarity (Sreejesh, Mohapatra and Anusree, 2014). K-means sorts data into groups without a hierarchical structure. Other K-means investigations include Wisna, Rani and Kastaman (2023) who found that 3 clusters were best. Sharma, Sharma & Sharma (2016) Organizations large and small prioritize culture, engagement, leadership, and development. Because both studies used one cluster and did not test clustering results, the best cluster was not found. Then a study finds the best cluster and tests the grouping results. Therefore, this study uses K-means to determine the best group and test the results. In addition, this research classifies Sharia BPRs in East Java Province using 2022 data.

II. METHODS

Secondary data was used in this research. The data used is 13 Sharia BPRs in East Java Province in 2022. The grouping of Sharia BPRs based on Intellectual Capital includes Human Capital, Structural Capital and Employed Capital.

Cluster analysis groups objects that have similar properties using multivariate analysis. Objects in a cluster have significant similarities, while the characteristics of objects between groups are low. K-means is the most widely used non-hierarchical clustering approach Johnson, Wichern & others (2002) The algorithm or steps of the K-means method are as follows:
1. Determine the number of groups to be formed (amount k).
2. Randomly assign data to group k.
3. Determine the average centroid value for each group.
4. Using Euclidean distance, group each data set to the nearest centroid.
5. If there is still data transfer from one group to another, return to step 3 (Agusta, 2007).

The ideal number of groups is determined using pseudo F statistics Orpin & Kostylev (2006). The multivariate normal test can be carried out using the correlation coefficient test. The homogeneity test is used to determine whether the variance covariance matrix is homogeneous or not. One-way MANOVA compares the means of two or more populations with several dependent variables or tests the effect of a treatment on a response (Johnson, Wichern & others, 2002). Wilk's Lambda is a One-Way MANOVA if the tests of normality and multivariate homogeneity are met. If the normal and multivariate homogeneity tests fail, Pillai's Trace will be used. One-way MANOVA is sometimes used to evaluate group differences with a single dependent variable or between group members (Johnson, Wichern & others, 2002).

III. RESULTS AND DISCUSSION

Grouping Sharia BPRs based on Intellectual Capital using k-means in 2022. This research will use 13 Sharia BPRs which are divided into several groups. Grouping uses two groupings. Table 1 shows the grouping results for each group.

Table 1 Sharia BPR Grouping Results

Cluster	Number of Members
1	10
2	3

Source : Processed Data, 2023

Of the 13 Sharia BPRs in East Java Province, 2 clusters were formed where cluster 1 had 10 Sharia BPR members, while cluster 2 had 3 Sharia BPR members. This shows that the majority of Sharia BPRs in East Java Province have characteristics similar to those of cluster 1.

Table 2 shows the members of each group. In grouping Sharia BPRs based on Intellectual Capital, including Human Capital, Structural Capital and Employed Capital using the k-means method, it is hoped that there will be differences in the characteristics of each group in all Intellectual Capital factors.

Table 2 Clustering Results

Cluster	Name of Sharia BPR
1	PT BPRS Mandiri Mitra Sukses
	PT BPRS Artha Pamenang
	PT BPRS Madinah
	PT BPRS Syariah Magetan
	PT BPRS Al Mabrur Babadan
	PT BPRS Bakti Artha Sejahtera Sampang
	PT BPRS Annisa Mukti
	PT BPRS Baktimakmur Indah
	PT BPRS Situbondo
	PT BPRS Mitra Harmoni Kota Malang
2	PT BPRS Lantabur Tebuireng
	PT BPRS Sarana Prima Mandiri

PT BPRS Tanmiya Artha

Source : Processed Data, 2023

One-way ANOVA tests group differences in variables. Following are the findings of a one-way ANOVA.

Table 3. One-Way ANOVA Test Results

Variabel	F	Sig
HCE	16,356	0,002
SCE	14,782	0,003
CEE	1,688	0,220

Source : Processed Data, 2023

Table 3 shows the F value of each variable. This value will be compared with 3.86 F3;9;0.05. Compared with F3;9;0.05, the HCE and SCE variables have a larger F value, thereby rejecting H0. This means that the two variables have different influences on group formation. Because Sharia BPR uses more human resources and capital structure than the capital used. Employees create value, therefore they are not a burden. The operational activity system, corporate culture and intellectual property owned by BPR Syariah in East Java Province have provided value for improving the management and quality of structural capital. The CEE variable has a greater F value, so H0 is accepted, meaning that the two CEE variables have no effect on group formation because the characteristics are the same. Because Islamic BPR capital was underutilized during this research period, they may have used human capital rather than physical capital.

Table 4. One-Way MANOVA Test Results

Nilai Pillai's Trace	Sig.
0,780	0,003

Source : Processed Data, 2023

Table 4 shows that Pillai's Trace sig value is 0.003 which represents a significant value below 0.05 (sig<5%), indicating group differences and rejecting H0.

Table 5. Cluster Average

	Cluster	
	1	2
HCE	-0.40691	1.35635
SCE	-0.39847	1.32822
CEE	-0.19194	0.63979

Source : Processed Data, 2023

Table 5 shows that the HCE, SCE and CEE variables of cluster 1 are negative and have the lowest average value, while cluster 2 has the largest average value. In cluster 1, 10 Sharia BPRS have low Human Capital, Structur

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Capital and Employed Capital: PT BPRS Mandiri Mitra Sukses, Artha Pamenang, Madinah, Syariah Magetan, Al Mabrur Babadan, Bakti Artha Sejahtera Sampang, Annisa Mukti, Baktimakmur Indah, Situbondo, and Mitra Harmoni Malang. The first cluster shows that 10 Sharia BPRs in East Java failed to manage Intellectual Capital to increase company value. The second cluster shows that the 3 Sharia BPRS in East Java Province have been efficient in managing Intellectual Capital to increase company value.

IV. CONCLUSION

The first cluster of 10 Sharia BPRS with low Human Capital, Structural Capital, and Employed Capital is PT BPRS Mandiri Mitra Sukses, Artha Pamenang, Madinah, Syariah Magetan, Al Mabrur Babadan, Bakti Artha Sejahtera Sampang, Annisa Mukti, Baktimakmur Indah, and Group 1 has poor Human Capital, Structural Capital and Employed Capital, therefore all factors must be improved. This research has limitations in that data collection is limited to 2022 and focuses on 10 Sharia BPRs in East Java Province so that it provides a limited picture of the dynamics of change over a longer period or at the national level. Future research can use fuzzy c-means and other regional clustering approaches. Apart from that, the right approach must be chosen so that the clustering results can be used to take the right policies.

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REFERENCES

Agusta, Y. (2007) 'K-means--penerapan, permasalahan dan metode terkait', *Jurnal Sistem dan informatika*, 3(1), pp. 47–60.

Ahuja, B. R. and Ahuja, N. L. (2012) 'Intellectual capital approach to performance evaluation: a case study of the banking sector in India', *International Research Journal of Finance and Economics*, 93(1), pp. 110–122.

Armstrong, C. E. and Shimizu, K. (2007) 'A review of approaches to empirical research on the resource-based view of the firm', *Journal of management*, 33(6), pp. 959–986.

Barney, J. (1991) 'Firm Resources and Sustained Competitive Advantage', *Journal of Management*, 17(1), pp. 99–120. doi: 10.1177/014920639101700108.

Bontis, N., Janošević, S. and Dženopoljac, V. (2015) 'Intellectual capital in Serbia's hotel industry', *International Journal of Contemporary Hospitality Management*, 27(6), pp. 1365–1384.

Chang, W. S. and Hsieh, J. J. (2011) 'Intellectual capital and value creation-is innovation capital a missing link?', *International Journal of Business and Management*, 6(2), p. 3.

Galabova, L. and Ahonen, G. (2011) 'Is intellectual capital-based strategy market-based or resource-based? On sustainable strategy in a knowledge-based economy', *Journal of Human Resource Costing \& Accounting*, 15(4), pp. 313–327.

Johnson, R. A., Wichern, D. W. and others (2002) 'Applied multivariate statistical analysis'.

Kamaluddin, A. and Rahman, R. A. (2013) 'The intellectual capital model: the resource-based theory application', *International Journal of Learning and Intellectual Capital*, 10(3–4), pp. 294–313.

Maditinos, D. *et al.* (2011) 'The impact of intellectual capital on firms' market value and financial performance', *Journal of intellectual capital*, 12(1), pp. 132–151.

Orpin, A. R. and Kostylev, V. E. (2006) 'Towards a statistically valid method of textural sea floor characterization of benthic habitats', *Marine Geology*, 225(1–4), pp. 209–222.

Ousama, A. A., Hammami, H. and Abdulkarim, M. (2020) 'The association between intellectual capital and financial performance in the Islamic banking industry: An analysis of the GCC banks', *International Journal of Islamic and Middle Eastern Finance and Management*, 13(1), pp. 75–93.

Pulic, A. (2000) 'MVA and VAIC^{TM} Analysis of Randomly Selected Companies from FTSE 250', *Austrian Intellectual Capital Research Center, Graz–London.*

Pulic, A. (2008) 'The principles of intellectual capital efficiency-A brief description', *Croatian Intellectual Capital Center, Zagreb*, 76.

Sharma, G., Sharma, M. K. and Sharma, D. (2016) 'Analysis of K-means clustering for human capital trends', in *2016 International Conference on ICT in Business Industry \& Government (ICTBIG)*, pp. 1–4.

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Sreejesh, S., Mohapatra, S. and Anusree, M. R. (2014) 'Cluster Analysis', in *Business Research Methods: An Applied Orientation*. Cham: Springer International Publishing, pp. 229–244. doi: 10.1007/978-3-319-00539-3_10.

Wernerfelt, B. (1984) 'A resource-based view of the firm', *Strategic management journal*, 5(2), pp. 171–180.

Wisna, N., Rani, M. C. and Kastaman, K. (2023) 'Algoritma K-Means Clustering Analisis Rasio Aktivitas Menggunakan Python', *Ecobisma (Jurnal Ekonomi, Bisnis Dan Manajemen)*, 10(2), pp. 11–21.

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