



Evaluation of Digital Banking Efficiency in Indonesian Banking Sector using Data Envelopment Analysis (DEA) Approach

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ABSTRACT: The digital banking industry in Indonesia has experienced significant growth, driven by changing customer demands, technological advancements, and regulatory support. The digitalization of Indonesian banks aims to enhance cost efficiency. This research utilizes the Data Envelopment Analysis (DEA) method to measure the cost efficiency of Indonesian commercial banks. The research includes digital banks as business units and neo-banks, comparing their cost efficiency from 2012 to 2020, with digital banks and neo-banks generally operating more efficiently than non-digital banks. The findings highlight the significant impact of digital transformation on cost efficiency in the banking industry. Stakeholders, including banks and financial authorities, can utilize these insights to plan strategies, reduce operating costs, and enhance cost efficiency. Further research can explore additional factors, such as macroeconomic influences, and categorize commercial banks based on their core capital categories.

KEYWORDS: Banking Industry, Cost Efficiency, Digitalization, Digital Bank, DEA.

INTRODUCTION

Due to shifting customer demands and increasing smartphone penetration, the banking industry in Indonesia has witnessed a significant transition toward digital banking. Digital banking initially emerged in 2016, when fintech companies began providing financial services through digital platforms. Bank Indonesia established a regulation in 2018, Peraturan Bank Indonesia Nomor 20/6/PBI/2018 regarding electronic money, while Financial Services Authority (OJK) established a regulation in 2021, Peraturan Otoritas Jasa Keuangan Nomor 12/POJK.03/2021 regarding digital banks, that allowed conventional banks to offer digital banking services, resulting in rapid growth in the industry. The growing middle-class population, improving digital literacy, favorable government regulations, and the COVID-19 pandemic in 2020 have all supported the growth of digital banking in Indonesia. According to Bank Indonesia's survey in 2021, electronic money transactions reached Rp786.35 trillion in 2021 and it increased by 55.73% compared to the previous year, while the findings of McKinsey's new Personal Financial Services 2021 survey shows that 90% of the 15 Asian market customers are actively use digital banking and most of the respondents are willing to purchase more banking services through digital platforms. The growing market encouraged especially the incumbent banks in Indonesia to implement the strategic bank digitalization policy and compete in the market. Conventional banks in Indonesia have made significant investments in digital platforms in order to increase customer access and provide more convenient banking experience. Concerns such as the high expenses of operating physical branches and reaching customers in rural areas are addressed by digital banking. Digital bank generally only has a headquarter and do not have physical branches or only use a few physical branches. It provides banks with possibilities for cost reduction and increase banks' cost efficiency, while also encouraging new customers. The expansion of digital banking may also benefit the economy due to increase of financial inclusion. The digital transformation in the banking industry is expected to increase cost efficiency due to the reduction of employees and physical branches.

Therefore, this research aims to: (1) analyze the cost efficiency of digital banks compared to non-digital banking system before and after the digitalization, (2) evaluate the influence of digital transformation in banking industry on the cost efficiency.

This research is limited to the digital banks based in the research of Momentum Works in 2021, the data only includes the commercial banks with complete availability of financial reports from 2012 to 2020, does not exclude data from the COVID19 pandemic in 2020, and the author used secondary data that ranges from 2012 to 2020 from the quarterly financial report.

LITERATURE REVIEW

A. Digital Bank

Digital bank is a financial institution that operates primarily through digital channels and leverage the technology at all functional levels and on all service delivery platforms. Banks can be seen as three digital businesses in one, which are as a manufacturer of



products, a processor of transactions and a retailer of services (Skinner, 2014). According to Harjanti et al. (2019), because digital transactions need an improved banking experience, the banking industry is also conducting trials using innovative technologies to promote mobility and increase transaction speeds, security and efficiency of all banking and financial operations and services for its customers (Sajic et al., 2017). The characteristics of digital banks are branchless design, superior customer experience, and use of technology (Choi et al., 2020). Digital banks are competing on lower cost of service, speed of innovation, and differentiated propositions designed to suit the identified demands of the modern banking customer, because the main advantages of digitalization for banks are cost reduction, increased productivity, and optimization of the banks' performance (Koroleva and Kudryavtseva, 2019). Citi (2019) stated that digitalization in banking industry could decrease banks' operational cost by 30% to 50% mainly due to fewer branches and employees.

B. Bank Efficiency

Bank performance is frequently assessed using frontier efficiency, which compares banks' efficiency. Efficiency can be defined as the ability of an organization to achieve its output from the minimum input level (Drucker, 1963). According to Khalid and Battal (2006), there are several components of efficiency, such as technical efficiency, allocative efficiency, and cost efficiency. Technical efficiency refers to the greatest output generated by a given input level (Wahyudi and Azizah, 2018). Allocative efficiency or distributive efficiency refers to the selection of inputs for a certain level of outputs at a specific level of output prices, where the cost of production is lowest (Khalid and Battal, 2006). Cost efficiency measures the combination of inputs that could generate the desired outputs at minimum cost and it also could control the input variables to achieve the desired performance (Sudrajad, 2018). Bank efficiency is an important indicator of bank performance and management efficiency, and it gives information that can be used to make policy decisions.

In the banking theory literature according to Sealey and Lindley (1977), there are two main approaches that are extensively used, which are production and intermediation approaches.

1. The production approach implies that financial institutions act as service providers to account holders, performing transactions on deposit accounts and processing documents such as loans.
2. The intermediation or asset approach implies that banks essentially act as financial intermediaries whose primary job is to receive funds from savers in return for their liabilities, and the banks, in turn, will provide loans to others for profit making (Chu and Lim, 1998). Banks are also viewed as acquiring labour, resources, and deposit funds in order to generate loans and investment.

C. Methods to Measure Efficiency

Two types of techniques are used to measure efficiency: parametric and non-parametric. The Stochastic Frontier Analysis (SFA), Distribution-Free Analysis (DFA), and Thick Frontier Analysis (TFA) are the parametric approach. While the Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) are the non-parametric methods. Meeusen and van Den Broeck (1977) and Aigner et al. (1977) proposed the SFA to assess bank efficiency. The parametric approach requires the specification of a functional form for the technology and for the inefficiency error term (Murillo-Zamorano and VegaCervera, 2001). This method using linear programming to measure the relative efficiency of a number of DMUs through the identification of the optimal inputs and outputs. The parametric approach produces a stochastic cost frontier, while the nonparametric produces a production frontier. The advantages of this approach are it provides the possibilities to use panel data, to distinguish the random noise from inefficiency and to calculate the standard error of efficiency measurement results, so it allows random error in efficiency estimation (Arshinova, 2007; Wang and Wang, 2002). In general, the parametric approach is more likely to be appealing than DEA when the data contains substantial measurement errors, random events, and difficulties distinguishing inputs and outputs. When random errors are less of a concern and price information is unavailable, DEA may be a better solution (Wang and Wang, 2002). According to Erkie and Andualem (2018), DEA's computations are easy to estimate, the data could be in a qualitative format and in an ordinal ranking, and it does not require as many as restrictive assumptions as parametric statistical inference.

D. Data Envelopment Analysis

The use of non-parametric approaches, such as data envelopment analysis has been widely used in the banking industry (Antunes et al., 2021; Azad et al., 2016; Chowdhury and Haron, 2021; Faturohman et al., 2019; Sakouvogui, 2020; Wahyudi and Azizah, 2018; Yusgiantoro, 2019). Research by Sakouvogui (2020) compared the cost efficiency of commercial and domestic banks in the United States using SFA and DEA, and concluded that the DEA model provides more stable rankings when comparing the cost efficiency.



Efficiency measurement in banking can be conducted using two models: input-oriented model and output-oriented model. The input-oriented model focuses on minimizing inputs while maintaining at least the given output levels, meanwhile the output-oriented model aims to maximize outputs without requiring additional input values (Yong-bae and Choonjoo, 2010). Furthermore, there are two optimization approaches, which are Constant Return-to-Scale (CRS) and Variable Return-to-Scale (VRS). The difference is in the assumption whether the firm operates at an optimal scale or not.

E. Previous Study

Several research studies have investigated the efficiency levels in banking industry. Yusgiantoro (2019) conducted a study using data from 2012 to 2017 and found a significant positive impact of digital banking technology adoption on banks' efficiency. Vong et al. (2016) explored the correlation between digital financial services and economic performance in Indonesia, highlighting the potential of online banking, SMS banking, and mobile banking to reduce operating costs and improve financial services accessibility, particularly in rural areas. The efficiency of the banking sector has also been analyzed using different approaches and variables. Phan et al. (2018) measured the cost efficiency of the Hong Kong banking sector and identified factors such as bank size and GDP growth as positively affecting efficiency, while revenue diversification and listing status had a negative impact. Wahyudi and Azizah (2018) assessed banking efficiency in ASEAN-5 and found relatively high efficiency levels but with variations over different periods due to economic conditions. Faturahman et al. (2019) compared the efficiency of Islamic banks in ASEAN using different approaches and variables, highlighting the influence of internal and external factors on efficiency outcomes. Sakouvogui (2020) compared the stability of rankings between the DEA and SFA models when assessing cost efficiency. Sudrajad (2018) analyzed cost efficiency in the ASEAN banking sector, focusing on the retail bank business model and the differences between conventional and Islamic banks. Another study by Ramadhan and Sudrajad (2022) examined the financial performance of banks in Indonesia before and after implementing digitalization strategies. While the study found a significant influence of digitalization on banking performance, there was no significant improvement in efficiency and profitability during the period studied.

F. Conceptual Framework

The conceptual framework in this research can be briefly seen in Figure 1 as follows

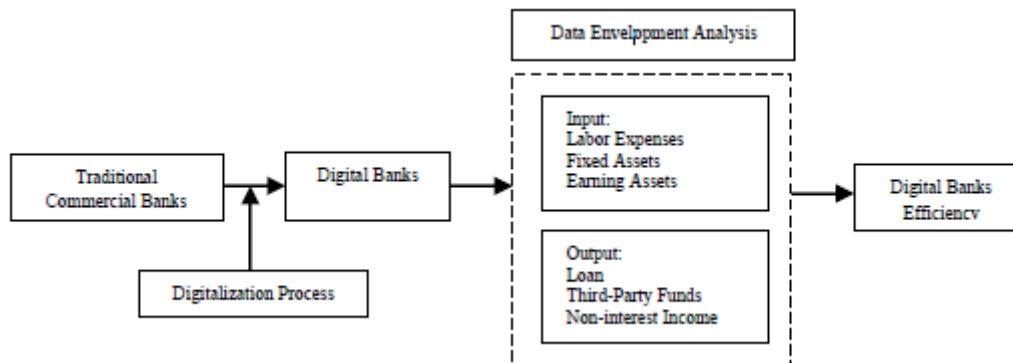


Figure 1. Conceptual Framework (Source: Author Analysis, 2023)

Traditional commercial banking has been practised for many years, with individuals visiting banks to satisfy their financial needs. It might be used to gather money, invest it, or transfer funds from one bank account to another. They had to stand in long queues to meet their financial obligations. This entire process took time and with the digitalization of various industries, banks saw the need to switch to digital banking operations. The main objective of this research is to examine the efficiency of digital banks in Indonesia using Data Envelopment Analysis method, which has several inputs and outputs as the variables. The input variables are labor expenses, fixed assets and earning assets, while the output variables are loan, third-party funds, and non-interest income.

METHODOLOGY

The data resources used in this research is secondary data. The data is obtained from quarterly reports of the banking industry published by the Indonesian Financial Services Authority website over the period 2012 to 2022. The population in this research is



Commercial Banks in Indonesia, which include 39 banks that have a complete data in four quarters for eleven years observation. There are several commercial banks that are excluded because the data for several years are unavailable in the OJK website. The sample selection is based on the findings from Momentum Works' research in 2021 about Rise of Digital Banks in Indonesia. It includes seven digital banks as a subsidiary of an incumbent banks and four neo-banks.

The data analysis used in this research was DEA with the help of the RStudio program. This research measures the production frontier using VRS assumption, because the CRS assumption is appropriate only when all the banks are operating at optimal scale, while in fact there will be internal and external factors of the DMU, such as regulation, constraint with resources, imperfect competition that are not the same and make it not operate optimally. This research also uses an input orientation because it is assumed that the banks need to optimize their cost to remain competitive, because it drives efficiencies. The production approach is adopted by this research to determine the input and output variables. This approach is suitable for digital banks, because it provides three aspects of services, which are funding, loan disbursement, and other banking services. It provides savings and time deposit accounts, offers short-term and long-term funding through investment loans, and facilitates QRIS payment, billing payments, virtual debit card, e-wallet balance top up, e-commerce shopping payment, digital services on partner applications (account opening, online transaction payments), etc. In the production approach, banks utilize labour and capital to produce loans, deposits, and other bank outputs (Berger and De Young, 1997; Resti, 1997). Therefore, a bank's inputs are labour expenses (x_1), earning assets (x_2) and fixed assets and equipment (x_3), while the outputs are loan (y_1), third-party funds (y_2) and non-interest income (y_3). Furthermore, the DEA results was analysed with Welch's t-test to evaluate the influence of input-output variables on banks' efficiency before and after the digitalization.

FINDINGS AND DISCUSSION

Figure 2 below shows the cost efficiency trend of Indonesian commercial banks over the past eleven years that keeps fluctuate, with a significant decline in 2020 and 2022. The average cost efficiency score is less than 1, indicating that the population of commercial banks in Indonesia is not operating cost efficiently.

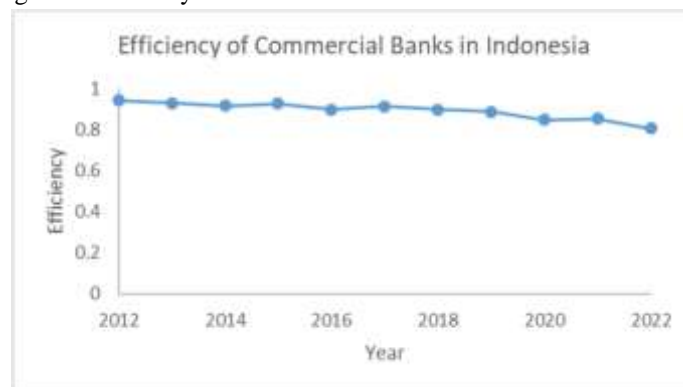


Figure 2. Indonesian Commercial Banks Cost Efficiency
(Source: Author Analysis, 2023)

Based on Figure 3, digital banks as a business unit and neo-banks in Indonesia have higher cost efficiency scores compared to non-digital banks. Digital banks and neo-banks exhibit a similar efficiency trend over the years, except for 2020 and 2022, where neo-banks have the lowest scores. The findings indicate that digital banks operated more efficiently than traditional banks after the digitalization transformation in 2016, with the highest average efficiency score in 2017. While traditional banks experienced a decline in efficiency in 2020, digital banks showed an increase in their cost efficiency scores.

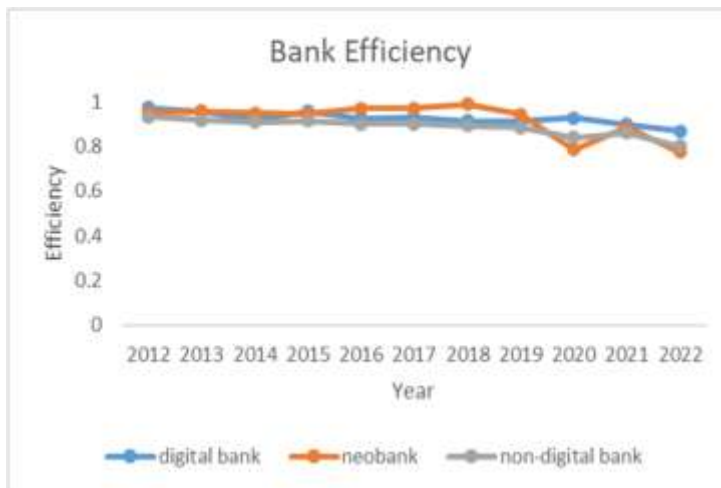


Figure 3. Indonesian Bank Cost Efficiency
(Source: Author Analysis, 2023)

The cost efficiency scores of individual Indonesian digital banks fluctuate over time, as depicted in the Figure 4. Bank BTPN has consistently performed efficiently since 2019, with improving efficiency scores since the digitalization transformation. Bank UOB operated efficiently from 2015 to 2019 but experienced a decrease in cost efficiency scores after the digital transformation in 2020. Bank KB Bukopin faced a significant decline in 2022, with its efficiency score dropping from 0.9458 to 0.7022.



Figure 4. Cost Efficiency of Indonesian Digital Bank as a Business Unit
(Source: Author Analysis, 2023)

The cost efficiency trend of Indonesian neo-banks, as shown in Figure 5, exhibits fluctuations, particularly from 2020 to 2022. Bank Seabank experienced a significant drop in 2020, reaching a low efficiency score of 0.7198. Bank Jago's cost efficiency continues to decline, reaching 0.5639 in 2022. Bank BCA Digital also faced a significant decline, reaching its lowest cost efficiency score of 0.3592 in 2020. However, Allo Bank displayed a steady cost efficiency score and operated at full efficiency in 2021 with a score of 1.

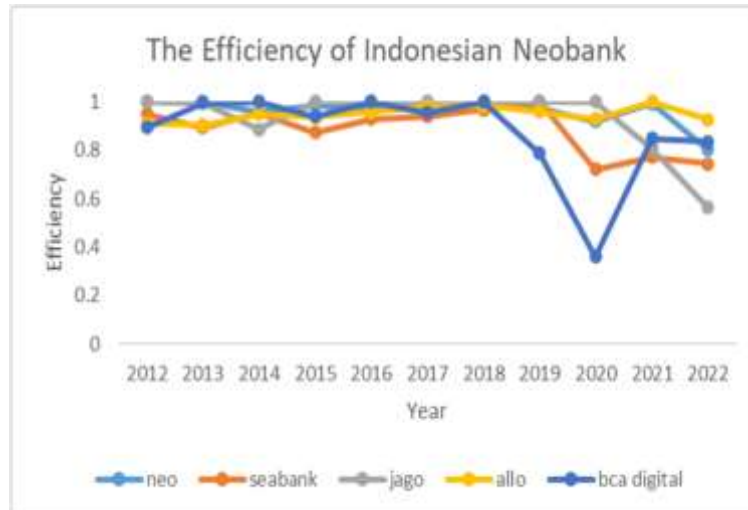


Figure 5. Cost Efficiency of Indonesian Neo-bank
(Source: Author Analysis, 2023)

The Welch’s t-test was used to determine whether there is a significant difference in banks’ cost efficiency between nondigital and digital banks after the digital transformation, test all Indonesian digital bank before and after the digitalization, test digital banks and neo-banks before and after the digitalization. The results shows that the digitalization in the Indonesian banking industry has a significant influence on the cost efficiency of the banks, despite the result indicated that the impact was negative, because the average of banks’ cost efficiency before the digitalization period remained higher.

Most of the digital banks and neo-banks in Indonesia started their digital transformation in different period, but the trend shows that the cost efficiency scores tend to not improve, even though digitalization is expected to reduce operating costs, such as lower labor costs, and lower fixed assets and equipment because digital banks do not require physical branch offices and operational employees. Meanwhile, there has been no significant reduction in the number of employees or fixed assets. All the neo-banks in Indonesia are banks that have been acquired by other banks, such as Allo Bank, previously known as Bank Harda Internasional; Bank Neo Commerce, previously known as Bank Yudha Bhakti; Bank Seabank, previously known as Bank Kesejahteraan Ekonomi; Bank Jago, previously known as Bank Artos Indonesia, and Bank BCA Digital, previously known as Bank Royal. The cost efficiency scores of the majority of Indonesian neo-banks have not improved.

Despite successful increases in net income and bank profitability under new management, efficiency levels did not necessarily improve. This finding is consistent with earlier studies showing that mergers and acquisitions of a bank do not necessarily result in enhanced cost efficiency.

Digitalization in the banking industry require strategic investments in technology and human resources. Banks have to implement policies, procedures and standards to integrate IT development with their entire business strategy. Continuous IT development improves productivity, competitive positioning, and risk management. However, due to the requirement for technology investments and talent development, reducing operating costs during the first phase of digital transformation may be challenging. According to Scott et al. (2017), implementing network-based technological infrastructure has a significant impact on long-term profitability, with initial costs offset by reduced recurrent costs and enhanced operational efficiency through streamlined personnel and brand utilization. Due to differences in core capital, the digital transformation in the banking industry may have varied consequences for each size of bank. Large initial investments tend to favor larger banks with more capital since they may be better equipped to deal with the uncertain impact of this investment while maintaining low profitability. Therefore, investing in technology is considered capital-intensive.

Customers’ preference for traditional banks over digital banks may have caused the negative impact on the cost reduction aims of digital transformation. Bendig (2023) discovered that a significant percentage of respondents, particularly among the elderly, still choose traditional banks because of the face-to-face service given by bank tellers. This tendency might be due to a degree of comfort



with human contact and a perceived sense of trust. Younger generations who are more comfortable with technology, on the other hand, may find digital banks more convenient and are more likely to use digital banking services.

According to OJK, a digital bank started to become profitable after seven years. The other sources estimates that it takes five to seven years for banks to break even on investments, although profitability is not guaranteed. However, it is important to note that the research period was relatively short, starting in 2020 during the COVID-19 pandemic and influenced by macroeconomic factors in 2020 that impacted the economy.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the results of the DEA approach show that the overall cost efficiency of Indonesian commercial banks is fluctuating over time. Non-digital banks' cost efficiency scores are lower when compared with digital banks as a business unit and neo-banks. After the digitalization process of each bank, the cost efficiency scores tend to not improve, and there is also no significant decrease in the number of employees, earning assets, or fixed assets. The findings of the Welch's t-test show a statistically significant impact of digitalization on the cost efficiency of the Indonesian banking industry from 2012 to 2020, despite the negative impact.

Based on the findings and discussions, the following suggestions are given:

For the government, including Bank Indonesia as the Central Bank in Indonesia and Financial Service Authorities, it is necessary to carry out their duties as a regulatory and supervisory authorities, such as establish comprehensive guidelines and regulations that may cover several aspects regarding digital banks, coordinate with other authorities such as Lembaga Penjamin Simpanan (LPS), and closely supervise the digital transformation in the banking industry regularly, in order to maintaining financial stability within the banking system.

For each bank, it is critical for the Bank to recognize that digital transformation is a long-term investment, which require investing in new technologies, infrastructure upgrades, software licenses, cybersecurity measures, employees training, and change management processes. Furthermore, the Bank needs to assess its current digital infrastructure by analysis their technological readiness and evaluate it regularly. The Bank also needs to implementing a strong digital culture especially within the entire organization that will drive the transformation needed to stay competitive in the banking industry.

To enhance the understanding of digital transformation's impact on banks' cost efficiency, future research can consider categorizing the sample of banks based on their core capital categories. Additionally, to comprehend the effects of the COVID-19 pandemic, it may be beneficial to exclude data from 2020. The limited data timeframe for some digital banks since each digital banks began its digital transformation at a different time period should be taken into account, as a longer observation period would provide a more comprehensive depiction of the trend after digitalization.

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