Impact of Usage and Investment in Banking Technology on its Profitability

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ABSTRACT

Banking industry had witnessed a huge amount of investment in technology since the Banking liberalization. The banking industry claimed that the use of technology like ATM, online banking, mobile payments, etc. improved the efficiency of banking operations. But this improved efficiency comes with an added cost. During this period, the banking sector spent a higher amount on technology as compared to their financial service industry counterparts. For instance, the banking sector spent on an average 4.7 to 9.4 %of operating income on technology during last decade whereas Insurance Companies and Airline companies spent 3.3 % and 2.6% of operating income in the last decade. ("2019 Banking Industry Outlook." ,2019) In this paper, we explored whether large IT budgets could generate higher revenue and improved operational efficiency or not. We examined the performance of selected Public Sector and Private sector banks through Data Envelope Method (DEA). Results of the DEA model suggested an increasing trend inefficiency in most of the banks during the last decade.

Keywords: *Banking; IT budget; Profitability: Technology.*

1.0 Introduction

The liberalization and globalization have brought many changes in business practices and economic systems in the world. The banking sector has undergone a huge transformation during this period. It embraced modern technology to improve the operational performance with speed and accuracy. (Yurcan, 2018) A Forbes report said that globally banks are going to spend around $ 100 billion in technology in coming years which is a large investment. ("How Much Do Banks Spend on Technology? n.d.) Globally, adoption of technology-enabled innovations in financial services also known as FinTech had been increasing rapidly in the recent years. Driving forces behind FinTech revolutions are; I) consumer preference for ease, speed, cost effectiveness in financial interactions; and (ii) technological improvements related to internet, big data, mobile telephony, and computing power. The emergence of FinTech is also attributed to the high cost of financial intermediation by existing system despite significant developments in information technology (IT)signifying inefficiency prevailing in the system. ("Tech Trends 2018",2017).

Previously the impact of electronic investment of banks on their profitability was assessed using Synthesized Approach, Cluster Analysis, Agglomerative-Hierarchical Method, etc. Data Envelopment Analysis (DEA) was also one of the approaches to conduct such type of analysis. (Rashedul &Israt, 2012) & (Sherman & Gold, 1985). The present study used Data Envelopment Analysis (DEA) to assess the impact of IT investment on Banks profitability. We selected as many as 23 banks (before the recent merger) which included major public sector and private sector banks for this study.

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2.0 Literature Review

In order to be competitive, cost effective, customer oriented and customer friendly, banking industry across globe had spent huge amount on banking technology. This inflow of investment in technology may continue in next decade as well, as innovative technology enters into market every now and then. To understand whether such a huge inflow in technology by banking sector would result into increasing profitability or not was the main objective of the study.

Different researchers had different view to measure efficiency or profitability of the banks in general. For example, Norman (2011) had established Enterprise Performance Management ('EPM') framework which could help banks to measure their performance. He suggested that ROA - Return on Assets, RAROA - Risk Adjusted Return on Assets, ROE - Return on Equity, RAROE - Risk Adjusted Return on Equity, RAROC - Risk Adjusted Return on Capital and EVA - Economic Value Added could be part of the EPM. And hence the same could be used for analysing banks' profitability and performance. He concluded that profitability-based performance management framework would be important tool to translate organisational strategy into appropriate transactional goals. This would help banks to track and monitor at the right levels and frequency which might lead to deliver expected enhancement in metrics like ROA and thereby increase in valuation.

Another question was when to measure impact of IT investment on profitability. Brynjolfsson & Saunders (2009) examined the measures of impact of Information Technology on economy. They further said that although many researchers questioned contribution of IT on growth of economy, many other researchers specifically after 2000, started believing that increase in the productivity after 2000 were due to heavy investment made in Information Technology in late 90s. With the help of source of growth model (originally developed by Robort Solow), they tried to measure the role of Information Technology in growth of economy. Further they said that if you invest today in Information Technology, you would experience the growth in productivity after the gap of 3to 4 years.

Apart from banking industry, other industries also redressed themselves with new technology. Hence, Mahmood and Mann (1993) explored the organization impact of Information Technology investment, which can apply to any industry. They found significant relationship between them. However, they also suggested that the relation between them was also affected by many other factors such as economic circumstances, competitive situation and managerial judgements. Organization impact was measured through sales by employees, sales by total assets, market value to book value, return on investment, return on sales, etc. They measured IT investment as number of PCs and terminals as a percentage of total employees, IT budget spent as percentage of revenue, IT budget spent on training, etc.

Other researchers across the world developed various specific tools to find out the whether the investment on Fintech by Banking Industry was profitable or not. As this revolution of banking industry started mainly in developed countries, researchers of these countries were pioneers in establishing such tools. For example, Beccalli (2003) explored 737 banks for the period 1993-2000 to study the impact of technological investments on profitability of banks in United Kingdom, France, Germany, Italy and Spain. He used software cost, hardware cost and service cost as investment variables and ROA and ROE as performance variables. He concluded that there is no significant relationship between information technology expenditure and improvement in profitability.

Parsons et al. (1993) studied the impact of Information Technology on banking industry for Canada. They took data for the period 1974-1987 and measured the impact with the help of production function. They concluded that banking industry witnessed productivity growth associated with the enhanced investment in Information Technology. However, they also noted that benefits mostly got credited to customers and not to banks.

Many technologies giant made entry into financial market of USA using their technology such as Amazon, PayPal, Apple, Facebook, etc. Hence, it was estimated that banking sector of USA would continue to observe technology influx to grow in this decade as well to be competitive. So many researchers developed different tools to measure the impact of such huge investment on profitability. For example, Shirley and Mallick (2005) explored and tested a differential model which was extension of production model to examine the effects of information technology in the US banking industry. They developed the model based on two beliefs: IT could reduce operational cost (cost effect) and could facilitate transactions among customers within the same network (network effect). They studied panel data of 68 US banks over 20 years and found that the bank profits declined due to adoption and diffusion of IT investment, reflecting negative network effects in this industry.

While the above researchers could not establish positive relationship between IT investment and profitability of USA banking sector; another researchers team, Alpar and Kim (1990) also analysed the impact of IT on economic performance 759 US banks during 1979-1986. They applied cost function approach and concluded that IT was able to save personnel costs, hence overall operating costs and increase capital expenditures of banks (as IT expenditure was part of capital expenditure) led shrinking demand deposits, and boosting time deposits.

Another researcher Sullivan (2000) had come out with similar findings. He argued that Internet Banking also performed well as compared to brick-and-mortar banks despite of huge additional investment in IT. He also said that these Internet Banks generate comparatively more non-interest income, which might have helped them to overcome additional expenses.

There were few researchers whose research showed neutral impact of IT investment on profitability of USA banking sector. DeYoung (2005) studied and compared the US **traditional brick and mortar banks and Internet only banks**. His investigation was based on the performances on the US economy. He observed that majority of the newly start-up Internet-only banks underperformed the well-known banks at first. Also, he said that bank profitability was lower for internet-only banks and remarked that the said performance of this bank diminishes over time as these fresh banks grow older, larger and stronger; and recommended in his study that the Internet-only banking model could possibly be feasible as far as it performed efficiently.

Furst et al. (2002) also tried to establish a link between offering electronic banking and bank's profitability. They concluded that federally chartered US banks had higher Return on Equity (ROE) by adopting the Click and Mortar Business Model and they also observed that more profitable banks adopted internet banking after 1998 but yet they were not the first movers. These researchers concluded that e-banking was too small a factor to have affected bank profitability at that time.

So, basically researchers of the USA had the mixed opinion about the relationship between the IT investment and profitability of the banks.

Another developed country- Spain's banking industry was ahead in accepting technological challenges and incorporated technological innovations to increase competitiveness of their banks and Fintech as compare to their counterparts across the world. Hernando and Nieto (2007) studied Internet banking scenario in Spain and argued that Internet banking was perceived as an additional channel to complement traditional banking. They studied the effect of adopting of a transactional website on over 70 Spanish banks between 1994 and 2002 and found a **steady decline in staff expenses** and overhead and as a result of the adoption of Internet **Banking**, which they in turn associated with improved bank profits. These researchers predicted that larger Spanish banks would adopt Internet banking.

Russia – non developed country could represent Asia as well as European culture being transcontinental country. Kiselev et al. (2016) developed "methodical approaches to assess the impact of electronic banking service on the economic parameters of the Bank activity" using Russian Banks' data. To develop this model, they used factor analysis, pair correlation, multiple correlation analysis, matrix models, and mathematical modelling. They suggested through a proposed mathematical model

that when information technologies which were embedded in the organizational system of the banking organizations have systemic effects. And these systemic effects were expressed in the boosting of processes of consolidation, innovation activity, which influence significantly the economic and functional parameters of the banking organization's activity in the whole.

India is a developing country and we compare Indian banks' outcome with their counterparts from developed countries, it would be unfair towards them. So, the similar kind of research performed in few developing countries like Mexico, Brazil, Russia as well as India was taken into consideration. Ivatury and Mas (2008) noted in their paper that **branchless banking** could reduce the transaction cost and hence could be beneficial to the poor and unbanked people. Also in this regard, they observed that few poor and unbanked people started using branchless banking of financial services specifically they were operating mobile banking. Yet, another observation made by them that branchless banking facilities adopted by customers generally for payment purpose not for savings and credit.

1991 year was also remarkable in Indian banking history as it paved the way for private banks to enter in Indian financial market. Although, India's first ATM was installed in 1980, Indian banks started embracing technology wholeheartedly only after IT sector boom in India. So, the Indian researchers started talking about Banking Technology and Fintech then after.

Gopalan et al. (2012) studied the IT investment weightage in banking industry and bifurcated banks into different categories realizing all Indian banks had different approach towards Information Technology. Four categories were i) Heavy IT transformer ii) High IT spenders iii) Effective Business Enablers iv) IT executors. "Heavy IT transformer" whose spending in IT was high as compared to other categories. "Effective Business Enablers" were those banks whose spending in IT was high and but at the same time they experienced the highest revenue growth as compared to "Heavy IT transformer". Effective Business Enablers could experience high growth because of stringent demand management process to govern Project Section and funding. Top management often formulate IT strategy and IT road map and make deliverables aligned business strategies.

Sujeesh Kumar (2013) and Dhingra (2014) had used different tools to measure the profitability. Sujeesh Kumar (2013) found the impact of Information Technology on Total Factor Productivity (TFP). He applied non parametric Data Envelopment Analysis (DEA) for public sector, private and foreign banks operating in India. He used multiple regression models and concluded that increased electronic transactions in the banking channel had resulted in the increase in productivity.

Dhingra (2014) measured the efficiency of IT deployment using Data envelopment Analysis (DEA). He applied non parametric Data Envelopment Analysis (DEA) for 26 public sector Banks for the period 2003 till 2009 and made an observation that overall efficiency had improved due to improvement in scale efficiency. He concluded that banks improved their efficiency in terms of finding proper locations of ATMs where they could be maximally utilized and ensuring the minimum downtime of the IT systems.

Narwal and Pathneja (2015) also measured profitability and productivity using DEA analysis. They performed the analysis on private and public sector banks and found that private sector banks were more productive and profitable.

Parameswar et al. (2017) analysed the IT investment in one specific Indian bank - ICICI bank. They concluded that if the investment in IT could be done through detail product study, its application and usability; then technology could be used to broaden boundary. Banks would be able to reach under-served consumers in rural communities with innovative products, financial literacy outreach, and efficient modes of product delivery.

So various literatures whether they were from developed countries or developing countries had diverse opinion. Similar type of suggestion was made by Ahmed et al. (2010) as they reviewed many literatures to analyse the view of researchers on "Impact of Internet Banking on banks

performance". They found mixed opinion of researchers on Banks performance. Although it was concluded that indeed Internet banking had raised cost significantly, still several benefits were also experienced by Banking Industry. One of the benefits was - Banks were able to offer additional financial services to their customers through Internet.

Alpar and Kim (1990), Mahmood and Mann (1993), Kiselev et al. (2016), Sullivan (2000), Sujeesh Kumar (2013) and Hernado and Nieto (2007) found positive impact on profitability by IT investment. Parsons et al. (1993) also found positive impact but they said that benefits of increased IT investment were being credited to customers' account not to the banks. While Sullivan (2000) suggested that the positive correlation was because of generation of higher non- interest income. And Dhingra (2014) attributed improved scale efficiency as the factor to the positive correlation.

On the other hand, a few researchers did not find positive impact between increased IT investment and its impact on profitability. Noteworthy among them were Beccalli (2003), DeYoung (2005) and Parameswar et al. (2017) who could not establish any positive correlation between increased IT investment and its impact on profitability. Whereas, Furst et al. (2002) concluded that increased IT investment was very small factor to decide profitability of the banks.

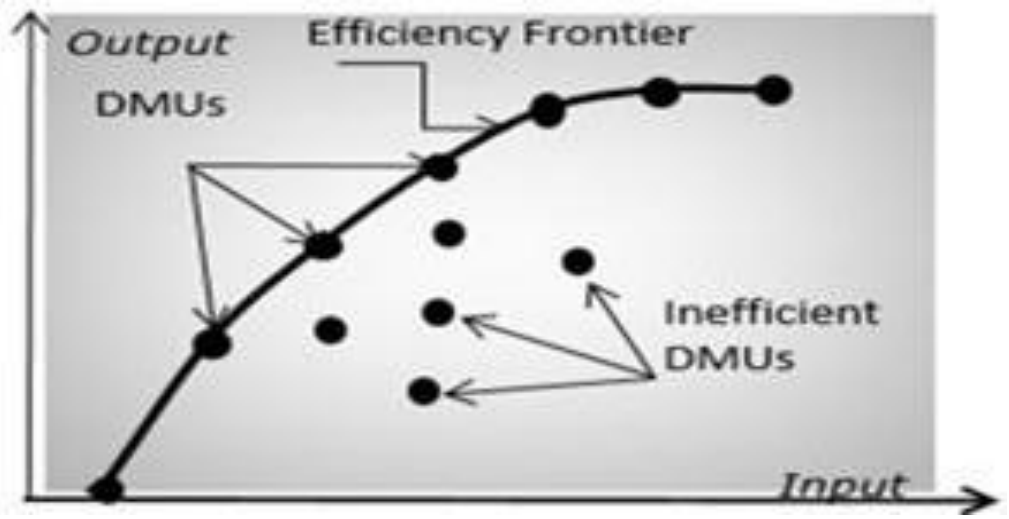
In contrast to above researchers, Shirley and Mallick (2005) suggested that banks profits declined due to adoption and diffusion of IT.

3.0 Research Methodology

Data Envelopment Analysis (DEA), developed by Charnes et al. (1978) had emerged as an important tool to evaluate the efficiency of a set of "Decision Making Units" (DMUs) using multiple inputs to product multiple outputs. DEA is a non-parametric method of operation research. DEA extensively applied in performance evaluation and benchmarking in a wide variety of contexts including educational departments in public schools and universities, health care units, prisons, agricultural production, and banks.

DEA evaluates the inputs consumed and outputs produced by DMUs and identify those units that comprise an efficient frontier and those that lie below this frontier as shown in Figure 1. (Tlig et al.,

Figure 1: Efficient Frontier of DEA



2009) DEA determines a set of weights such that the efficiency of DMU_0 (target DMU) relative to the other DMUs is maximised. For an inefficient DMU, it identifies the source and the amount of inefficiency in each input relative to each output. DEA models can be either constant or variable

returns to scale (Banker et al., 1984). DEA model can be used with very small data precisely because it is a non-parametric approach.

In other words, to perform DEA model in evaluating multiple DMU'swith multiple inputs and outputs, the following are required:

- Input and output for each DMU is to be specified;
- Define efficiency for each DMU as a weighted sum of outputs [total output] divided by a weighted sum of inputs [total input]; where all efficiencies are restricted to lie between zero and one (i.e., between 0% and 100%).

In calculating the numerical value for the efficiency of a particular DMU weights are chosen so as maximise its efficiency, thereby presenting the DMU in the best possible light

The CCR Model of DEA

CCR model, which was initially proposed by Charnes et al. (1978), can be represented as a fractional linear programming problem.

4.0 DEA Mathematical Model

Objective Function:

Maximize

$$Eo = \frac{u_1 y_{1o} + u_2 y_{2o} + \cdots + u_s y_{so}}{v_1 x_{1o} + v_2 x_{2o} + \cdots + v_m x_{mo}}$$

(Maximize the efficiency rating ¢ for service unit 0.)

This is subject to the constraint that when the same set of u and v coefficients is applied to all other service units that are being compared, no service unit (SU) will be more than 100% efficient as follows:

Subject to

$$\frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}} \leq 1$$

$v_1, v_2, \ldots\ldots, v_m \geq 0$

$u_1, u_2, \ldots\ldots, u_s \geq 0$

Where E_0*= the efficiency of the 0th DMU,*

y_{so}*= sth output of 0th DMU*

u_s *= weight of sth output*

x_{mo} *= mth input of the 0th DMU*

v_m *= weight of mth input*

Here the DMU_j to be evaluated on any trial be designed as DMU_o where j ranges over 1, 2, n.

The constraints meant that the ratio of "virtual output" to "virtual input" should not exceed '1' for every DMU.

4.1 Input /Output variable

To measure the efficiency of IT deployment, input variables need to be decided (Dhingra, 2014). The input variables included in the present study were;

i) Computerization expenditure to operating expenditure
ii) Number of ATMs,
iii) Electronic transaction volume to total transaction volume

The following variables were used as output variables in the present study

i) Business per employee,
ii) Business per branch
iii) Operating profits per employee to measure the efficiency of IT deployment

DEA technique as discussed earlier was used to find out profitability of IT investment. Brynjolfsson& Saunders (2009) suggested that if Banks invest today in Information Technology, they would experience the growth in productivity after the gap of 3to 4 years. Hence, the DEA model used for the study took into consideration input for last four financial years and calculated their efficiency or productivity. For example, input variable values considered for 2009-10, 2010-11, 2011-12 and 2012-13financial years, then output variable values used for the financial year 2012-13 and efficiency was calculated using DEA model for the financial year 2012-13. We selected 23 banks from private sector and public sector based on convenient sampling and availability of the data. Each bank in DEA calculations considered as separate DMU. Out of the 23 studied banks, 11 are public sector banks whereas 12 banks are private banks. We calculated efficiency separately for private and public sector banks as both the sector worked on different scale. To calculate efficiency, Data was taken from last decade i.e., from 2008-09 till 2018-19, from Prowess database, a corporate database developed by Centre for Monitoring of Indian Economy (CMIE); MoneyControl.com and RBI trend and progress reports and various other RBI reports from 2008-09 till 2018-19.

Most of the existing empirical studies adopted the production function approach, describing business profits (outputs) as a specific function (i.e., Cobb-Douglous) of inputs. The production approach considers the efficiency, with which inputs (physical variables such as e-transactions, ATMs, IT expenditure, etc) are converted into business outputs. So, in the same line, in the proposed study, we adopted DEA model and all output variables and input variables was converted to objective function and constraints to solve linear programming. Objective function in the study was to maximize the efficiency of IT investments.

Microsoft Excel and DEA frontier software were used for computation purpose. And DEA analysis was performed using 'Solver' add-in in Microsoft Excel i.e., a customized program was written to solve DEA mathematical model. As DEA analysis was supposed to perform for 243times (23 banks multiplied by 11 years), analysis was done though automated process. For that VBA program code was developed and executed to get the result (efficiency). Efficiency scores between 0 and 1 was obtained for every bank, for each year. The average efficiency of all the public sector and private sector banks for each year was computed. On each year of data, CCR model and BCC model was applied.

5.0 Results & Finding

The technical efficiency for all 23 banks was calculated for the period from 2012-13 to 2018-19. DEA used all the banks as separate DMUs. For example, for the year 2012-13, while calculating technical efficiency of Allahabad bank, DEA model would consider it as DMU_0. DEA model would then compare DMU_0's efficiency with all other DMUs (i.e., with all other banks). If the DMU_0 is part of efficient frontier (refer Figure 1), its technical efficiency would be 1.00 i.e., 100%. So, by referring the Table -1, it was observed that Allahabad bank -DMU_0 was on efficient frontier for the year 2012-13. Apart from the Allahabad Bank - Bank of India, Bank of Maharashtra, Central Bank of India, Dena Bank and State Bank of India from public sector banks could achieve100% efficiency for the year 2012-13 i.e., the whole amount of input could generate the desired output. In other words, we could say that input variables such as e-transactions, ATMs, IT expenditure led to growth in ratios such as Business per employee, Business per branch operating profits per employee. On the other hand, Andhra Bank, Canara Bank, Bank of Baroda, Corporation Bank and IDBI Bank Limited from public sector banks were below the efficient frontier line i.e., could not attain 100% efficiency as compare to their counterparts.

Table 1: Technical Efficiency of 23 select banks for the period from 2012-13 to 2018-19

Bank Name	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Public Sector Bank							
Allahabad Bank	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Andhra Bank	0.75	0.83	0.91	0.93	0.94	0.92	0.99
Bank Of Baroda	0.90	0.72	0.72	1.00	0.93	0.91	0.72
Bank Of India	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bank Of Maharashtra	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Canara Bank	0.64	0.77	0.77	1.00	0.95	1.00	0.76
Central Bank of India	1.00	1.00	1.00	0.90	0.97	1.00	1.00
Corporation Bank	0.51	0.63	0.63	0.94	0.70	1.00	0.63
Dena Bank	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IDBI Bank Limited	0.60	0.51	0.51	0.75	0.72	0.85	0.51
State Bank of India	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Private Sector Banks							
Axis Bank Ltd.	0.78	0.89	0.89	0.98	1.00	0.70	0.95
Catholic Syrian Bank Ltd	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Federal Bank Ltd	0.41	1.00	1.00	0.23	0.60	0.40	1.00
HDFC Bank Ltd.	0.61	0.40	0.40	0.47	1.00	0.76	0.40
ICICI Bank Ltd.	0.59	0.77	0.77	0.92	1.00	0.82	0.77
Karry's Bank	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Indusind Bank	0.40	0.53	0.53	0.59	0.91	0.58	0.50
Jammu & Kashmir Bank Ltd	0.99	1.00	1.00	1.00	1.00	0.93	1.00
Karnataka Bank Ltd	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Kotak Mahindra Bank Ltd.	0.54	0.46	0.46	0.50	0.84	0.61	0.45
Lakshmi Vilas Bank Ltd	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes Bank Ltd.	0.49	0.42	0.54	0.71	0.98	0.58	0.63

From the Table I, it was noted that among all Public Sector Banks, Allahabad Bank, Bank of India, Bank of Maharashtra, Central Bank of India, Dena Bank and State Bank of India achieved 100% efficiency for the years of select period. For these banks expenditure made for Banking Technology led to profitability for the period 2008-09 to 2018-19.

Similar kind of observations made for few of the Private Sector Banks such as Catholic Syrian Bank Ltd., Karur Vysya Bank, Karnataka Bank Ltd. and Laxmi Vilas Bank; as they could achieve 100% efficiency for the entire period. Banks such as Jammu & Kashmir Bank could achieve 100% efficiency except one year. For all other banks, we could say they had scope to improve the efficiency in terms of investment in IT. All this could be partly due to the factors such as demand for innovative customer services through mobile banking and social media, major changes in regulatory environment, inflexibility of banking technology to cope up with service requirement.

To take a comprehensive view of the public sector and private sector banks, we derived and calculated from Table -I 'Average Efficiency' for all the select public sector and private sector banks. Table -2 shows sector wise the Average Efficiency, which makes comparison of two sectors more visible.

Table 2: Average Efficiency of 23 select banks for the period from 2012-13 to 2018-19

Bank Name	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Public Sector Banks	0.854	0.859	0.866	0.956	0.929	0.971	0.872
Private Sector Banks	0.734	0.788	0.798	0.783	0.944	0.782	0.808
Overall Average Efficiency	0.794	0.824	0.832	0.870	0.937	0.876	0.840

From Table II, it was observed that Average Efficiency of Public sector banks outruns the average efficiency of Private sector banks for the entire period except financial year 2016-17. In 2018-19 year, all the banks achieved highest efficiency all together as compared to other years.

CCR model of DEA which was used to calculate efficiency, had limitation. The result of CCR Model was purely based on technical efficiency and it does not take into consideration scale. Return to scale Model of DEA or BCC Model proposed by Banker et al., 1984 can be applied to remove the effect of scale in finding out efficiency. So, the BCC Model of DEA also was applied to the above data. For all the select public sector and private sector banks, BCC model calculated efficiency exactly as 1.00 for the entire period.

There is a concept called scale efficiency. Scale efficiency can be calculated by dividing CCR model efficiency with BCC model score efficiency. Then the scale inefficiency can be calculated by subtracting scale efficiency from 1. (Banker et al., 1984) Percentage scale inefficiency could be obtained by multiplying it with 100. The Table III showed the composite scale inefficiency of public and private sector bank. It was observed from the table that public sector banks' scale inefficiency was reduced marginally from 14.6% to 12.8%, while Private sector banks' scale inefficiency was reduced from 26.6% to 19.2% for the select period. So, we could say that because of more investment and usage of IT, Public and Private sector banks could shrink their scale inefficiency.

Table 3: Average inefficiency in percentage of 23 select banks for the period from 2012-13 to 2018-19

Bank Name	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Public Sector Banks	14.6%	14.1%	13.4%	4.4%	7.1%	2.9%	12.8%
Private Sector Banks	26.6%	21.2%	20.2%	21.7%	5.6%	21.8%	19.2%

Apart from just calculating efficiency (€), DEA also identifies Banks' inefficiency directly against another Bank. (Cooper et al., 2000) This efficiency reference set (ERS) includes the group of Banks against which each inefficient Bank was found to be most directly inefficient. The presentation in Table 4 summarizes the magnitude of the identified inefficiencies by comparing the inefficient Bank with its efficiency reference set for the year 2018-19 for private banks.

Table - 4: Efficiency Reference Set for the year 2018-19

			Catholic Syrian Bank Ltd	Jammu & Kashmir Bank Ltd	KarurVysya Bank	Yes Bank Ltd.
DMU No.	DMU Name	Efficiency	Optimal Lambdas			
1	Axis Bank Ltd.	0.95	0.0010	0.0062	0.0032	
2	Catholic Syrian Bank Ltd	1.00				
3	Federal Bank Ltd	1.00				
4	HDFC Bank Ltd.	0.40	0.0001	0.0505		0.3448
5	ICICI Bank Ltd.	0.77				
6	Karur Vysya Bank	1.00				
7	Indusind Bank	0.50		0.0348		0.4684
8	Jammu & Kashmir Bank Ltd	1.00	0.4758	0.4758		0.5752
9	Karnataka Bank Ltd	1.00				
10	Kotak Mahindra Bank Ltd.	0.45		0.0355		0.4174
11	Lakshmi Vilas Bank Ltd	1.00	0.5674			0.6610
12	Yes Bank Ltd.	0.63		0.0512	0.0012	

DEA calculates ERS for all inefficient banks. As shown in Table -IV, HDFC Bank 's efficiency is 0.40 i.e., it had scope to improve its efficiency. ERS showed that HDFC Bank found to have operating inefficiencies in direct comparison with Catholic Syrian Bank Ltd. (0.001), Jammu & Kashmir Bank Ltd. (0.0505) and Yes Bank Ltd. (0.3448). The value in parentheses in Table IV represents the relative weight assigned to each efficiency reference set (ERS) member to calculate the efficiency rating (0). For example, one way for HDFC bank to become efficient was to reduce its inputs to 40%of its current level. This would move HDFC Bank into the relatively efficient production segment.

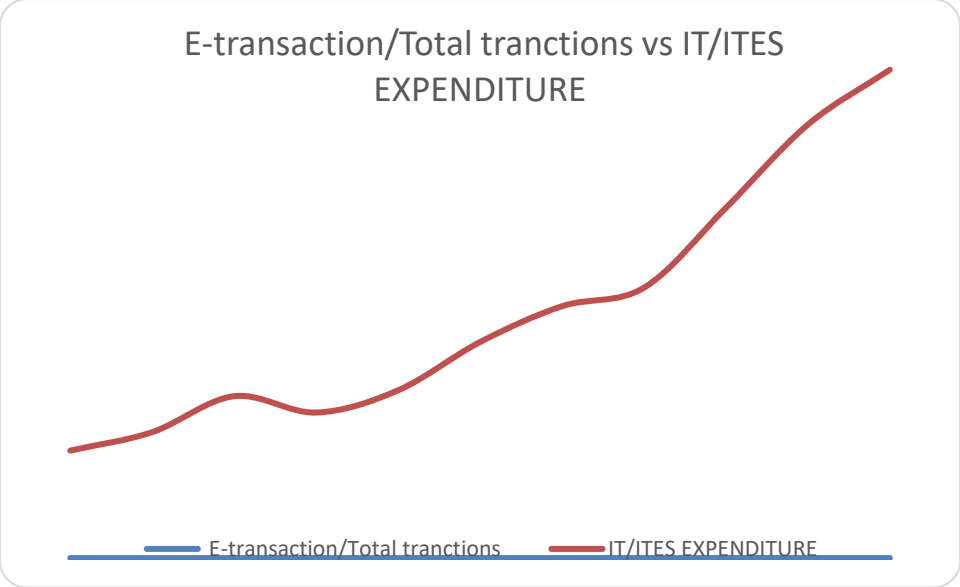
The inputs and outputs of the Catholic Syrian Bank Ltd., Jammu & Kashmir Bank Ltd. and Yes Bank Ltd. were multiplied by the weights derived by ERS noted in Table III, 0.001, 0.0505 and 0.3448, respectively. These are then added together to create a composite unit that provides as much or more services as the inefficient Bank- HDFC Bank, while also using less inputs than HDFC Bank.

Similarly, Lakshmi Vilas Bank Ltd. found to have operating inefficiencies in direct comparison with Catholic Syrian Bank Ltd. (0.5674) and Yes Bank Ltd. (0.6610).

6.0 Discussion on Findings

It is generally assumed that when E-transactions increases; to accommodate, save and process this increased traffic of transactions, IT expenditure also increases as bankers will have to spend more on servers, data storage, network, etc. Figure 2 shows increasing trend in ratio of E-transactions with respect to total transactions along with increasing trend of IT investment of the select banks for the period of 2008-09 to 2018-19.

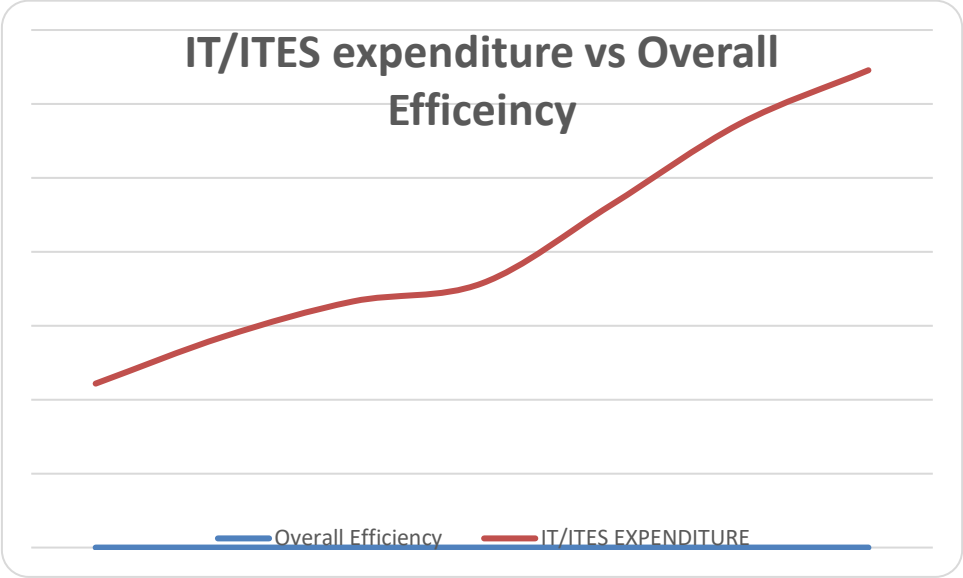
Figure 2: E-transaction vsIT/ITES expenditure,



Source: RBI

Next is IT/ITES expenditure and overall efficiency graph was captured for the select banks for the period of 2012-13 to 2018-19, which showed increasing trend in expenditure which matched with the trend of overall efficiency of select banks till 2016-17, then overall efficiency showed downward trend.

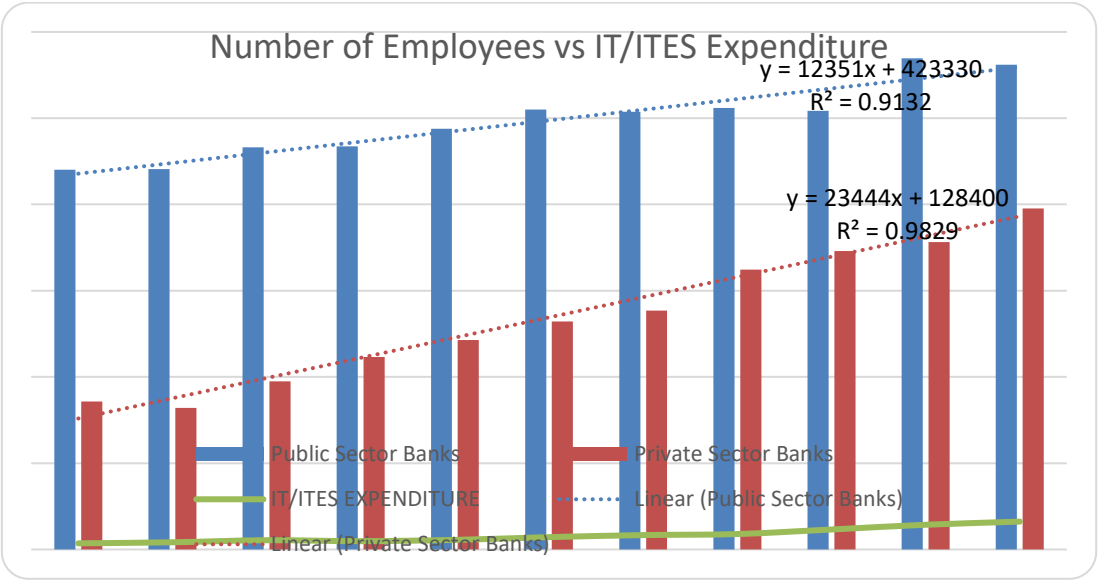
Figure 3:IT/IT Expenditure Trend



Source: Prowess database by CMIE

Sujeesh Kumar (2013) & Sullivan (2000) observed that Banks were investing in technology by acquiring innovative technology or replacing legacy system; to improve customer satisfaction, to survive in competition, to improve operating efficiency, etc. However, if we observe the collected data from Table II and figure 3 for the select banks, it was evident that although IT/ITES expenditure was increasing year on year but efficiency was not moving at the same pace for the entire select period. So, as pointed out by Parsons et al. (1993), we could say that increase in expenditure might have resulted in increased customer satisfaction but may not have contributed in increasing efficiency.

Figure 4: Number of Employees Overall Efficiency



Source: RBI Annual Data & Prowess database by CMIE

Number of employees had also experienced increasing trend for the select banks and so would be IT/ITES expenditure (Refer Figure 4). But trend line slopes were different for expenditure

and number of employees. Select public sector banks had experienced mere 27.7% growth in number of employees for the period 2008-09 to 2018-19 while select private sector banks had experienced 130.4% growth in number of employees for the period 2008-09 to 2018-19. Whereas IT/ITES expenditure witnessed huge 354.4% growth for the same period.

Hence, as Alpar and Kim (1990) concluded that IT expenditure would be able to shrink personnel cost, this could be evident specifically for the select public sector banks.

One another observation was, average efficiency was higher for public sector banks as compared to private sector banks (Refer Table II). However, Agrawal et al. (2017) derived from their study that private sector banks were performing better than public sector banks. The difference in efficiency may be due to the technology or production process used, how well that process is managed. Another reason attributed to lower efficiency of private sector banks was due to increase in number of branches in small towns and rural setups, wherein the banks had to spend on the infrastructure. And in the initial gestation period the revenue of such banks would be lower as compared to PSUs.

In another finding, Efficiency Reference Set was calculated and revealed their operating inefficiencies in direct comparison other efficient banks. Banks can improve their efficiency by taking lessons from successful strategies, technology and operations adopted by their peer banks.

7.0 Limitations

1. Due to limited time and unavailability of data, DEA analysis was performed on select 23 banks only.
2. For one of the selected input variables 'electronic transaction volume to total transaction volume' overall banks volume was considered as bank wise transaction volume was not available easily.

8.0 Conclusions

Indian banks have adopted innovative &modern banking technology at a fast pace. Both public sector and private sector banks have already implemented e-banking facilities and hence made huge investments. These technology-driven services are going to make jobs easier for bankers as well as customers. Ahmed et al. (2010) concluded in their paper that banks could offer more innovative services to customers. This has raised customer satisfaction in terms of availability of services 24 *7, services available at the tip of the fingers; need not to stand long queue, etc.

Data collected for total number of e-transactions as compared to total number transactions showed increasing trend since 2008-09 till 2018-19; despite of the security threats, payment challenges. Similar trend was observed for the investment in Technology. This scenario suggested increasing popularity of banking technology among bankers as well as customers over the period of time. As shown in Table II, average efficiency of the public sector banks was higher than private banks for the period from 2012-13 till 2018-19that means they were utilizing resources more efficiently than private sector banks. Also, DEA calculations indicated that in 2016-17-year, overall efficiency of all the banks was highest as compared to other years. Still, only some of the banks could achieve 100% efficiency which signals that the other banks still have a scope to improve their efficiency. Ultimately, Banks' victory in digital transformation will depend on how strategy, technology and operations work together across domains. (Egland et al, 1998) To achieve this, banks should improve their skills at data management, modernizing core infrastructure, embracing Artificial Intelligence ('AI') and migrating to the public in the coming years.

To achieve the desired efficiency out of IT Technology, bankers should have to make wise decision as they might face challenges like which systems should be replaced first? Systems that process high volumes of transactions like core deposits and credit card platforms, will likely take significant effort to transform versus some lending platforms that might be easier to migrate. Another challenge could be choice between Robotics Process Automation ('RPA') and AI. RPA increases productivity whereas AI gives intelligent insights on clients, compliance and operations. Therefore, if banks could resolve their above issues, they would definitely be able to increase their revenue and in turn can pass the benefits to their stakeholders.

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