

# INFORMATION TECHNOLOGY ROLE ON PRIVATE COMMERCIAL BANKS' EFFICIENCY WITH COST AND PROFIT DEA TECHNOLOGY

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## ABSTRACT

Information Technology plays a pivotal role to improve the competitiveness of the bank by providing its existing customers with satisfactory services, while at the same time bringing about a significant reduction in cost. This study measures the effect of IT factors on cost and profit efficiency of Private Commercial Banks (PCBs) in Bangladesh employing cost and profit Data Envelopment Analysis (DEA) and Ordinary Least Square (OLS) method. The average cost efficiency (41.4%) was recorded higher than the average profit efficiency (18.8%) for PCBs. Prime bank was the most cost and profit efficient among PCBs. The Credit card transaction (0.000006) and Credit card expenses (0.0002) were observed positively significant for cost efficiency of PCBs and the IT personnel expenses (0.0015) and Credit card transaction (0.00008) were found positively significant for profit efficiency of PCBs. IT factors were found more significant for PCBs in profit efficiency. The results attained from this study could aid government, managers and depositors to remove the hindrance of progress in Bangladesh. This type of empirical analysis could be applied in another sector of the economic market.

**Keywords:** Efficiency, IT, Cost DEA, Profit DEA, PCBs.

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Internationally, Information Technology (IT) is now more available and vital worldwide, than it was ever before in the past days. But in Bangladesh, there is still a long way to go to successfully virtualize the long-run banking transactions. Technology has presented all new extents to the banking sector creating the scope for many opportunities for product marketing and enabling the organizations to manage their branches. The Online Banking system performs the banking transactions via Internet, Intranet and Extranet and the influence of IT in banking sector is huge and has worldwide influence. The augmented demand for IT turned into looming and inevitable in Bangladesh banking industry (<https://www.thefinancialexpress.com.bd/views/ict-in-banking-industry>). Huda, Momen and Ahmed (2004) commented the importance of information technology for the success in the banking sector in Bangladesh. Rahman (2010) argued that most recently with the introduction of e-commerce has taken away from the conventional banking is a giant pace towards digital Bangladesh.

According to (Ovia, 2005) they deliberated the use of IT based bank's products such as ATM, smart cards, internet banking, mobile/telephone banking, MICR, electronic funds transfer, electronic data interchange, point of sale terminals, computerized financial accounting and reporting, and electronic home and office banking. Most of the Private Commercial Banks (PCBs) perform E-banking. Banking sector of Bangladesh consists of six state-owned commercial banks (SOCBs), thirty nine private commercial banks (PCBs), nine foreign banks (FBs), two specialized banks (SBs), and four non-scheduled banks. According to the BIBM report, SOCBs are large in terms of shares in assets and number of branches; they could cover only around 72.3 per cent of their branches under computerization by 2015 while the PCBs and FCBs brought 99.5 and 100 per cent of their branches, respectively, under computerization. In the context of computerization of the maximum branches of PCBs, this study assess the role of IT on both cost and profit efficiency of PCBs in Bangladesh.

The estimation of efficiency can be categorized according to the assumptions and techniques used to construct the efficient frontier. Non-parametric methods like DEA rely on linear programming to calculate piecewise linear segments of the efficient frontier and do neither impose any assumptions about functional form of the frontier nor any distributional assumptions about inefficiency. In addition, DEA also allows random error in observed input-output combination. On the other hand, parametric methods impose an explicit functional form for both the frontier and deviations from inefficiency. The bank efficiency works have been accomplished with DEA technology without IT variables in Bangladesh and other countries (e.g., Ahmed & Liza 2013; Hoque & Rayhan 2012; Hossain et al. 2016; Ariff & Can 2008; Isik & Hassan 2002).

A few studies have been conducted in Bangladesh by using SFA and DEA on both cost and profit efficiency of banks (Hasib & Mahmud, 2018; Ara, 2016) without IT variables. On the other hand, other researchers considered IT variables (Sadekin & Sheik 2016; Alam et al. 2017) in Bangladesh but they did not measure the cost and profit efficiency of banks. Therefore, the goal of this study is to investigate the IT influence on 17 Private Commercial Banks (PCBs) in the context of both cost and profit efficiency in Bangladesh by VRS cost DEA and profit DEA models. Examining the role of IT components on PCBs banks with the efficiency of both cost and profit by using Ordinary Least Square (OLS) method is a concern. In addition, the year-wise and bank-wise cost and profit efficiency comparison are made for PCBs. Specifically this study undertakes to investigate the use and development of some classes of IT applications such as It expenses, IT income, IT investment, IT personnel, IT personnel expenses, ATM transaction, ATM expenses, Credit Card transaction, and Credit Card expenses on the selected 17 Private Commercial Banks (PCBs) which are only available for the ICT data during the period from 2008 to 2017.

## LITERATURE STUDY

A lot of studies have been performed over the past decade in the area of measuring efficiency of firm companies, banks and other decision making units. The basic DEA model developed by Charnes, Cooper and Rhodes (1978) was based on the assumption of constant return to scale and this model has been modified by Banker, Charnes and Cooper (1984) with the assumption of variable return to scale. Since 1985 DEA has been extensively functional in the banking sector. DEA has been applied widely in measuring efficiency of Indian banks by Pramodh et al. (2008). Berger and Humphery (1997) reviewed 130 efficiency studies of financial institutions including commercial banks and explained that efficiency estimates of financial institutions in 21 countries vary across studies due to use of different methods in different studies.

The different applications of DEA are used to assess the bank efficiencies by the researchers (e.g., Tuškan & Stojanović 2016; Paradi et al. 2018). A few studies are found in bank efficiency analysis using DEA in Bangladesh (e.g., Hoque & Rayhan 2012; Bhuia et al. 2012; Ahmed & Liza 2013; Hossain et al. 2016; Islam et al. 2017; Fatema et al. 2019; Azad et al. 2020). There are several studies available on the analysis of cost and / or profit efficiency in Latvian banking (Titko et al. 2014); in Slovak banking (Grmanová & Ivanová 2018); and in the banking sectors of developing countries (Sohrab & Suzuki 2011). Besides, Ramona and Estelle (2009) evaluated cost efficiency of French was around 86.40 to 91.52%, and Spanish banks was around 95.07% to 98.32%, while in the other countries a declined in cost efficiency is noted. Kristina (2015) showed that the Czech

banks were more cost, revenue and profit efficient than Slovak ones during the whole analyzed period. Gulati and Kumar (2016) found that the impact of global financial crisis on profit efficiency of Indian banking industry was modest and short-lived since the profit efficiency declined only by about 3 percentage points during the crisis years.

In the context of IT, DEA is used to examine the bank or firm's efficiency widely. The application of information technology in banking sector and organizational IT firms is investigated by (Titko et al. 2014; Abri & Mahmoudzadeh 2014; Grmanova' & Ivanova' 2018; Peter et al. 2019). Chu-Fen Li (2007) explored, banks can reduce operating costs by increasing the number of financial cards issued and improve operational efficiency by installing more automated teller machines and providing customers with a wide variety of information technology services.

## METHODOLOGY

### *Data Description And The Variables*

Only 17 private commercial banks have been selected for this study because the ICT data are not available for all the banks. The data were collected from the annual report of individual bank over the period 2008 to 2017. The link of the annual reports the samples of banks in Bangladesh are given below.

<https://www.dutchbanglabank.com/investor-relations/financial-statements.html>  
<https://www.bracbank.com/en/investor-relations>  
<https://www.thecitybank.com/report/annualreports>  
[https://www.ebl.com.bd/home/Annual\\_Reports](https://www.ebl.com.bd/home/Annual_Reports)  
[http://www.mblbd.com/home/annual\\_reports](http://www.mblbd.com/home/annual_reports)  
<https://www.mutualtrustbank.com/investor-relations/annual-report/>  
[https://www.primebank.com.bd/index.php/home/financial\\_reports](https://www.primebank.com.bd/index.php/home/financial_reports)  
<http://premierbankltd.com/pbl/financial-reports/>  
<https://www.onebank.com.bd/home/financial/annual-reports/>  
[https://www.southeastbank.com.bd/annual\\_reports.php](https://www.southeastbank.com.bd/annual_reports.php)  
<https://www.ucb.com.bd/index.php?page=know-ucb/investor-relations/annual-report>  
[http://www.ificbank.com.bd/annual\\_report.php](http://www.ificbank.com.bd/annual_report.php)  
[https://www.islamibankbd.com/annual\\_report.php](https://www.islamibankbd.com/annual_report.php)  
<https://al-arafahbank.com/Annual-Reports.php>  
[https://www.sjibld.com/Financial\\_Statements\\_2017.php](https://www.sjibld.com/Financial_Statements_2017.php)  
[https://www.sibld.com/home/annual\\_reports](https://www.sibld.com/home/annual_reports)  
[http://www.eximbankbd.com/report/Annual\\_Reports](http://www.eximbankbd.com/report/Annual_Reports)

In this study the yearly data such as Non-IT and IT are used by the Table 1.

Variable	Definition
<b>Dependent Variables</b>	
Operating cost	Total cost comprises the income salaried to investor, staff expenditures, and other functioning expenditures.
Profit after tax	Total profit is subtracted of the entire cost from entire income.
<b>Output Quantity</b>	
Loan	The sum of long-term and short-term loan, trade bills and reduced bills and other loans.
Off balance sheet item	Off-balance Sheet Items measures the sum of guarantees, commitment and financial derivative instrument
<b>Output Price</b>	
Price of Loan	Price of Loan measures the net interest income or net interest expenditures divided by total loan
Price of off balance sheet items	Price of off-balance sheet items is defined the ratio of total operating expenses and the total securities
<b>Input quantity</b>	
Total fund	Total Funds measures the sum of deposit and non-deposit funds at the end of the respective years

**Table-1:**  
Definitions of the  
Variables for DEA  
(Outputs, Input  
Quantity, Output  
and Input Prices  
Variables) and IT  
Variables

Fixed assets	Fixed assets measure the book, the value of premises and fixed capital.
Labor	The quantity of labor measures the number of bank staff members.
Input Price	
Price of Fund	Price of Fund is defined by the ratio of total interest expenditures to all deposits.
Price of Fixed Assets	Price of fixed assets measures the ratio of non- interest expenditures to fixed assets.
Price of Labor	Price of Labor calculates the ratio of personnel expenses to the number of bank staffs.
<b>IT Variables</b>	
IT Expenses	The total IT refers to the expenses of the maintenance and repair, rent, depletion of IT equipment and information sourcing services.
IT Income	The total income from IT Sector in Bank.
IT Investment	IT investment is total IT budget of the bank which included hardware, software, network, security training and other IT purpose
IT Personnel	The total no of IT staff member in the bank.
IT personnel Expenses	IT personnel expenses are designed as total salaries of IT staff expenses.
ATM Transaction	The total amount of deposit is withdrawn by ATM Card.
ATM Expenses	Banking Service Charge is provided by ATM Card.
Credit Card Transaction	The total amount of deposit is withdrawn by Credit Card.
Credit Card Expenses	Credit card service charge is calculated price of credit card.

**VRS Cost Minimization DEA Model Specification**

The specification of VRS cost DEA model is followed by (Coelli et al. 2005) as follows:

$$\begin{aligned}
 \text{Min } h_k &= \sum_{i=1}^m w_{iq} x_{iq}^* \\
 \text{st } \sum_{j=1}^n \lambda_j x_{ij} &\leq x_{iq}^* \quad ; i = 1, 2, \dots, m \\
 \sum_{j=1}^n \lambda_j y_{rj} &\leq y_{rq} \quad ; r = 1, 2, \dots, s \\
 \sum_{j=1}^n \lambda_j &= 1 \\
 \lambda_j &\geq 0 \quad ; j = 1, 2, \dots, n
 \end{aligned}$$

where  $w_{iq}$  is a vector of input prices such as (Price of fund, Price of fixed assets and Price of labor) of  $j^{\text{th}}$  bank;  $x_{iq}^*$  is the vector of input quantities such as (Total fund, Fixed assets and labor) for  $j^{\text{th}}$  bank; are the  $r^{\text{th}}$  output such as (Loan, Off-balance sheet items) into  $j^{\text{th}}$  bank.

The overall cost efficiency ( $CE_q$ ) is defined as

$$CE_q = \frac{\sum_{i=1}^m w_{iq} x_{iq}^*}{\sum_{i=1}^m w_{iq} x_{iq}}$$

The cost efficiency is the product of technical and allocative efficiency and the value of cost efficiency is restricted by zero and one.

**VRS Profit Maximization DEA Model Specification**

The profit maximization DEA model is specified as follows:

$$\begin{aligned}
 &Max \quad \sum_{r=1}^s P_{rq} y_{rq}^* - \sum_{i=1}^m w_{iq} x_{iq}^* \\
 &\sum_{j=1}^n \lambda_j y_{rj} \geq y_{rj}^* \quad ; r = 1, 2, \dots, s \\
 &\sum_{j=1}^n \lambda_j x_{ij} \leq x_{ij}^* \quad ; i = 1, 2, \dots, m \\
 &\sum_{j=1}^n \lambda_j = 1 \\
 &\lambda_j \geq 0 \quad ; j = 1, 2, \dots, n
 \end{aligned}$$

where  $p_r$  are the  $r$ th output price (Price of Loan, Price of off-balance sheet items);  $y^*$  are the  $r$ th output (Loan, Off-balance sheet items) into  $j$ th bank;  $w_i$  are the  $i$ th input price ((Price of fund, Price of fixed assets and Price of labor) into  $j$ th bank;  $x^*$  are the  $i$ th input ((Total fund, Fixed assets and labor) into  $j$ th bank.

The profit efficiency ( $PE_q$ ) can be calculated by the ratio of observed profit to maximum profit for the Decision Making Unit ( $DMU$ ) $_q$  (Coelli et al. 2005):

$$PE_q = \frac{\sum_{r=1}^s P_{rq} y_{rq} - \sum_{i=1}^m w_{iq} x_{iq}}{\sum_{r=1}^s P_{rq} y_{rq}^* - \sum_{i=1}^m w_{iq} x_{iq}^*}$$

The profit efficiency measure is not bounded by zero and one as well as it is negative if a profit is negative, or it is undefined if profit is zero (Coelli et al. 2005).

**Empirical Specification of Ordinary Least Square Method**

The specification of the Ordinary Least Square Method is defined as

$$\begin{aligned}
 E_{it} = & \phi_0 + \phi_1 ITE_{it} + \phi_2 ITI_{it} + \phi_3 ITIN_{it} + \phi_4 ITP_{it} + \\
 & \phi_5 ITPE_{it} + \phi_6 ATMT_{it} + \phi_7 ATME_{it} + \phi_8 CCT_{it} + \phi_9 CCE_{it} + \xi_{it} .
 \end{aligned}$$

where  $E_{it}$  represents both the cost and profit efficiency estimated by VRS Cost DEA and profit DEA respectively for the  $i$ -th bank in period  $t$ ;  $ITE_{it}$  is the IT expense of bank;  $ITI_{it}$  is the IT income of bank;  $ITIN_{it}$  is the IT investment of bank;  $ITP_{it}$  is the IT personnel of bank;  $ITPE_{it}$  is the IT personnel expenses of bank;  $ATMT_{it}$  is the ATM transaction of bank;  $ATME_{it}$  is the ATM expenses of bank;  $CCT$  is the Credit Card Transaction of bank;  $CCE$  is the credit card expenses of bank.  $\xi_{it}$  is the error term.

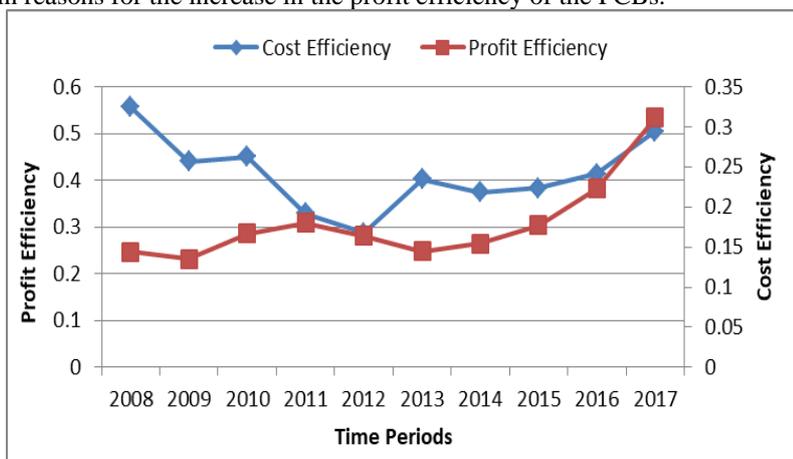
**RESULTS AND DISCUSSION**

**Yearly Average Cost and Profit Efficiency Score of PCBs with DEA**

Both the cost and profit efficiency scores of PCBs using DEA are presented in Figure 1. The average cost efficiency (41.4%) was higher than profit efficiency (18.8%) score implies that PCBs were most cost efficient and less profit efficient. These results show that the banks are 55.6% highest cost efficient in the year of 2008 and then it decreased gradually at 44% to 28.7% until 2012 and after then it increased 40.2% in 2013 and next year it fell and finally it rose at 50% on the last year. Contrarily, the profit efficiency scores were very low and the profit efficiency score had 20% below over the period. The highest profit efficiency score was occurred (31.1%) in the year of 2017. This study is supported by (Gulati & Kumar, 2016) who found that Indian banking industry was less profit efficient rather than cost efficient. This study is contradicted by (Kristina, 2015) who examined that commercial banks were observed the most revenue efficient rather than cost and profit efficient. Generally, during the period of study, we found the highest cost efficiency in 2008 while the lowest cost efficiency in 2012. This indicates 2012 as the best year in the sample period in terms of PCBs efficiency in Bangladesh. In terms of individual PCBs performance based on cost efficiency, we can see the downward trend of the contribution of the percentage of the PCBs to the cost efficiency frontier in Figure 1. After that in 2013, there was a slight upturn of the contribution. However, due to the political stability, the trend again, increases. If we analyse the crisis period of the study in Figure 1, we find that overall profit efficiency of the PCBs in 2009 is lower than in 2008 and 2010.

However, the profit efficiency level declined sharply in 2013 and these results suggested that banking profit efficiency was affected by the crisis. Though there was an downturn in profit efficiency in 2013, the overall profit efficiency is going to increase from 2014. This can be explained by the fact that the political stability of Bangladesh could be one of the main reasons for the increase in the profit efficiency of the PCBs.

**Figure 1.**  
Yearly Cost and Profit Efficiency Score of PCBs with DEA



Source: Author's calculation

**Table 1.**  
Bank-wise VRS Cost Efficiency of PCBs using DEA

*Bank-wise VRS Cost Efficiency of PCBs using DEA*

The results of VRS cost efficiency of PCBs are offered in Table 1

Name of Banks	Cost DEA Model		
	Cost Efficiency	Technical Efficiency	Allocative Efficiency
DBBL	0.223	0.346	0.931
Brac	0.251	0.365	0.910
City	0.380	0.464	0.891
Mercantile	0.645	0.780	0.930
Mutual	0.357	0.626	0.920
One	0.425	0.654	0.912
Premium	0.513	0.744	0.915
Prime	0.713	0.810	0.923
Southeast	0.468	0.657	0.915
Eastern	0.378	0.472	0.926
UCB Limited	0.439	0.788	0.904
IFIC	0.314	0.513	0.930
IBBL	0.528	0.559	0.943
Al-Arafah	0.318	0.490	0.926
Social	0.401	0.573	0.908
Exim	0.313	0.706	0.923
Shajalal	0.374	0.572	0.933
Mean	0.414	0.595	0.920

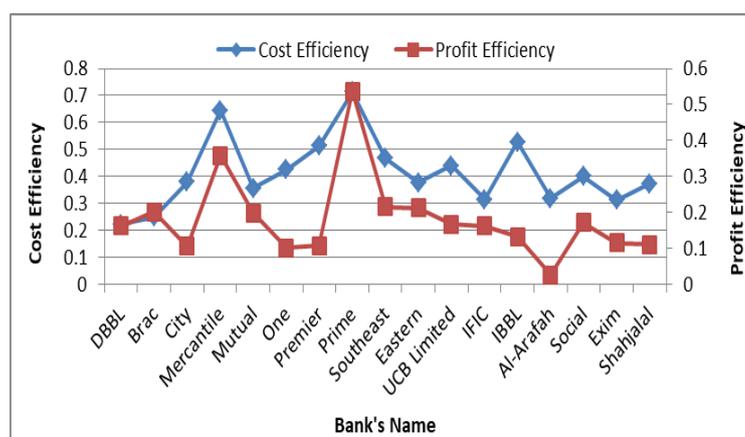
Source: Author's calculation

The average cost technical, and allocative efficiency scores were 41.4%, 59.5%, and 92% respectively. The results show that prime bank was the most cost efficient (71.3%) and their technical and allocative efficiency score of 81%, and 92.3% respectively. Moreover, the mercantile bank was the 2nd cost efficient with the score of 64.5% and their technical and allocative efficiency score of 78%, and 93% respectively. Besides DBBL bank was the less cost efficient with the score of 22.3% and their technical and allocative efficiency score of 34.6%, and

93.1% respectively. Furthermore, the allocative efficiencies had greater than technical efficiency in case of PCBs. These results were found different of Majid (2012) who examined Public Sector Banks were more efficient in India. The average cost efficiency (inefficiency) score of PCBs operating in Bangladesh is 41.4% (58.9%), which depicts that they exploit 41.4% of their inputs to produce the current output. Allocative efficiency (inefficiency) is 92.0% (8.0%) whereas technical efficiency (inefficiency) is 59.5% (40.5%). That means, average PCBs in Bangladesh can improve their efficiency by some 40.5% with better input-output structure (i.e., technical efficiency), and around another 40.5% by adjusting to the most effective production scale. The focus of this study on technical efficiency also based on findings from previous studies such as Berger et al. (1993), which argued that technical efficiency accounts for around 20 percent of costs in banking. The above results in Table 1 highlight that allocative inefficiency seems to be the major cause of cost inefficiency among PCBs. The allocative efficiency scores are higher as compared to the technical efficiency scores. This depicts that bank managers being aware about the input prices so they are to some extent able to select the cost minimizing combinations.

#### **Bank-wise VRS Cost and Profit Efficiency of PCBs**

Bank-wise cost and profit efficiency of PCBs using DEA is offered in Figure 2. The results show that prime bank was the most cost and profit efficient with 71.3% and 53.7% respectively. Moreover, the mercantile bank was the second cost (64.5%) and profit efficient (35.8%). Besides DBBL bank was the less cost efficient (22.3%) and Al-arafah was the less profit efficient (2.6%) respectively. Furthermore, the IBBL and the premium bank had 50% above cost efficiency scores but the majority of the PCBs were around 20% to 40% regarding cost efficiency and around 10% to 20% in terms of profit efficiency. The bank-wise average cost and profit efficiency were 41.4% and 18.2% respectively. According to the argument of Sathye (2001), there is ample room for PCBs in Bangladesh move towards the frontier of world's best practice. Thus, there is a need for the Bangladesh government to create a more favourable environment for the development of banking sector. In the case of this study, DEA results show that the importance of efficient banks (i.e., banks that were referred to many times as peers for inefficient banks) may differ among the PCBs. For example, the Prime Bank in Bangladesh is considered to have an influential role to be both profit efficient and cost efficient compared to others.



Source: Author's calculation

**Figure 2: Bank-wise VRS Cost and Profit Efficiency of PCBs**

#### **IT Determinants on Cost DEA Efficiency for PCBs by OLS Method**

Table 2 represents the results of IT determinants on cost DEA efficiency for PCBs during 2007-2018. The IT personnel  $\phi_4$  (-0.0009) was negatively significant and credit card transaction  $\phi_8$  (0.000006) and credit card expenses  $\phi_9$  (0.0002) were positively significant for the cost efficiency of PCBs. The results convey that PCBs have shown a significant and improving trend in their performance due to the adoption of IT. This adoption is required mandatory to take the country into the 21st century. Again Bangladesh banking environment has become more compatible as compare to the standards of international financial system, by the positive impact of all these efforts. The results suggest that IT impact on banks performance was positive which is also consistent with previous studies such as Chen et al. (2006), Chen and Zhu, (2004) and Wang et al. (1997). Also the IT expenses  $\phi_1$  (-0.00007), IT income  $\phi_2$  (-0.00003), IT Investment  $\phi_3$  (-0.000004) and ATM transaction  $\phi_6$  (-0.00003) had negative effect on the cost efficiency of PCBs. This result contradicts to Syrine, (2013) who assessed the impact of various categories of IT investments on banks' cost efficiencies.

**Table 2:** IT Determinants of Cost DEA Efficiency for PCBs by OLS Method

Cost DEA Efficiency		Private Commercial Banks	
Variable	Parameters	Coefficient	P-value
Intercept	$\phi_0$	0.44***	0.0000
IT Expenses	$\phi_1$	-0.00007	0.189
IT Income	$\phi_2$	-0.00003	0.684
IT Investment	$\phi_3$	-0.000004	0.075
IT Personnel	$\phi_4$	-0.0009**	0.003
IT Personnel Expenses	$\phi_5$	0.00056	0.183
ATM Transaction	$\phi_6$	-0.00003	0.232
ATM Expenses	$\phi_7$	0.00009	0.587
Credit Card Transaction	$\phi_8$	0.000006**	0.004
Credit Card Expenses	$\phi_9$	0.0002***	0.000

Source: Author’s calculation

**IT Determinants of Profit DEA Efficiency for PCBs by OLS Method**

Table 3 represents the results of IT determinants on profit DEA efficiency for PCBs from 2007 to 2018. The IT personnel expenses  $\phi_5$  (0.0015) and credit card transaction  $\phi_8$  (0.00008) were positively significant and IT Investment  $\phi_3$  (-0.00007), IT personnel  $\phi_4$  (-0.0007) and Credit card expenses  $\phi_9$  (-0.0001) were negatively significant for the profit efficiency of PCBs. Also the IT expenses  $\phi_1$  (-0.000002), ATM transaction  $\phi_6$  (-0.00002) and ATM expenses  $\phi_7$  (-0.0002) had negative effect on the profit efficiency of PCBs. This result contradicts with the study of Loveman (1994) who used Ordinary Least Square method to assess the productivity effect of IT on manufacturing firms. Bangladesh banking industry and other firms may benefit from the results of this study as they may have a better understanding of relationship between IT investment and bank’s efficiency. Customers’ and investors may benefit from the findings of this study as the findings would add value to their knowledge of how efficient their various bank branches are, in terms of managing their investments.

**Table 3.** IT Determinants of Profit DEA Efficiency for PCBs by Ordinary Least Square

Profit DEA Efficiency		Private Commercial Banks	
Variable	Parameters	Coefficient	P-value
Intercept	$\phi_0$	0.078**	0.001
IT Expenses	$\phi_1$	-0.000002	0.956
IT Income	$\phi_2$	0.00006	0.456
IT Investment	$\phi_3$	-0.00007**	0.003
IT Personnel	$\phi_4$	-0.0007*	0.031
IT Personnel Expenses	$\phi_5$	0.0015***	0.000
ATM Transaction	$\phi_6$	-0.00002	0.373
ATM Expenses	$\phi_7$	-0.0002	0.311
Credit Card Transaction	$\phi_8$	0.00008***	0.000
Credit Card Expenses	$\phi_9$	-0.0001*	0.049

Source: Author’s calculation

**CONCLUSION**

This study examined the role of IT on the cost and profit efficiency of 17 PCBs in Bangladesh during 2007-2018 employing VRS cost DEA and profit DEA. The Tobit regression model could not apply for estimating the IT determinants of VRS profit model for DEA because the Tobit model is used when the dependent variable was bounded [0,1]. So the ordinary least square method is employed to evaluate the IT determinants of both VRS cost DEA efficiency and profit DEA efficiency on PCBs with ordinary least square method. In PCBs, the average cost efficiency (41.4%) was higher than profit efficiency (18.8%). Prime bank was the most cost and profit efficient with 71.3% and 53.7% respectively. Besides DBBL bank was the less cost efficient (16.2%) and Al-arafah was

the less profit efficient (2.6%) respectively. In IT determinants of cost DEA efficiency for PCBs, the IT personnel  $\phi_4$  (-0.0009) was negatively significant and credit card transaction  $\phi_8$  (0.000006) and credit card expenses  $\phi_9$  (0.0002) were positively significant for the cost efficiency of PCBs. Since the profit DEA efficiency score is recorded negative, we used the ordinary least square method to analyze the impact of ICT factor on banks. IT personnel expenses  $\phi_5$  (0.0015) and Credit card transaction  $\phi_8$  (0.00008) were positively significant and IT Investment  $\phi_3$  (-0.00007) and IT personnel  $\phi_4$  (0.00007) were found negatively significant for the profit efficiency of PCBs. Overall, the IT factors are found more significant for PCBs. Finally, the ICT component had great impact on PCBs. This study shapes a new measure of efficiency because this study employs the IT data for gauging the role of IT components on Bangladeshi banking industry with cost DEA and profit DEA efficiency.

In this study, the researchers found that the company paid attention to the occupational health and safety merely because they want to get an occupational safety and health certification (OHSAS 18001) or fear of an occupational safety and health audit caused by a high number of work accidents or low level of employee health. However, due to the COVID-19 pandemic, the management of occupational health and safety inevitably requires the company to implement the 5M health protocols properly to prevent the spread of the COVID-19 in the work environment. During this period of the COVID-19 pandemic, we are reminded again that the management of occupational health and safety is not only the responsibility of the company, but also the responsibility of various parties, namely employees and consumers to comply with and implement the 5M health protocols for the sake of common good. Occupational health and safety management runs well if the interests of the management, employees and consumers are well fulfilled.

The researchers found that the implementation of the 5M health protocols that has been carried out by all employees of Rembang Post Office every day has become a behavioral element of organizational culture (daily belief). The head of Rembang Post Office has a transformational leadership style where the head of Rembang Post Office is disciplined to implement the 5M health protocols and invites all employees of Rembang Post Office during morning briefing to be disciplined in implementing health protocols so that Rembang Post Office does not become a cluster for the spread of the COVID-19 in order to maintain the good image of Rembang Post Office. This study also proved that occupational health and safety does not have a direct influence on employee performance (Ekowati & Amin, 2018) and occupational health and safety management systems can improve occupational health and safety conditions and support the creation of a healthy and safe workplace (Mohammadfam et al., 2017).

The COVID-19 pandemic has forced companies, especially post offices, as public service offices to comply with occupational health and safety by being disciplined in carrying out health protocols. The existence of discipline in carrying out health protocols indirectly improves employee performance. Improved employee performance indirectly affects employee satisfaction. 5M health protocol can be implemented properly if there is good cooperation between post office management, employees, and postal customers.

### **Research Implication**

It is very important to the fact that in the modern age, ICT is a crucial resource of an organization like banks. The banking industries are influenced by technology, mostly in the following three aspects:

1. ICT increases competition and the degree of contest-ability among the banks.
2. Technology impacts the economy of scale in banking.
3. Technology provides better services in the economy.

This study builds a new measure of efficiency because this study employs the huge ICT data for measuring the impact of ICT component on cost and profit efficiency of PCBs in Bangladesh which is different from other studies. This study emphasized the PCBs that has to be internally efficient and technologically advanced. The information obtained from efficiency studies can be used to help government, regulators, and investors to remove the hindrance of progress in economy of Bangladesh.

### **Limitation and Further Study**

Specifically the study undertakes to investigate the use of IT variables (e.g., IT expenses, IT income, IT investment, IT personnel, IT personnel expenses, ATM transaction, ATM expenses, Credit Card transaction, and Credit Card expenses) on the selected 17 PCBs in Bangladesh where IT data are available. There are a few IT factors, cannot be used in this study as banks are unwilling to disclose data bothering on these issues for competitive reasons. So data obtained from published reports and banks officials are expected to serve the objectives of the study. Again, DEA is limited in terms of using it to estimate the efficiency of new banks in the

face of their IT variables. Future studies can combine DEA model and machine learning algorithms like random forest, decision trees, and artificial neural network to develop models for predicting future bank's efficiency.

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