Average Cost Per Transaction (Taka)

■ Min ■ Max ■ Avg

Chart data:

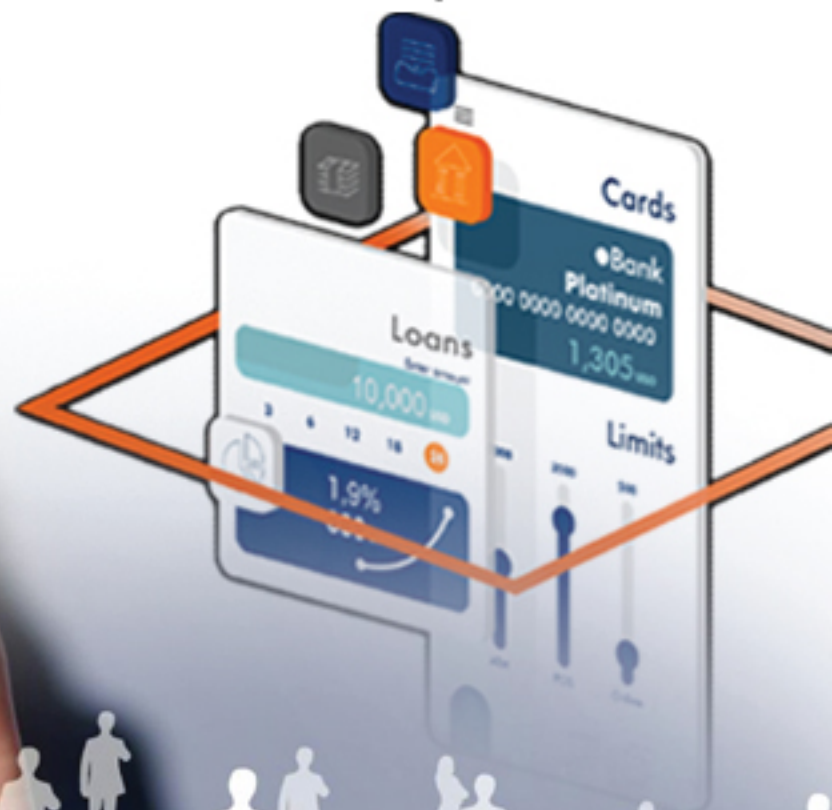| Channel	Min	Max	Avg
Branch	39	144	90.3
ATM/Fast Track	18	116	52.1
Internet Banking	0.23	5	1.746
Agent Banking	20	38.6	—
Mobile Banking	1.25	1.75	—

Impact of Information and Communication Technology (ICT) on Enhancement of Business and Profitability of Banks

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The views in this publication are of authors only and do not necessarily reflect the views of the institutions involved in this publication.

Foreword

As part of the ongoing dissemination of BIBM research outputs, the present research monograph contains the findings of the research project: "Impact of Information and Communication Technology (ICT) on Enhancement of Business and Profitability of Banks." ICT is introduced to change the operating environment of banks significantly. Technology has already helped most of the banks in Bangladesh to introduce Financial Technology (FinTech) and Alternative Delivery Channels (ADCs) like ATM, POST, MFS, Internet banking, e-wallet, Apps banking, Agent banking, Social Media banking, Chat-bot, etc. to provide innovative products and services to their customers. Customers of banks have felt the positive impact of technological solutions implemented by banks. ICT also have helped in automating and networking the branches that ensured timely flow of information and aid quick decision-making process. Bangladeshi banking sector has come a long way in terms of using ICT and have been investing heavily in ICT for last two decades to achieve increased productivity, efficiency, profitability and competitive advantage and a reasonable number of banks have already attained international standard maturity in technology adoption.

The study aims to look into the pace and pattern of ICT expansion in banks of Bangladesh, to find the impact of information and communication technology on enhancement of banking business in terms of financial inclusion by reducing cost and satisfying customers, to see the empirical relationship of ICT investment with efficiency, productivity and profitability of banks in Bangladesh and give some policy recommendations.

It gives me immense pleasure, on behalf of BIBM, to offer this important resource of academic inputs to the practitioners of the banks and financial institutions, regulatory agencies as well as to the academics and common readers. This study is perhaps the first one that examines the effect of ICT investment on banking business enhancement, the efficiency, productivity and profitability of Bangladeshi banks using panel data. I hope, this monograph will be a valuable resource for professionals, especially for the banking community, for understanding the influence of investment in ICT on the performance of banks in Bangladesh. In future the findings may help the banking executives and policy makers in this regard.

We do encourage feedback from our esteemed readers on this issue which certainly would help us to improve our research activities in the years to ahead.

Md. Akhtaruzzaman, *Ph.D.*
Director General, BIBM

Acknowledgement

This research project has been completed with the great support from many persons and organizations.

Impact of Information and Communication Technology (ICT) on Enhancement of Business and Profitability of Banks

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Abbreviations

ACPS	Automated Cheque Processing System
ADC	Alternative Delivery Channel
AFI	Alliance for Financial Inclusion
ANOVA	Analysis of Variance
ATM	Automated Teller Machine
BACH	Bangladesh Automated Clearing House
BACPS	Bangladesh Automated Cheque. Processing System
Bank-ISAC	Information Sharing and Analysis Center for Banks
BB	Bangladesh Bank
BCP	Business Continuity Planning
BEFTN	Bangladesh Electronic Funds Transfer Network
BIBM	Bangladesh Institute of Bank Management
BLUE	Best Linear Unbiased Estimator
CAGR	Compound Annual Growth Rate
CBA	Cost-Benefit Analysis
CBS	Core Banking Solution
CER	Computer to Employee Ratio
CIB	Credit Information Bureau
CRM	Customer Relationship Management
DBBL	Dutch-Bangla Bank Limited
DBMS	Database Management System
DC	Data Center
DEA	Data Envelopment Analysis
DFI	Development Finance
DMU	Decision Making Unit
DNS	Deferred Net Settlement
DRS	Disaster Recovery Site
EIR	Expenditure Income Ratio
EMI	Equated Monthly Installment
EPS	Earning Per Share
ES	Efficiency Scores
FCB	Foreign Commercial Bank
FDIC	Federal Deposit Insurance Corporation
FinTech	Financial Technology
HS	Highest Score
HV	High Value

IBFT	Internet Banking Fund Transfer
ICT	Information and Communication Technology
IDRBT	Institute for Development & Research in Banking Technology
IS	Information Systems
ITI	ICT Index
ITIER	ICT Investment to Employee Ratio
ITNITER	ICT-Employee to Non-ICT Employee Ratio
MFI	Micro Finance Institution
MFS	Mobile Financial Service
MIS	Management Information System
MSI	Market Size Index
MVA	Market Value Added
NBFI	Non-Bank Financial Institution
NGO	Non-Governmental Organisation
NPL	Non-Performing Loans
NPM	Net Profit Margin
NPSB	National Payment Switch Bangladesh
PCB	Private Commercial Bank
PIN	Personal Identification Number
POST	Point of Sale Terminal
RHS	Right Hand Side
ROA	Return on Assets
ROE	Return on Equity
RTGS	Real Time Gross Settlement
RV	Regular Value
SDB	Specialized Bank
SER	Salary to Expenditure Ratio
SME	Small and Medium-sized Enterprise
SMS	Short Message Service
SOCB	State-owned Commercial Bank
SPSS	Statistical Package for Social Sciences
SSN	Social Safety Net
SWIFT	Society for Worldwide Interbank Financial Telecommunication
VIF	Variance Inflation Factor
WAN	Wide Area Network

Now-a-days banking industry is considered as the heart of any robust economy whereas Information and Communication Technology (ICT) becomes the heart of any bank. ICT is introduced to change the operating environment of banks significantly. Technology has already helped most of the banks in Bangladesh to introduce Financial Technology (FinTech) and Alternative Delivery Channels (ADCs) like ATM, POST, MFS, Internet banking, e-wallet, Apps banking, Agent banking, social media banking, chat-bot, etc. to provide innovative products and services to their customers. Customers of banks have felt the positive impact of technological solutions implemented by banks. Technology can also be harnessed in automating and networking the branches that will ensure timely flow of information and aid quick decision-making process. Prompt adoption of information technology resources allows banks to maintain a competitive advantage over their rivals. The enlarged demand for ICT in banking sector becomes unavoidable in home and abroad. Consistently, the future lies in the FinTech driven banking systems and services.

Bangladeshi banking sector has come a long way in terms of using ICT. Bangladeshi banks have been investing heavily in ICT for last two decades to achieve increased productivity, efficiency, profitability and competitive advantage through improved internal and external transaction flow, better access to clients and markets and enhanced reach and quality of products and services and a reasonable number of banks have already attained international standard maturity in technology adoption.

Both primary and secondary data have been collected to accomplish the purposes of the study. Secondary data has been collected from annual reports of respective banks, various publications of Bangladesh Bank and BIBM, research articles, and websites of Bangladeshi banks. Primary data have mainly been collected from the ICT department of banks on the basis of a structured questionnaire. A total of 21 banks have been selected as sample banks. The selection of banks has been determined purposively based on the consideration that the sample banks should represent all categories of banks in terms of ownership, number of branches and state of computerization. To analyze the customers' satisfaction, a total of 500 respondents have been selected from all over the country covering all divisions of Bangladesh. To run the regression models we used data from 2000-2019 for 21 banks. The data are then pooled and estimated by using R, EViews and Stata.

ICT introduced a drastic change in the latest style of banking business in a way that is threatening the traditional form of banks. A strong ICT infrastructure have been developed by the banks of Bangladesh by investing Tk. 40,943 crore, mainly in last two decades, under the guidance and monitoring of the central bank. As a result, besides 90% online branches different ADCs like ATM, Credit and Debit Card, POST, MFS, Agent Banking, Internet Banking, Call Center Banking, Banking through Apps, etc. has been

introduced very rapidly in Bangladesh. The higher CAGR of these ADCs with respect to numbers, customer base and transactions indicates rapid expansion and acceptance of online banking and financial inclusion in this country. Consequently, cost of transactions, distance of financial access points, cost to access a financial service point, travel time to get a financial access point also reduced dramatically. To get the maximum benefits of this investment and technological achievement a tactical roadmap may be developed by the government with the help of Bangladesh Bank in collaboration with other regulators of financial sector to develop a cashless society and digital financial sector to achieve the broader national goals in the shorter, medium, and longer-term target to develop a Digital Bangladesh.

The paper investigates the efficiency of Bangladeshi banks since ICT Investment started in the late 1990s. By using Data Envelopment Analysis technique and bank-specific data from 2000 to 2019 it is found that foreign banks are the most efficient followed by private banks. Though the efficiency scores of all types of banks have increased over the study period, the private banks have recorded the strongest gains. In case of government banks, though the gain in efficiency is notable in last few years due to huge investment in ICT, huge bank branch expansion and Non-Performing Loans (NPL) hurt to achieve the expected efficiency. It seems that good managerial control of PCBs and FCBs due to adoption of centralized online banking technology has added to their efficiency. Thus, investment on ICT in banks has elevated efficiency scores over time of all banks in Bangladesh regardless of their ownership. Still, efficiency of SOCBs and SDBs are less compared to other groups.

The Computer Employee Ratio and exercise of employment of more ICT officers compared to non-ICT officers among FCBs and PCBs also seems to have backed to their boosted profitability. The statistically significant dummies indicate that the SOCBs has not been successful in leveraging its relatively large market share to raise either its efficiency or its profitability compared to PCBs and FCBs. Profitability of banks has also improved due to the gains in efficiency. Still, profitability of SOCBs and SDBs are less compared to other groups.

Satisfaction of customers directly helps to increase any business. ICT and emergence of e-Banking has changed the banking business style dynamically satisfying their customers more and more. As a result, financial inclusion increased rapidly and banks were able to enhance the business covering the whole country (or globe) by providing round the clock services all the year round. In this study, highest satisfaction of customers' is seen in case of accuracy of operations which implies that ICT helps bankers to reduce operational errors. Lowest satisfaction is found for handling grievances. That is customers are not getting right and quick solution when they complain for any dispute. Management may consider this issue seriously. Moreover, satisfaction level of customers of different bank groups (SOCBs, SDBs, PCBs and FCBs) varies with most of the constructs like

geography, different occupations, age group and education level. This study also identified major factors that affect customers' satisfaction on online banking services. 'Digitization of Banking', 'Operational Efficiency', 'Post Purchase Behavior of Banks' and 'After Sales Support' are the most important identified factors.

The study also finds that ICT has substantial role and positive impacts on productivity of banks. The findings, however, indicates that there are significant returns to more investment in ICT labor and capital. The descriptive analysis indicates that productivity of employees has been increased from minimum 353% to maximum 839% due to the impact of ICT in last two decades. Moreover, using a Cobb-Douglas production function, it is found that there are "substantial excess returns to investment in ICT capital and ICT labour. While considering advances and deposit as an output of the industry, the study indicates that banks using older technology (Category-2: decentralized scattered branch automation) is 9% more productive than manual banking system (without technology) and online centralized banking technology (Category-1) provides 47% more productivity than older technology banking system (Category-2). Additionally, the study also indicates that Category-2 technology banking is 19% more productive than manual banking system and Category-1 technology banking is 86% more productive than Category-2 banking system while output of the industry is considered as revenue. In Bangladesh, private sector banks, which took more ICT initiative, were found to be more efficient in productivity and profitability parameters than public sector banks.

BB has been working proactively for a long period to develop the overall ICT infrastructure of banking sector. Proper guidelines and monitoring of BB has also been helping the ICT departments of different banks to expand in right way. As a result, expectation from BB has been increasing day by day and banks have been demanding some important initiatives to be taken by BB for the last few years. These are: detailed and updated version of ICT security policy; guidelines for standardization of ICT department and inspecting banks frequently (quarterly or half yearly instead of yearly visiting) by BB inspection team to check the implementation status of the recommendations given in the yearly ICT core risk inspection report.

It can be concluded that banks with higher usability of ICT perform significantly better than those with low ICT usability and there are substantial returns due to an increase in investment in ICT capital and labor which will incentivize the bank's management to shift its emphasis on ICT investment. In fact, not only are the ICT contributions positive, they pay more than what is being spent on them. Also, the returns on ICT resources are higher than those accruing from non-ICT resources.

It has now become impossible to separate Information and Communication Technology (ICT) from the business of the banks and the financial institutions. As many financial products and services directly or indirectly depend on ICT, banks have to think how to

involve ICT to minimize the cost, increase the efficiency and how to provide better services to the customers ensuring reliability, safety and security. Otherwise, banks may face ICT risks as well as business risks. There are several basic requirements for ICT which must be met; these include a sound technical infrastructure, efficiency of the employees, and interaction with technical developments. Moreover, ICT security and governance must be ensured for next generation online banking in Bangladesh.

The impact of ICT on banking performance has remained a mystery for Bangladeshi banks. Policy makers did not widely accept traditional ratios like ICT expenditures as percentage of operating cost, ICT investment per employee, etc. to see the impact of ICT investment on banking business. Though many studies carried out in different developed and developing countries, such studies are rare in Bangladesh. This study is perhaps the first one that examines the effect of ICT investment on business enhancement, the efficiency, productivity and profitability of Bangladeshi banks using panel data. In this regard, this study explores the influence of investment in ICT on the performance of banks in Bangladesh. In future the findings may help the banking executives and policy makers in this regard.

Impact of Information and Communication Technology (ICT) on Enhancement of Business and Profitability of Banks

1.1 Introduction

Now-a-days banking industry is considered as the heart of any robust economy whereas Information and Communication Technology (ICT) becomes the heart of any bank. ICT has created a new opportunity for banks to become truly global and also provided a competitive advantage over their rivals. However, banks have made huge investments in ICT and customers have also accepted electronic banking system as swift, transparent, secure, useful and easy to use. Businesses worth billions of dollars can only take place in seconds throughout the globe by pressing a single button.

The modernization of ICT has set the stage for extraordinary improvement in banking procedures throughout the world. For instance the development of worldwide networks has considerably decreased the cost of global funds transfer. Banks that are using ICT related products such as online banking, electronic payments, security investments, can deliver high quality customer services with less effort.

Information and Communications Technology is introduced to change the operating environment of banks significantly. Technology has already helped most of the banks in Bangladesh to introduce Financial Technology (FinTech) and Alternative Delivery Channels (ADCs) like ATM, POST, MFS, Internet banking, e-wallet, Apps banking, Agent banking, social media banking, chat-bot, etc. to provide innovative products and services to their customers. Customers of banks have felt the positive impact of technological solutions implemented by banks. Technology can also be harnessed in automating and networking the branches that will ensure timely flow of information and aid quick decision making process. Prompt adoption of information technology resources allows banks to maintain a competitive advantage over their rivals. The enlarged demand for ICT in banking sector becomes unavoidable in home and abroad. Consistently, the future lies in the FinTech driven banking systems and services.

Bangladesh Bank (BB), as a regulatory body, has been playing distinguished role to uphold smooth and secured online banking operations. Bangladesh Bank has taken necessary initiatives to start e-banking, e-commerce and e-payment, automated clearing house system, mobile phone banking etc. Banks have been allowed to make online money transactions, payment of utility bills, transfer of funds, payments for trading goods and services through e-channels like Internet, ATM, mobile phone etc. Considering the vital importance of ICT security in banks Bangladesh Bank has issued "ICT security guidelines for banking and financial institutions". Access to Online Credit Information Bureau (CIB),

installations of Bangladesh Automated Clearing House (BACH), Bangladesh Electronic Fund Transfer Network (BEFTN), National Payment Switch (NPS) and Real Time Gross Settlement (RTGS) are other extraordinary achievement of the Central Bank.

In tune with the global trends Bangladeshi banks have been investing heavily in technology infrastructure, solutions and manpower. Possibly, the key purpose of such high investments in ICT is to achieve increased productivity, efficiency, profitability and competitive advantage through improved internal and external transaction flow, better access to clients and markets and enhanced reach and quality of products and services.

Many studies have been done to see the relationship of the investment in Information and Communication Technology (ICT) with the increases in productivity, efficiency and profitability of banking business. Numerous studies in different countries have added different understandings of this phenomenon. Worldwide the policy makers, bankers, researchers and scholars are curious to see the association between ICT and banks performance.

The impact of ICT on banking performance has remained a mystery for Bangladeshi banks. Policy makers did not widely accept traditional ratios like ICT expenditures as percentage of operating cost, ICT investment per employee, etc. to see the impact of ICT investment on banking business. Though many studies carried out in different developed and developing countries, such studies are rare in Bangladesh. This study is perhaps the first one that examines the effect of ICT investment on the efficiency, productivity and profitability of Bangladeshi banks using panel data. In this regard, this study explores the influence of investment in ICT on the performance of banks in Bangladesh.

1.2 Objectives of the Study

The specific objectives of the study are: **one**, to look into the pace and pattern of ICT expansion in banks of Bangladesh; **two**, to find the impact of information and communication technology on enhancement of banking business in terms of financial inclusion by reducing cost and satisfying customers; **three**, to see the empirical relationship of ICT investment with efficiency, productivity and profitability of banks in Bangladesh.

1.3 Methodology and Data

Both primary and secondary data have been collected to accomplish the purposes of the study. Secondary data has been collected from annual reports of respective banks, various publications of Bangladesh Bank and BIBM, research articles, and websites of Bangladeshi banks. Primary data have mainly been collected from the ICT department of banks on the basis of a structured questionnaire. A total of 21 banks have been selected as sample banks. The selection of banks has been determined purposively based on the consideration that

the sample banks should represent all categories of banks in terms of ownership, number of branches and state of computerization.

In categorizing the sample banks, we considered the automation level defined by the ICT security guidelines of Bangladesh Bank. According to the Bangladesh Bank guideline, depending on the architecture of core business application solution, ICT infrastructure, operational environment and procedures, commercial banks are categorized as Category-1 and Category-2. Category-1 means Centralized ICT Operation for managing core business application solution through Data Center (DC) with backup assets for continuation of critical services including Disaster Recovery Site (DRS)/Secondary Data Center to which all other offices, branches and booths are connected through WAN with 24x7 hours attended operation. Category-2 means Decentralized ICT operation for managing distributed business application solution hosted at DC or operational offices/branches with backup assets for continuation of critical services connected through WAN or having standalone operations. The distribution of 21 sample banks is given in Table-1.

Table 1: Sample Distribution of Banks

Bank Category	Sampled Banks
State-Owned Commercial Banks (SOCBs)	3
Specialized Banks (SDBs)	1
Private Commercial Banks (PCBs)	14
Foreign Commercial Banks (FCBs)	3
Total	**21**

To analyze the customers' satisfaction, a total of 500 respondents have been selected from all over the country. Sample size distribution with respect to bank-types, divisions, and background characteristics of the respondents are given in Appendix-A. Data has been collected covering all divisions of Bangladesh. In each division 2 to 4 districts have been selected purposively and then from each selected district 2 to 4 Upazila/Thana have also been selected purposively. Respondents have been selected randomly in each stage, i.e., from divisional cities, district headquarters and Upazila/Thana/Union/Pourasava level. Finally, 7 Divisions, 18 Districts and 60 Upazila/Thana have been covered to select respondents. All selected respondents have been interviewed individually.

The questionnaire of the survey has been designed using 30 statements relating to the objective of the research. A five point 'Likert' scale ranging from 'strongly agree' to 'strongly disagree' was used as the scale of measurement for each question in the questionnaire. Analysis of the study is done with the help of the relevant statistical techniques like regression analysis, factor analysis, gap analysis and analysis of variance (ANOVA). The data has been analyzed by using MS-Excel 2010 and SPSS 17.0 software.

To run the regression models we used data from 2000-2019 for 21 banks. The data are then pooled and estimated by using R, EViews and Stata.

1.4 Organization of the Research Report

The paper is organized into five sections. After an introductory section with objectives, methodological issues and literature review, section 2 discusses the impact of ICT on banking business enhancement and financial inclusion. The typical activities performed by the ICT department are also summarized in this section. Section 3 presents the major findings of the study, i.e. the impact of ICT on profitability of banks by using regression analysis. Finally, section 4 and 5 puts forward some recommendations and concluding remarks, respectively.

1.5 Literature Review

This part reviews relevant literature and findings of previous researches that addressed the impact of ICT on the profitability of banks. The studies conducted in the context of developed and developing countries are presented herein to highlight the existing knowledge.

Gwashi and Alkali (1996) observe that, "ICT covers all forms of computer and communications equipment and software used to create, store, transmit, interpret, and manipulate information in its various formats e.g., business data, voice conversations, still images, motion pictures and multimedia presentations. It also refers to the electronic devices used to collect, process, store and disseminate information. Similarly, the deployment of ICT is skyrocketing with many organizations using it in office automation, i.e., word processing, electronic mail, telecommunicating and teleconferencing. In business management, computerized Database Management System (DBMS) and Management Information System (MIS) are now making commerce and Industry pleasurable and ensuring decision making."

According to Twati and Gammack (2006), "ICT initiated a radical change in the latest style of banking business in a way that is threatening the traditional form of banks. Technological advances are the most important variables which have contributed to the radical shift in the patterns of the banking business in the era of globalisation; technology has focused the keen interest of banks to intensify attempts to take advantage of the latest information technologies, communications and computers, and to adapt efficiently in order to invent banking services and the development of novel methods of submission."

Oni and Ayo (2010) found that "electronic banking structure has tuned into the key technology-driven change in carrying out financial operations. Nonetheless banks have invested substantially in electronic and communication structures and users have also

verified the electronic banking structure as helpful and convenient. Indeed, internet banking as an important part of a new technology has presented a competitive advantage via cost reduction, and better satisfaction, trust and loyalty of clients."

Mastoori, 2009; Xu, *et al.*, 2009; Ahmed, *et al.*, 2009; Evans and Sawyer, 2009, identified that "the internet has given banks the ability to communicate with customers in a personalised way without the need for face-to-face interaction, thus saving communications costs. In reality, it has led to an increase in service efficiency of banks, with lower costs of operations towards customers, thus reducing costs and improving profit margins for banks. Thus, commercial banks consider the adoption of ICT as a means to increase the banks' efficiency and performance as well as quality of service." In this context, Ho and Mallick (2006 p. 1) cited that "It is believed that ICT can improve bank's performance in two ways: ICT can reduce operational cost (cost effect), and facilitate transactions among customers within the same network (network effect)."

According to Morrison and Berndt (1990), "it has been a matter of much debate whether or not investment in Information Technology (ICT) provides improvements in productivity and business efficiency." Arguing that "estimated marginal benefits of investment (in ICT) are less than the estimated marginal costs", Morrison and Berndt (1990) concluded that "additional ICT investments contributed negatively to productivity." Others, such as Loveman (1994) and Barua *et al.* (1991), suggest that "there is no conclusive evidence to refute the hypothesis that ICT investment in inconsequential to productivity."

Lichtenberg (1995), for his analysis, draws data from annual surveys conducted between 1988 and 1991 by *Information Week* and *Computer World* magazines and found that "there is significant benefit from investment in ICT." Using a Cobb-Douglas production function, he estimates that "there are substantial excess returns to investment in computer capital and one Information Systems (IS) employee is equivalent to six non-IS employees in terms of marginal productivity."

Using a Cobb-Douglas production function, Brynjolfsson and Hitt (1996) conclude that "computers contribute significantly to firm-level output and computer capital contributes an 81% marginal increase in output, whereas non- ICT capital contributes 6%. Similarly, IS-labor is more than twice as productive as non-IS labor."

Using a sample of 55 community banks providing online services in the five midwestern states of the United States of America, Acharya, *et al.*, (2008), examined the "Impact of ICT on community bank's performance." The author employed multiple regression models and shows that "banks with higher usability of ICT perform significantly better than those with low ICT usability."

The study of Dos Santos and Peffers (1993) revealed that "the introduction of ATM technology improves the bank's performance." Akram and Hamdan (2010) examined "The effects of Information and Communication Technology (ICT) on Jordanian banking industry for the period of 2003 – 2007." The authors used a sample of 15 banks to analyze the data obtained by applying multiple regression model and diagnostics test to check the normality and multicollinearity problems. The results of the study indicated that "there is a significant impact on the use of ICT in Jordanian banks on the Market Value Added (MVA) Earnings Per Share (EPS), Return on Assets (ROA) and Net Profit Margin (NPM)."

Kagan, *et al*. (2005) examined "The impact of online banking applications on community bank performance in the United States" using data collected from 1183 banks operating in Iowa, Minnesota, Montana, North Dakota, and South Dakota. The authors employed an econometric model (Structural Equation Model) for the data analysis. The findings of the study revealed that "online banking helps community banks improve their earning ability."

Studies on the effects of ATMs on profitability provide evidence of cost savings and better services for customers. Survey of banks conducted by Abdullah (1985) in Malaysia, Katagiri (1989) in Japan and Shawkey (1995) in the USA, revealed that "investing in ATMs reduces banking transaction costs, the number of staff and the number of branches. Therefore, investing in ATMs increases the value of deposit accounts, which are cheaper in terms of costs of funds than other sources, such as borrowing money from other institutions, hence reducing the overall cost of funds. This indicates that there is a role for ICT investment in the explanation of bank profitability."

Kozak (2005) analyzed the values of Return on Asset (ROA) for the period of 1992 – 2003. According to Kozak, "the value of the return on assets for the U.S, the banking sector has increased by 51 percent. This result suggests that ICT improvements, associated with extensive office networks and range of offered services have helped to generate additional revenues for banks. For the same period much smaller reduction of the non-interest costs has been achieved. It means the value of cost efficiency fell by 13 percent. This means that a huge number of diverse operations require higher ICT investments and additional non-interest charges." In order to assess relationships between the degree of the ICT progress, and the profitability (ROA) and cost efficiency, the regression analysis was used to achieve more precise statistical results, based on quarterly values obtained from the FDIC.

Several researchers like Khaled A. Saeed and Roberta Bampton (2013) established that "ICT channels have a profitable effect on the banks that just have internet startups compared to the traditional banks." Agbolade (2011) and Uppal (2011) assert that "ICT was a key aspect that influences profitability of banks." A study by Furst, *et al.,* (2002) found that "federally chartered banks in USA had positive level of profitability and this attributed to use ICT." Agbolade (2011) discloses that, "Internet banking as an important

part of a new technology has presented competitive advantage via cost reduction, better satisfaction, trust and loyalty of clients. Moreover, a positive correlation is found between ICT and Nigerian banks' profitability." Indeed, Evans and Sawyer (2009) identified that "the Internet has given banks the ability to communicate with customers in a personalised way without the need for face to face, saving communications costs with generation of revenues when communications occur through emails and live chats." Rajput and Gupta (2011) illustrated that "the association linking ICT and the banks' performance and efficiency have positive results." DeYoung, *et. al.*, 2004 think that, "the most significant impact of ICT on the banking system might be seen on the payments system, in which traditional method (paper-based payments) have switched to modern technique (electronic-based payments)". Berger, 2003; Frank and Oluwafemi, 2012 found some evident in developed and developing economies regarding "the dramatic reduction in costs by using advanced electronic payments."

Ho and Mallick (2006) documented the two positive effects regarding the relation between Information Technology and banks performance, "First, ICT can reduce banks' operational costs. Second, ICT can facilitate transactions among customers within the same network." According to Ho and Mallick "Banks have used Information Technology to enhance profitability, productivity and customer satisfaction."

"ICTs have direct effects on how managers decide, plan and what products and services are offered in the banking industry. Such technologies have continued to change the way banks and their corporate relationships are organized worldwide and the variety of innovative devices available to enhance the speed and quality of service delivery"-Agbolade, 2011.

The study of Prasad & Harker (1997) examined "The effect of ICT investment on both productivity and profitability in the US retail banking sector." The paper concluded that "additional investment in ICT capital may have no real benefits and may be more of a strategic necessity to stay even with competitors. However, the results indicated that there are substantially high returns on increase in investment in ICT labor, and that retail banks need to shift their emphasis on ICT investment from capital to labor."

In their study on the contribution of information technology to banks' profit, the authors, Shu & Strassmann (2005) revealed that the data gathered in 1980 might not have pointed to a strong ICT productivity in the banking industry, but their research using data from 12 US banks covering the period between 1989 to 1997 showed that "ICT is the only variable with positive marginal gain and its productivity is far better than labor." Holland, Lockett & Blackman (1997) argued that "the broad competitive forces of information technology, globalization and deregulation destabilizes the banking industry, this leads to irrevocable

changes and allow new entrants, disintermediation, innovation and customer changes on a much greater scale than has occurred in the past."

The research of Ho & Mallick (2006) analyzed how ICT-related spending affect (both theoretically and empirically) bank profits via competition in financial services that are offered by the banks. The paper utilized a Hotelling model to examine the differential effects of the Information and Communication Technology (ICT) on moderating the relationship between costs and revenue. The impact of ICT on profitability was estimated using a panel of 68 US banks over 20 years. The paper found that bank profits declined due to the adoption and diffusion of ICT investment, reflecting negative network effects in the banking industry.

As for studies on the topic concerned with the developing world, Mittal & Dhingra, (2007) used the method of Data Envelopment Analysis (DEA) to study the impact of computerization on Indian banks' profitability and productivity. Private sector banks, which took more ICT initiative, were found to be more efficient in productivity and profitability parameters than public sector banks.

Mashal (2006) examined "The effect of ICT investment in productivity and profitability" by analyzing data from the Arab Bank, one of the leading banks in Jordan, during the period between 1985 to 2004. The results indicated that "there are substantial returns due to an increase in investment in ICT capital, a fact which incentivizes the bank's management to shift its emphasis on ICT investment from labor to capital."

Siam (2006) examined "The effects of electronic banking on bank's profitability". The author concluded that "the impact of electronic banking on bank's profitability will be a feature of the short run due to the capital investment by the banks on infrastructure and training, but, it will be positive in the long run." In the same regard, Khrawish & Al-Sa'di (2011) tested "The effect of e-banking services provided by banks on the internet on the profitability" of these banks. The regression analysis showed that, "there is no significant impact of e-banking services on the profitability of recent adopter's banks in terms of ROA, and ROE. For early adopters, the results were much better than those for the early adopters, but still not significant with the profitability of these banks."

2.0 ICT Infrastructure of Banks, Its Impact on Banking Business Enhancement and Financial Inclusion

Financial Technology (Fintech) based on ICT saves more time and cost and creates new alternatives. The Central Bank plays a vital role in promoting the use of financial technology through different initiatives. As a result, banks have developed a strong ICT infrastructure under the guidance and monitoring of the central bank. Consequently, besides online branches different ADCs like ATM, POST, MFS, Agent Banking, Internet

Banking, Call Center Banking, Banking through Apps, etc. has been introduced in Bangladesh.

Having access to a transaction account of banks by an individual is a first step towards broader financial inclusion. As a bank account primarily allows people to save money, and send and receive payments, it serves as a gateway to other financial services. Depending on policy supports, reforms and product design of Bangladesh Bank, banks have implemented several initiatives to attain financial inclusion for individuals starting from No Frill Accounts to technology-based delivery channels. This section examines the current ICT infrastructure of banks, its impact on financial inclusion and banking business enhancement.

2.1 ICT Investment and Sector-wise ICT Budget

In 2015, about Tk. 1703 crore was invested for ICT operations in the banking sector, excluding the Bangladesh Bank. Total investment up to 2019 was estimated at Tk. 40,943 crore since 1968 (considering the installation of computer at Agrani Bank in 1968 which was the first installation of computer in the banking sector of Bangladesh). And in 2019, around Tk. 2478 crore was invested in ICT System in the banking sector, excluding the Bangladesh Bank (Figure-1).

Figure 1: ICT Investment in Banks (In Crore BDT)
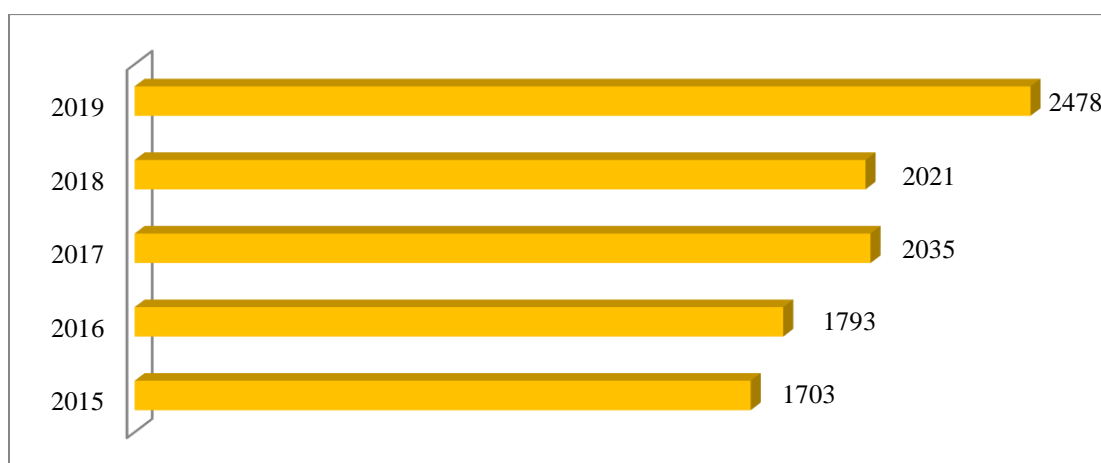
Source: Survey Information

2.2 Centralized Operations using DC, ADC, DRS and Branch Automation

According to the Guideline of Bangladesh Bank on ICT Security for Banks and Non-Bank Financial Institutions (Version 3.0, which was released on May, 2015) 58 banks have fully introduced real time online banking, meeting the Category-1 architecture at the end of 2019. One bank fall in the Category-2 and another one have introduced Mixed Category (Some branches operate under centralize system and rest are totally decentralized)

architecture. Bank of Mixed Category partially implemented Category-1 architecture and gradually transferring the branches to meet the Category-1 architecture from Category-2 architecture. SDBs mainly fall in this category. Table-2 shows computerization status of bank branches in Bangladesh at the end of 2019.

Table 2: Centralized Online Branches by Types of Bank (2019)

Types of Bank	No. of Total Branches	No. of Fully Online Branches	% of Online Branches
SOCBs	3,777	3,706	98.12
SDBs	1,421	439	30.89
PCBs	5,283	5,282	99.98
FCBs	64	64	100.00
Total	**10,545**	**9,491**	**90.00**

Source: Financial Stability Report, 2019, Bangladesh Bank (p. 87)

Bank branches density provides a rough proxy for financial inclusion (Global Financial Development Report, 2014). More branches in rural areas compared to urban areas actually indicate financial inclusion in rural areas. Bank branches in rural areas dropped from 57.4 in 2010 to 48.5 percent in 2019 in spite of the Bangladesh Bank's initiatives to ensure financial inclusion of rural people[1]. On the other hand, share of bank branches in urban areas enlarged by 8.9 percent in 2019 compared to 2010 (*Scheduled Bank Statistics*, Bangladesh Bank). The results refer that 51.5 percent branches serve 37.4 percent population of the country whereas the remaining 48.5 percent banks' branches work for 62.60 percent population of the country who are staying in rural areas[2]. The share of online branch, 90 percent in 2019 raises hope for quick expansion of bank based financial services for mass people across the country in future.

2.3 Alternative Delivery Channels (ADCs)

2.3.1 Internet Banking

The development of internet banking encourages people to do virtual banking activities for account inquiry, funds transfer; payment of utility and credit card bills; loan installments, insurance premium etc. even from remote areas. Apart from urban people, individuals involved in agri-business and SME business are gradually using internet banking. At the end of 2019 it is seen that 84% banks provides some sort of informational and transactional Internet Banking services, which was only 48% at the end of 2014.The soaring growth rates of number and volume of transactions show how effectively it does financial inclusion and

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[1] To bring more rural people under banking services, Bangladesh Bank adopted a policy allowing PCBs to open branches 1:1 in urban and rural areas in place of 4:1 permitted in 2006 with a new definition of urban areas (city corporation, municipalities, the suburbs will be considered as urban areas).

[2] As per World Bank collection of development indicators, rural population (% of total population) in Bangladesh was reported at 62.6 % in 2019.

penetrates traditional branch-based banking activities (Table-3). A rise in the number of smartphone users also encouraged the use of internet banking through mobile Apps.

Table 3: Internet Banking

Year	Number of Users	Number of Transaction	Volume of Transaction (in Crore BDT)
2015	1525642	6392282	21757.11
2016	1526588	7756893	30751.89
2017	1742429	7278521	36482.08
2018	2040418	9544759	32466.66
2019	2472151	15228247	64979.08
CAGR	12.83	24.24	31.46

Source: Monthly Economic Trends, Bangladesh Bank

2.3.2 Plastic Card (Debit, Credit and Prepaid)

Electronic payment instruments such as credit, debit and prepaid cards in banking transactions substituting money-based transaction have gained wide attention in financial inclusion in Bangladesh (Table-4). However, this attention is mostly confined in urban individual financial inclusion as it is evidenced from the share of ATM in urban (70.2%) and rural areas (29.8%) at the end of 2019. Significant growth rates of plastic cards and its use indicate its extensive acceptability among individuals.

Table 4: Number of Plastic Cards and Total Transactions including Amount

Types	Year	2015	2016	2017	2018	2019	CAGR
Debit	Number	8622507	9948690	11653879	14302966	18231093	20.59
	Transactions	126568036	157795633	164913734	195209740	224337103	15.38
	Amount*	96093.30	115252.50	123080.30	142076.10	166801.80	14.78
Credit	Number	620328	946954	908507	1180414	1537202	25.47
	Transactions	10096670	12389944	16220582	20704917	26060650	26.75
	Amount	6518.70	7571.65	9602.00	11922.90	13441.20	19.83
Prepaid	Number	135119	176185	138500	210358	413582	32.27
	Transactions	568876	725434	1025288	1575882	3025149	51.86
	Amount	412.0	607.1	871.1	947.3	1491.0	37.93
Others**	Transactions	141948700	172781366	184618797	220510951	255572706	15.84
	Amount	107322.63	125362.09	135726.37	157886.8	183931.8973	14.42
All	Number	9377954	11071829	12700886	15693738	20181877	21.12
	Transactions	137233582	170911011	182159604	217490539	253422902	16.57
	Amount	103024	123431.25	133553.43	154946.3	181734	15.25

Source: Monthly Economic Trends, Bangladesh Bank
Note: *Amount in Crore Taka. **Others include Internationally Issued Cards Transactions

2.3.3 POST

A Point of Sale Terminal (POST) is a hardware system for processing card payments at retail locations. POST allows all types of debit and credit cards for making transactions. The growth of POST in Bangladesh is shown in the following table (Table-5).

Table 5: Total POSTs, Number of Transactions and its Volume

Year	No. of POST	Number of Transactions	Volume of Transactions (Crore BDT)
2015	30336	14082447	12093.74
2016	32953	17356869	12391.89
2017	37379	21161592	13302.53
2018	45896	26021058	15081.72
2019	58527	31667168	17677.36
CAGR	17.86	22.46	9.95

Source: Monthly Economic Trends, Bangladesh Bank

Most POSTs (91.8%) are being operated in urban areas. Dhaka is the city where 86% POSTs is in operation. It is notable that this service is provided by the PCBs only. Moreover, about 35% banks have branch POS facility. Average number of transaction per day is 530. Total number of branch POS is approximately 2100.

2.3.4 ATM

Automated Teller Machine (ATM) provides electronic access to customers not only for cash withdrawals but also for a number of other services outside of bank branch. An Automated Teller Machine (ATM) enables banks' customers to perform transactions, like cash withdrawal, deposit, funds transfer, or inquiries about account information, at any time and without the need for direct communication with bank employee. The growth of ATM Banking in Bangladesh is shown in the following table (Table-6).

Table 6: Total ATMs, Number of Transactions and its Volume

Year	No. of ATMs	Number of Transactions	Volume of Transactions (Crore BDT)
2015	7839	141948700	107322.63
2016	9019	172781366	125362.09
2017	9522	184618797	135726.37
2018	10355	178265554	138529.7
2019	10924	205589671	162740.9
CAGR	8.65	9.70	10.97

Source: Monthly Economic Trends, Bangladesh Bank

SOCBs have only 264 ATMs whereas PCBs have 10495. In fact PCBs own more than 96% of total ATMs in Bangladesh. It is mentionable that 46.9% ATMs is set up by the DBBL alone.

2.3.5 Mobile Banking

Mobile banking and payment technologies assist banks to provide basic financial services to previously unbanked clients and locations. Bangladesh Bank has taken steps to introduce bank-led Mobile Financial Services for massive financial inclusion. At present, 16 banks are providing mobile financial services. Bangladesh Bank has earned 'Alliance for Financial Inclusion (AFI) Policy Award' for its successful regulation of mobile financial service.

Mobile Financial Services is a medium of offering financial services with mobile networks which enable users to make deposits, withdrawals and send or receive funds from another account. Considering the potentials in promoting financial inclusion, Bangladesh Bank introduced Bank-led MFS in 2011. Since the inception of MFS, the flow of money into the rural parts of Bangladesh has been increasing significantly. A high growth per year is observed in terms of number of customers, volume of transactions and number of transactions since 2014 (Table-7).

Table 7: Growth of Mobile Banking

Parameters	2014	2015	2016	2017	2018	2019	CAGR
No. of Approved Banks	28	28	19	18	18	16	-
No. of Banks Offering MFS	19	18	17	18	18	16	-
No. of Agents (Thousands)	541.0	561.2	710.0	786.5	886.5	971.6	12.42
No. of Customers (Millions)	25.2	31.8	41.1	58.8	67.5	79.6	25.86
No. of Active Customers (Millions)	12.2	13.2	15.9	21.1	37.3	34.6	23.18
No. of Total Transaction (Millions)	589.5	1166.1	1473.2	1875.6	2272.8	2589.8	34.45
Total Transaction Amount (Billions BDT)	1031.6	1772.8	2346.9	3146.6	3788.9	4343.2	33.31

Source: Financial Stability Report and Payment Systems Department, Bangladesh Bank

Table-7 shows the enormous success of MFS in individual financial inclusion. The transactions grew with CAGR of 34.45 from 2015 to 2019 which is simply phenomenal. In case of volume, CAGR at the same period with 33.31 per cent is almost same that of number of transactions. The clients' growth rate also supports this exceptionally upward trend.

It has been found from survey that only 24% banks give profit/interest against MFS account. In our country, 58% banks have already introduced mobile banking App.

2.3.6 Agent Banking

Agent banking has been introduced in Bangladesh in 2013 through a Guideline issued by Bangladesh Bank. Agent banking is one of the most useful ADCs for financial inclusion to give financial services to poor or extreme poor. The purpose of introducing agent banking is to provide a safe and secure alternative delivery channel for banking services to the under-privileged, under-served population who generally live in a geographically remote area and beyond the reach of the traditional banking networks. Agent banking provides services like cash deposits and withdrawals, fund transfers, bill payments, loan payments, payment of benefits and salaries, and collection of account and loan applications. It was hosted targeting to provide formal banking services to unbanked people in Bangladesh. Considering the cost of setting a full-fledged branch, banks prefer agent banking as a cost-effective delivery channel. Though lack of trust and reliability on agent banking outlets was a barrier in spreading agent banking, this ADC is expanding quickly among individuals. Since inception, it has gained much popularity in the rural areas. The tremendous growth rates of number of agents and clients indicate how fast poor unbanked people are availing agent banking services (Table-8). These high growth rates of number and volume of banking transaction indicates the expansion of financial inclusion under this delivery channel in Bangladesh. As of June 2020, 23 banks in Bangladesh have undertaken agent banking operations through 8,764 agents with 12,449 outlets and opened a cumulative of 7,358,190 accounts (Bangladesh Bank, 2020).

Table 8: Status of Agent Banking

Year	Number of Agents	Number of Customers	Volume of Transactions (Crore BDT)	Number of Transactions
2014	49	14478	79.51	67777
2015	208	97037	1508.73	844670
2016	2334	525144	7306.43	4202310
2017	2577	1214561	21034.29	9870045
2018	4506	2456765	53713.65	22640323
2019	7914	5257769	133292.58	49458584
CAGR	176.46	225.10	341.45	273.79

Source: Monthly Economic Trends, Bangladesh Bank

2.4 Clearing through Central Bank

2.4.1 Bangladesh Automated Clearing House (BACH)

Bangladesh Automated Clearing House (BACH) started automated cheque clearing from 2010 for settling bank cheaques instantly by replacing the manual clearing system. BACH is the first major milestone of Bangladesh Bank towards digitalizing the payments landscape of the country. It is an automated inter-bank clearing facility for retail payments that clears both paper and instruction based payments via Bangladesh Automated Cheque

Processing System (BACPS) and Bangladesh Electronic Funds Transfer Network (BEFTN). Both the systems operate in batch processing mode, transactions received from the banks during the day are processed at a pre-fixed time and settled through a single multilateral netting figure on respective bank's book maintained with Bangladesh Bank (Financial Stability Report, 2019, Bangladesh Bank).

2.4.1.1 Bangladesh Automated Cheque Processing System (BACPS)

Automated Cheque Processing System (ACPS) is used to reduce the cheque clearing time. Through faster reconciliation and fraud prevention, it facilitates banks to provide better and faster customer service with increasing operational efficiency. Two sessions, namely High Value (HV) and Regular Value (RV) are available daily under BACPS. HV session accommodates cheques with a minimum value of BDT 5 lac while RV session accommodates cheques of any amount (Financial Stability Report, 2019, Bangladesh Bank). During the period 2010-2019, CAGR of the number of transactions and the volume of transaction were 44.34% and 36.15% respectively, through BEFTN.

Table 9: Automated Cheque Processing

Year	Transactions (Thousands)			Volume (Billion Tk.)		
	High Value	Regular Value	Total	High Value	Regular Value	Total
2010	82.00	742.00	824.00	679.60	751.10	1,430.70
2011	3,123.00	17,954.00	21077.00	4,177.80	5,093.90	9,271.70
2012	1,263.00	18,824.00	20087.00	5,977.42	4,827.44	10,804.86
2013	1,365.00	20,695.00	22060.00	6,877.90	5,165.50	12,043.40
2014	1,610.00	23,505.00	25115.00	8,812.30	5,497.40	14,309.70
2015	1,808.40	21,019.40	22827.80	9,794.50	5,707.30	15,501.80
2016	1,987.00	20,215.50	22202.50	11,479.50	6,518.30	17,997.80
2017	2,222.50	20,950.70	23173.20	12,969.20	7,462.50	20,431.70
2018	2,414.63	20,849.23	23263.86	14,732.77	8,214.20	22,946.97
2019	2,039.77	20,362.00	22401.77	14,480.46	8,519.94	23,000.40
CAGR	42.92	44.49	44.34	40.48	30.98	36.15

Source: Financial Stability Report, 2010-2019, Bangladesh Bank

2.4.1.2 Bangladesh Electronic Funds Transfer Network (BEFTN)

Bangladesh Electronic Funds Transfer Network (BEFTN) is the central clearing system that facilitates settlement among the participating banks. This system is introduced to reduce paper-based transaction and increase electronic payment. The system receives entries from Originating Banks and distributes the entries to Receiving Banks. BEFTN settles various credit transactions such as foreign and domestic remittances, social security payments, payroll, company dividends, bill payments, corporate payments, government tax payments, person to person payments etc. and also similarly settles debit

transactions such as utility bill payments, insurance premium payments, club/association payments, EMI payments etc. Most of the government payments are processed through BEFTN (Financial Stability Report, 2019, Bangladesh Bank).

During the period 2012-2019, CAGR of the number of transactions and the volume of transaction were 25.37 and 32.15 percent, respectively, through BEFTN.

Table 10: Electronic Funds Transfer

Year	No. of Transactions (Millions)	Volume of Transactions (Billion BDT)
2012	7.6	284.3
2013	7.7	396.1
2014	10.2	598.0
2015	13.8	873.8
2016	15.3	986.0
2017	18.6	1333.6
2018	24.8	1722.9
2019	37.0	2000.5
CAGR	25.37	32.15

Source: Financial Stability Report, 2010-2019, Bangladesh Bank

2.4.2 Real Time Gross Settlement (RTGS)

RTGS is an instant electronic settlement system where the transfer of funds takes place from one bank to another bank on real-time basis. The system is designed to settle high value (more than or equal to BDT 100,000) local currency and foreign currency transactions. The system is currently allowed to settle local currency only. However, domestic foreign currency transactions are expected to be launched soon. Along with individual interbank transactions, there are provisions for Deferred Net Settlement (DNS) (i.e. BACPS, BEFTN or NPSB) transactions to be settled through RTGS system. Out of total 11000 bank branches of 58 banks in the country, more than 8000 online branches of 56 scheduled banks are connected to this system till 2019 and the coverage of branches has been increasing gradually (Financial Stability Report, 2019, Bangladesh Bank).

Table 11: Real Time Gross Settlement

Year	No. of Transactions	Volume of Transactions (Billion Tk.)
2016	222,550	11283.88
2017	785,290	20,063.90
2018	863,352	6,674.75
2019	1,848,079	13,260.96
CAGR	102.50	5.53

Source: Financial Stability Report, 2010-2019, Bangladesh Bank

During the period 2016-2019, CAGR of the number of transactions and the volume of transaction were 102.50 and 5.53 percent, respectively, through RTGS.

2.4.3 National Payment Switch Bangladesh (NPSB)

National payment Switch Bangladesh (NPSB) was first introduced in Bangladesh in 2012 to facilitate interbank card-based or online retail transactions through different delivery channels like Automated Teller Machine, Point of Sales and Internet Banking Fund Transfer (IBFT). It geared up the card-based payment networks substantially and promoted e-commerce throughout the country. The NPSB is currently connected to 52 banks for ATM, 51 banks for POS and 23 banks for internet banking transactions. The number and volume of the interbank transactions through NPSB are growing with great speed (Financial Stability Report, 2019, Bangladesh Bank).

Table 12: National Payment Switch Transactions

Year	Number of Transactions (Millions)	Volume of Transactions (Billion BDT)
2015	7.78	45.24
2016	10.48	67.99
2017	17.00	104.00
2018	24.00	155.00
2019	30.70	211.25
CAGR	40.94	47.00

Source: Financial Stability Report, 2010-2019, Bangladesh Bank

During the period 2015-2019, CAGR of the number of transactions and the volume of transaction were 40.94 and 47.0 percent, respectively, through NPSB.

2.5 Trends in Technology Adoption

In order to provide banking service at lower cost and at shorter time to remote area, banks have adopted various modern technology viz. installation of ATM, POS, introducing credit card and debit card, uses of mobile phone, internet banking, online banking. It is observed that mobile banking is the potent instrument for increasing outreach and mobile phone is an ideal platform to increase the outreach of financial services to the rural population as their penetration is already large and growing. Table-13 shows adoption of technology by total number of banks during the period 1998 to 2019. It is evident from the table that, out of different innovative technology driven products and services, significant response among the banks is observed since 1998.

Year	Cr. card	Dr. card	ATM	POST	Internet Banking	Centralized Online Banking	SWIFT	Call Center	Mobile Banking	Agent Banking	BACPS	RTGS	NPSB	BEFTN
1998	2	0	1	1	0	2	4							
1999	3	1	2	3	0	2	11							
2000	3	1	2	3	0	4	17							
2001	4	4	7	4	1	6	23							
2002	4	10	12	5	3	7	30							
2003	4	11	14	5	3	16	36							
2004	8	15	18	7	7	19	40							
2005	12	18	22	10	7	22	41							
2006	15	22	26	10	7	29	43							
2007	17	23	28	10	7	31	43							
2008	19	23	29	11	7	33	43							
2009	21	24	30	11	8	35	43	1						
2010	26	36	36	13	18	38	44	2	2		31			
2011	26	38	38	15	24	40	45	5	3		45			12
2012	28	40	40	15	27	40	45	11	18		48		3	25
2013	28	41	41	17	27	50	45	13	18		50		28	31
2014	28	41	41	18	27	50	50	24	18	1	51		31	47
2015	34	50	50	18	30	50	50	26	18	3	52	15	47	50
2016	37	50	50	20	41	55	52	30	17	10	55	51	50	51
2017	37	53	53	24	46	57	52	35	18	14	57	54	51	51
2018	39	53	53	25	46	56	54	36	16	21	58	55	51	52
2019	40	54	54	25	56	58	56	36	16	23	58	56	52	58

Source: Financial Stability Report, Bangladesh Bank and Survey Information

2.6. Impact of ICT on Transaction Cost, Time and Distance Reduction

2.6.1 Transaction Cost

Banks play a vital role in developing the economic and social conditions of a country. The major share of the profit of banks generally comes from spread. But the profitability of banks is under tremendous pressure because of continuous shrinking of spread. It becomes important for banks to reduce the cost per transaction for increasing spread that in turns will increase the profitability of banks. Use of technology in banks reduces the cost. Banks have realized that cost of transaction drastically reduces from brick-and-mortar structure of the branch to online delivery channels like ATM, POS Terminal, Mobile Phone, Internet, etc. Each of these channels has its own specific advantages in terms of improved customer service and reduced transaction cost. The basic difference between online banking and

traditional banking is that, in traditional banking the customer has to visit the branch for the basic banking needs viz. withdrawal or deposit of cash, transfer of funds, statement of accounts etc. online-business saves customers' time. Bank also enjoys lower overheads, establishment, premises and maintenance costs, which results in reduction of transaction cost. Low transaction cost is one of the main reasons why online business is getting popularity. According to Diniz (1998) Internet banking provides the lowest transaction cost in USA of $0.01 where as other delivery channels like ATM and Phone banking cost $0.27 and $ 0.52 respectively. In India transaction cost in an old generation bank is Rs. 256 and which is of Rs. 150 of a new generation computerized bank. ATM transaction costs Rs. 27, Phone banking have a cost of Rs. 15 whereas transaction costs through Internet is least only of Rs. 11 (Bhasin, 2003). Bangladesh also shows a reduction of transaction cost as a result of using computer technology. Here, transaction cost is $3.33 (Tk. 200.00) for a manual branch, $2.5 (Tk. 150.00) in a computerized branch and $ 0.6 (Tk. 40.00) for ATM (Rahman 2003). On the other hand, in USA transaction cost is only $1.14 in a computerized branch of a bank. It is seen that during the period 2003-2019 all electronic transaction costs except ATM reduced slightly in Bangladesh (Table-14).

Table 14: Average Transaction Cos t (in USD)

Delivery Channels	USA		India		Bangladesh				
	1998	2013	2003	2013	2003	2013	2015	20 17	2019
Manual Branch Banking	1.27	-	5.61	-	3.33	-	-		-
Computerized Branch Banking	1.14	4.25	3.29	-	2.50	1.84	1.54		1.12
Phone Banking	0.52	1.30	0.33	-	-	-	-	-	-
ATM Banking	0.27	1.25	0.59	0.32	0.52	0.64	0.49	-	0.65
Mobile Banking	0.16	0.10	-	-	-	0.24	0.24*	0.19*	0.12*
Internet Banking	0.1	0.24	-	0.19	-	-	-		0.022
Agent Banking	-	-	-	-	-	-	-	-	0.40
Remittance Channeling	-	-	-	-	$6.5	6.8	4.5	3.8	3.75

Source: BIBM Survey
Note: *Per 1000 Tk. ** Per 200 USD

2.6.2 Distance of Financial Access Points

In Bangladesh it is found that about 74% of the MFS (Mobile Financial Service) users have access to an agent within one kilometer whereas 62% Agent Banking Point lies between 2 to 5 kilometers. On the contrary, only 19% of bank account holders have a bank branch within the same distance. Most of the ATMs are available within 2 to 10 km. Maximum MFIs are reachable within 1 to 5 km. To access a post office, user has to travel more compared to others access points of financial services.

Figure 2: Distance of Financial Access Points
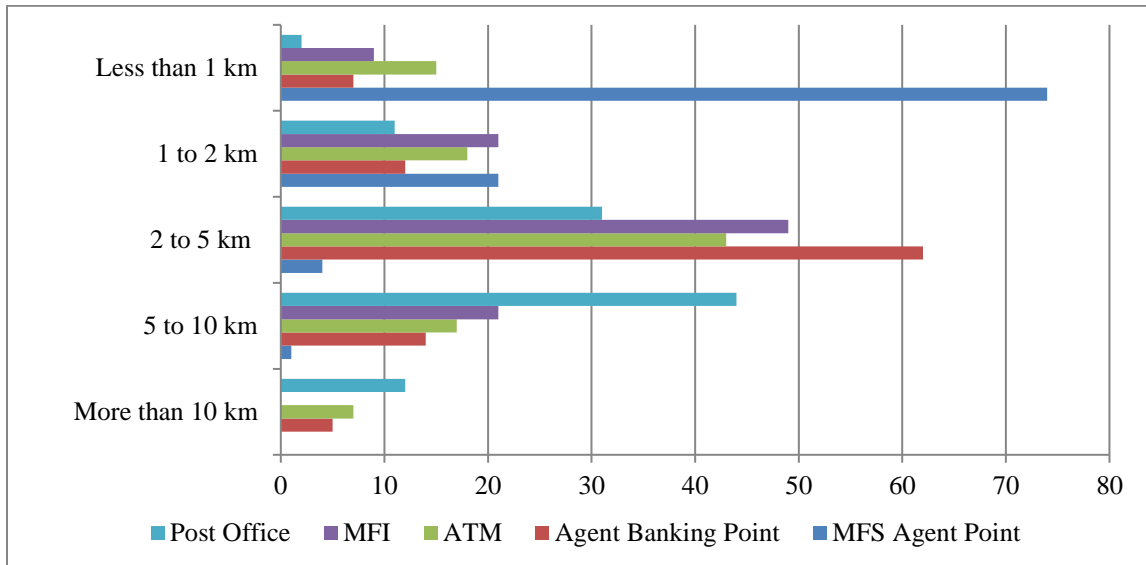
2.6.3 Cost to Access a Financial Service Point

About 53% of MFS users do not incur any costs to travel to an MFS agent point; whereas only 23% of the bank account holders' can visit their bank branches without any cost. On the other hand, 61% of bank account holders' have to spend more than BDT 10 to travel round trip to go to a bank branch, but only 23% MFS users' need to spend that amount to visit to an MFS agent point.

Figure 3: Travelling Cost per Transaction Including Man-Hour

	Bank Branch	MFS Agent Point	Agent Banking Point	ATM	MFI	Post Office
■ No Cost	23	44	8	15	9	0
■ 0-10 BDT	16	33	18	17	14	9
■ 10-30 BDT	43	16	48	45	49	41
■ 31-50 BDT	11	7	15	10	19	48
■ Greater Than 50 BDT	7	0	11	13	9	2
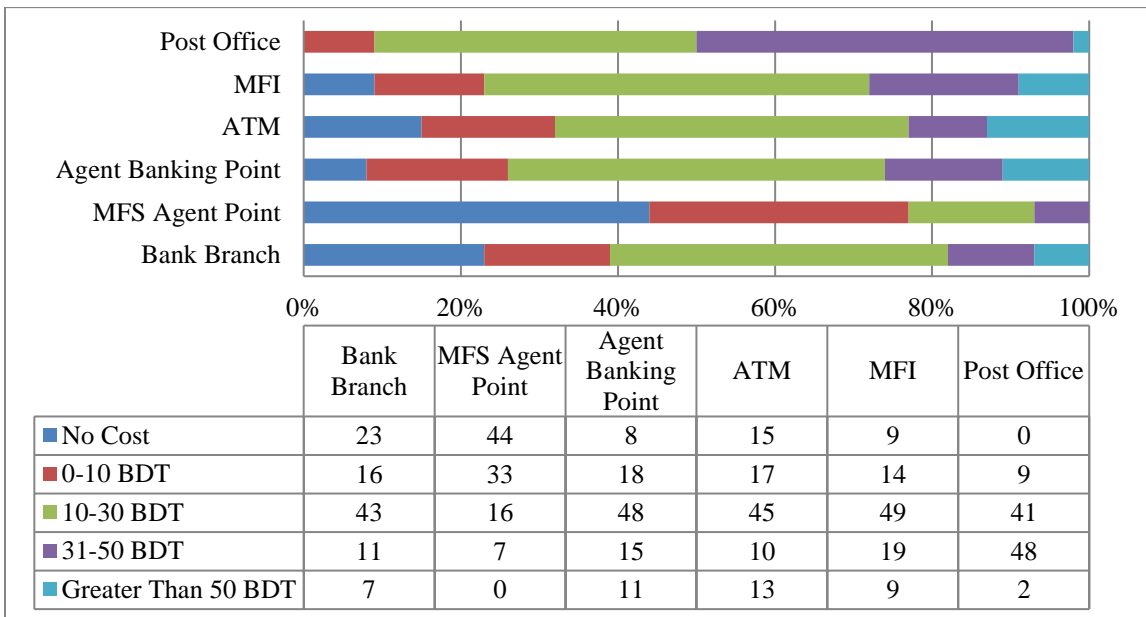
2.6.4 Travel Time to get a Financial Access Point

Among MFS users, 74% noted that it takes them less than 30 minutes round trip to their nearest MFS agent point, a figure that drops to only 55% for bank account holders. On the other hand, 81% of bank account users have to spend more than 30 minutes round trip to travel to a bank branch, while only 26% of MFS users need that amount of time to visit an MFS agent point. In case of Agent Banking, 62% needs 45-60 minutes to get an agent point.

Figure 4: Travel Time for Doing a Transaction (% of Customers)
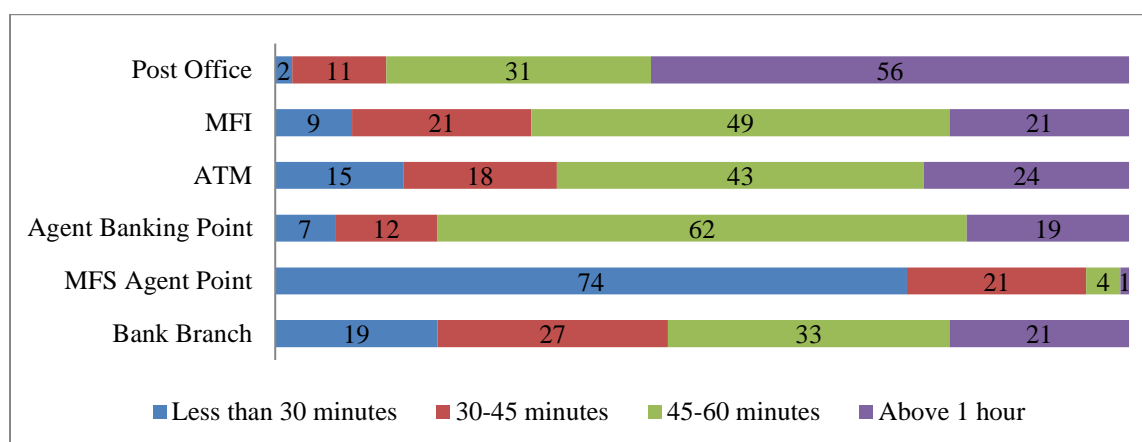
Source: BIBM Survey

2.7. Impact of ICT on Financial Inclusion

2.7.1 Financial Inclusion Measurement

Technology based business model plays a key role in Bangladesh bank's policies to enhance financial inclusion. Availing the opportunity of modern technology, financial inclusion process may be expedited. ATM, POST, Internet banking, online banking, MFSs, agent banking etc. are playing a very vibrant role for covering more people in the banking services. Moreover, Bangladesh Bank's policies inspire banks to reach out to distant communities with FinTech and accordingly huge progress has been observed to use FinTech for individual financial inclusion. It has lower overhead costs and allows banks to serve the customers who are not being fully benefitted from the traditional bank based financial services or are completely unbanked. As a result, both banks and customers are incentivized for offering and availing of FinTech services.

Currently we have 24.918 crore accounts in the banks. Distribution of total number of different types of accounts, total number of e-banking transactions and its volume are given in Table-15, Table-16 and Table-17, respectively.

Table 15: Total Number of Bank Accounts (In Millions)

Type of Accounts	2015	2016	2017	2018	2019	CAGR (%)	% of Total Accounts (2019)
Deposit	76.22	81.43	87.52	95.23	106.6	8.75	42.78
Advance	9.89	10.14	10.57	10.63	10.83	2.30	4.35
MFS Agent Accounts	0.56	0.71	0.79	0.89	0.97	14.72	0.39
MFS Clients Accounts	31.8	41.1	58.8	67.5	79.6	25.78	31.94
Social Safety Net (SSN) Program	3.9201	4.2497	4.5806	5.0622	5.6007	9.33	2.25
Employment Generation Program for the Poorest	2.0416	2.2026	2.2729	2.5792	2.6622	6.86	1.07
Freedom Fighters	0.1914	0.2168	0.201	0.2061	0.2475	6.64	0.10
Farmer's Account	8.9339	9.0436	9.238	9.6868	10.1866	3.33	4.09
Others* 10, 50, 100 Taka Accounts	0.5862	0.7582	0.7771	0.944	1.8232	32.80	0.73
Agent Banking Agents Account	0.000208	0.002334	0.002577	0.004506	0.007914	148.36	0.00
Agent Banking Clients Account	0.097037	0.525144	1.214561	2.456765	5.257769	171.31	2.11
Credit Card Accounts	0.62	0.95	0.91	1.18	1.54	25.54	0.62
Debit Cards	8.62	9.95	11.65	14.3	18.23	20.59	7.32
Prepaid Cards	0.14	0.18	0.14	0.21	0.41	30.82	0.16
SME Accounts	0.7049	0.6067	0.712	0.6608	0.7513	1.61	0.30
School Banking	1.035	1.2574	1.4539	1.8184	1.9929	17.80	0.80
Internet Banking Customers	1.53	1.53	1.74	2.04	2.47	12.72	0.99
Total	**146.89**	**164.85**	**192.57**	**215.40**	**249.18**	**14.12**	**100.00**

Source: Monthly Economic Trends, Scheduled Bank Statistics and Financial Inclusion Department, Bangladesh Bank,
Note: *Others include accounts for garments workers, cleaners of city corporations, handicapped people, etc.

Table 16: Total Number of E-Banking Transactions (In Millions)

Types of Transactions	2015	2016	2017	2018	2019	CAGR
BACPS (Started on 07 Oct, 2010)	22.83	22.2	23.17	23.26	22.4	-0.47
BEFTN (Started on 28 Feb, 2011)	13.76	15.28	18.64	24.8	37.01	28.06
RTGS (Started on 29 Oct, 2015)	-	0.22	0.79	0.86	1.85	103.35
NPSB (Started on 27 Dec, 2012)	7.78	10.48	17	24	30.7	40.94
Total Card (Credit Card, Debit Card, etc.)	137.23	170.91	182.16	217.49	253.42	16.57
Internet Banking	6.39	7.76	7.28	9.54	15.23	24.25
Mobile Banking (Started on October, 2011)	1166.1	1473.2	1875.6	2272.8	2589.8	22.08
Agent Banking	0.84	4.2	9.87	22.64	49.46	177.01
ATM	141.95	172.78	184.62	178.27	205.59	9.70
POST	14.08	17.36	21.16	26.02	31.67	22.46
Total	**1510.96**	**1894.39**	**2340.29**	**2799.68**	**3237.13**	**20.98**

Source: Monthly Economic Trends and Scheduled Bank Statistics, Bangladesh Bank

Table 17: Volume of E-Banking Transactions (In Billion Crore Taka)

Types of Transactions	2015	2016	2017	2018	2019	CAGR
BACPS (Started on 07 Oct, 2010)	15501.80	17997.80	20431.70	22946.97	23000.40	10.37
BEFTN (Started on 28 Feb, 2011)	873.80	986.00	1333.60	1722.85	2000.50	23.01
RTGS (Started on 29 Oct, 2015)	-	11283.88	20063.90	6674.75	13260.96	5.53
NPSB (Started on 27 Dec, 2012)	45.24	67.99	104.00	155.00	211.25	47.00
Card (Credit Card, Debit Card, etc.)	1030.24	1234.31	1335.53	1549.46	1817.34	15.25
Internet Banking	217.57	307.52	364.82	324.67	649.79	31.46
Mobile Banking (Started on October, 2011)	1772.80	2346.90	3146.60	3788.90	4343.20	25.11
Agent Banking	15.09	73.06	210.34	537.14	1332.93	206.57
ATM	1073.23	1253.62	1357.26	1385.30	1627.41	10.97
POST	120.94	123.92	133.03	150.82	176.77	9.95
Total	**20650.71**	**35675.00**	**48480.78**	**39235.86**	**48420.55**	**23.74**

Source: Financial Stability Report, Appendix XXXV; Monthly Economic Trends, 2016-2020, Bangladesh Bank

2.7.1.1 Geographic Concentration of Financial Services (Per 1000 Square Kilometer)

Considering geographical penetration, it is seen that the quantity of bank branches per 1000 square kilometer in 2019 expanded to 71.25 compared to 63.30 in 2015. The quantity of ATMs per 1000 square kilometer has expanded immensely from 52.8 in 2015 to 73.58 in 2019 (Table-18) and crossed the number of bank branches per 1000 square kilometer. Access to finance backed by NGO-MFIs is vital in Bangladesh. The most recent information (December, 2019) demonstrate that 724 NGO-MFIs established 19 thousand branches all through the nation (for the most part in provincial regions). The aggregate number of customers of NGO-MFIs was 32.4 million toward the end of December, 2019. As number of branches of MFIs is bigger than bank branches their entrance is higher than banks with higher CAGR over the time frame. In case of Agent Banking, agent per square kilometer, the development is gigantic with highest CAGR (148.36%). Beginning from 2014, it crossed the geological penetration of all banking channels and MFIs.

Table 18: Geographic Penetration of Financial Services (Per 1000 Square Kilometer)

Types of Services	2015	2016	2017	2018	2019	CAGR
Bank Branches	63.30	65.03	67.06	69.28	71.25	3.00
MFI Branches	105.80	110.30	116.00	123.30	131.20	5.53
MFS Agents	3780.14	4782.43	5297.72	5971.31	6544.52	14.71
Agent Banking Agents	1.40	15.72	17.36	30.35	53.31	148.36
ATM	52.80	60.75	64.14	69.75	73.58	8.65
POST	204.34	221.97	251.78	309.15	394.23	17.86

Source: Authors' Calculation

Figure 5: Geographic Penetration of Financial Services (Per 1000 Square Kilometer)
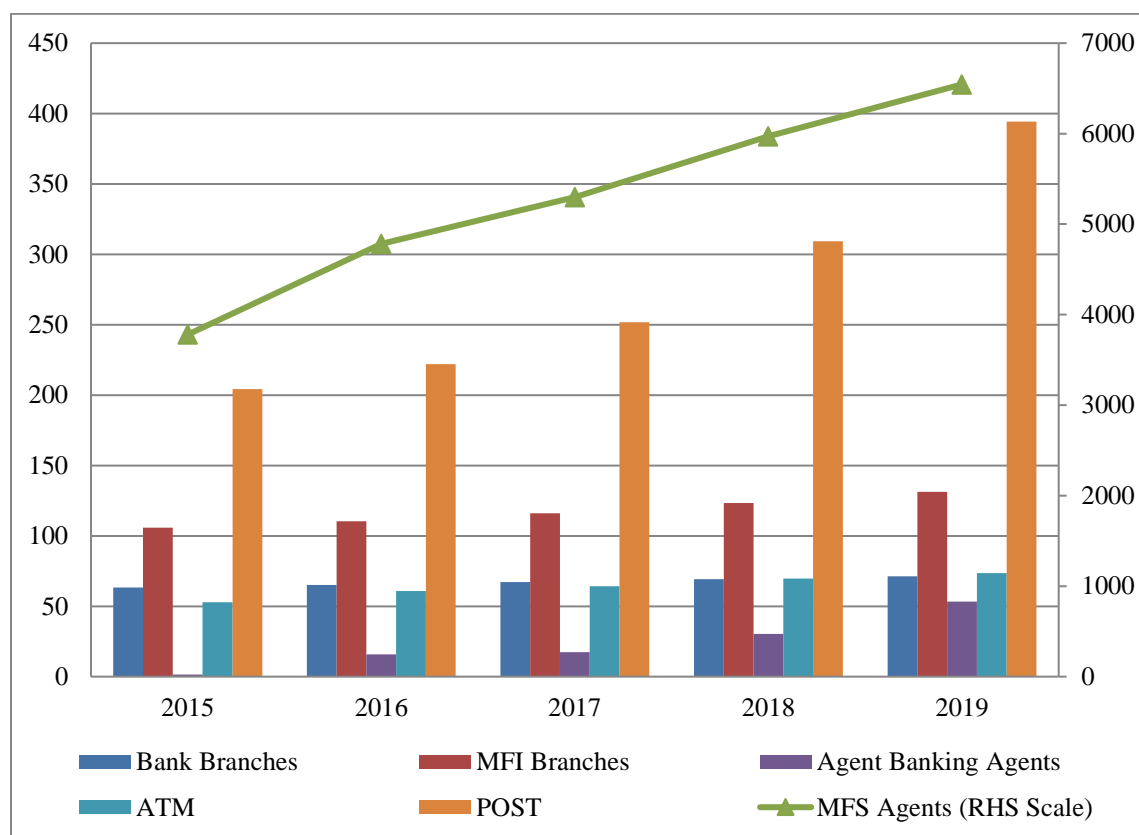
2.7.1.2 Demographic Concentration of Financial Services (Per 100000 Adult Population)

In view of demographic penetration, the quantity of branches per 100,000, populace expanded from 9.62 in 2015 to 10.09 in 2019. The quantity of ATMs per 100,000 populaces expanded from 8.03 in 2015 to 10.42 in 2019 (Table-19). Developments in geographical and demographic penetration demonstrate that entrance to finance is relentlessly expanding over time in Bangladesh. Population penetration by NGO-MFIs shows that 16.08 branches existed per 100,000, populace toward the end of December 2015, increasing imperceptibly to 18.57 branches toward the end of December 2019. In case of Agent Banking services per 100000 grown-up populace, the development is the highest (CAGR for Agents and Customers is 143.98 and 166.52, respectively). Beginning from 2014, within five years, it crossed the demographic penetration of all other financial services.

Table 19: Demographic Penetration of Financial Services (Per 100000 Adult Population)

	2015	2016	2017	2018	2019	CAGR
Bank Branches	9.62	9.78	9.88	10.01	10.09	1.19
Deposit Accounts	78046.28	82519.25	86885.73	92645.20	101649.66	6.83
Advance Accounts	10126.97	10275.64	10493.40	10341.47	10327.07	0.49
MFI Branches	16.08	16.59	17.10	17.81	18.57	3.66
ATM	8.03	9.14	9.45	10.07	10.42	6.73
POST	31.06	33.39	37.11	44.65	55.81	15.78
Internet Banking Users	1562.20	1547.01	1729.80	1985.04	2357.35	10.83
Debit Card	8829.11	10081.77	11569.42	13914.74	17384.47	18.46
Credit Card	635.19	959.62	901.92	1148.37	1465.82	23.25
Prepaid Card	138.36	178.54	137.50	204.65	394.38	29.94
MFS Agents	574.65	719.50	780.80	862.44	926.48	12.68
MFS Customers	32561.95	41649.78	58373.87	65667.87	75903.50	23.56
Agent Banking Agents	0.21	2.37	2.56	4.38	7.55	143.98
Agent Banking Customers	99.36	532.17	1205.76	2390.08	5013.61	166.52
Internet Banking Customers	1566.66	1550.47	1727.39	1984.63	2355.30	10.73

Source: Authors' Calculation

The continuous growth of the number of delivery channels like bank branches, ATMs, MFI, Agent Banking and Mobile Financial Services (MFS) per 1000 square kilometer and per 100,000 populations identifies growing financial inclusion. Among all delivery channels, an outstanding growth has been seen in case of Agent Banking, followed by MFS and ATM/POST (Plastic Card based banking services) in terms of both geographic and demographic penetration showing massive use of FinTech in getting banking services. Even number of bank branches has also been increasing with a very tiny change rate (CAGR). But number of Micro Finance Institutions (MFI) is with a higher growth rate than bank branches since 2015.

At the end of 2019, it is noteworthy that share of rural MFS account is almost double (62.6%) as compared to urban MFS account (37.4%) implying that FinTech is very effective in rural financial inclusion. The huge success of Agent Banking in individual financial inclusion is recognized with the plenty share of rural people. With respect to internet banking, growth between 2015 and 2019 indicates quick penetration of the virtual banking activities with traditional branch-based banking. Electronic payment instruments such as credit and debit cards in banking transactions substituting money-based transaction have also gained wide attention in financial inclusion of individuals in Bangladesh particularly in the urban area.

3.0 Impact of ICT on Banking Operations, Productivity, Efficiency and Profitability of Banks

Research studies reveal that measurement of the impact of ICT on bank's performance is an important and deeply felt necessity. It is also acknowledged widely that while traditional measures and ratio analysis might be a way of assessing a bank's performance, it has several limitations of applicability when it comes to evaluating outputs as related to ICT inputs. As a result, conventional evaluation techniques like Cost-Benefit Analysis (CBA) and Return on Investment (ROI) when used in ICT context are viewed with scepticism. Accordingly, parametric and non-parametric approaches to measuring ICT productivity and profitability have come into greater prominence.

3.1 Impact of ICT on Banking Operations

At the end of 2019, sum of all types of bank account stood at 24.918 crore and 1,91,360 employees were working in this sector. It is seen that majority of the employees (64%) are working for private commercial banks followed by state-owned commercial banks (27%). Rest of the 9% of the human resources is employed for specialized and foreign banks (Figure-6).

Figure 6: Employee Distribution of Banks (2019)
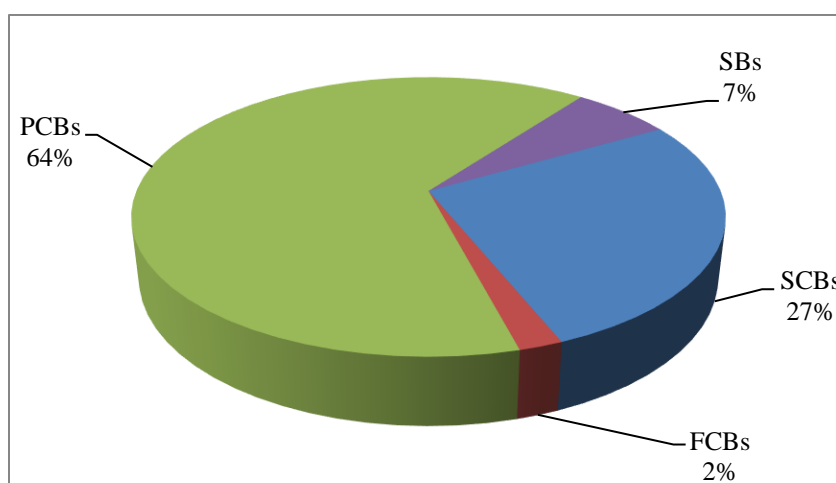
Source: Bangladesh Bank

Distribution of employees from 1975 to 2019 is shown in Table-20. It is seen that though the number of branches and accounts are increasing day by day in case of government banks, number of employees are gradually decreasing after 1990. The scenario is just opposite for private and foreign banks. 39.78% CAGR for PCBs indicate a huge growth since 1985. Growth of human resources for FCBs is also notable with 20.54% CAGR.

Table 20: Distribution of Employees

Year	1975	1980	1985	1990	1995	2000	2005	2010	2015	2019	CAGR
SOCBs	24921	51333	56334	63831	63803	62091	56417	50069	54501	52002	-1.14
FCBs	707	912	1051	1135	966	1280	1713	3143	4074	3886	20.54
PCBs	-	-	11813	16916	20083	25975	36715	68720	100178	123186	39.78
SBs	3594	6990	16069	16798	16459	16164	15406	14367	13953	12286	-3.76
All Banks	29222	59235	85267	98680	101311	105510	110251	136299	172819	191360	12.24

Source: Monthly Economic Trends, Bangladesh Bank

Total number of transactions from 2015 to 2019 is given in the Table-21. In 2019, considering branch transactions only, it is seen that average number of transactions per employee was about 12,302 (Table-22). Whereas it was about 29,218 if we combine online (ADC) and branch transactions. In banks, SMS is also considered as a transaction since it requires to run a business process. In 2019, total number of transactions was recorded at 16191.54 crore considering branch, ADCs and SMSs.

Table 21: Total Number of Transactions (In Millions)

Source of Transactions	2015	2016	2017	2018	2019	CAGR
Transactions from Branch Only	1685.68	1797.97	1941.04	2118.34	2354.06	8.71
Online Transactions (ADCs and Clearing through Bangladesh Bank)	1510.96	1894.39	2340.29	2799.68	3237.13	20.98
Transactional SMS (Branches and ADCs)	3196.64	3692.36	4281.33	4918.02	5591.19	15.00
SMS (Monthly and Yearly Balance)	1762.68	1978.23	2310.87	2584.79	2990.16	14.12
Total Transactions	10170.96	11378.95	12890.53	14438.83	16191.54	58.81

Source: Authors' Survey and Bangladesh Bank

Table 22: Average Number of Transactions per Employee

Source of Transactions	2015	2016	2017	2018	2019	CAGR
Transactions from Branch Only	9966	11021	10977	11719	12302	5.40
Branch and Online Transactions (ADCs and Clearing through Bangladesh Bank)	18899	22633	24211	27206	29218	11.51
Branch and Online Transactions (ADCs and Clearing through Bangladesh Bank) Including All Types of SMS	48220	57392	61490	68712	74062	11.32

Source: Authors' Survey and Bangladesh Bank

There were 1,91,360 employees in the banking sector at the end of 2019 and about 2354.06 million transactions were done from branches only. It is estimated that to do the same amount of transactions we need about 6,14,476 and 5,07,997 employees, if

we consider the productivity of employees in 1980 and 1990, respectively. Moreover, number of transactions from Alternate Delivery Channels (other than branches) was recorded at 3237.13 million in 2019. And total number of transactions from branch and ADCs reached at 5591.19 million. It is also calculated that to do the same amount of transactions about 14,59,460 and 12,06,558 employees are needed if we consider the productivity of employees in 1980 and 1990, respectively. These findings clearly show that productivity of employees has been increased from minimum 353% to maximum 839% due to the impact of ICT.

3.1.1 Total Number of Accounts (Deposit and Advance) Per Employee

Automation increases the efficiency of employees in banking. Total number of accounts (Deposit and Advance) per employee has increased radically from 1995 to 2000, when automation has rolled out. And in 2010 (when many banks have finished automation), total number of accounts (Deposit and Advance) per employee has escalated to a new height.

Figure 7: Total Number of Accounts (Deposit and Advance) Per Employee
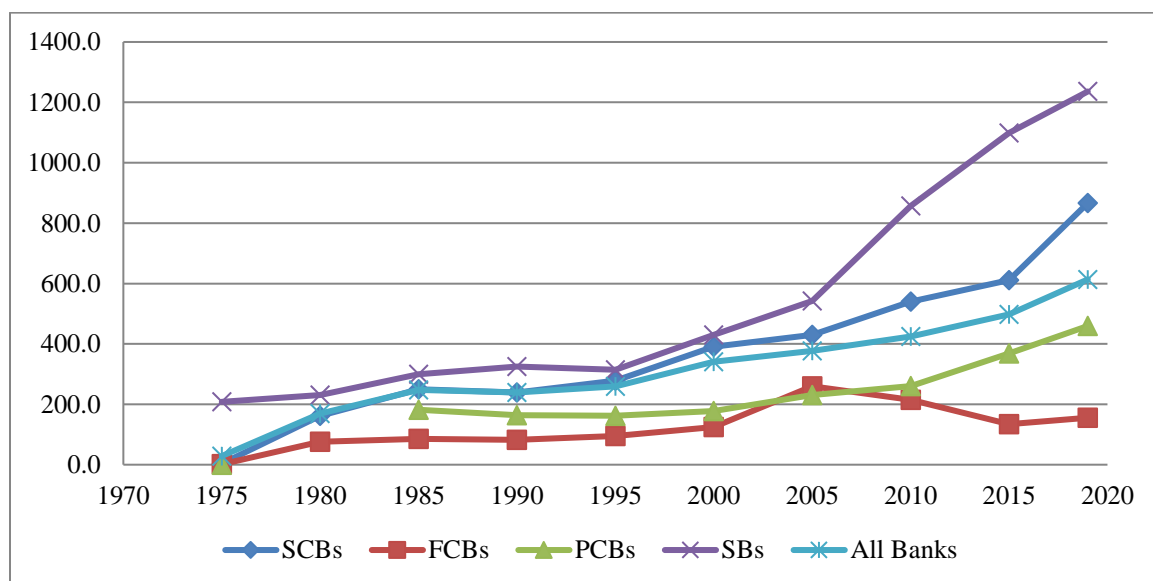
Source: Bangladesh Bank

3.1.2 Total Accounts (Deposit and Advance) Per Branch

From Figure-8, we clearly understand that automation helps banks to maintain more accounts per branch efficiently. As a whole, a notable growth has been seen in terms of total accounts (Deposit and Advance) per branch from 1995. And the growth has increased further from 2000 and onwards.

Figure 8: Total Accounts (Deposit and Advance) Per Branch
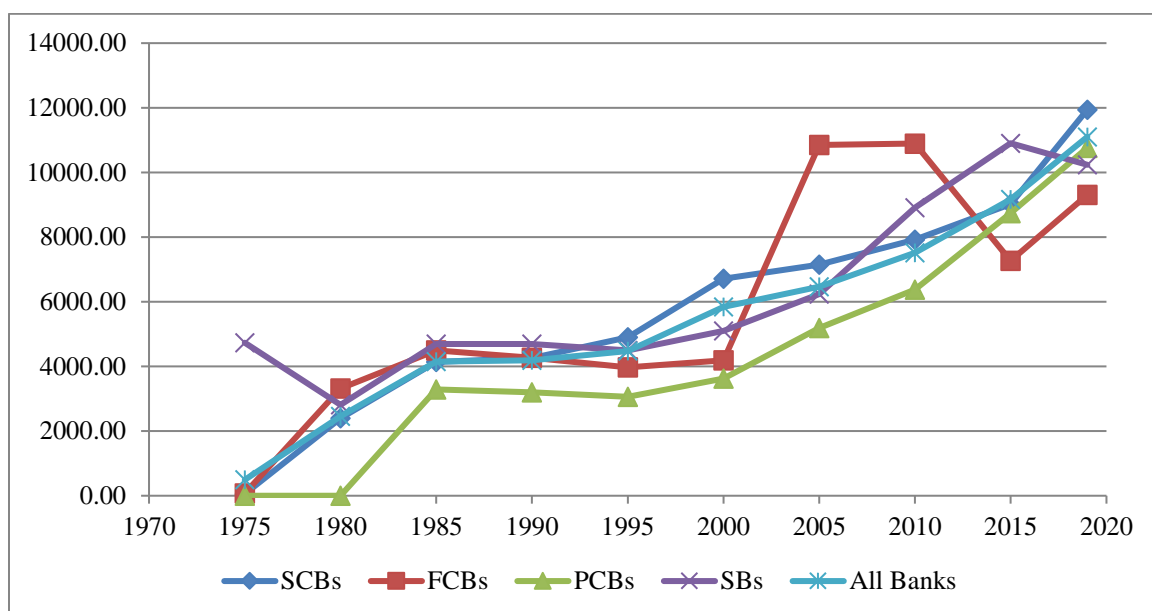
3.1.3 Total Income per Employee (In Lac Taka)

Table-23 depicts the total income per employee in Lac Taka. The growth is very insignificant from 1975 to 1985 in case of SOCBs, PCBs and SDBs. FCBs has shown an earlier progress than other categories of banks from 1985. In case of SOCBs, PCBs and SDBs, the headway was happening from 1995 and more particularly from 2000. In the year 2005, total income per employee (in Lac Taka) is 8.57, 24.89 and 6.66 for SOCBs, PCBs and SDBs, respectively. Here also, the position of PCBs is higher than other groups of banks. The significant growth of overall banking system is seen from 2000 when most of the banks started centralized banking operation.

Table 23: Total Income per Employee (In Lac Taka)

Year	1975	1980	1985	1990	1995	2000	2005	2010	2015	2019	CAGR
SOCBs	0.60	0.66	1.62	2.48	3.11	6.00	8.57	20.49	38.13	42.75	59.55
FCBS	1.26	3.59	11.84	18.08	34.75	75.59	79.84	83.77	132.73	185.91	48.20
PCBs	-	-	2.37	4.23	4.70	12.58	24.89	47.84	63.92	79.52	65.16
SDBs	0.53	1.00	1.81	2.45	1.43	5.08	6.66	18.17	14.77	16.15	36.71
All Banks	0.61	0.74	1.89	2.95	3.45	8.32	14.85	35.49	53.40	67.62	66.72

3.1.4 Export, Import and Remittance Handling Per Employee (In Lac Tk.)

Computerization brought a silent revolution in banking sector, which is clear from Figure-9. Export, import and remittance handling per employee was not so significant during the period 1975 to 1990 when banks had no automation system at

all. But the ration has risen significantly from the year 2000, when banks have started implementing centralized system.
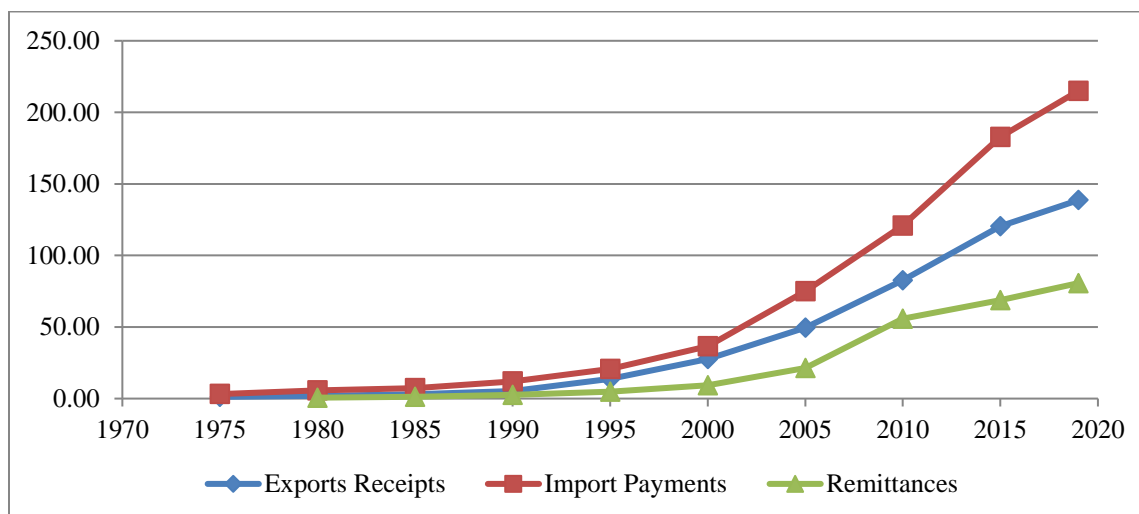
Figure 9: Export, Import and Remittance Handling Per Employee (In Lac Tk.)

3.1.5 Expenditure-Income Ratio

By analyzing Expenditure-Income Ratio, impact of ICT is clearly understood. The available data from 2004 reveals that the ratio has decreased significantly in the last few years though there was a moderate increase in salary and other administrative expenses.

Figure 10: Expenditure-Income Ratio
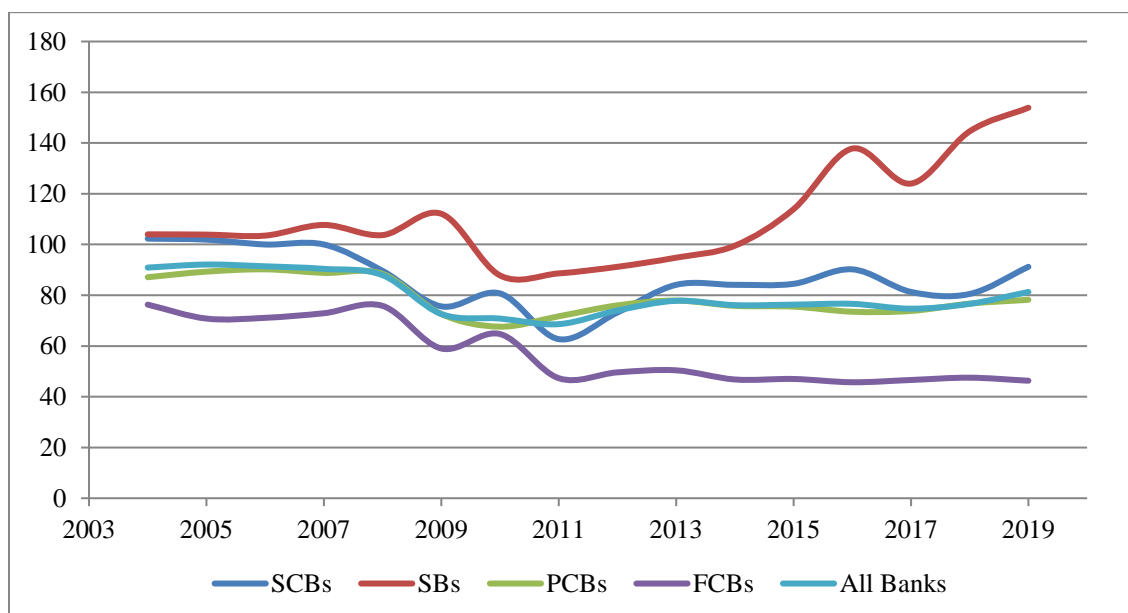
The main reasons might be the reduction of stationery and transaction cost and improvement of productivity of employees by using ICT. Expenditure-Income ratio of different categories of banks from 2004 to 2019 is shown in Figure-10.

3.1.6 Total Transactions per Employee (Branch Only)

It is clear from Figure-11 that computerization has changed the banking industry significantly. ICT has increased the productivity and efficiency of bank employees at a constant pace. In 1985, on an average an employee of the banking sector could handle 4946 transactions in branch, whereas in 2019, it was 12302. It clearly indicates that ICT has changed the working environment of the banks in a positive way.

Figure 11: Total Transactions per Employee (Branch Only)
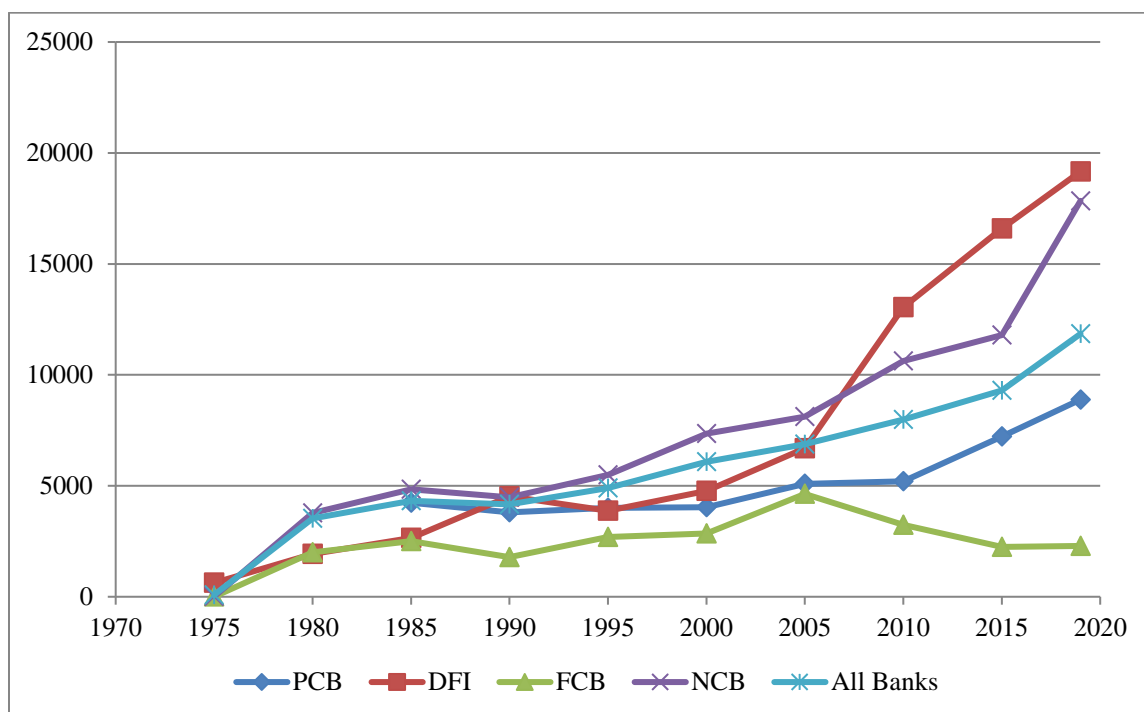
Source: Bangladesh Bank

3.1.7 Total Number of Employees per Branch

From Figure-12, it is evident that FCBs are always ahead in terms of employees per branch. Total number of employees per branch of FCBs is always greater compared to SOCBs, PCBs and SDBs. It is also seen from the figure that since 1975 average number of employees per branch remains almost constant for the industry as a whole.

Figure 12: Total Number of Employees per Branch
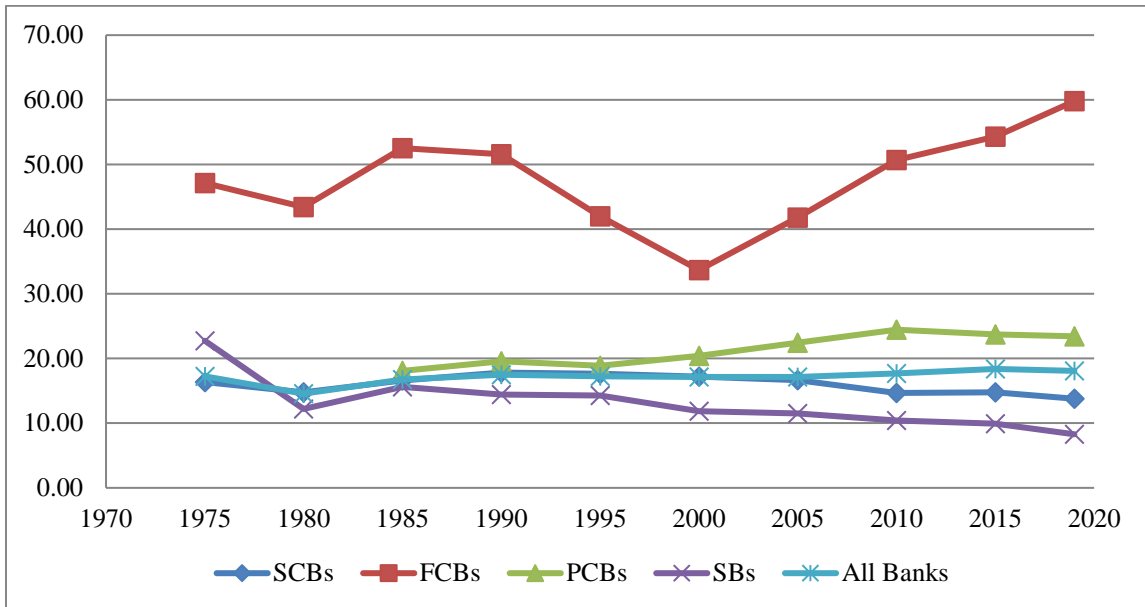
Though the average number of employees per branch for the banking industry was almost same since 1975 to 2019, it is observed that total number of accounts (deposit and advance) per employee, total accounts (deposit and advance) per branch, total income per employee, total export, import and remittance handling per employee and total transactions in branch per employee has been increased tremendously due the technological advancement in the banking sector. Since 1990, banks have started scattered automation process by using decentralize banking system and there after the above-mentioned parameters started to increase slightly but major growth is observed after 2000 when most of the banks started centralized banking operations through data center.

3.2 Impact of ICT on Productivity of Banks

Productive efficiency gives a measure of performance of the bank in producing outputs relative to inputs. Productivity is thus an important component of analyzing and monitoring a bank's performance. Parametric approaches to measuring productivity involve parameterizing the relationship between the level of inputs and the technically efficient level of outputs. In the non-parametric approach, no such assumptions are made on the form of the production function.

Among the popular parametric methods employed is the production function framework derived from the economic theory of production relating the outputs of a firm to its inputs. Barua *et al.* (1995), Parsons, Gotlieb and Denny (1993), Brynjolfsson and Hitt (1996), Prasad and Harker (1997) among others used this

methodology to study returns on ICT investment and/or the impact of IT on the productivity and profitability of the firm.

Prasad and Harker (1997) bring out through empirical studies that use of production function techniques in banks is valid and successful. The typical form of the Cobb-Douglas Production Function to study the impact of ICT takes the form (Brynjolfsson and Hitt, 1996):

$$Q = e^{\beta_0} C^{\beta_1} K^{\beta_2} S^{\beta_3} L^{\beta_4}$$

Where

$Q = Output\ of\ the\ Firm,$ $C = IT\ Capital,$ $K = Non - IT\ Capital,$ $S = IT\ Staff\ expense,$

$L = Non - IT\ Staff\ Expense$ and $\beta_1, \beta_2, \beta_3, \beta_4$ are the associated output elasticities.

For estimation purposes, the above equation is linearized by taking its logarithms and adding two dummies (to see the impact of different automation levels of ICT in banks) and an error term as follows:

$$Log\ Q = \beta_0 + \beta_1 \log C + \beta_2 \log K + \beta_3 \log S + \beta_4 Log\ L + \beta_5 D_1 + \beta_6 D_2 + \varepsilon \ldots \ldots (1)$$

Dummy Variables

$$D_1 = 1, if\ the\ bank\ is\ in\ Category - 1\ automation; Otherwise\ 0$$

$$D_2 = 1, if\ the\ bank\ is\ in\ Category - 2\ automation; Otherwise\ 0$$

All Dummies '0' means there was a very little scattered branch automation only or no automation at all.

We will test the following hypotheses for the model (1):

H_{1a}:

   $\beta_1 > 0; \beta_3 > 0$ versus the null hypothesis that $\beta_1 = \beta_3 = 0$

i.e. the marginal products of ICT capital and ICT labor are positive, which means that investment in ICT improves productivity.

H_{1b}:

   β_1* (Output/ICT Capital) - Cost of ICT Capital > 0; and

   β_3* (Output/ICT Labour) - Cost of ICT Labour > 0.

H_{1b} helps us to confirm that ICT investment is not only positive, but also it pays more than what we spend on it. This is a robust test than H_{1a}, which only exams for the gross benefits, since we are assessing whether there are any positive net benefits (i.e., benefits after we have subtracted the costs from the gross benefits) associated with ICT.

Finally, we shall also test the following hypothesis:

H_{1c}:

β_1- (ICT Capital/Non-ICT Capital)* $\beta_2 > 0$ and

β_3- (ICT Labour/Non-ICT Labour)* $\beta_4 > 0$

This hypothesis states that the ratio of the marginal product to the investment in ICT capital and labor is higher than it is for the corresponding non-ICT investments; this is a much stronger hypothesis than H_{1a}. Not only does it imply that there are positive returns to investment in ICT capital and labor but also that the returns are higher than those from non-ICT capital and labor.

The data is taken from the published annual reports of the banks concerned. For the ICT investments variable "Other Fixed Assets" in the balance sheets is used as a proxy. Banks account for investments in ICT infrastructure and related supporting assets under this head. In the absence of a separate line item in the balance sheets this head most closely represents the ICT investments made. For the non-ICT investments variable additions during the year to fixed assets and work in progress are considered. Personnel expenses are taken from the head of 'salary and allowance'. This is split up into ICT and non-ICT components in the same ratio as number of ICT personnel and non-ICT personnel in the total employee strength. For the rest figures arrived at are based on the information shared by the respective heads of ICT departments in personal/telephonic interviews. Data from 4 Govt. (3 SOCBs and 1 SDB), 3 FCBs and 14 PCBs from 2000-2019 are pooled and analyzed. Summary of the input output data are given in the following table:

Table 24: Summary Statistics of Input-Output data

Output (Dependent Variable)			
Average Advance and Deposit Tk. 11275.12 Crore		Average Revenue Tk. 1271.15 Crore	
Inputs: Independent Variables			
Average ICT Investments Tk. 15.4 Crore	Average Non-ICT Investments Tk. 56.42 Crore	Average ICT Personnel Expenses Tk. 3.94 Crore	Average Non-ICT Personnel Expenses Tk. 166.48 Crore

Source: Authors' Calculation

Result and Discussion

The following are the key results obtained from the summary statistics (Table-25) and the regression equation (1):

Table 25: Estimates from Random Effect Model

Parameter	Coefficient	t-statistics	p-value	Ratio to Output	Marginal Product
ICT Investments	0.1866	3.75	0.000	0.00137	136.620
Non-ICT Investments	0.2931	2.73	0.023	0.00500	58.571
ICT Personnel Expenses	0.1183	5.59	0.000	0.00035	338.542
Non-ICT Personnel Expenses	0.6739	3.31	0.002	0.01477	45.641
Constant	0.089	1.37	0.175		
D1	0.391	2.18	0.031		
D2	0.092	1.79	0.076		

Statistic	Value	p-value
F-Statistic	23.0	0.000
R^2	0.89	
Adjusted R^2	0.82	
Modified Wald *	12.94	0.226
Wooldridge*	1.98	0.192

Source: Authors' Calculation
Note: *Values are given after correction for autocorrelation and heteroskedasticity.

Test of Hypothesis, when Output = Total Loans and Deposits

$H_{1a}: \beta_1 > 0; \beta_3 > 0$ versus the null hypothesis that $\beta_1 = \beta_3 = 0$

It is observed that the elasticity (coefficient) associated with ICT investments is positive and high. Therefore, there is strong evidence to conclude that ICT investments contribute to productivity. The marginal product of ICT investments is positive and high at 136.620. By the same way, there is evidence that expenses on ICT personnel too contribute to productivity, with the marginal product positive and high at 338.542. Though there is evidence of positive returns accruing through the non-ICT components too, their marginal products are lower.

$H_{1b} : \beta_1$* (Output/ICT Capital) - Cost of ICT Capital> 0; and

β_3*(Output/ICT Labour) - Cost of ICT Labour> 0.

From Table-25 it is evident that the marginal product of ICT investments is very high at 136.620 far exceeding the cost of fund (7.5 percent). Thus we can accept H_{1b} for ICT

capital. We also see that the marginal product for ICT labor is very high at Tk. 338.542. Since ICT labor is a flow variable, it means that every taka of ICT labor costs a taka. In view of this, the excess returns from ICT labor can be computed to be (338.542 - 1), or 337.542. Thus, H_{1b} can be accepted for ICT personnel too. Thus, verifies that ICT yields are not just positive alone, but pay more than what is spent on ICT.

Also third hypothesis can be tested as:

$H_{1c}: \beta_1$- (ICT Capital/Non-ICT Capital)* $\beta_2 > 0$ and

β_3- (ICT Labour/Non-ICT Labour)* $\beta_4 > 0$

Using the figures from summary statistics (Table-24) as well as the coefficients (Table-25) and applying them to the equation, it is observed that:

β_1- (ICT Investment/Non-ICT Investment)* $\beta_2 = 0.1065 > 0$

Thus. Hypothesis H_{lc} is proven that the ratio of marginal product to investments in ICT is higher than it is for corresponding non-ICT investments. Hence it implies that there are positive returns to ICT investments and that the yields are higher than those from non-ICT investments.

Applying in the same way to ICT labour:

β_3- (ICT Labour/Non-ICT Labour)* $\beta_4 = 0.10235 > 0$

Thus it implies that there are positive returns to expenditure on ICT personnel and that the returns are higher than those on Non-ICT personnel.

The above results also reveal that, ICT personnel are a resource that yields better returns than ICT investments. This is reflective of the banking industry, where emphasis on service delivery means that labour is considered to be a more worthwhile investment than capital.

Significant value of the dummy variable D_2 implies that there is a significant technology shift from manual banking system to Category-2 online banking process. But low value of D_2 (0.092) indicates that impact of Category-2 technology over manual banking system is very little.

However, high significant value of the dummy variable D_1 implies that there is a big technology shift from Category-2 system to Category-1 online banking process. And higher value of D_1 (0.391) indicates that impact of Category-1 technology over Category-2 technology is very high.

Test of Hypothesis when Output = Revenue

The following are the key results, computed from the summary statistics (Table-24) as well as the regression equation (1).

Table 26: Estimates from Random Effect Model

Parameter	Coefficient	t-statistics	p-value	Ratio to Output	Marginal Product
ICT Investments	0.1998	3.18	0.001	0.01212	16.49
Non-ICT Investments	0.6319	2.34	0.022	0.04439	14.24
ICT Personnel Expenses	0.0774	3.13	0.002	0.00310	24.97
Non-ICT Personnel Expenses	0.8166	7.05	0.000	0.13097	6.240
Constant	0.1101	1.50	0.132		
D1	0.6236	3.22	0.002		
D2	0.1813	1.79	0.075		

Statistic	Value	p-value
F-Statistic	19.0	0.000
R^2	0.84	
Adjusted R^2	0.78	
Modified Wald *	8.78	0.226
Wooldridge*	1.01	0.198

Source: Authors' Calculation
Note: *Values are given after correction for autocorrelation and heteroskedasticity.

Hypothesis: H_{1a}

From the foregoing discussion, this hypothesis reads:

$H_{1a}: \beta_1 > 0; \beta_3 > 0$ versus the null hypothesis that $\beta_1 = \beta_3 = 0$

As in the previous instance, coefficients of both ICT and Non-ICT inputs are positive, reflecting positive returns. However, marginal products are much lower.

Hypothesis: H_{1b}

$H_{1b} : \beta_1$* (Output/ICT Capital) - Cost of ICT Capital > 0; and

$\quad \beta_3$*(Output/ICT Labour) - Cost of ICT Labour > 0.

Following the discussion in the previous case (output = loan and advances), it can be inferred that H_{1b} can be accepted in the case of revenue as output criterion too. However, considering the low marginal product values, it may be concluded that the evidence of ICT resources paying more than what is spent on them is rather weak.

Hypothesis: H_{1c}

Using the figures from summary statistics as well as the coefficients and applying them to the equation, it can be observed that:

β_1- (ICT Investment/Non-ICT Investment)* $\beta_2 = 0.0273 > 0$

Thus, hypothesis H_{1c} is proven that the ratio of marginal product to ICT investment is higher than it is for the corresponding non-ICT investments. It implies that there are positive returns to ICT capital and that the returns are higher than those from non-ICT capital.

Applying in the same way to ICT labour:

β_3- (ICT Labour/Non-ICT Labour)* $\beta_4 = 0.0580 > 0$

Thus, H_{1c} can be accepted for revenue as output too.

From the foregoing analysis of the contribution of ICT to banks' productivity, it could be inferred that ICT capital and ICT labour contribute significantly to the productivity of the banking sector for both business mix (advance and deposit) and revenue as outputs. In fact not only are the ICT contributions positive, they pay more than what is being spent on them. Also, the returns on ICT resources are higher than those accruing from non-ICT resources.

Significant value of the dummy variable D_2 implies that there is a significant technology shift from manual banking system to Category-2 online banking process. But low value of D_2 (0.1813) indicates that impact of Category-2 technology over manual banking system is very low.

However, high significant value of the dummy variable D_1 implies that there is a big technology shift from Category-2 system to Category-1 online banking process. And higher value of D_1 (0.6236) indicates that impact of Category-1 technology over Category-2 technology is very high.

Before we run the regression analysis we used the Variance Inflation Factor (VIF) and test variability allowed Tolerance between independent variables to clarify if there is a multicollinearity problem between the independent variables. We found some variables that are excluded from the model were highly correlated with some independent variables. Depending on the Variance Inflation Factor (VIF) and variability allowed Tolerance test for each variable which should not exceed the inflation coefficient value of 10 and Tolerance should be greater than 0.05 we removed them from the model. Therefore, the model under study is reliable as there is no significant effect of Variance Inflation Factor problem.

We estimated equation (1) using both random and fixed effects model separately. A series of tests were carried out to select the use of the best model for the regression analysis. According to Yaffee (2005) either of the fixed-effects or random-effects estimators would be the best linear unbiased estimator (BLUE). The Hausman specification test was used to find the BLUE and the random effects estimator was selected as the most appropriate one.

While running fixed effect model we observed autocorrelation and heteroskedasticity in the data. Finally, we removed it by running a rectified model. Modified Wald and Wooldridge test ensured the removal of the problems.

3.3 Impact of ICT on Bank's Efficiency

3.3.1 Data Envelopment Analysis

Charnes, Cooper and Rhodes (1978) developed Data Envelopment Analysis (DEA) that uses linear programming technique to study how a specific Decision Making Unit (DMU) – like a bank in this study – operates relative to other DMUs in the sample. The ratio of output to input is considered as a measure of Efficiency. This is very simple if there is only one input and one output. But the process converts complex when multiple inputs and outputs are used. Data Envelopment Analysis gets around this problem by constructing an efficiency frontier from weighted inputs (virtual input) and weighted outputs (virtual output). An efficiency score of 1 is given to DMUs on the frontier while scores between zero and one are given to others inside. The more away a bank is from the frontier, the lower its efficiency score.

This study considered deposits as an output in addition to advances and non-interest income. The number of branches, total operating expenses and equity are considered as input variables. In a country like Bangladesh, total number of branches is a very important parameter in providing banking products and services, especially where a majority of a bank's customers are likely to have only limited ability to travel. A widespread branch network allows a bank to generate more deposits and more loans with the same level of operating expenses.

In recent years, banks have been investing more in Financial Technologies like ATMs, MFSs, Agent Banking, Internet Banking, Banking Apps, Virtual Banking, etc. Banks are also inspiring their customers to use these technologies. As a result operating costs are expected to drop while fixed costs surge but we would still expect an overall enhancement in bank efficiency and profitability.

3.3.2 Efficiency Scores

The output of DEA (efficiency scores) is shown in Table-27 from 2000 to 2019. But due to limitation of table space we intentionally skipped data of some years between 2000 and 2015. Our study includes 21 banks – 4 Govt. Banks (3 SOCBs and 1 DFI), 14 PCBs and 3 FCBs. We calculated ES for each bank separately for the period 2000-2019. But the following table shows scores by categories of banks only.

Table 27: Banks Efficiency Scores (ES) under Data Envelop Analysis

Types of Bank	2000	2005	2010	2015	2016	2017	2018	2019
SOCBs	0.458	0.403	0.584	0.578	0.456	0.632	0.540	0.571
SDBs	0.37	0.384	0.497	0.454	0.499	0.444	0.344	0.457
PCBs	0.604	0.691	0.744	0.703	0.732	0.771	0.794	0.811
FCBs	0.730	0.737	0.758	0.831	0.788	0.755	0.827	0.822

Source: Authors' Calculation

From Table-27 we see that in last few years, Foreign Commercial Banks (FCBs) are seen to be the most efficient. Thus, with the limited number of branches foreign banks seem to make good use of their inputs. Efficiency of Private Commercial Banks (PCBs) is slightly behind foreign banks. State-owned Commercial Banks (SOCBs) rate third in efficiency, behind private and foreign banks. The reasons might be the high amount of NPL and large number of branches that are being operated in the rural areas. However, due to the huge investment in ICT, government banks gained most in efficiency during the period 2010 to 2019. In general, it is also seen that efficiency scores have enhanced for all types of banks during the period under study.

3.3.3 Explaining Efficiency Differences

In this section, we try to clarify differences in bank efficiency. We used the following multiple regression method for our pooled data.

$$ES = \beta_0 + \beta_1 SER + \beta_2\, ITNITER + \beta_3 CER + \beta_4 ITIER + \beta_5 D_1 + \beta_6 D_2 + \varepsilon \dots\dots\dots. (2)$$

Each individual bank's efficiency score (ES) is the dependent variable in the equation and the explanatory variables are: SER (Salary to Expenditure Ratio), ITNITER (ICT-Employee to Non-ICT Employee Ratio), CER (Computer to Employee Ratio), ITIER (ICT Investment to Employee Ratio) and two Dummy variables to check the impact of the levels of automation of banks.

$$D_1 = 1, \text{if the bank is in Category} - 1 \text{ automation; Otherwise } 0$$

$$D_2 = 1, \text{if the bank is in Category} - 2 \text{ automation; Otherwise } 0$$

Here all Dummies '0' means there was very little automation or no automation at all. Finally, we added ε, the error term of the model. Statistical estimations are given in the following table.

Table 28: Summary from Random Effect Model

Independent Variables	Coefficient	t-Statistic	p-value
Constant	0.2299	9.17	0.000
SER (Salary Expenditure Ratio)	0.1717	2.18	0.041
ITNITER (ICT-Employee Non-ICT Employee Ratio)	1.1509	1.56	0.133
CER (Computer Employee Ratio)	0.3650	10.04	0.000
ITIER (ICT Investment Employee Ratio)	0.0033	3.94	0.001
D_1: Category $-$ 1 Automation	0.0862	3.06	0.006
D_2: Category $-$ 2 Automation	0.0321	1.54	0.140

Statistic	Value	p-value
F-Statistic	13.0	0.000
R^2	0.78	
Adjusted R^2	0.72	
Modified Wald *	12.94	0.246
Wooldridge*	0.018	0.895

Source: Authors' Calculation
Note: *Values are given after correction for autocorrelation and heteroskedasticity.

It is detected from the regression results in Table-28 that the SER (Salary Expenditure Ratio), has a positive impact on ES. This implies that banks giving a higher portion of their expenditure as salary have higher efficiency in the market. This is due to the fact that the employees who are highly paid in the market have high quality and efficiency compared to ill paid employees. CER (Computer to Employee Ratio) is found very significant because, in reality, the employees who are directly providing services to the customers actually need the computer, the basic tool to interact with an online bank, to enhance efficiency and productivity. Though the per capita investment on ICT indicates the overall automation status of a bank, it is also found significant though the contribution towards efficiency is a little bit low. Significant value of the dummy variable for Category $-$ 1 automation implies that online centralized bank have much higher efficiency than Category $-$ 2 banks. The insignificant value of the dummy variable for Category $-$ 2 automation implied that Category $-$ 2 automation did not help banks to increase their efficiency at all. Finally, insignificant ITNITER (ICT-Employee to Non-ICT Employee Ratio) value indicates that though increased ICT employee may help to increase the business volume, productivity and ICT operational efficiency, they have little impact on business efficiency because most of them are working behind the machines not directly handling the business customers.

Before we run the regression analysis we used the Variance Inflation Factor (VIF) and test variability allowed Tolerance between independent variables to clarify if there is a multicollinearity problem between the independent variables. We found some variables that are excluded from the model were highly correlated with some independent variables. Depending on the Variance Inflation Factor (VIF) and variability allowed Tolerance test for each variable which should not exceed the inflation coefficient value of 10 and Tolerance should be greater than 0.05 we removed them from the model. Therefore, the model under study is reliable as there is no significant effect of Variance Inflation Factor problem.

We estimated equation (2) using both random and fixed effects model separately. The Hausman specification test was used to select the best model for the regression analysis and the random effects estimator was selected as the most appropriate one. While running fixed effect model we observed autocorrelation and heteroskedasticity in the data. Finally, we removed it by running a rectified model. Modified Wald and Wooldridge test ensured the removal of the problems.

3.4 Impact of Efficiency on Profitability of Banks

In the previous section we estimated the bank-specific efficiency levels. Finally, in this section, impact of estimated bank-specific efficiency levels on bank's profitability is examined. To do this, we used the following regression model:

$$Profitability = \beta_0 + \beta_1 ES + \beta_2 ITI + \beta_3 MSI + \beta_4 D_1 + \beta_5 D_2 + \varepsilon \dots \dots \dots (3)$$

Where,

ES: Efficiency Score (obtained from equation-2), MSI: Market Size Index, ITI: ICT Index (Appendix B)

Dummy Variables

$D_1 = 1, if\ the\ bank\ is\ a\ Private\ bank; Otherwise\ 0.$
$D_2 = 1, if\ the\ bank\ is\ a\ Foreign\ bank; Otherwise\ 0.$
$All\ Dummies\ `0'\ means\ the\ bank\ is\ a\ Government\ bank.$

ε : error term

While calculating MSI, we considered total assets, employees and branches of a particular bank as a percentage of total assets, employees and branches of the banking sector, respectively. Moreover, we have given 50% weight to Assets, 25% to Branches and 25% to Employees while calculating MSI.

To measure the profitability of a bank we used three proxy measures, namely, Expenditure to Income Ratio, Non-Interest Income to Total Operating Income Ratio and Return on Assets (ROA).

Table 29: Estimates from Random Effect Model

Independent Variables	Dependent Variable								
	Expenditure Income Ratio			Non-Interest Income to Total Operating Income Ratio			Return on Assets		
	Coefficient	t-Statistic	p-value	Coefficient	t-Statistic	p-value	Coefficient	t-Statistic	p-value
Constant	0.830	5.17	0.000	0.300	3.86	0.000	0.384	4.120	0.000
ES (Efficiency Score)	-3.172	-8.999	0.000	0.276	1.37	0.178	1.790	6.600	0.000
ITI (ICT Index)	-0.651	3.04	0.003	6.051	2.41	0.018	0.651	1.951	0.054
MSI (Market Size Index)	1.137	1.95	0.054	0.325	0.45	0.067	0.225	1.459	0.156
D_1: Private Bank	-0.021	-2.18	0.041	0.031	13.07	0.000	0.940	8.241	0.000
D_2: Foreign Bank	0.001	-1.43	0.156	0.046	10.26	0.000	2.640	11.254	0.000

Dependent Variable	F-Statistic	R^2	Adjusted R^2	Modified Wald *	Wooldridge*
Expenditure Income Ratio	13.6 (0.000)	0.79	0.74	11.69 (0.299)	0.27 (0.795)
Non-Interest Income to Total Operating Income Ratio	12.5 (0.000)	0.82	0.78	9.65 (0.324)	1.91 (0.193)
Return on Assets	10.65 (0.000)	0.72	0.69	8.71 (0.229)	1.02 (0.196)

Source: Authors' Calculation
Note: *Values are given after correction for autocorrelation and heteroskedasticity.

Before we run the regression analysis we used the Variance Inflation Factor (VIF) and test variability allowed Tolerance between independent variables to clarify if there is a multicollinearity problem between the independent variables. We found some variables that are excluded from the model were highly correlated with some independent variables. Depending on the Variance Inflation Factor (VIF) and variability allowed Tolerance test for each variable which should not exceed the inflation coefficient value of 10 and Tolerance should be greater than 0.05 we removed them from the model. Therefore, the model under study is reliable as there is no significant effect of Variance Inflation Factor problem.

We estimated equation (3) using both random and fixed effects model separately. The Hausman specification test was used to select the best model for the regression analysis and the random effects estimator was selected as the most appropriate one. While running

fixed effect model we observed autocorrelation and heteroskedasticity in the data. Finally, we removed it by running a rectified model. Modified Wald and Wooldridge test ensured the removal of the problems.

From the estimates we see that ES (Efficiency Score) has a negative relationship with Expenditure Income Ratio which is highly significant. This suggests that ES is an essential variable in expenditure income ratio measure of bank profitability. Bank with higher efficiency management has a lower Expenditure Income Ratio, and will results in higher profitability.

From Non-Interest Income to Total Operating Income Ratio model, we see that MSI is not a factor of bank profitability. It is affected by ITI, because high tech banks gain higher Non-Interest Income like ICT enabled service charges. Moreover, high-tech banks have ability to higher online payment system than a bank which is lagging behind. The Efficiency Ratio is not significant in this regard because majority of the ICT enabled charges generated automatically without human interaction.

From Table-29, we notice that effects of ES, ITI and MSI variables are statistically significant. As expected, EIR (Expenditure Income Ratio) decreases as ESs increase and the decline in EIR is also statistically significant. It is also seen that increased ITI directly reduce EIR. We found that when MSI increases EIR also increases. But if we look at the impact of dummies, we see that it is significantly less for private banks compared to SOCBs as D1 is -0.021. In reality, it is seen that private banks are increasing their market size day by day which indicates better management control over banks. The dummy variable, D_2 for FCBs indicates that their expenditure income ratio also slightly increases as they increase the market size holding other things constant.

Model summary of three models are shown in Table-29. Among these models, highest R square (0.82) is seen in the 'Non-Interest Income' to 'Total Operating Income' Ratio model which means that 82% of the variance in 'Non-Interest Income' to 'Total Operating Income' Ratio are explained by explanatory variables used in this study and still 18% remain undiscovered. That means, other additional variables are required to explain 'Non-Interest Income' to 'Total Operating Income' Ratio that yet to be considered in this study.

The R square for expenditure income ratio model is 0.79 which means the independent variables explain 79% of expenditure income ratio. In case of ROA model it is only 0.72. ROA model generates the bottom R squares, and the sample only explains 72% of ROA and the rest 28% unexplained.

In case of ROA model, Efficiency Score (ES) is found to be the most critical factor and it has a positive impact on profitability of banks. Additional factor of ROA model is ITI. ITI has also a positive relationship with ROA. That means higher the ITI, higher profitability

can be gained by the bank. By increasing market size ROA can't be increased, that is indicated by the coefficient which is not significant. We can't conclude that big size banks are more profitable than smaller banks.

Both significant dummy variables indicate that private and foreign banks gaining higher ROA compared to NCBs. But ROA gain of FCBs is also higher than PCBs. Only one variable, ITI, is found the determinants in all three models of profitability measure. This implied that ITI significantly improves the profitability performance of banks.

3.5. Impact of ICT on Customers' Satisfaction

3.5.1 Measurement of Customers' Satisfaction

A customer satisfaction is an abstruse and abstract concept. Actual state of satisfaction varies from person to person, product to product and service to service and depends on a number of psychological, economic and physical factors. In banking industry, one of the major elements of the customer satisfaction is the quality of services. Moreover, if customers are not satisfied, it is very tough to expand the banking business. However, we feel that, there are may be some likelihood of gaps between customers' hopes and actual perception of service quality, brand perception and perceived value in online banking. Therefore, this section is introduced to detect the major factors that affect customers' satisfaction in electronic banking in Bangladesh. The following Table describes the constructs with description that are used to estimate the satisfaction of customers'. Moreover, overall customers' satisfaction and loyalty towards the bank was also measured here.

Table-31 summarizes the customers' satisfaction regarding online banking with respect to different construct (ex. availability, accuracy, security, etc.). Satisfaction is calculated by the following formula for each construct.

$$Satisfaction\ (\%) = \frac{\sum_{i=1}^{n} S_i}{n \times HS} \times 100$$

Here, $\sum_{i=1}^{n} S_i$ is the sum of scores of n respondents for each question/construct to understand the satisfaction level. HS is the highest score assigned for each question. Actually, we have calculated the satisfaction level of customers for each question as a percentage of maximum satisfaction a customer expects from a bank. In this study we have used five-point 'Likert' Scale 'Very Poor: 1; Poor: 2; Good:3; Very Good: 4; Excellent: 5' or 'Strongly Disagree: 1 Disagree: 2 Neutral: 3 Agree: 4 Strongly Agree: 5', where necessary.

Table 30: Construct and Description

S. No.	Construct	Description
1	Availability of Online Banking Services	Latest equipment and physical facilities-Full Branch Automation, Core Banking Solution, ATM, POST, Internet Banking, Agent Banking, Mobile Financial Services, SMS Notifications, Credit Card, Electronic Fund Transfer, Online Bill Payment, Call Center, etc.
2	E- Requirement	Scope of services offered, Availability of International Network, Digitalization of Business Information, and Variety of Services.
3	Accuracy	Accurate E-services through Online and Alternative Delivery Channels.
4	Efficiency	Immediate and quick transaction and check out with minimal time: speed of clearing, depositing, enquiry, getting information, money transfer, response etc.
5	Security	Building customer confidence through trust, privacy, believability, truthfulness, and security. Guarantee from fear about money losses, fraud; PIN and password theft; hacking etc.
6	Responsiveness	Problem management, prompt and timeliness service, helping nature, employee curtsey, recovery of PIN, password and money losses.
7	Easy Operations	Easy use of online delivery channels like ATM, internet banking, Mobile banking, credit card, debit card etc.
8	Convenience	Customized services, anywhere and anytime banking, appropriate language support, etc.
9	Cost Effectiveness	Price, Fee and Charges: commission for fund transfer, interest rate, clearing charges, bill collection and payments' fee, transaction charges, processing fees etc., Price, charges and commissions should be less for Telecommunication Company and internet service providers.
10	Problem Handling	It refers to problem solving process regarding computerized banking services
11	Settlement of Grievances	It refers to recover the losses regarding to problems and inconvenience occurred in using online banking delivery channels.
12	Contact and Help Desk Support	Communication: Bank to customer or customers to bank via e-mail, SMS, Phone, interactive website, call center, etc.
13	Brand Perception	Overall perception of customers according to commitment given by bank for banking services.
14	Perceived Value	Consolidated perception from banking service in term of perceived quality and money spent for getting banking services.

From the above table highest satisfaction is seen in case of accuracy of operations which implies that ICT helps bankers to reduce operational errors. Lowest satisfaction is found in case of handling grievances. That is customers are not getting right and quick solution when they complain for any dispute. Moreover, overall customers' satisfaction (61%)

implies that though online banking adopted in our country very widely and rapidly, there are enough scopes to develop good customer relationship by satisfying them more.

Table 31: Mean and Satisfaction Score for All Banks

S. No.	Construct	Mean	Satisfaction (%)
1.	Availability of Online Banking Services	3.77	75
2.	E- Requirement	3.41	68
3.	Efficiency	3.69	74
4.	Accuracy	3.98	80
5.	Security	3.05	61
6.	Responsiveness	3.46	69
7.	Easy Operations	3.42	68
8.	Convenience	3.34	67
9.	Cost Effectiveness	3.67	73
10.	Problem Handling	2.81	56
11.	Settlement of Grievances	2.62	52
12.	Contact and Help Desk Support	2.77	55
13.	Brand Perception	3.14	63
14.	Perceived Value	3.43	69
15.	Overall Customer Satisfaction	3.05	61
16.	Continue with this Bank	3.45	69
17.	Recommend this Bank to Others	2.78	56

Source: Authors' Calculation

However, with this level of overall satisfaction the customers would like to continue their relationship with the bank for the time being but they don't like to recommend other customers to make a relationship with the respective bank. This might lead the customer to search a better bank in the long run putting questions regarding customer relation with the bank.

A comparative satisfaction level of customers w.r.t. different categories of banks are given in the following table.

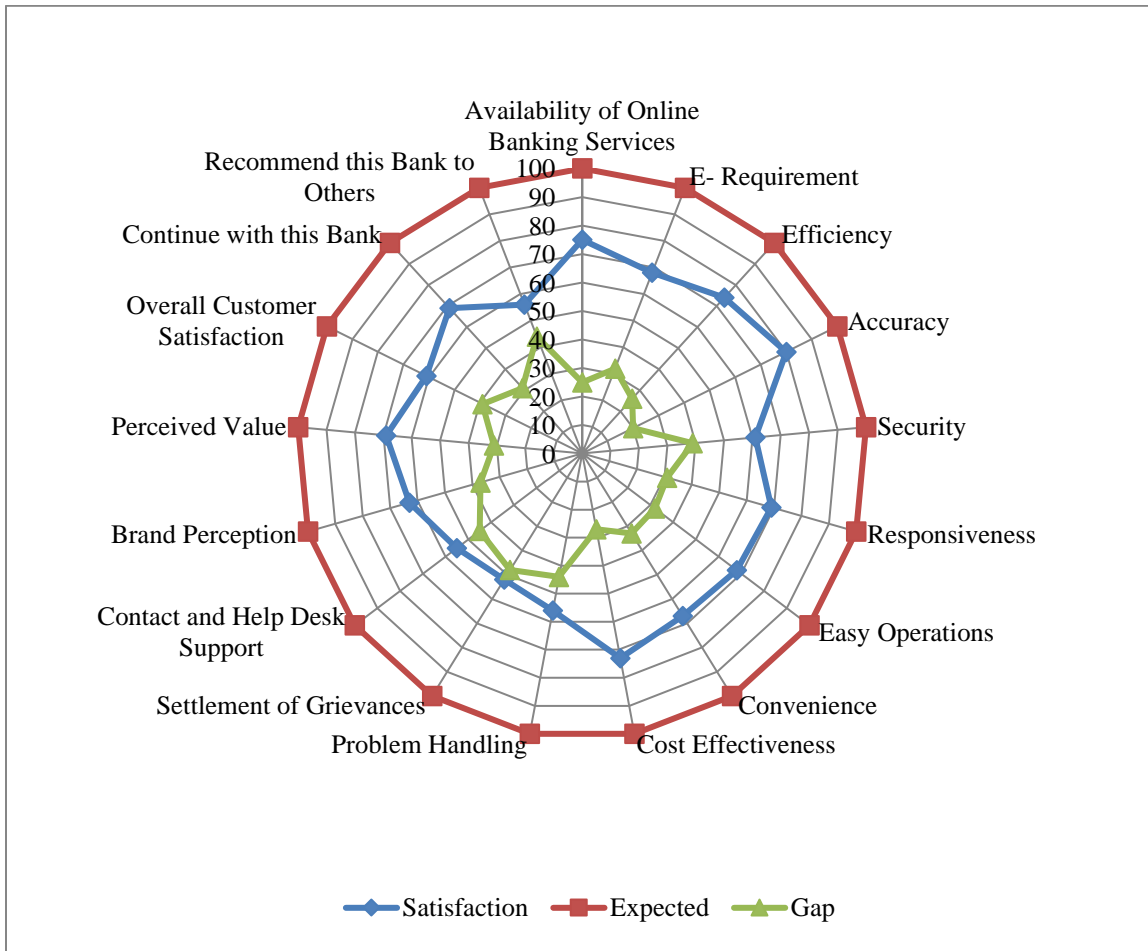**Table 32: Mean and Satisfaction Score for Different Categories of Banks**

Constructs	SOCBs and SDBs		PCBs		FCBs	
	Mean	Satisfaction (%)	Mean	Satisfaction (%)	Mean	Satisfaction (%)
Availability of Online Banking Services	2.5	50.0	4.4	88.0	3.1	62.0
E- Requirement	2.4	48.0	3.8	76.0	4.1	82.0
Efficiency	3.1	62.0	3.9	78.0	4.3	86.0
Accuracy	3.6	72.0	4.1	82.0	4.5	90.0
Security	3.3	66.0	2.9	58.0	3.5	70.0
Responsiveness	3.0	60.0	3.6	72.0	4.2	84.0
Easy Operations	2.9	58.0	3.6	72.0	4.0	80.0
Convenience	2.3	46.0	3.8	76.0	3.3	66.0
Cost Effectiveness	4.2	84.0	3.4	68.0	4.1	82.0
Problem Handling	2.0	40.0	3.1	62.0	3.5	70.0
Settlement of Grievances	1.7	34.0	2.9	58.0	4.1	82.0
Contact and Help Desk Support	1.5	30.0	3.2	64.0	4.2	84.0
Brand Perception	2.3	46.0	3.4	68.0	4.3	86.0
Perceived Value	3.1	62.0	3.5	70.0	4.2	84.0
Continue with this Bank	2.8	56.0	3.7	74.0	3.9	78.0
Recommend this Bank to Others	1.8	36.0	3.1	62.0	4.1	82.0
Overall Customer Satisfaction	2.1	42.0	3.4	68.0	3.8	76.0

Source: Authors' Calculation

3.5.2 Gap between Highest Expectation and Current Service Quality

Gaps were assessed purely on the basis of the percentage of satisfaction values for each question/parameter comparing with a reference score '100' which was considered to be the maximum and that any organization should like to achieve for excelling. A service gap close to 30 and more than 30 was considered to be highly critical area for the improvement of the performance dimensions. A service gap between less than 30 and more than 20 was considered as critical and further needs for improvements and service gap below 20 is treated as less significant. Figure-13 shows the gap between the percentage of satisfaction and highest expectation (100) of customers' regarding e-banking services. This will help the management to reduce the gap between the demand of customers and existing available facilities.

Figure 13: Gap between Expectation and Current Service Quality

F values with very high significance level (*) of Table-33 implies that satisfaction level of customers of different bank groups (SOCBs/PCBs and FCBs) vary very highly with respect to all constructs. Moreover, satisfaction level of customers residing division, district and Upazila level also significantly varies with most of the constructs. For some constructs satisfaction level of customers also significantly varies for different occupations, age group and education level.

Table 33: Analysis of Variance (ANOVA)

Constructs	Occupation		Age group		Education Level		Categories of Banks (SOCB/PCB/FCB)		Different Region (Div./Dist./Upazila)	
	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value
Availability of Online Banking Services	2.725	0.044	1.210	0.300	0.545	0.652	7.350	0.000*	9.594	0.000*
E-Requirement	3.148	0.025*	2.678	0.047*	2.659	0.015*	3.406	0.018*	2.602	0.052*
Efficiency	1.481	0.219	1.803	0.097	1.092	0.352	9.602	0.000*	8.701	0.003*
Accuracy	0.722	0.632	1.429	0.202	0.527	0.664	3.737	0.011*	3.806	0.052*
Security	5.106	0.002*	2.667	0.015*	3.736	0.011*	5.003	0.002*	6.567	0.011*
Responsiveness	1.711	0.164	1.589	0.149	0.278	0.841	2.603	0.052*	2.543	0.051*
Easy Operations	4.223	0.006*	2.063	0.057*	3.644	0.013*	4.991	0.002*	5.765	0.017*
Convenience	4.043	0.008*	1.623	0.139	0.420	0.739	2.110	0.098*	2.192	0.088*
Cost Effectiveness	0.533	0.660	1.485	0.182	1.202	0.309	4.046	0.007*	8.506	0.004*
Problem Handling	0.512	0.674	0.225	0.879	0.786	0.502	1.531	0.206	2.459	0.118
Settlement of Grievances	1.324	0.266	1.453	0.193	0.037	0.991	9.530	0.000*	13.870	0.000*
Contact and Help Desk Support	3.023	0.030*	1.352	0.233	0.837	0.474	3.720	0.012*	8.512	0.004*
Brand Perception	1.623	0.139	1.481	0.219	0.527	0.664	4.991	0.002*	1.202	0.309
Perceived Value	1.429	0.202	1.623	0.139	1.481	0.219	5.003	0.002*	1.092	0.352

Source: BIBM Survey

3.5.3 Factor Analysis

In this section a factor analysis is done to see what factors actually affecting satisfaction of customers regarding online banking. Here, 14 response items (Table-31) among 17 items were used.

Presence of nonzero correlation is ensured by Bartlett's Test of Sphericity which is significant at the 0.00001 level (Table-34(a)). The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.714 which exceeds there recommended cut-off level of 0.5 and individual measures were all well above this cut-off level. It is clear that the fundamental requirements of factor analysis are ensured by this data set.

Table 34 (a): KMO and Bartlett's Test		
	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.714
Bartlett's Test of Sphericity	Approx. Chi-Square	934.661
	df	136
	Sig.	0.00001

Table 34 (b): Total Variance Explained

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	2.992	23.013	23.013
2	1.894	14.573	37.586
3	1.706	13.12	50.706
4	1.17	9.003	59.708

Extraction Method: Principal Component Analysis.

Using the principles of an eigenvalue greater than 1 and Scree Plot four factors are clearly identified. These four factors accounted for 59.708% of the total variance (Table-34(b)). Also a Varimax Rotation with Kaiser Normalization was performed as a common practice to attain simpler and ideally more meaningful factors.

Table 35: Component Matrix

	Rotated Component Matrix			
	Component			
	1	2	3	4
Availability of Online Banking Services	**0.829**	0.184	0.056	0.471
E-Requirement	**0.743**	0.002	0.105	0.030
Efficiency	0.268	**0.680**	0.148	0.012
Accuracy	0.684	0.049	0.014	0.242
Security	0.690	**0.775**	0.057	0.100
Responsiveness	0.094	**0.770**	0.034	0.269
Easy Operations	0.176	**0.637**	0.385	0.163
Convenience	**0.622**	0.325	0.128	0.491
Cost Effectiveness	0.096	0.095	**0.746**	0.098
Problem Handling	0.071	0.168	0.166	**0.778**
Settlement of Grievances	0.429	0.334	0.044	**0.746**
Contact and Help Desk Support	0.153	0.018	0.159	**0.689**
Brand Perception	0.027	0.153	**0.799**	0.086
Perceived Value	0.019	0.026	**0.855**	.013

Source: Authors' Calculation
Note: Extraction Method: Principal Component Analysis.
Note: Rotation Method: Varimax with Kaiser Normalization.

Clearly four factors are identified from the original 14 response items by examining the factor loadings as pointed in Table-35. These four factors represent different elements of online banking services. Factor-1 represents Convenience, E- Requirement and Availability; it is therefore labeled 'Digitization of Banking'. Factor-2 represents Responsiveness, Efficiency, Easiness and Security; it is therefore labeled as 'Operational

Efficiency'. Factor-3 represents Cost, Brand Perception and Perceived Value; it is therefore labeled as 'Post Purchase Behavior of Banks'. Factor-4 represents Problem Handling, Settlement of Grievances and Contact and Support. It is therefore labeled as 'After Sales Support.'

4.0 Findings and Recommendations

With the rising demands for ICT budgets the bank managements are frustrated that they have no proper means of measuring the investments or impacts of ICT on their organization. They are increasingly introspecting whether they are making the technology investment decisions rightly and whether such resource commitments will indeed fetch them the envisaged benefits- be they in the form of financial returns, business advantages or enhanced capabilities. Knowledge of the nature and extent of contribution of ICT to bank's performance in terms of productivity and profitability has, therefore, can be considered valuable for a reality check on ICT. This study attempts to address this need to an extent by examining the impact of ICT on banking business enhancement. Moreover, effect of ICT on banking business output with respect to productivity, efficiency and profitability is also studied.

Business Enhancement: ICT introduced a drastic change in the latest style of banking business in a way that is threatening the traditional form of banks. A strong ICT infrastructure have been developed by the banks of Bangladesh by investing Tk. 40,943 crore, mainly in last two decades, under the guidance and monitoring of the central bank. As a result, besides 90% online branches different ADCs like ATM, Credit and Debit Card, POST, MFS, Agent Banking, Internet Banking, Call Center Banking, Banking through Apps, etc. has been introduced very rapidly in Bangladesh. The higher CAGR of these ADCs with respect to numbers, customer base and transactions indicates rapid expansion and acceptance of online banking and financial inclusion in this country. Consequently, cost of transactions, distance of financial access points, cost to access a financial service point, travel time to get a financial access point also reduced dramatically. To get the maximum benefits of this investment and technological achievement a tactical roadmap may be developed by the government with the help of Bangladesh Bank in collaboration with other regulators of financial sector to develop a cashless society and digital financial sector to achieve the broader national goals in the shorter, medium, and longer-term target to develop a Digital Bangladesh.

Reduction of Transaction Cost: Banks play a vital role in developing the economic and social conditions of a country. The major share of the profit of banks generally comes from spread. But the profitability of banks is under tremendous pressure because of continuous shrinking of spread. It becomes important for banks to reduce the cost per transaction for increasing spread that in turns will increase the profitability of banks. Use of technology in

banks reduces the cost. Bangladesh also shows a reduction of transaction cost as a result of using computer technology. Here, highest transaction cost is $1.12 (Tk. 90.3) for an online branch, followed by $ 0.65 (Tk. 52.10) for ATM, $0.12 (Tk. 9.60) per 1000 Tk. for MFS, $0.4 (Tk. 32.21) for Agent Banking and $0.022 (Tk. 1.5) for Internet Banking. It is seen that during the period 2003-2019 all electronic transaction costs except ATM reduced slightly in Bangladesh.

Distance of Financial Access Points: In Bangladesh it is found that about 74% of the MFS (Mobile Financial Service) users have access to an agent within one kilometer whereas 62% Agent Banking Point lies between 2 to5 kilometers. On the contrary, only 19% of bank account holders have a bank branch within the same distance. Most of the ATMs are available within 2 to 10 km. Maximum MFIs are reachable within 1 to 5 km. To access a post office user has to travel more compared to others access points of financial services. Clearly technology has reduced the distance of access points significantly. Moreover, in case of Internet Banking customers can do the transactions from anywhere of the globe without visiting an access point.

Cost to Access a Financial Service Point: About 53% of MFS users do not incur any costs to travel to an MFS agent point; whereas only 23% of the bank account holders' can visit their bank branches without any cost. On the other hand, 61% of bank account holders' have to spend more than BDT 10 to travel round trip to go to a bank branch, but only 23% MFS users' need to spend that amount to visit to an MFS agent point.

Travel Time to get a Financial Access Point: Among MFS users, 74% noted that it takes them less than 30 minutes round trip to their nearest MFS agent point, a figure that drops to only 55% for bank account holders. On the other hand, 81% of bank account users have to spend more than 30 minutes round trip to travel to a bank branch, while only 26% of MFS users need that amount of time to visit an MFS agent point. In case of Agent Banking 62% needs 45-60 minutes round trip to their nearest agent-point.

Financial Inclusion: In future FinTech based innovative financial services will lead the financial inclusion initiatives. Bangladeshi banks have been trying to get maximum benefits from it. New technologies are developing day by day. Innovation of artificial intelligence and big data analytics has given the opportunity to the financial sector to evaluate complex problems and provide solution in no time to anybody and anywhere of a country. Ensuring various uses of online delivery channel we may make banking profitable. A national strategic roadmap may be developed by Bangladesh Bank in collaboration with other financial sector regulators to align the financial sector with current and future emerging FinTech suitable for our country. Such a roadmap may help to achieve broader national goals in the shorter, medium, and longer-term.

Efficiency: The paper investigates the efficiency of Bangladeshi banks since ICT investment started in the late 1990s. By using Data Envelopment Analysis technique and bank-specific data from 2000 to 2019 it is found that foreign banks are the most efficient followed by private banks. Though the efficiency scores of all types of banks have increased over the study period, the private banks have recorded the strongest gains. In case of government banks, though the gain in efficiency is notable in last few years due to huge investment in ICT, huge bank branch expansion and Non-Performing Loans (NPL) hurt to achieve the expected efficiency. It seems that good managerial control of PCBs and FCBs due to adoption of centralized online banking technology has added to their efficiency. Thus, investment on ICT in banks has elevated efficiency scores over time of all banks in Bangladesh regardless of their ownership. Still, efficiency of SOCBs and SDBs are less compared to other groups.

Profitability: The Computer Employee Ratio and exercise of employment of more ICT officers compared to non-ICT officers among FCBs and PCBs also seems to have backed to their boosted profitability. The statistically significant dummies indicate that the SOCBs has not been successful in leveraging its relatively large market share to raise either its efficiency or its profitability compared to PCBs and FCBs. Profitability of banks has also improved due to the gains in efficiency. Still, profitability of SOCBs and SDBs are less compared to other groups.

Customers' Satisfaction: Satisfaction of customers directly helps to increase any business. ICT and emergence of e-Banking has changed the banking business style dynamically satisfying their customers more and more. As a result financial inclusion increased rapidly and banks were able to enhance the business covering the whole country (or globe) by providing round the clock services all the year round. In this study, highest satisfaction of customers' is seen in case of accuracy of operations which implies that ICT helps bankers to reduce operational errors. Lowest satisfaction is found for handling grievances. That is customers are not getting right and quick solution when they complain for any dispute. Management may consider this issue seriously. Moreover, overall customers' satisfaction score is 61%, which implies that though online banking adopted in our country very widely and rapidly, there is enough scopes to develop good customer relationship by satisfying them more. Moreover, satisfaction level of customers of different bank groups (SOCBs, SDBs, PCBs and FCBs) vary very highly with respect to all constructs. It is also found that satisfaction level of customers residing division, district and Upazila level also significantly varies with most of the constructs. For some constructs satisfaction level of customers also significantly varies for different occupations, age group and education level. Targeting these groups banks may take necessary actions to provide them more satisfactory services. This study also identified major factors that affect customers' satisfaction on online banking services. 'Digitization of Banking', 'Operational

Efficiency', 'Post Purchase Behavior of Banks' and 'After Sales Support' are the most important identified factors.

Productivity: Information Technology, a revolutionary force has not left the banking sector untouched. It has been a matter of much debate whether or not investment in ICT provides improvements in productivity. The study finds that ICT has substantial role and positive impacts on productivity of banks. The findings, however, indicates that there are significant returns to more investment in ICT labor and capital. The descriptive analysis indicates that productivity of employees has been increased from minimum 353% to maximum 839% due to the impact of ICT in last two decades. Moreover, using a Cobb-Douglas production function, it is found that there are "substantial excess returns to investment in ICT capital and ICT labour. While considering advances and deposit as an output of the industry, the study indicates that banks using older technology (Category-2: decentralized scattered branch automation) is 9% more productive than manual banking system (without technology) and online centralized banking technology (Category-1) provides 47% more productivity than older technology banking system (Category-2). Additionally, the study also indicates that Category-2 technology banking is 19% more productive than manual banking system and Category-1 technology banking is 86% more productive than Category-2 banking system while output of the industry is considered as revenue. In Bangladesh, private sector banks, which took more ICT initiative, were found to be more efficient in productivity and profitability parameters than public sector banks.

Role of Bangladesh Bank: Bangladesh Bank has been working proactively for a long period to develop the overall ICT infrastructure of banking sector. Proper guidelines and monitoring of Bangladesh Bank has also been helping the ICT departments of different banks to expand in right way. As a result, expectation from Bangladesh Bank has been increasing day by day and banks have been demanding some important initiatives to be taken by Bangladesh Bank for the last few years. These are: detailed and updated version of ICT security policy; guidelines for standardization of ICT department and inspecting banks frequently (quarterly or half yearly instead of yearly) by Bangladesh Bank inspection team to check the implementation status of the recommendations given in the yearly ICT core risk inspection report.

Bangladesh Bank with the joint effort of BIBM may take initiatives to develop an Information Sharing and Analysis Center for Banks (Bank-ISAC), where the members can discuss and share their opinion regarding the various ICT operational and security issues to mitigate the risks and be aware about the latest security threats. Moreover, Bangladesh Bank can play a vital role in setting up a cell/wing, including a data bank for all of the commercial banks to help collect and share up-to-date information regarding current status, growth and problems of the e-banking/digital banking system. ICT Heads of 86% banks

agreed that banking sector should have a center for sharing electronic banking experiences, problems and solutions. Bangladesh Bank, with the help of BIBM, can take initiatives in this regard. A specialized Information Technology Institute/Academy (like IDRBT, India) may be set up for the purpose of research, development and consultancy in the area of banking/financial technology of our country.

5.0 Conclusion

Bangladeshi banking sector has come a long way in terms of using ICT. Bangladeshi banks have been investing heavily in ICT for last two decades to achieve increased productivity, efficiency, profitability and competitive advantage through improved internal and external transaction flow, better access to clients and markets and enhanced reach and quality of products and services and a reasonable number of banks have already attained international standard maturity in technology adoption.

It can be concluded that banks with higher usability of ICT perform significantly better than those with low ICT usability and there are substantial returns due to an increase in investment in ICT capital and labor which will incentivize the bank's management to shift its emphasis on ICT investment. In fact, not only are the ICT contributions positive, they pay more than what is being spent on them. Also, the returns on ICT resources are higher than those accruing from non-ICT resources.

It has now become impossible to separate Information and Communication Technology (ICT) from the business of the banks and the financial institutions. As many financial products and services directly or indirectly depend on ICT, banks have to think how to involve ICT to minimize the cost, increase the efficiency and how to provide better services to the customers ensuring reliability, safety and security. Otherwise, banks may face ICT risks as well as business risks. There are several basic requirements for ICT which must be met; these include a sound technical infrastructure, efficiency of the employees, and interaction with technical developments. Moreover, ICT security and governance must be ensured for next generation online banking in Bangladesh.

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Appendix-A

Table 1: Sample Size Distribution w.r.t Bank-types and Divisions

	SOCBs and SDBs	PCBs	FCBs	Total
Dhaka	18	270	20	310
Chittagong	8	66	6	85
Khulna	3	24	0	30
Rajshahi	2	10	0	10
Barisal	2	12	0	10
Sylhet	2	42	4	40
Rangpur	0	11	0	15
Total	**145**	**325**	**30**	**500**

Table 2: Sample Size Distribution w.r.t Background Characteristics of the Respondents

Background Characteristics of the Respondents		SOCBs and SDBs	PCBs	FCBs	All Banks	All Banks
		Respondents 35	Respondents 435	Respondents 30	Respondents	Total
Gender	Male	32	370	21	423	500
	Female	3	65	9	77	
Age	18-30	26	241	17	284	500
	31-40	8	179	8	195	
	41-50	1	14	4	19	
	51-60		1	1	2	
	60+				0	
Education	Illiterate		8		8	500
	Under Graduate	17	12	6	35	
	Graduate	16	280	10	306	
	Post Graduate	2	132	13	147	
	Doctorate		3	1	4	
Income Per Month (BDT)	Less Than 50,000	30	162	1	193	500
	50,000-1,00,000	3	204	7	214	
	1,00,000-2,00,000	2	56	13	71	
	More Than 2,00,000		13	9	22	
Occupation	Business	7	65	16	88	500
	Govt. Employee	20	96	1	117	
	Private Employee	6	228	11	245	
	Professional	2	34	2	38	
	Agriculture		12		12	

Appendix-B

IT Index (ITI)

S. No.	Description	Score
1	IT Assets: Total Assets	10
2	IT Employees: Total Employees	15
3	IT Budget: Total Budget	10
4	IT Security Budget: Total IT Budget	10
5	IT Training Budget: Total IT Budget	15
6	Total Application Software being Used	10
7	Quality of CBS, DC and DRS Status and Effectiveness of BCP	10
8	Hardware and Network Infrastructure and Robustness	10
9	IT System and Operations Monitoring	5
10	IT Governance, Audit and Standardization	10
11	Online MIS, Data Warehouse and Data mining	10
12	e-CRM and Call Center	5
13	E-Payment Gateway and Electronic Fund Transfer	5
14	Business Intelligent Software	5
15	ATM/DM/KIOSK: Total ATM/DM/KIOSK in Bangladesh	10
	POST: Total POST in Bangladesh	5
	IB Accounts: Total IB Accounts in Bangladesh	5
	Debit Card: Total Debit Cards in Bangladesh	10
	Credit Card: Total Credit Cards in Bangladesh	10
	Mobile Banking Accounts: Total Mobile Banking Accounts in Bangladesh	10
	Mobile Banking Agent: Total Mobile Banking Agents in Bangladesh	10
	Agents Banking Customers: Total Agents Banking Customers in Bangladesh	5
	Agent: Total Agents in Bangladesh	5
Total Score		200*

Note: *Finally, we converted this score to 100.