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Efficiency Analysis in Islamic Merge Bank Branch Using Data Envelopment Analysis

Muhammad Dwipa A. Putra* and Ratih D. Kusumastuti

Faculty of Economic and Business, Universitas Indonesia, Indonesia

E-mail address: pintonap@gmail.com

Abstract - **The process of merging three participant banks into one large bank delivers some operational issues. This paper assessed the merger of Islamic Banks in Indonesia in terms of performance evaluation to seek the best optimization strategy. The research is conducted by evaluating the operational efficiency of 50 branches from the three participant banks prior to merger for last two years. The inputs are employee number, rent cost, and the number of tellers, while the outputs are amount of deposits, amount of financing, number of transactions, and number of customers. The performance is evaluated using data envelopment analysis (DEA) and Malmquist index as the performance benchmarking tools by measuring the technical, scale efficiency and total productivity change. The results show which participant bank has a better performance, indicate area of bank branches that need to be optimized, and give recommendation about the suitable branch model for the merged bank.**

Keywords - **data envelopment analysis, operational efficiency, Malmquist index, merger and acquisition, bank branch network**

I. INTRODUCTION

Bank is one of the entities that always evolve in terms of the emerging of technology that pushed the existence of the bank branch. The current situation changes the role of the bank to provide the customer with a variety of distribution channels of financial solution products and services. The current condition leads the bank to apply cost advantages to increase their profit [14]. For the large bank, branches are the dominant players that deliver the largest operational expenses which need to be controlled and evaluated to maintain the bank's competitiveness. However, bank branch performance is difficult to be assessed due to many variety aspects that are related to the bank performance [11]

Operational efficiency is one of the performance measures that is commonly determined by using various approaches such as ratios, indices, and regression analysis [13]. Data envelopment analysis (DEA) is one of the methods that is already used to measure efficiency in the bank industry. This approach is frontier-based model analysis, which predicts the performance of the firm in the similar operating condition and has the advantage to measure the efficiency in different and various variable simultaneously [13].

The use of DEA was established in 1978 by Charnes Chopper and Rhodes [4] based on the Farrel's work in 1957 [9] and developed the CCR model. Then, the BCC model was developed in 1984 by Banker [3]. The first research in banking industry was conducted in 1985 for the production model approach by Sherman [5]. Because of its capability of dealing with multiple output/input and also the flexibility without needing any specification of variable, this approach was applied and developed for many researches, not only the productivity model but also for profitability [10, 12, 13], intermediation [8, 13], services [7, 14] and also to make benchmarking evaluation at the branch level, domestic and across nation [2]. The use of DEA in banking industry is also extended to understand the impact of merger and acquisition. Sherman and Rupert [17] examined the benefit of merger by conducting cost saving analysis based on branch operating efficiency performance comparison in pre-merger and post-merger conditions. Paradi [12] examined the impact of culture differences on merged branch performance of the participant banks. Based on these literature review, we can infer that the usage of operational efficiency and pre-merger analysis in Islamic bank is still limited. Thus, this study will complete the gap by measuring the performance of participant bank's branch in Islamic bank based on operational efficiency prior to merger, to suggest recommendation for the future strategy in branch optimization. Today, there are many developments of DEA application which lead DEA into two stage analysis by combining DEA with other method such as regression analysis and Tobit, as well as using DEA and Malmquist simultaneously to analyze the efficiency over time [2]. Thus, this study try to capture

In this study, DEA is applied to measure the operational efficiency of the newly merged Islamic Banks in Indonesia. The merger results in the large number of branches from each participant bank. This condition requires the bank to determine the strategy to optimize the presence of branch in the future. Thus, this measurement is conducted to evaluate the performance of each branch that will be used as performance benchmarking among the participant banks at pre-merger, by applying an operational efficiency model based on Thanassoulis [14] and Paradi & Zhu [13] studies. Therefore, this study examines the operational efficiency by using BCC model, scale efficiency and Malmquist model to answer the research question about the branch efficiency, comparison of participant banks' performances, and the further strategy

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for the merged bank. The results of the study could be used as an additional reference for the operational efficiency model using DEA including the merger and acquisition in banking industry and also for helping the management to find a proper strategy in optimizing the branch performance after merger.

This paper is written in the following structure. Section 2 explains bank branch data source, efficiency model, and DEA parameters. Then, analysis and evaluation of the results are discussed to understand the problem and find the answer of the research question. On the last section, this study will deliver some conclusions and recommendations in terms of the optimization strategy for the merged bank.

II. METHODOLOGY

2.1. The flowchart of the research methodology

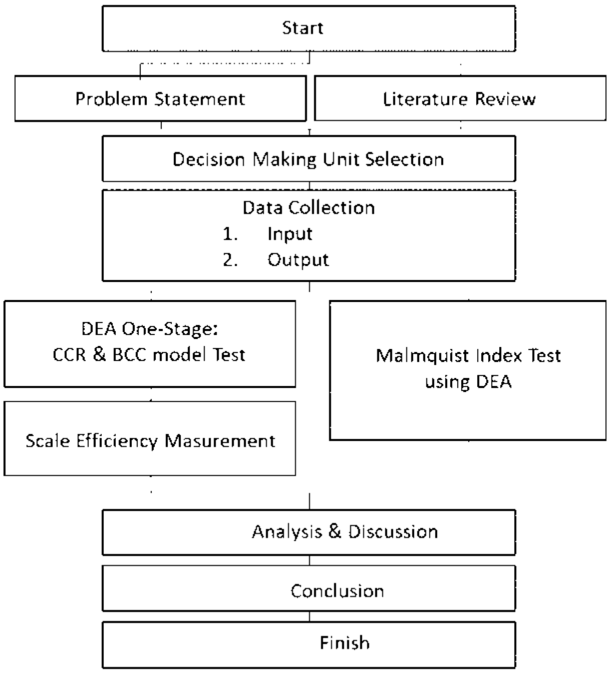

Fig. 1 Flowchart Methodology

Fig. 1 shows the flowchart of the research methodology. It starts with problem statement and literature review, followed by selecting the decision-making unit (DMU) as well as selecting the input and output and collecting the data. Next, the efficiency is analyzed by using data envelopment analysis and Malmquist index. Last, the results are analyzed, and recommendations are proposed.

2.2. Data Source – Decision Making Unit (DMU)

This study is conducted on the largest Indonesian Islamic Bank, Bank Syariah Indonesia, which was recently merged in February 2021. The merger came from three participant banks, namely, Bank A, Bank B, and Bank C, which total assets of around $17 Billion USD and the network of around 1.369 outlets across nation, consisting of 268 branches, 973 subbranches, and 128 other outlets (region, area and cash outlets). The bank currently provides various financial services which include personal, commercial, and corporate banking, such as deposits, mortgage, line of loans or financing, trade finance, wealth management, credit card, foreign exchange, treasury, and many more products. Because the bank is classified as Islamic bank, all the products comply with Islamic-based concept which has different approaches with the conventional one. For instance, all product revenues are based on profit sharing, margin or fees revenue model. The bank also offers both traditional channel (brick and mortar channel) and modern channel by providing many e-channel platforms such as mobile banking, internet banking, QR payments and many more.

The decision-making unit (DMU) is focused on the branches that are located in the capital area of Indonesia, which is around 50 branches in Jakarta, Bogor, Depok, Tangerang and Bekasi (Greater Jakarta), consisting of 29 Bank A branches, 9 Bank B branches, and 12 Bank C branches. The areas are chosen because most of the transactions and money are centered and pooled in these areas. The study is conducted in three participant banks in the period of 2019-2020, or two consecutive years prior to merger.

The process of merging three participant banks leads the bank to experience two different strategies in terms of branch optimization. The former three participant banks have applied two different branch models: (1) single outlet branch; (2) multi outlet branch. Single outlet branch means that the branch is independent and has no sub-branches under its control. In multi outlet branch, on the other hand, a branch supervises several sub-branches under its control. Thus, the main different from the branch model that is related to performance analysis is the amount of the resources to generate the business. Referring to the branch model, Bank A is classified as single outlet branch, while Bank B and Bank C are classified as multi outlet branch.

2.3. Operational Efficiency Model

The operational efficiency measures all the operating activities that generate value added operations, including sales [14]. Thanassoulis examined the number of staffs and rent expense as the input and many varieties of sales improvement, number of clients, deposits, and transactions as the output to measure the operational efficiency of Portuguese bank. Combining with Paradi [13] for the intermediary model, the input and output of this study is presented in TABLE 1.

TABLE 1.
OPERATIONAL EFFICIENCY MODEL

Input	Output
Number of employees	Third party fund (deposits)
Rent expense	Consumer financing
Number of tellers	Productive financing
	Number of customers
	Number of transactions

The study will examine the operational efficiency by considering the number of employees, amount of rent expense, and number of tellers as the input in generating third party funds, while consumer financing, productive financing, number of customers, and number of transactions are considered as the output.

2.4. DEA Model

One stage DEA using both CCR and BCC models are used for the current study to calculate the technical efficiency. These models are presented at first by Charnes for CCR and enhanced by Banker for the BCC model. The CCR model was original model that exhibited the constant return to scale (CRS) whereas the BCC was variable return to scale (VRS) production technology. The result from these CCR and BCC models were used to calculate the scale efficiency by determining the ratio of CCR efficiency to BCC efficiency. The input orientation model is chosen because the bank branches have different branch models which allowed different amount of resource to generate the business as output.

For the input orientation - BCC model is described with the following formulations by Cooper [1]:

$$\min_{\theta_B,\lambda} \quad \theta_B \tag{1}$$

$$subject\ to \quad \theta_B x_0 - X\lambda \geq 0 \tag{2}$$

$$Y\lambda \geq y_0 \tag{3}$$

$$e_n\lambda = 1 \tag{4}$$

$$\lambda \geq 0 \tag{5}$$

where $x_0$and y_0 are the column vector of input and output for DMU_0, X and Y are the matrices input and output for each DMUs, $\theta_B$is radial contraction factor input which be applied to DMU_0 , λ is the column vector of intensity variables denoting linear combination of DMU, $\mathrm{e_n}$ is the row vector of n where the sum of intensity variables, λ's, is equal to one (4).

2.5. Malmquist Index

DEA is often conducted to analyze the time series data of the same DMU on multi years period. Malmquist index is one of technique that accommodate window analysis which is combined with DEA in terms of efficiency change analysis over a period of time [6]. This technique measures the total factor productivity change of a DMU which requires determining its efficiency score for each time periods, relative to the frontiers for each of period. The following is the efficiency change base formula of input-oriented efficiency of the DMU in period *a* relative to the frontier in time *b* as $\theta_{a,b}$:

$$EC = \frac{\theta_{2,2}}{\theta_{1,1}} \tag{6}$$

the technology change (TC) component:

$$TC = \sqrt{\frac{\theta_{1,2}}{\theta_{2,2}} * \frac{\theta_{1,1}}{\theta_{2,1}}} \tag{7}$$

Malmquist Index equation:

$$MI = \sqrt{\frac{\theta_{1,2}}{\theta_{1,1}} * \frac{\theta_{2,2}}{\theta_{2,1}}} \tag{8}$$

III. RESULTS

3.1. Technical Efficiency from DEA

The measurement of efficiency for 50 branches results in TABLE 2, which shows the average of technical efficiency for period 2019 and 2020 with the CCR and BCC models. All efficiency scores for every model are higher in year 2020, compared to year 2019. Based on the average efficiency for each model, we could determine that there are 31 and 29 efficient branches for consecutives years for CCR model and 35 efficient branches for BCC model consecutively. Thus, CCR model shows decreasing number of efficient branches whereas BCC model shows the opposite. This inefficient branch is classified when the branch efficiency score is under the average score.

TABLE 2
AVERAGE TECHNICAL EFFICIENCY SCORES FROM DEA

	2019		2020	
	CCR	BCC	CCR	BCC
Average Efficiency	0.784	0.895	0.812	0.898
Efficient DMU	31	35	29	35
Inefficient DMU	19	15	21	15
% Efficient DMU	62%	70%	58%	70%

Based on the distribution map on Fig. 2, most of the branches are efficient and have efficiency scores of 1. The inefficient branches based on BCC distribution map are distributed dispersedly from 0.333 until the average of BCC scores. For instance, branch B005 has the smallest BCC scores 0.333 in 2019 and also 0.422 in 2020. The result shows that B005 is inefficient to optimize the input to generate the output. Based on the DEA, we could also see the slack result as the variable that could be more efficient or more optimized to improve the performance of the branch. For B005, based on slack result in 2019, it has to optimize the output such as increasing third party fund around 94Billion IDR, consumer loan around 55Billion IDR, productive loan around 27Billion IDR, 2,976 customers, and 17,323 transactions to make the branch efficient.

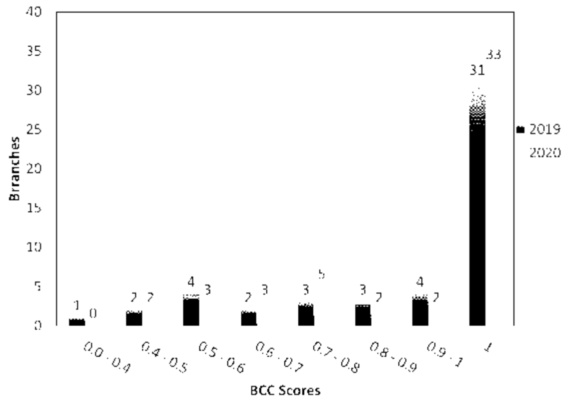

Fig. 2. Distribution map of technical efficiency score

3.2. *Participant Bank Efficiency Comparison*

Average efficiency for each participant bank is shown in the TABLE 3, where Bank A has the highest result compared to the others. The BCC efficiency result in period 2019 is 0.946 and in 2020 is 0.943 for Bank A. For the second position is Bank C which has BCC efficiency score 0.927 in 2019 and 0.892 in 2020. The lowest score was Bank B, which has 0.691 and 0.759 for consecutive years. Based on these results, we could see both Bank A and Bank C has decreasing performance in 2020 whereas the Bank B shows improvement at the same time.

TABLE 3
MERGER'S PARTICIPANT BANK COMPARISON

	2019		2020	
	CCR	BCC	CCR	BCC
Efficiency Bank A	0.859	0.946	0.862	0.943
Efficiency Bank B	0.498	0.691	0.624	0.759
Efficiency Bank C	0.818	0.927	0.833	0.892

Based on Fig. 3 we could see the distribution of efficient branch amount for each bank. This figure shows that Bank A had 79% branch that are classified as efficient for both consecutive years, Bank B had 33% efficient branch in 2019 and increased to 44% in 2020, and Bank C has 75% efficient branch in 2019 and decreased to 67%. These results also show that Bank A has a better performance in terms of number of efficient branches, and Bank B has the worst one.

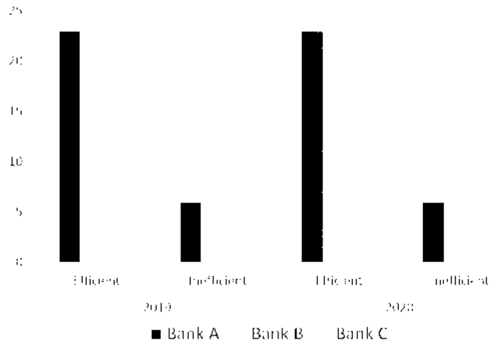

Fig. 3. Participant banks performance comparison

3.3. *Scale Efficiency from DEA*

Scale efficiency was calculated by divided CCR to BCC efficiency. This result show whether the branch is working in an optimal size. The following result from the scale efficiency lead the determining of return to scale characteristics; constant return to scale (CRS), increasing return to scale (IRS) or decreasing return to scale (DRS). Paradi, Tam, & Sherman [2] explain that there are several cases where the larger branch is less efficient than the smaller one, understanding the characteristic of return to scale that are expected to be increasing to scale will deliver some possibility that the larger branch is less efficient because the way it operates, not because of decreasing to scale or any scale affect.

The results of study on TABLE 4 show that the average scale efficiency of Indonesian Islamic merger bank has an increasing trend from 0.865 in 2019 to 0.900 in 2020, where Bank A has the best performance among the others. The increasing trend of scale efficiency also existed for all participant banks which means Bank A, Bank B and Bank C have larger scale efficiency scores in 2020. Based on the Fig. 4. Return to scale distribution mapwe could determine the characteristic of return to scale, where in 2019 for all branches, 30% CRS, 22% DRS, and 48% IRS, meanwhile in 2020, 36% CRS, 20% DRS, and 44% IRS. For Bank A in 2019, they had 38% CRS, 10% DRS, and 52% IRS, whereas in 2020, they had 45% CRS, 7% DRS, and 48% IRS; Bank B in 2019 they had 11% CRS, none DRS, and 52% IRS, meanwhile in 2020, they had 22% CRS, 0% DRS, and 78% DRS; for Bank C in 2019, they had 25% CRS, 67%DRS, and 8% IRS, meanwhile in 2020, they had 25% CRS, 67% DRS, and 8% IRS. Based on these results, each bank has different characteristics in term of the return to scale that will be elaborated further in the discussion.

TABLE 4
PARTICIPANT BANK COMPARISON RESULT

	2019			2020		
	CCR	BCC	Scale	CCR	BCC	Scale
Average efficiency	0.784	0.895	0.865	0.812	0.898	0.900

Bank A	0.859	0.946	0.909	0.862	0.943	0.915
Bank B	0.498	0.691	0.731	0.624	0.759	0.810
Bank C	0.818	0.927	0.857	0.833	0.892	0.929

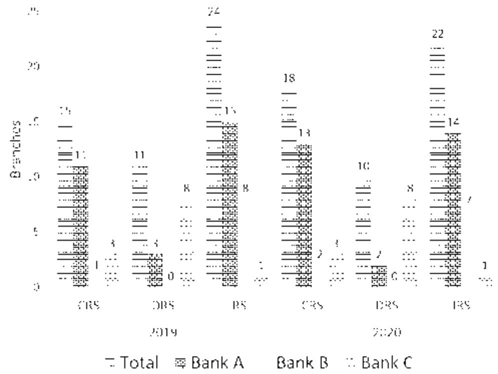

Fig. 4. Return to scale distribution map

3.4. Malmquist Index Result from DEA

Concerning the Malmquist Index, the productivity change is measured by calculating the efficiency change and technology change as in [7]. The study of Malmquist Index in banking industry are well-established. For instance, Kamarudin & Sufian [16], performed study of the impact of merger and acquisition on productivity change in Malaysian bank, which compared the acquirer bank and the target bank to be acquired, on pre-merger and post-merger periods. Related to this study, the Malmquist Index will be used to understand the productivity change of the Indonesian Islamic Bank branch prior to merger.

Based on TABLE 5, it can be seen that in the period of 2019–2020, Islamic Indonesian Bank has efficiency change score of 1.071, technology change of 0.901, and pure technical efficiency change of 1.058, scale efficiency change of 1.012, and these all result in the yield the total factor productivity change around 0.965. These results show that the total factor productivity change is less than 1 and the efficiency change is greater than the technology change.

TABLE 5
MALMQUIST INDEX RESULT

	efficiency change	technology change	pure tech. efficiency change	scale efficiency change	total factor productivity
Mean	1.071	0.901	1.058	1.012	0.965

IV. DISCUSSION

In this study, DEA as non-parametric frontier analysis tool, is used to calculate the technical efficiency and scale efficiency that could be used to determine the inefficient branch. Based on the BCC result, the branch has 30% inefficient branches for both years, 2019 and 2020. This result could determine the rank of branch performance and differentiate the classification to decide the prioritization of the branches which need to be improved. The top 10% branches could be a template and benchmark branch to be adopted at post-merger bank [13]. The bottom 10% branches could be the main focus for the management to improve their performances by applying efficiency in input resources or improving the output result. Based on the slack result from DEA, Indonesian Islamic bank could be more efficient by reducing 18 employees, saving 3.48Billion IDR rent expense, and reducing 10 tellers, moreover at the same time they could improve 66.34Trillion third party fund, 1.02Trillion IDR consumer financing, 380.58Billion IDR productive financing, 175,385 number of customers, and 277,844 number of transactions. The following slack results could be used as an alternative suggestion for the management to improve the performance of branch

The DEA results can also be used to compare the bank participants' performances prior to merger as the management reference to determine the optimization strategy for their branches. The results show that Bank A which applied single outlet model has better performance than multi outlet model. Not only based on the efficiency score obtained, but also based on the number of efficient branches (see Fig. 3), Bank A has more efficient branches than others. This result indicates that as an independent branch, Bank A could optimize their fewer resource to generate more output and yield better performance among the others. By applying the single outlet model, the branch only maintains the employee on its branch, so they are more focused on optimizing their resources to generate the business expansively.

Related to [14] and [13], the scale efficiency is obtained to understand the character of return to scale, and whether the branch is working optimally. Based on the results on Table 3, Bank A is the best in terms of scale efficiency, while Bank B is the worst one, which means bank B was not working on its optimal scale. Based on Fig.3, the characteristics of branch bank A and bank B are similar. Both banks have more IRS than the other characteristic. These branches show that they depend much on their input resources to generate their output which means decreasing input may cause the branch operating under optimal scale [13]. On the other hand, bank C had more DRS, which means bank C branch has issues in generating the output. Therefore, bank C need to do some restructuring/modifying the input combination to enhance the performance of generating output [13].

In terms of the merger process of Indonesian Islamic Bank, all participant banks show increasing efficiency performance (see TABLE 4) during period 2020, except for bank C for BCC efficiency score. These increasing performance means in 2020 they had better productivity. Otherwise, Malmquist Index show that total productivity change during period 2019 to 2020 was decreasing due to the score is less than 1 [6, 15]. This contradictive result existed due to in Malmquist Index, the main contributor to generate the productivity change are not only technical efficiency change but also technology change. The results from TABLE 5 show that technology change is 0.901 which

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means lower than technical efficiency change. Therefore, prior to merging, the bank increased the business to obtain higher efficiency in terms of increasing the productivity performance, and there is still room for improvement to enhance the technology for the bank at post-merger.

V. CONCLUSION

This paper measures the operational efficiency of 50 branches of Indonesian Islamic Bank by using BCC model, scale efficiency and Malmquist model to answer the research question about the branch efficiency, comparison of participant banks' performances, and the further strategy for the merged bank. The analysis from one-stage DEA is conducted to obtain the efficiency score as a benchmarking method. The result of operational efficiency performance shows that Bank A which adopts single outlet branch has the best performance among the merger participants. Thus, the single outlet model is suggested as the suitable strategy that could be adopted by the merged bank.

The scale efficiency shows that there are still many branches which are not working on an optimal scale. This study also gives reference for the management regarding the inefficient branches which need to be improved and provides some recommendations about the input and output variables that could be optimized to increase the performance of the branches. Based on the slack result, the DEA show that decreasing 4% number of employees, 1% rent expense, 4% number of tellers, and increasing 8% deposits, 9% consumer financing, 8% productive financing, 10% number of customers, and 9% number of transactions are the solutions to improve the efficiency of the branches in the future.

After conducting the one-stage DEA to measure the technical efficiency, results of the Malmquist Index show that the bank has an opportunity to improve the technology efficiency to aim the higher productivity in the future. Thus, this pre-merger analysis delivers valuable insights for management and academics in developing the strategy for the merged bank. These results show that DEA can be used for branches performance benchmarking and the comparison of the participant banks at pre-merger to deliver some recommendations for the post-merger strategy and complete the literature gap in Islamic merged bank.

This study has some limitations. The study only assesses branches in the Jabodetabek (or Greater Jakarta) area and measures only two years of performance prior to the merger using an operational model. Conducting another production and profitability model analysis, as well as post-merger analysis are recommended for further studies to obtain a comprehensive analysis of the performance of bank branches and the benefit of the merger.

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