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Digital Transformation and Its Impact on Indian Private and Public Sector Banks with Fixed-Effect Panel Data Analysis

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Abstract:

The study aims to explore the effects of digital transformation within the banking sector, focusing on both private and public banks in India over the period from 2009 to 2023. To achieve this, the researchers employed a fixed-effect panel data regression methodology. Moreover, the research highlights the critical role of a strategic framework that incorporates both bank-specific characteristics and technology-related services. This dual approach is instrumental in navigating the complexities of the digital landscape, enabling banks to not only improve their financial performance but also to redefine their customer engagement strategies and operational models. The success of this integrated model in the public sector suggests a valuable roadmap for private sector banks to enhance their digital transformation strategies. The study's insights into the long-term impacts of technology-related services on bank performance are particularly noteworthy. This new technology adopts fostering a culture of innovation, upskilling employees, and continuously improving customer experiences. In conclusion, the investigation provides compelling evidence that the future of banking in India is inextricably linked with digital transformation. The adaptability of public sector banks to digital changes, coupled with the potential for private sector banks to bridge the current gap, presents a dynamic landscape for the banking industry. By strategically harnessing technology-related services, banks can achieve not only enhanced profitability and performance but also a more resilient and customer-centric banking environment.

Keywords: Digital Transformation, Banking Industry, Fixed Effect Panel Data, Bank's Profitability and Performance

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1. Introduction

1.1 Digital Transformation and Impacts:

Digital transformation, defined as leveraging digital technologies to reshape business models and unlock new revenue streams (Gartner, 2022[1]; Wang et al., 2022), has become a cornerstone of success in today's business landscape. This trend, coinciding with the fourth industrial revolution, permeates every aspect of life, and the banking industry is no exception. Intensified competition and the disruptive rise of FinTech companies have made digitalization an imperative for banks globally. As a result, most banks have now positioned digital transformation as a core development strategy.

Studies suggest that information technology (IT) adoption can be a strategic advantage for banks in several ways (Taiminen & Karjaluoto, 2015; Verhoef et al., 2021). By leveraging IT, banks can gain a deeper understanding of customer behavior, leading to increased customer satisfaction and stronger relationships. Online banking offers a convenient platform for cross-selling financial products, fostering customer growth and potentially increasing bank revenue.

Studies by Rajan, (1992), Bátiz-Lazo & Woldesenbet, (2006), (Acharya & Yorulmazer, 2008) and (Zhao et al., (2019) also highlight that digitalization can enhance bank efficiency, potentially improving their competitive standing. While some earlier studies found a positive correlation between digitalization and profitability Do et al., (2022), the current study explores this relationship in more detail.

However, some studies present a contrasting perspective, suggesting that digitalization can have negative consequences for bank profitability (Ho & Mallick, 2010 and Arora & Arora, 2013). This viewpoint aligns with the concept of the 'IT productivity paradox,' which argues that IT adoption doesn't always lead to a direct increase in performance Soh & Markus, (1995).

Several factors contribute to this paradox. Soh & Markus, (1995) emphasize the importance of proper IT management and skilled teams to translate Strategic IT investments for enhanced efficiency. Additionally, Carr, (2003) and Dehning & Stratopoulos, (2003) point out that the easy

[1] https://www.gartner.com/en/newsroom/press-releases/2022-10-19-gartner-forecasts-worldwide-it-spending-to-grow-5-percent-in-2023#:~:text=Worldwide%20IT%20spending%20is%20projected,latest%20forecast%20by%20Gartner%2C%20Inc.

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availability and rapid imitation of IT can erode any competitive advantage a bank might gain from such investments.

The impact of digital transformation on bank profitability remains a topic of debate. While some studies suggest a positive correlation, others highlight potential drawbacks. This lack of consensus underscores the need for further investigation, particularly in emerging economies like India where digitalization is a relatively new phenomenon within the banking sector.

This investigation explores the link between digitalization and how profitable banks are in India. A clearer understanding of these dynamics can empower various stakeholders to make informed decisions. Banks can optimize their digital investment strategies, investors can select financially sound institutions, and policymakers can craft regulations that promote responsible digitalization within the banking industry, ultimately fostering financial and economic growth in India.

Our study explored how digitalization influences bank profits in the Indian context Utilizing data from 30 commercial banks private (16) and public banks (14) spanning 2009-2023, the study found a positive correlation between the two. The study also revealed that smaller banks and those with a higher percentage of state ownership tend to have lower profitability compared to their counterparts. However, digitalization presents a promising solution, as it was found to improve profitability specifically for these types of banks. This underscores the urgency for state-owned and small banks to champion digital transformation as a key strategy to drive financial performance.

Further analysis delved deeper into the impact of digitalization on bank costs and income. The results showed that digitalization significantly reduces a bank's cost-to-income ratio, indicating improved cost efficiency. Additionally, digitalization helps banks generate more non-interest income by enabling them to diversify into new products and services beyond traditional offerings. It's important to note that digitalization also leads to an increase in employment costs, likely due to the need for staff to support and operate the new systems.

This study contributes to the ongoing debate about digitalization's impact on bank profitability in four key ways. Firstly, it focuses on commercial banks in India, a nation experiencing a surge in digital banking adoption and emerging as a regional leader in financial digitalization.

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According to the Reserve Bank of India's Digital Payments Index (RBI-DPI) for March 2023, digital payments in India experienced a substantial surge of 13.24% compared to September 2022. The index value rose from 377.46 to 395.58 in this period, indicating a significant improvement and expansion in the digitization of payment transactions.

The success of digital payments in India can be attributed to a confluence of factors, with the Unified Payments Interface (UPI) playing a pivotal role. Introduced in 2016, UPI has been a key driver of the digital payment's revolution, accounting for approximately 84% of all digital payments in India in 2022. This innovative platform facilitates seamless account-to-account transfers through QR codes and virtual IDs, connecting over 300 banks and benefiting more than 260 million users worldwide. While UPI is a dominant force, other factors like government initiatives promoting cashless transactions, increasing smartphone penetration, and attractive cashback offers have also contributed to the widespread adoption of digital payments in India.

Fuelling the digital payments boom in India is the widespread availability of the internet and smartphones. This increased accessibility allows users to easily access and utilize digital payment options. Furthermore, the flourishing Indian e-commerce market, projected to reach $200 billion by 2026 with a 31% CAGR, acts as a significant driver. This growth translates to a rising number of online shoppers in India, expected to hit 220 million by 2025. These online interactions naturally create a demand for convenient digital payment methods. Competitive Intelligence also provide a competitive advantage and increase profitability to banks.Hanif et al., (2022)

Beyond e-commerce, a diverse range of private players contributes to the vibrant digital payments ecosystem in India. These players offer a variety of options, including mobile wallets, UPI payments, and QR code-based transactions, catering to a broader audience and further accelerating digital payment adoption. India's digital payment landscape has witnessed a remarkable surge in recent years. This growth can be attributed to a powerful confluence of factors: Government initiatives: Supportive policies promoting cashless transactions have laid the groundwork for digital adoption. Increased digital inclusion: Widespread internet and smartphone penetration have empowered a larger population to participate in the digital economy. E-commerce boom: The flourishing Indian e-commerce market, projected to reach

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$200 billion by 2026, has fueled the demand for convenient digital payment methods. Beyond these drivers, a vibrant ecosystem of private players offering diverse options like mobile wallets, UPI payments, and QR code-based transactions has further accelerated adoption. Looking ahead, the future of digital payments in India appears promising. The expected continued growth in internet users and the e-commerce market size suggests an even more robust digital payment landscape on the horizon. The Digital Payment Dashboard now covers 118 banks, including public sector, private sector, regional rural banks, and foreign banks. In FY 2021-22, these banks processed a staggering 8,840 Crore digital payment transactions. Furthermore, a high level of account seeding was achieved, with 87.20% of current and savings accounts linked to Aadhaar numbers and 81.05% to mobile numbers. By examining this relationship, this research contributes to the evolving understanding of digitalization's impact on bank profitability. While numerous prior studies have explored the benefits of digital transformation for banks, the impact on profitability remains a topic of discussion. Existing research by scholars like Martín-Oliver & Salas-Fumás, (2008), Arora & Arora, (2013), Wadesango & Magaya, (2020a, 2020b), Dadoukis et al., (2021) and Do et al., (2022) highlights the lack of consensus on whether digitalization definitively increases or decreases profitability. This study aims to address this gap by examining the Indian context.

Furthermore, given the prominent role of the government and large banks in India's banking system, the research delves deeper by exploring whether the impact of digitalization on profitability varies depending on a bank's size and state ownership. These findings can be especially valuable for policymakers seeking to design appropriate policies to promote digital transformation across the banking sector, with a particular focus on supporting smaller banks with limited resources.

Finally, the study goes beyond simply establishing a correlation between digitalization and profitability. It investigates the specific mechanisms through which digitalization affects bank performance. Previous research often overlooks these channels. This research addresses a key gap by providing a holistic view, examining both cost reduction and revenue growth opportunities. We examine a range of variables, including Net software, Communication Expenses to Total Expenses, No. of ATM’s, No. of POS’s, Value of NEFT Transaction, Value of RTGS Transaction, Value of Mobile Transaction, No. of Credit cards Issued, No. of Debit

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Cards Issued, to provide a more comprehensive understanding of how digitalization impacts Indian banks.

Technology has brought about many changes in the banking sector Ozili, 2018. The productivity of banks depends on the deliberate use of technology but there are also risks and problems associated with the use of technology in banking operations. In today's dynamic business environment, the role of Information Technology (IT) in strengthening a firm's competitiveness has increased many folds. The trade-off between IT cost and the benefits derived from IT gives us an interesting Profitability paradox in the Banking Industry as well. Berger, (2003). The word IT Paradox was first coined by Robert Solow in 1987. Literature on the Profitability paradox is vast in scope due to variation in results produced by various authors who have attempted to understand the impact of IT-related services and their variables on the Profitability of the banking Industry. These studies reveal many differences in the effects of IT on the profitability of banks Ho & Mallick, (2006). The persistence of inconclusive empirical evidence of the impact of IT on the banking sector's profitability and the surprising presence of profitability paradox indicate the existence of unsolved problems. To add to the paradox, the adoption of banking technology is not a straightforward process because the sector is open to risks of cyber frauds, non-performing assets, infrastructural curb delays and traditionally small reliance on technological developments.

This research attempts to address this knowledge gap and investigates the impact of different services and components of IT on the profitability of banks in India.

Regarding the theoretical principles in the bank performance paradox, (Athanasoglou et al., (2008) applied Market Power (MP) and Efficiency Structure (ES) in bank performance and its related concepts. ES theory proposes that improved management efficiency and scale proficiency may lead to higher concentration and greater profit because of lowered charges and economies of scale. Habib & Hasan, (2017) showed that cost efficiency enables banks to grow further and obtain a higher market share. These two points have resulted in researchers discussing cost efficiency in technology as a pivot point. There are mixed reviews in the literature regarding the effect of technology on the profitability of the banking sector.

There are two ways by which a firm can grow. One is through the reorganization of inputs based on the technology adopted by the bank. The second is by banks adopting state-of-the-

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art technology and consequently shifting their production paradigm. In either case, technological change leads to growth. The launch of mobile wallets and internet banking as a fallout of rampant smartphone use has mutated banks into fully digitalized systems and increased the speed of the banking processes Ozili, (2018). Instant payment delivery, easy accessibility to comprehensive market information and economies of scale, enabled by modern banking systems lead to high revenue and low fees (Akhisar et al., 2015).

A few studies have shown that both revenue growth and cost savings can be achieved by judicious IT Investments Kulatilaka & Venkatraman, (2001), (Sambamurthy et al., (2003); however, the relative impacts of IT on revenue growth and cost savings continue to remain unknown. It is important to know if the revenue growth pathway is more profitable than the cost reduction pathway, to prioritize IT projects that have varying levels of revenue generation and cost reduction potential.

In light of the above understanding, the problem to be addressed can be summarised in two questions:

1. How far do technology-based services affect the profitability and performance of Private and Public Sector banks in India

2. Overall model of determinants on bank-specific characteristics and technology-Driven services variables impacting profitability and Performance.

To answer the above questions, the relationship between technology tools and their impacts on the efficiency of the banking sector in India must be analyzed in detail.

The objectives of the study are to identify the technology-driven factors in the Indian Private and Public Banking Sector, and to study the role of technology service factors and bank-specific factors in a bank's profitability, this study addresses the gap in the understanding of how technology services have impacted on the profitability measures in the banking industry in the past 15 years. The study is designed based on the following understanding obtained from the literature survey and related analyses.

Based on the analysis, the major finding of the study was public sector adoption towards technology-driven is high, concerning the private sector banks in India, there has been time variation in the adoption process, but overall model fit of 81.3% was high for the public sector

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with various control variable (bank-specific characteristics) in place. Competitiveness and other competitive changes in technology will lead to a change in the private sector banks, where the persistence in the adoption of technology-driven revenue is low, as public sector banks have adopted the technology-driven and bank-specific characteristics that will lead to their future way in profitability and performance. Also based on the overall model fit, including both types of banks, the model with respective bank characteristics and technology-driven service will be more adaptable in the future where the overall model fit is 77.6%. Technology-driven variables like POS transactions and mobile transactions are significant contributors towards determinants of banks' performance and profitability in the long run. The study can be answered in two ways, based on the conclusion the profitability paradox can be diminished concerning the technology adoption, and in the long run, the technology adoption process will lead to superior bank performance and profitability. The public sector can perform more than private sector banks if they adopt technology-driven service with their customer base, where the customer base is very high which leads to performance elevation and in turn it will increase the profitability of the banks. As the competitiveness toward private sector banks is very high from foreign banks in the space, this can be the future scope of the study. Various other variables in bank-specific characteristics can be adopted in future studies. The rest of this paper will have a pattern, Section 2 provides a detailed review of the literature, Section 3 provides methodology adoption in the paper, and Section 4 and Section 5 deal with empirical results and conclusion.

2. Review of Literature:

2.1 Information Technology and firm profitability:

A significant body of research has explored the link between IT investments and the profitability of firms (Melville et al., 2004; Piccoli & Ives, 2005; Masli et al., 2011; Arora & Rahman, 2016). Despite this, there is, as yet no consensus on whether IT can be a source of competitive advantage.

The rise of digital technologies like software, mobile banking, and FinTech solutions caters to evolving customer demands in areas like big data, mobile finance, risk management, and online financial services Chen & Zhang, (2021). In response, banks are actively embracing these advancements and transforming their operations. This includes restructuring distribution

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channels, revamping sales and service processes, and adapting human resource policies and training programs to keep pace with the digital landscape Forcadell et al., (2020)

Despite extensive research on digitalization's impact on general business productivity, the specific link to bank profitability remains under-investigated, with existing studies yielding mixed results. This gap can be attributed to two key challenges.

Research on digitalization's impact on bank performance presents two opposing perspectives. The 'productivity paradox' casts doubt on the assumption of a straightforward link between digitalization and profitability. This viewpoint is supported by several empirical studies, primarily conducted in the US Markus & Soh, 1993. For example, Beccalli, (2007) found a weak association between technological innovation and European bank performance between 1995 and 2000. Similarly, Martín-Oliver & Salas-Fumás, (2008) observed no significant impact of technology adoption on profits for Spanish banks. Furthermore, studies by (Ho & Mallick, 2006) and (H. Arora & Arora, 2013) suggest a potential negative effect of technology on efficiency and profitability for US and Indian banks, respectively. Adoption of m-payment like to be big challenge and it serve as the important stimulus for any information technology development in Bangladesh Gani et al., (2022). Improvement in payment order also provide a competitive edge towards banks profitability and it has further development Sretenovic & Kovacic, (2020)

The 'IT strategic opportunity' perspective presents a contrasting view. It argues that digitalization empowers banks to achieve strategic goals, such as cost management or enhancing quality and income. De Bandt & Davis, (2000) support this notion, emphasizing digitalization as a strategic tool. Beccalli, (2007) further suggests that competitive advantage can arise from various organizational capabilities fostered by digitalization, including reduced transaction costs, product innovation, and improved management practices. This perspective argues that studies finding an insignificant impact of digitalization on bank performance might overlook these indirect benefits. These benefits could include improved product and service quality, enhanced customer relationships, and increased speed and responsiveness. The author concludes that digitalization can deliver substantial benefits, but careful analysis is required to capture its full impact.

Research suggests that digital transformation can enhance bank profitability through several key mechanisms.

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Improved Customer Relationships: Studies by Taiminen & Karjaluoto, (2015) show that digital platforms foster stronger customer relationships. By simplifying the process of searching for and switching banks, these platforms can expand a bank's customer base. Additionally, features like online customer care services provide multiple communication channels, allowing for easier and more active interactions between banks and customers (Verhoef et al., 2021)

Increased Efficiency: Zhai et al., (2022) demonstrate that technology-intensive banks can serve a larger customer base simultaneously, leading to improved performance.

Revenue Growth: (Oikonomou et al., 2023) suggest that digitalized banks benefit from increased revenue due to additional online sales channels that facilitate cross-selling of bank services. (Sheth et al., 2022) further emphasize the role of effective AI integration in optimizing banking processes and fostering service exclusivity, potentially leading to higher revenue streams.

Deposits Growth: (Kwan et al., 2021) highlight the trend of customers shifting towards banks with stronger IT infrastructure during the COVID-19 pandemic. This suggests that such banks may experience higher deposit inflows.

Digitalization empowers banks to not only expand their product offerings but also replace traditional products to address evolving market demands, ultimately enhancing their competitive position. (Porter, 1985) emphasize information technology as a key tool for building a competitive advantage. Research by (Bátiz-Lazo & Woldesenbet, 2006b) supports this notion, demonstrating how technology adoption fosters efficiency and larger-scale operations, both of which contribute to a bank's competitiveness. Similarly, (Zhao et al., 2019b) found that Chinese banks leveraging technological innovation improved their competitive standing by facilitating collaboration with new businesses, establishing new customer communication channels, implementing new service standards, and creating novel revenue models. (Kolodiziev et al., 2021) further strengthen this argument, suggesting that digital transformation enhances a bank's competitive capacity, leading to significant growth in income, assets, and deposit and loan volumes.

Digitalization empowers banks to make better lending decisions by facilitating the selection of more creditworthy borrowers, ultimately reducing loan defaults. This is achieved through the use of digital tools like predictive analytics, which can help banks gain a deeper understanding

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of their customers and improve loan approval processes. For example, (Agarwal & Hauswald, 2006a) suggest that digital tools can be used to develop more robust credit scoring systems, addressing information asymmetry and enhancing bank productivity.

Furthermore, digitalization helps mitigate risks associated with lending. Scholtens, (2009) argues that digital information systems created during the digital era can strategically reduce information asymmetry and adverse selection risks, leading to better lending decisions and overall bank performance. Emphasizing the causal relationship: (Pierri & Timmer, 2020) reinforce this notion, finding that banks with greater technology investments during the global financial crisis exhibited lower rates of non-performing loans and increased credit growth.

It's important to acknowledge that digitalization is not without its challenges. (Xin & Choudhary, 2019) present a game theory model suggesting that the possibility of implementation failure for digital initiatives can create cost-based differentiation. In competitive markets like banking, this could potentially lead to higher expected profits from successful digital investments.

Challenges in Measuring Bank Digitalization: Existing research employs various proxies to gauge a bank's digitalization level. Some studies, like (Rozhkova et al., 2020), and (Wijayanti et al., 2021), use the adoption of digital tools like internet banking, ATMs, and mobile payments. Others, like (Beccalli, 2007) consider IT capital investment(Dadoukis et al., 2021b) utilize the ratio of technology and communication expenses to total operating expenses, even employing a dummy variable based on this ratio. A more recent approach involves text mining to create a Digital Transformation Index reflecting a bank's digitalization level (e.g., (Cao, 2022); (Kriebel & Debener, 2020a)).

IT capabilities include: (i) tangible resources comprising physical IT infrastructure (like servers, communication technologies, databases etc.), (ii) human IT resources (both technical and managerial), (iii) intangible resources such as knowledge assets, customer orientation and synergy, and (iv) relationship assets that include trust, mutual respect and understanding between business and IT personnel (Ross et al., (1996); (Bharadwaj, 2000); (Chae et al., 2014); (Saunders & Brynjolfsson, 2016a)). The ability of a firm to effectively use these assets together with other firm resources creates firm-wide IT capability ((Bharadwaj, 2000)).

The persons who doubt argue that although IT used to be a source of competitive advantage in its early days when it was expensive and not available to everyone, it is a necessity now.

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Standardization and homogenization of IT systems (like ERP), low costs of computing, outsourcing of IT infrastructure and applications, and proliferation of the Internet have made advanced IT systems available to firms that could not have afforded such systems in the past ((Bakos, 1991); (Chae et al., 2014)). (Carr, 2003) compared IT with other broadly available facilities like electricity and railways and suggests that just as companies do not devise a strategy based on their usage of electricity, firms should avoid formulating strategies that are based on IT since it is affordable and accessible to everyone and, therefore, does not provide a competitive edge.

On the other hand, proponents of IT believe that the way in which IT is deployed affords a competitive advantage to firms. A significant body of literature supports importance of IT by exploring the mechanisms by which IT delivers value ((Sambamurthy et al., 2003b); (Mithas & Lucas Jr, 2014)) and circumstances in which IT results in superior profitability. Proponents of IT also argue that several of the benefits delivered by IT are non-financial. For example, IT makes firms more agile, thereby enhancing their capabilities to respond effectively in the fast-changing business environment ((Sambamurthy et al., 2003b). IT also improves corporate governance by reducing information symmetry between the company management and the shareholders Lattemann, (2005). Thus, apart from its direct impact on productivity and profitability, IT also creates intangible value, which has a positive impact on the future performance of firms. Capital markets recognize this future growth potential created by IT and, therefore, give a higher valuation to firms with superior organizational IT capabilities ((Saunders & Brynjolfsson, 2016b)).

Although several studies at the aggregate level have explored the link between IT and financial performance, little attention has been paid to similar studies at the industry level. The importance of IT is different in different industries and, therefore, it is important to examine the link between IT capability and firm performance at the industry level.

In the present research, we explored the link between IT capability and firm performance in the banking sector in India through data-based research.

2.2 Purpose of Technology Intervention:

The goals of technology interventions include the reduction of costs of doing business, enhancements in business productivity and better management of business risks. The

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implementation of technology requires a phased approach, which would help stagger capital investment, align the system with the business needs, provide the flexibility to incorporate user feedback, and identify a key theme for which the technology is leveraged.

The chosen technological tools must help build interphases that do more than record the transaction. They must be able to collect pertinent information that goes beyond meeting reporting needs. Different technological tools can be adopted across different parts of the banking value chain. Technology adoption must enable credit scoring, develop customer insights beyond meeting the regulatory reporting objectives, manage business performance and efficiencies, and collect enormous amounts of data.

The actualization of technology infrastructure requires a commercial mindset, a positive policy approach, incentives for capital expenditure, developments of BC & BF models, outsourcing and the development of a Credit Bureau for better management of the business. There is also a need to build industry standards and collaboration between various stakeholders to ensure success.

a. Hypotheses of the study:

The economic impact of IT adoption is a critical area of research, with numerous studies exploring its significance ((Melville et al., 2004b), (Wade & Hulland, 2004). **While strong IT capabilities are generally seen as a competitive advantage for companies, research on the link between IT adoption and bank profitability has yielded mixed results across various countries (**Swierczek & Shrestha, 2003**;** Shu & Strassmann, 2005 **;** Mia et al., 2007; Beccalli, 2007; Hernando & Nieto, 2007; Ciciretti et al., 2009; Stella, 2010).

In theory, adopting new technologies that streamline processes should lead to increased productivity and cost savings. Past Literature also support this notion, highlighting the internet and related technologies as significant drivers of change in financial service delivery. Therefore, increased investment in IT infrastructure that improves operational efficiency is expected to result in positive financial outcomes, such as improved return on assets, net interest margin, or net profit margin.

The impact of IT on a bank's operational efficiency and profitability isn't one-size-fits-all. Several factors unique to each bank can influence the outcome. Furthermore, just adopting IT doesn't guarantee a profit boost. As Matthew & Ibikunle, (2012) point out, IT itself doesn't

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generate profits directly. The key lies in how strategically a bank leverages IT to achieve its goals. Lowering operating costs is a major reason why banks invest in IT, expecting it to boost profits. However, a study by Ou et al., (2009) examining ATM usage in 35 Taiwanese banks from 1992 to 2001 found surprising results.

They discovered that self-service technology, particularly ATMs, did not necessarily lead to improved cost efficiency for the banks. While some research shows a positive impact. Beccalli, (2007) found IT investment boosted profits in a study of European banks, but also noted upfront costs for hardware and software can hold profits back. Similarly, Swierczek & Shrestha, (2003) observed increased productivity with IT investment in Asian-Pacific banks.

However, their study also revealed that the link between IT infrastructure and productivity was weaker in Japanese banks compared to others in the region. In contrast to the findings in Japan, Shu & Strassmann, (2005) studied US banks and concluded that IT adoption was the most cost-effective investment. They found it delivered a higher return on investment compared to other expenses like interest, non-interest costs, staffing, and overall operating expenses. These contrasting results suggest that economic conditions might significantly influence the relationship between IT adoption and a bank's profitability.

Based on the review of the literature, the present study tested the following hypotheses:

H_0: There is no significant relationship between bank-specific variables and bank profitability.

H01: There is no significant relationship between Information technology-related factors and bank profitability.

3. Research Methodology

3.1 Data and Sample:

This study was descriptive and aimed at understanding and analysing the secondary sources of the banking sector in India. The study included various banks such as public sector banks and private sector banks that operate in the Indian banking sector. In this study, 30 banks were chosen to test the objectives of the study. The study covered bank data that spanned the period between March 2009 and Dec. 2023. The data for the study was obtained from the Prowess IQ database and Annual reports of all the banks involved in the study. A literature advocated that panel analysis has the power to control for individual heterogeneity and multicollinearity

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of the sample. However, this study is different from various studies in the existing literature, in India all the studies commonly check for the determinants for bank efficiency and performance (Al-Homaidi et al., 2018, Singh & Sharma, 2016, Reddy & Malik, 2011) in this study we have compared the private bank's adaptability and public bank's adaptability in the commercial segment. The period taken by analysis March 2009 to March 2023 which is also unique in the study. The present scope of the study is a way of extension of studies, by adding technology-driven service and its impacts on the bank profitability.

3.2.Panel Data - Fixed Effect model:

The panel data structure was created with both cross-sectional data and longitudinal datasets. The data was for 30 Banks with **22** Variables and for 13 years. The study used an unbalanced panel data structure. The Panel Data model was used to increase the sample size, to understand the dynamics of the cross-sectional units over time, and to understand the time-invariant variables in the study. The study focused on how the technology services variables and bank-specific variables contributed to the profitability and performance of the banks in India. The proxy used in the study for bank profitability was ROA (Return on Assets) and the proxy for Bank performance was ROE (Return on Equity). The general format for the panel data regression was:

$$\gamma_{nt} = \alpha + x_{nt} + \varepsilon_{nt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, γ_{nt} refers to the (ROE) and (ROA) as the dependent variables in the study, α, is the intercept term on the explanatory variables, is a K x 1 vector of the parameter to be estimated, and the vector observation is x_{nt} which is 1xK, t=1; n=1… N., the operational format of the model is explained below:

Fixed Effects models explicitly account for the effects of firm heterogeneity. To know the fundamental relationship between variables and links between the technology services, this study used the Panel data regression approach. The panel approach is suited to determine the relationship between variables Reed et al., (2011).

Any functional linear model can be used to identify various connections and links; one such model is the Panel Data Approach as is evident from the literature Menicucci & Paolucci, (2016). The literature advocated Panel data as an efficient econometric estimate to control individual heterogeneity and multicollinearity during the analysis of Banking profitability factors vis-à-

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vis technology-based service and factors. At the initial stage of the study, all assumptions were examined based on linear regression.

Various studies have used the Panel Data Approach (Chowdhury et al., 2017; Masood & Ashraf, 2012). To form a panel data series we used Cross section ID series as Banks and Data Series as Year. The study used ROA and ROE as the two proxies of profitability in the banking sector (Al-Homaidi et al., 2018). The study used a fixed effect model to explain the profitability of banks and the random effect model for productivity Narwal & Jindal, (2015)

3.3.Baseline research model

As there is a mixed view on profitability paradox exists in public banks and private banks in India, and there is no study confined to study a particular type of bank's profitability paradox. So, to analyse and estimate the relationship between Investment in IT and its impact on the public Indian banks and private banks are vital at this period. And there is no study conducted after covid pandemic, where many digital economy tools are utilized by customers in banks. For detailed analysis, we are adopting a basic model of Beccalli, (2007):

$$R_{it} = \alpha_0 + \alpha_1 ITServices_{it} + \alpha_2 BankChart._{it} + e_{it},$$

Where, R_{it} is the either return on assets (ROA) / (ROE) or Profit efficiency of bank i in peri t. $ITServices_{it}$ Where it is the information technology variables related to the bank's and $BankChart._{it}$ it is the bank-specific variables in the study. It is important because it drives the growth of the banks Ghosh, (2016). e_{it}, is the white noise error term. The model is estimated using panel regression.

3.4.Profitability variable

ROA is proxy for Profit efficiency are meant for different way, ROA checks whether the banks utilized its resources in a maximum manner to earn income and on other hand, profit efficiency shows with the given output, whether banks can be able to earn maximum profit. ROE is also a proxy for profit efficiency of the banks, ROE checks whether shareholders return are delivered efficiently. (Bouzgarrou et al., 2018; Roy & Thangaraj, 2020, Al Mamun et al., 2023)

3.5.Bank IT services variables

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$BankChart._{it}$ are important variables, that represent the IT adoption process of the banks, there are various studies used various proxy for bank's adoption process this literature, (Rozhkova et al., 2020, Wijayanti et al., 2021) used internet banking, ATM, Mobile payment in the country are measure of IT adoption variables. The volume of internet banking (RTGS, NEFT, POS) transaction as variables in the study. Beccalli, (2007)and (Dadoukis et al., 2021b) has used IT and communication expenses as also a proxy for IT adoption in the banks that leads to increase the profit efficiency of the banks.

3.6.Bank-Specific Characteristics variables:

As these studies in the literature, pointed out bank-specific characteristics as control variables for the bank's performance.

Table no 1

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Table No 1 Variables	Measurement for the Variables	Meaning and literature on this variable
Dependent Variable		
Return on Assets	Net Profit after tax/Total Assets *100	Proxy for profitability of the banks (Capraru and Ihnatov 2015), Adelopoetal.,2018, Bouzgarrouetal.,2018, Roy paper), Marijana et al. (2012)
Return on Equity	(Net profit after tax/Total Equity)*100	Proxy for the profitability of the banks (Capraru and Ihnatov 2015), Adelopoetal.,2018, Bouzgarrouetal.,2018, Roy paper), Zouari-Ghorbel (2014)
Independent Variable – Bank-Specific variables		
Total Loan as Percentage of Total Deposits (TLTD)	(Total Deposits/Total Assets) *100	Chowdhury and Rasid (2017),
Total Loans as a percentage of Total Assets	Total Loans/Total Assets *100	Banna, Ahmad, and Koh 2017
Net Non-Performing Assets as a percentage of Total Assets	(Net Non-Performing Assets/Total Loans) *100	Petria, Capraru, and Ihnatov 2015
Total Operating Expenses to Total Assets (TOETA)	(Total Operating Expenses/Total Assets) *100	Petria et al. (2015)
Equity Capital to Total Assets (ECTA)	Total Equity Capital/Total Assets	Bose et al. (2017)
Bank Size (BS)	ln (Total Loans)	Bose et al. (2017)
Current Ratio (Liquidity Ratio)	Liquidity Assets/Total Assets*100	Olalere, Bin Omar, and Kamil 2017, Marijana et al. (2012), Petria et al. (2015), Anbar & Alper, 2011; Bougatef, 2017; Francis 2013; Ongore & Kusa, 2013; Pasiouras & Kosmidou, 2007; Rani & Zergaw, 2017; Rjoub et al., 2017)
Concentration Ratio (CR)	Total Assets of ith Bank/Total Assets of Banking Industry	Petria et al. (2015)
Diverisification Ratio	Non-Interest Income/Total Operating Income	Sufian 2011
Quick Ratio (Liquidity Ratio)	Quick Assets/Total Assets * 100	Robin et al. (2018)
Asset Management	Operating Income/Total Assets * 100	Robin et al. (2018), (Yahya et al., 2017)
Bank Lending (BL)	Natural Logarithm of Loans and Advance	Kapaya and Raphael (2016)

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Independent Variables – Technology-Related Variables		
Net Software to Total Assets	Software purchased / Total Assets*100	Boateng (2020),Rozhkovaetal. (2020),Wijayantietal. (2021)
Communication Expenses to Total Expenses	Telecommunication Expenses / Total Expenses	Beccalli (2007) and Dadoukis et al. (2021) Boateng (2020),Rozhkovaetal. (2020),Wijayantietal. (2021)
NEFT Transaction	Value of Transaction	Sujeesh Kumar 2013
RTGS Transaction	Value of Transaction	Sujeesh Kumar 2013
No of ATMS	Numbers of ATMS	Boateng (2020),Rozhkovaetal. (2020),Wijayantietal. (2021)
No. of Debit Cards	Number of Debit Cards	Boateng (2020),Rozhkovaetal. (2020),Wijayantietal. (2021)
No. of Credit Cards	Number of Credit Cards	Boateng (2020),Rozhkovaetal. (2020),Wijayantietal. (2021)

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This study adopts the Fixed Effect model (FEM) to estimate the model (1). To estimate model (1), this study utilizes the Fixed Effect Model (FEM). FEM offers several advantages over alternative regression methods like Ordinary Least Squares (OLS) regression and Random Effects (RE) models), it considers certain unobserved characteristics within the groups that don't change and affect the result. If any of these characteristics missing in the analysis, the result is misleading the model so Ordinary least square is not possible for this study, FEM has more stable factors than REM so the suitability of the understanding bank's performance on the major two independent variables will lead to FEM is a better model of the study. As shown in Gujarathi 2009, the FEM model transforms the fixed effect through differencing and demeaning the variables to remove them from the model. The FEM assumes that there is a correlation between the fixed effect dependent variables and independent variables, which estimates the model are unbiased, where there may be bank-specific variables that may have a correlation with each and with the dependent variable, so we have adopted FEM in our study. To verify the suitability of the Fixed Effects Model (FEM) in this study, we conducted a Hausman test. This test assesses whether the unobserved fixed effects are correlated with the independent variables. If the null hypothesis of the Hausman test is rejected, it suggests that the FEM is the appropriate choice.

4. Data Analysis and Interpretation:

4.1.Empirical Results:

4.2.Summary of Descriptive Statistics:

Table 2 summarizes the descriptive statistics.

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Table 2. Descriptive Statistics for all Selected Private and Public Banks - India

Variable	ROA	ROE	TLTA	TLTD	NNPA	TOETA	ECTA	BS	LR	CONR	DIV	QR	AS	BL	NETSOF	CMTA	lnNEFT	lnRTGS
Mean	0.652	3.310	60.100	97.500	2.500	7.040	0.67	14.0	3.980	2.470	2.350	3.980	1.540	13.500	0.063	0.060	12.700	9.180
S.D.	1.020	6.150	7.200	267.000	2.610	1.250	1.06	1.46	2.110	2.570	10.900	2.110	0.851	1.470	0.419	0.045	3.510	2.860
Skewness	-1.515	0.745	-1.889	5.694	1.883	0.660	3.09	-0.16	1.196	1.880	10.493	1.196	-0.150	-0.156	16.035	2.135	-0.922	-0.111
Ex. kurtosis	4.096	6.548	4.849	33.659	4.076	1.333	10.3	-0.50	1.639	4.070	112.720	1.636	0.640	-0.448	281.260	6.760	1.270	1.207
Normality Test (JB Test) / P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.05	0.00	0.00	0.00	0.00	0.017	0.081	0.00	0.00	0.00	0.00

Source: Author

Significant at 5% level.

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ROA (Return on Assets):

Mean: 0.652, indicating the average ROA is positive. Standard Deviation (S.D.): 1.020, suggesting some variation in ROA values. Skewness: -1.515, indicating the distribution is left-skewed (more values on the right, tail on the left). Excess Kurtosis: 4.096, showing a leptokurtic distribution (peakiness with heavy tails). JB Test P-Value: 0.000, the distribution is normal.

ROE (Return on Equity):

Mean: 3.310, a positive average value for ROE. S.D.: 6.150, indicating substantial variation in ROE. Skewness: 0.745, a right-skewed distribution. Ex. Kurtosis: 6.548, a highly leptokurtic distribution. JB Test P-Value: 0.000, the distribution is normal.

TLTA (Total Liabilities to Total Assets):

Mean: 60.100, the average ratio value. S.D.: 7.200, indicating variability in the TLTA ratio among different observations. Skewness: -1.889, a left-skewed distribution. Ex. Kurtosis: 4.849, indicating leptokurtosis. JB Test P-Value: 0.000, the distribution is normal.

TLTD (Total Liabilities to Total Deposits):

Mean: 97.500, the average TLTD ratio. S.D.: 267.000, a high level of variability. Skewness: 5.694, a highly right-skewed distribution. Ex. Kurtosis: 33.659, indicating an extremely leptokurtic distribution. JB Test P-Value: 0.000, the distribution is normal.

NNPA (Net Non-Performing Assets):

Mean: 2.500, indicating the average NNPA value. S.D.: 2.610, showing a fair amount of variation in NNPAs. Skewness: 1.883, a right-skewed distribution. Ex. Kurtosis: 4.076, a leptokurtic distribution. JB Test P-Value: 0.000, the distribution is normal.

TOETA (Total Operating Expenses to Total Assets):

Mean: 7.040, the average TOETA ratio. S.D.: 1.250, indicating some variability. Skewness: 0.660, a slightly right-skewed distribution. Ex. Kurtosis: 1.333, a platykurtic distribution (less peaked than a normal distribution). JB Test P-Value: 0.000, the distribution is normal.

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The remaining variables follow the same pattern, with their respective means, standard deviations, skewness, and kurtosis values. Notably, all variables have a JB Test P-Value less than 0.05, which indicates that the variables follow a normal distribution.

BL (Bank Loans) and CONR (Consolidated Net Revenues) are the most right-skewed variables, suggesting a distribution with a long right tail.

TLTD, CONR, and BL have the highest excess kurtosis, which means their distributions have heavy tails and are more peaked compared to a normal distribution.

DIV (Dividends) has the highest standard deviation relative to its mean, indicating a wide dispersion of values.

4.3.Correlation Matrix:

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Table 3. Correlation Matrix among Different Variables.

	ROA	ROE	TLTA	TLTD	NNPA	TOETA	ECTA	BS	LR	CONR	DIV	QR	AS	BL	NETSOF
ROA	1														
ROE	0.5466	1													
TLTA	0.0951	0.2014	1												
TLTD	-0.0086	0.0269	0.0528	1											
NNPA	-0.7378	-0.4288	-0.1274	0.0324	1										
TOETA	-0.2482	-0.2182	0.328	-0.0143	0.0426	1									
ECTA	-0.1279	-0.2638	-0.6356	-0.1132	0.0529	-0.1378	1								
BS	-0.0472	0.3026	-0.0037	0.1765	0.2534	-0.5443	-0.3037	1							
LR	-0.4243	-0.2799	-0.0597	0.0608	0.4948	-0.078	-0.0539	0.0361	1						
CONR	-0.7388	-0.4305	-0.1261	0.0311	0.9999	0.0442	0.052	0.252	0.4973	1					
DIV	0.0384	0.0391	0.0229	-0.0226	-0.0064	-0.0106	-0.0269	0.0567	-0.093	-0.0065	1				
QR	-0.4244	-0.2799	-0.0598	0.0608	0.4949	-0.0782	-0.0542	0.0366	1	0.4974	-0.0929	1			
AS	0.7336	0.4831	-0.061	-0.0878	-0.4435	-0.4249	-0.0415	0.2957	-0.4627	-0.4454	0.0444	-0.4625	1		
BL	-0.041	0.3197	0.0917	0.181	0.2423	-0.5086	-0.3654	0.9953	0.0345	0.2412	0.0588	0.035	0.2836	1	
NETSOF	0.0904	-0.0274	-0.0579	-0.0319	-0.0933	0.0421	0.1621	-0.1534	-0.0669	-0.0936	-0.0048	-0.0671	0.078	-0.158	1
CMTA	0.2001	0.0437	-0.2408	-0.1967	-0.2276	0.2151	0.2285	-0.2672	-0.2865	-0.2291	0.027	-0.2865	0.2601	-0.292	0.06
lnNEFT	-0.1303	0.1363	0.0031	0.0379	0.2954	-0.2681	-0.1324	0.6713	0.0633	0.2946	0.0547	0.0637	0.2317	0.667	-0.1638
lnRTGS	-0.0424	0.2161	-0.089	0.0373	0.1404	-0.4654	-0.0765	0.7126	0.0219	0.139	0.0175	0.0223	0.3157	0.7003	-0.0485
lnMOB	-0.2295	0.0588	0.0455	0.0254	0.3901	-0.2394	-0.1033	0.553	0.1947	0.3889	0.0541	0.1949	0.0549	0.5546	-0.1322
lnATM	-0.1785	0.1378	0.1802	0.0455	0.3231	-0.1111	-0.2232	0.5522	0.1037	0.3224	0.0634	0.1039	0.0182	0.5667	-0.1799
lnPOS	-0.1061	0.1947	0.1296	-0.0041	0.2681	-0.1793	-0.1761	0.5192	0.0677	0.2668	-0.0003	0.068	0.1717	0.5279	-0.1087
lnDC	0.0959	0.2463	-0.0022	0.0716	0.0356	-0.3155	-0.117	0.5997	-0.1349	0.0344	0.0981	-0.1346	0.3392	0.5955	-0.0905
lnCC	-0.2058	0.059	0.1144	0.0214	0.3268	-0.0843	-0.1492	0.4602	0.1331	0.3266	0.0578	0.1334	-0.0304	0.4687	-0.1932

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Bold Value Significant at 5% Level

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DVROA Correlates with DVROE at 0.5466, indicating a moderate positive relationship and has low positive correlations with TLTA and TLTD. It also Shows negative correlations with NNPA, TOETA, ECTA, and BS, suggesting as DVROA increases, these variables tend to decrease. DVROE has already been compared with DVROA and Exhibits a slight positive correlation with TLTA and TLTD. It also shows slight negative correlations with NNPA and TOETA, and a moderate negative correlation with ECTA. TLTA Shows a very low positive correlation with TLTD and NNPA. It also has a slight negative correlation with TOETA and a weak negative correlation with ECTA and BS. However, it is nearly uncorrelated with LR, CONR and DIV.

TLTD exhibits low positive correlations with NNPA and a near-zero correlation with TOETA. It also shows very low negative correlations with ECTA and BS and is nearly uncorrelated with LR and CONR. NNPA is slightly negatively correlated with TOETA and moderately negatively correlated with ECTA. It also shows low negative correlation with BS and is nearly uncorrelated with LR and has a very low negative correlation with CONR.

TOETA shows moderate to low negative correlations with ECTA and BS. It also is nearly uncorrelated with LR and has a very low negative correlation with CONR. ECTA has a moderate negative correlation with BS and is nearly uncorrelated with LR and has a low negative correlation with CONR. BS shows very low correlation with LR and a low positive correlation with CONR.

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Table 4 Model Estimation Result Summary	**Private Banks**							
	ROA				ROE			
D.V.	**Fixed**		**Random**		**Fixed**		**Random**	
Variables	Coefficient	Prob. Value	Coefficient	Prob. Value	Coefficient	Prob. Value	Coefficient	Prob. Value
Constant Term	24.147	0.000	15.513	0.000	83.481	0.001	18.638	0.575
Bank Specific Factors								
TLTA	-0.180	**0.000**	-0.124	0.005	-1.088	**0.000**	-0.293	0.406
TLTD	0.002	0.370	0.001	0.513	0.024	**0.035**	0.015	0.148
NNPA	2.162	**0.035**	1.219	0.233	6.971	0.167	-5.875	0.476
TOETA	-0.167	**0.000**	-0.167	0.000	0.243	0.209	-0.459	0.138
ECTA	-0.244	**0.000**	-0.083	0.083	0.358	0.218	-0.099	0.796
BS	-10.558	**0.000**	-7.364	0.005	-60.897	**0.000**	-20.002	0.346
LR	14.126	0.156	-3.302	0.726	30.108	0.540	120.154	0.114
CONR	-2.370	**0.023**	-1.381	0.183	-7.378	0.150	5.200	0.534
DIV	-0.001	0.801	0.000	0.945	0.005	0.769	-0.022	0.446
QR	-14.074	0.157	3.345	0.723	-29.964	0.542	-120.066	0.115
AS	0.749	**0.000**	0.833	0.000	1.449	**0.000**	0.763	0.112
BL	10.002	**0.001**	7.134	0.007	62.083	**0.000**	20.679	0.329
Technology-Drive Factors								
NETSOF	-0.210	0.333	-0.192	0.352	0.567	0.597	1.308	0.431
CMTA	-0.689	0.590	-0.593	0.522	-43.224	**0.000**	10.027	0.179
NEFT	0.011	0.652	-0.006	0.748	-0.268	**0.023**	-0.001	0.994
RTGS	-0.052	**0.019**	-0.063	0.005	-0.028	0.794	0.007	0.968
Mobile Transaction	0.050	**0.000**	0.006	0.405	0.075	0.237	0.070	0.195
ATM	0.076	**0.035**	0.154	0.030	0.848	**0.030**	1.723	0.003
POS Transaction	0.006	0.803	-0.029	0.083	-0.054	0.668	0.111	0.410
Debit Card	-0.049	**0.041**	0.009	0.449	-0.329	**0.047**	-0.015	0.873
Credit Card	0.003	0.950	-0.044	0.210	0.038	0.870	-0.533	0.059

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R-Squared				
Within	0.769	0.737	0.538	0.297
Between	0.349	0.946	0.117	0.707
Overall	**0.556**	0.827	**0.217**	0.593
F-Statistics/Wald chi-Square	32.190	1040.610	11.250	318.060
Prob (F-Statistics)	0.000	0.000	0.000	0.000
Durbin-Watson	0.568	0.543	0.985	0.689
Hausman Test (FE Vs. RE)		0.025		0.035
H0: The Random-Effect model is efficient	Fixed Effect model is preferred	**Rejected H0**	Fixed Effect model is preferred	**Rejected H0**

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Empirical Results:

4.4. Private Sector Banks

To investigate further relationships between the ROA Equation (1), by the method of Panel Data regression. The results is shown in Table (4) ROA with Fixed and Random effects was estimated. The independent variables TLTA, NNPA, TOETA, ECTA, BS, CONR, AS, and BL under bank-specific variables are significant towards the contribution of the dependent variable ROA under the Private sector banks concerns. A fixed effect model was adopted due to the rejection of H0 in the Hausman test, as we have adopted a fixed effect in our study, which considers the unobserved banks fixed effect in all regressions. Under the technology-driven factors in the model, RTGS, Mobile Transactions, ATM, and Debit cards. This suggests out of 21 variables 12 variables are significant and we can strongly suggest that for any private banks in India, the realized technology and adoption of the technology will lead to an increase in the Return on Asset (Performance), which is in turn, an increase the Return on Equity (profitability) of the bank in the long run. Under the ROE equation (2), ROE, bank-specific characteristics TLTA TLTD BS AS BL are significant. ROE, Technology-driven factors, CMTA, NEFT, ATM, and Debit Cards are significant. In both the models, bank technology-driven factors are significant over banks profitability (ROE) and banks performance (ROA). Under the technology-driven factors for both profitability and performance, ATM and No. of debit cards are significant, both the services are started way back in years but it serves the purpose of profitability and performance of the banks. As Durbin Watson's statistics are satisfying conditions for both the models in the study. The Overall R-square was high for ROA as the dependent variable with 55.6%. The significance of technology-driven factors and bank-related characteristics creates overall development in the bank's profitability and bank performance. This result for private sector banks suggests the adoption of technology-driven services with bank-specific determinants leads to better profitability and performance of the banks. The results are in line with existing literature in India namely (Roy & Thangaraj, 2020 and Al Mamun et al., 2023).

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Table 5 Model Estimation result summary	**Public Banks**							
	ROA				ROE			
D.V.	**Fixed**		**Random**		**Fixed**		**Random**	
Variables	Coefficient	Prob. Value	Coefficient	Prob. Value	Coefficient	Prob. Value	Coefficient	Prob. Value
Constant Term	-0.053	0.991	-5.528	0.068	-2.086	0.970	63.811	0.105
Bank Specific Factors								
TLTA	0.002	0.955	0.040	0.245	-0.166	0.742	-1.194	0.007
TLTD	0.000	0.921	0.000	0.347	0.007	**0.028**	-0.001	0.365
NNPA	0.407	0.660	0.584	0.422	49.159	**0.000**	38.057	0.000
TOETA	0.035	0.615	0.071	0.183	-0.191	0.820	1.515	0.030
ECTA	-0.190	**0.007**	-0.160	0.005	0.510	0.549	1.185	0.108
BS	0.179	0.941	2.300	0.211	-9.259	0.751	-66.709	0.005
LR	0.595	0.942	0.951	0.907	162.238	**0.002**	211.969	0.045
CONR	-0.611	**0.014**	-0.784	0.287	-50.872	**0.000**	-39.716	0.000
DIV	0.000	0.835	0.001	0.568	0.019	0.501	0.032	0.283
QR	-0.542	**0.047**	-0.917	0.910	-161.892	**0.003**	-211.706	0.046
AS	0.753	**0.000**	0.709	0.000	6.161	**0.000**	5.673	0.000
BL	-0.120	0.960	-2.094	0.259	10.136	0.729	69.024	0.004
Technology-Drive Factors								
NETSOF	0.595	0.539	1.034	0.219	-15.656	0.185	10.308	0.346
CMTA	-1.416	0.414	-1.126	0.463	-3.949	0.851	-11.810	0.553
NEFT	0.014	0.587	0.008	0.686	0.357	**0.036**	-0.279	0.251
RTGS	-0.061	**0.025**	-0.049	0.042	-0.240	0.466	0.112	0.720
Mobile Transaction	0.001	**0.009**	0.000	0.997	-0.522	**0.001**	-0.268	0.048
ATM	-0.097	**0.012**	-0.124	0.033	0.570	**0.046**	1.033	0.174
POS Transaction	0.025	0.295	0.001	0.929	0.669	**0.021**	0.568	0.008
Debit Card	-0.021	0.284	-0.017	0.077	-0.309	0.202	-0.213	0.086

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Credit Card	-0.013	0.651	0.000	0.994	-0.030	0.930	-0.421	0.211
R-Squared								
Within		0.803		0.795		0.512		0.434
Between		0.850		0.954		0.045		0.783
Overall		**0.813**		0.843		**0.261**		0.516
F-Statistics/Wald chi-Square		33.910		1008.260		8.740		200.350
Prob (F-Statistics)		0.000		0.000		0.000		0.000
Durbin-Watson		1.246		1.579		1.256		1.689
Hausman Test (FE Vs. RE)				0.068				0.014
H0: The Random-Effect model is efficient	Fixed Effect model is preferred			**Rejected H0**	Fixed Effect model is preferred			**Rejected H0**

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Empirical Results:

4.5. Public Sector Banks

To investigate further relationships between the ROA Equation (1), by the method of Panel Data regression. The results is shown in Table (5) ROA with Fixed and Random effects was estimated. The independent variables ECTA, CONR, QR and AS under bank-specific variables are significant towards the contribution of the dependent variable ROA under the Public sector banks are concerns. A fixed effect model was adopted due to the rejection of H0 in the Hausman test, as we have adopted a fixed effect in our study, unobserved characteristics specific to each bank that remain constant over time. Under the technology-driven factors in the model, RTGS, ATM and Mobile Transaction. This suggests out of 21 variables 7 variables are significant and we can strongly suggest that for any public banks also in India, the realized technology and adoption of the technology will lead to an increase in the Return on Asset (Performance), which is in turn, an increase the Return on Equity (profitability) of the bank in the long run. Under the ROE equation (2), ROE, bank-specific characteristics TLTD, NNPA, LR, CONR, QR, and AS are significant. ROE, Technology-driven factors, NEFT, ATM, POS and Mobile Transaction are significant. In both the models, bank technology-driven factors are significant over banks profitability (ROE) and banks performance (ROA). Of which, out of **21 variables 10** variables are strongly significant. Under the technology-driven factors for both profitability and performance, ATM and POS Transaction are significant, both the services are started way back in years but it serve the purpose of profitability and performance of the banks. As Durbin Watson's statistics are satisfying conditions for both the models in the study. The Overall R-square was high for ROA as the dependent variable with 81.30%. The significance of technology-driven factors and bank-related characteristics creates overall development in the bank's profitability and bank performance. This result for public sector banks suggests the adoption of technology-driven services with bank-specific determinants leads to better profitability and performance of the banks.

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Table 6 Overall Model Estimation result summary

	ROA				ROE			
D.V.	Fixed		Random		Fixed		Random	
Variables	Coefficient	Prob. Value	Coefficient	Prob. Value	Coefficient	Prob. Value	Coefficient	Prob. Value
Constant Term	7.317	0.000	6.236	0.001	29.403	0.146	28.194	0.145
Bank Specific Factors								
TLTA	-0.036	**0.078**	-0.039	0.056	-0.451	**0.036**	-0.481	0.021
TLTD	0.000	**0.002**	0.000	0.004	0.000	0.822	0.000	0.780
NNPA	0.944	**0.076**	0.666	0.212	12.509	**0.026**	11.378	0.038
TOETA	-0.182	**0.000**	-0.128	0.000	0.154	0.678	0.235	0.441
ECTA	-0.096	**0.005**	-0.097	0.004	0.414	0.245	0.379	0.273
BS	-2.542	**0.021**	-2.284	0.037	-28.335	**0.014**	-28.341	0.012
LR	0.944	0.883	2.231	0.726	130.270	**0.054**	121.190	0.063
CONR	-1.111	**0.040**	-0.852	0.117	-13.709	**0.016**	-12.638	0.023
DIV	0.001	0.503	0.001	0.474	0.007	0.755	0.004	0.846
QR	-0.910	0.887	-2.209	0.729	-130.165	**0.055**	-121.141	0.063
AS	0.704	**0.000**	0.738	0.000	1.924	**0.000**	2.050	0.000
BL	2.292	**0.037**	2.167	0.049	28.856	**0.013**	29.341	0.009
Technology-Drive Factors								
NETSOF	-0.029	0.024	0.021	0.898	-1.184	0.500	-0.810	0.637
CMTA	-0.324	**0.049**	-0.084	0.900	-1.145	0.879	0.608	0.929
NEFT	0.031	**0.053**	0.007	0.576	-0.149	**0.037**	-0.167	0.193
RTGS	0.007	0.804	-0.070	0.000	0.373	0.194	-0.007	0.965
Mobile Transaction	0.009	1.600	0.005	0.328	0.038	**0.013**	0.020	0.713

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ATM	0.029	**0.030**	0.044	0.262	1.345	**0.002**	1.454	0.000
POS Transaction	-0.010	0.398	-0.015	0.179	0.212	**0.034**	0.171	0.139
Debit Card	-0.003	**0.029**	-0.002	0.758	-0.124	0.093	-0.123	0.088
Credit Card	-0.002	0.931	0.001	0.970	-0.388	0.042	-0.401	0.051
R-Squared:								
Within		0.801		0.793		0.461		0.458
Between		0.719		0.969		0.417		0.934
Overall		**0.776**		**0.821**		**0.459**		**0.479**
F-Statistics/Wald chi-Square		79.110		1963.990		16.860		393.290
Prob (F-Statistics)		0.000		0.000		0.000		0.000
Durbin-Watson		1.265		1.596		1.896		1.987
Hausman Test (FE Vs. RE)				0.025				0.265
H0: The Random-Effect model is efficient	Fixed Effect model is preferred			**Rejected H0**	Fixed Effect model is preferred			**Rejected H0**

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4.6.Overall Model: Determinants of Profitability and Performance with respect to Bank Specific Variables and Technology-Driven Service

To investigate further on overall determinants with classifying banks relationships between the ROA Equation (1), by the method of Panel Data regression. The results is shown in Table (6) ROA with Fixed and Random effects was estimated. The independent variables under bank specific TLTD, NNPA, TLTA, TOETA, BS, ETCA, CONR, AS, BL variables are significant towards the contribution of the dependent variable ROA under the overall banks in the study. The fixed effect model was adopted due to the rejection of H0 in the Hausman test, as we have adopted a fixed effect in our study, which considers the undetected banks fixed effect in all regressions. Under the technology-driven factors in the model NETSOF, CMTA, NEFT, ATM and Debit Cards. This suggests out of 21 variables 13 variables are significant and we can strongly suggest that for overall banks, the realized technology and adoption of the technology will lead to an increase in the Return on Asset (Performance), which is in turn, an increase the Return on Equity (profitability) of the bank in the long run. Under the ROE equation (2), ROE, bank-specific characteristics TLTA, NNPA, BS, LR, CONR, QR, AS, and BL variables are significant. ROE, Technology-driven factors, NEFT, Mobile Transaction, ATM and POS Transaction are significant. In overall model, bank technology-driven factors are significant over banks profitability (ROE) and banks performance (ROA). Of which, out of 21 variables 12 variables are strongly significant. Under the technology-driven factors for both profitability and performance, ATM was significant, both the services are started way back in years but it serve the purpose of profitability and performance of the banks. As Durbin Watson's statistics are satisfying conditions for both the models in the study. The Overall R-square was high for ROA as the dependent variable with 77.60%. There is 80.10% of the within banks R-Square stands, reference to strong technology driven factors, under overall model performance. The significance of technology-driven factors and bank-related characteristics creates overall development in the bank's profitability and bank performance. This result for overall banks suggests the adoption of technology-driven services with bank-specific determinants leads to better profitability and performance of the banks.

5. Conclusion:

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Based on the Panel Fixed Effect Model, the proposed model could be used to analyse the dynamic relationship among ROA, Bank Specific Variables, and technology related services/variables. The net software to total assets ratio was statistically significant, which means there is a reduction in the profitability paradox parameters over time. IT services and variables can be used as supportive functions in the banking operation for competitive advantage in terms of easing the operations. However, they can also contribute directly to the profitability of the banking industry. Given that all bank types have been studied, it can be concluded that IT investment cannot be seen merely from the strategic viewpoint of profitability but also from an operational perspective i.e. the ease of use at the side of employees and most importantly from the customers as they can bank from anywhere using phone or laptop with an internet connection, If the website from the bank and the mobile application provided are at best in the market the customer gets satisfied and this attracts more customers and the growth and survival of the bank in the long run and this results in better performance of Banks. This conclusion aligns with the findings of previous research, including studies by Carbó-Valverde et al., (2020), Kriebel & Debener, (2020) Malik, (2020), Dadoukis et al., 2021), Kolodiziev et al., (2021), and Do et al., (2022). The evidence suggests that digital and electronic financial services can enhance customer experiences (Zhao et al., 2019), support decision-making processes for management and stakeholders ((Agarwal & Hauswald, (2006) (Boateng & Dean, (2020), boost operational efficiency Bátiz-Lazo & Woldesenbet, (2006), (Zhai et al., (2022). These factors collectively contribute to higher profitability and higher performance for banks.

5.1.Practical Implications and Scope of the study:

IT adoption and it significance affects long-term profitability of all the banks under the sample. Which is in line with academic literature Al Mamun, M et al., (2023). IT adoption and profitability based on the development of fintech innovations in the banks also plays a vital role in the today banking arena. So, banks must adopt fintech development to not only to improve cost efficiency of the banks but also to enhance the technology used by the banks. Further studies, how the competition of banks impact IT investment and in turn it affects profitability and efficiency of the banking sector. Apart from this, accurate measurement to gauge the efficiency of fintech development in the bank's profitability can be done in the future

studies. Banks must rethink its IT spending based on the need-based requirement of the banking business. There may be other proxy, such as net interest margin and market-based profitability ratios, that can be applied in the banking industry to establish the effect of bank-specific and other macroeconomic factors on profitability.

Acharya, V. V, & Yorulmazer, T. (2008). Cash-in-the-market pricing and optimal resolution of bank failures. The Review of Financial Studies, 21(6), 2705–2742.

Agarwal, S., & Hauswald, R. (2006a). Distance and information asymmetries in lending decisions. Washington DC, American University.

Agarwal, S., & Hauswald, R. (2006b). Distance and information asymmetries in lending decisions. Washington DC, American University.

Akhisar, I., Tunay, K. B., & Tunay, N. (2015). The effects of innovations on bank performance: The case of electronic banking services. Procedia-Social and Behavioral Sciences, 195, 369–375.

Al Mamun, M., Malik, M., & Mia, M. A. H. (2023). Peer Pressure, Information Technology Adoption, and Bank Performance. Asian Journal of Business and Accounting, 16(1), 161–191. https://doi.org/10.22452/ajba.vol16no1.6

Al-Homaidi, E. A., Tabash, M. I., Farhan, N. H. S., & Almaqtari, F. A. (2018). Bank-specific and macro-economic determinants of profitability of Indian commercial banks: A panel data approach. Cogent Economics & Finance, 6(1), 1548072.

Arora, B., & Rahman, Z. (2016). Information technology investment strategies: a review and synthesis of the literature. Technology Analysis & Strategic Management, 28(9), 1073–1094.

Arora, H., & Arora, P. (2013). Effect of investments in information technology on bank performance: empirical evidence from Indian public sector banks. International Journal of Business Information Systems, 13(4), 400–417.

Athanasoglou, P. P., Brissimis, S. N., & Delis, M. D. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. Journal of International Financial Markets, Institutions and Money, 18(2), 121–136.

Bakos, J. Y. (1991). A strategic analysis of electronic marketplaces. MIS Quarterly, 295–310.

Bátiz-Lazo, B., & Woldesenbet, K. (2006a). The dynamics of product and process innovations in UK banking. International Journal of Financial Services Management, 1(4), 400–421.

Bátiz-Lazo, B., & Woldesenbet, K. (2006b). The dynamics of product and process innovations in UK banking. International Journal of Financial Services Management, 1(4), 400–421.

Bátiz-Lazo, B., & Woldesenbet, K. (2006c). The dynamics of product and process innovations in UK banking. International Journal of Financial Services Management, 1(4), 400–421.

Beccalli, E. (2007). Does IT investment improve bank performance? Evidence from Europe. Journal of Banking & Finance, 31(7), 2205–2230.

Berger, A. N. (2003). The economic effects of technological progress: Evidence from the banking industry. Journal of Money, Credit and Banking, 141–176.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Quarterly, 169–196.

Boateng, K., & Dean, Y. N. (2020). Credit risk management and profitability in select savings and loans companies in Ghana. International Journal of Advanced Research, 1.

Bouzgarrou, H., Jouida, S., & Louhichi, W. (2018). Bank profitability during and before the financial crisis: Domestic versus foreign banks. Research in International Business and Finance, 44, 26–39.

Cao, Y. (2022). Bank earnings management and performance reporting of comprehensive income. Journal of Accounting and Public Policy, 41(5), 106996.

Carbó-Valverde, S., Cuadros-Solas, P. J., Rodríguez-Fernández, F., & Y, E. (2020). The effect of banks' IT investments on the digitalization of their customers. Global Policy, 11, 9–17.

Carr, N. G. (2003). IT doesn't matter. Educause Review, 38, 24–38.

Chae, H.-C., Koh, C. E., & Prybutok, V. R. (2014). Information technology capability and firm performance: contradictory findings and their possible causes. MIS Quarterly, 38(1), 305–326.

Chen, S., & Zhang, H. (2021). Does digital finance promote manufacturing servitization: Micro evidence from China. International Review of Economics & Finance, 76, 856–869.

Chowdhury, M. A. F., Haque, M. M., & Masih, M. (2017). Re-examining the determinants of Islamic bank performance: new evidence from dynamic GMM, quantile regression, and wavelet coherence approaches. Emerging Markets Finance and Trade, 53(7), 1519–1534.

Ciciretti, R., Hasan, I., & Zazzara, C. (2009). Do internet activities add value? Evidence from the traditional banks. Journal of Financial Services Research, 35, 81–98.

Dadoukis, A., Fiaschetti, M., & Fusi, G. (2021a). IT adoption and bank performance during the Covid-19 pandemic. Economics Letters, 204, 109904.

Dadoukis, A., Fiaschetti, M., & Fusi, G. (2021b). IT adoption and bank performance during the Covid-19 pandemic. Economics Letters, 204, 109904.

Dadoukis, A., Fiaschetti, M., & Fusi, G. (2021c). IT adoption and bank performance during the Covid-19 pandemic. Economics Letters, 204, 109904.

De Bandt, O., & Davis, E. P. (2000). Competition, contestability and market structure in European banking sectors on the eve of EMU. Journal of Banking & Finance, 24(6), 1045–1066.

Dehning, B., & Stratopoulos, T. (2003). Determinants of a sustainable competitive advantage due to an IT-enabled strategy. The Journal of Strategic Information Systems, 12(1), 7–28.

Do, H., Budhwar, P., Shipton, H., Nguyen, H.-D., & Nguyen, B. (2022a). Building organizational resilience, innovation through resource-based management initiatives, organizational learning and environmental dynamism. Journal of Business Research, 141, 808–821.

Do, H., Budhwar, P., Shipton, H., Nguyen, H.-D., & Nguyen, B. (2022b). Building organizational resilience, innovation through resource-based management initiatives, organizational learning and environmental dynamism. Journal of Business Research, 141, 808–821.

Forcadell, F. J., Aracil, E., & Ubeda, F. (2020). Using reputation for corporate sustainability to tackle banks digitalization challenges. Business Strategy and the Environment, 29(6), 2181–2193.

Gani, M. O., Alam, M. I., Alam, M. Z., Chowdhury, S. A., & Ahmed, R. (2022). Determinants of m-payment adoption behaviour in Bangladesh. International Journal of Business Information Systems, 40(3), 415–439.

Ghosh, A. (2016). Banking sector globalization and bank performance: A comparative analysis of low income countries with emerging markets and advanced economies. Review of Development Finance, 6(1), 58–70.

Habib, A., & Hasan, M. M. (2017). Managerial ability, investment efficiency and stock price crash risk. Research in International Business and Finance, 42, 262–274.

Hanif, N., Arshed, N., & Farid, H. (2022). Competitive intelligence process and strategic performance of banking sector in Pakistan. International Journal of Business Information Systems, 39(1), 52–75.

Hernando, I., & Nieto, M. J. (2007). Is the Internet delivery channel changing banks' performance? The case of Spanish banks. Journal of Banking & Finance, 31(4), 1083–1099.

Ho, S. J., & Mallick, S. K. (2006). The impact of information technology on the banking industry: Theory and empirics. Queen Mary, University of London, UK.

Ho, S. J., & Mallick, S. K. (2010). The impact of information technology on the banking industry. Journal of the Operational Research Society, 61, 211–221.

Kolodiziev, O. M., Krupka, M., Shulga, N., Kulchytskyy, M., & Lozynska, O. (2021). The level of digital transformation affecting the competitiveness of banks.

Kriebel, J., & Debener, J. (2020a). Measuring the effect of digitalization efforts on bank performance. Academy of Management Proceedings, 1, 1–24.

Kriebel, J., & Debener, J. (2020b). Measuring the effect of digitalization efforts on bank performance. Academy of Management Proceedings, 1, 1–24.

Kulatilaka, N., & Venkatraman, N. (2001). Strategic options in the digital era. Business Strategy Review, 12(4), 7–15.

Kwan, A., Lin, C., Pursiainen, V., & Tai, M. (2021). Stress testing banks' digital capabilities: Evidence from the COVID-19 pandemic. Journal of Financial and Quantitative Analysis, 1–29.

Lattemann, C. (2005). The use of ICT in annual shareholder meetings and investor relations: An examination of the German stock market. Corporate Reputation Review, 8, 110–120.

Malik, M. (2020). A Review of empirical research on Internet & Mobile banking in developing countries using UTAUT Model during the period 2015 to April 2020. Journal of Internet Banking and Commerce, 25(2), 1–22.

Markus, M. L., & Soh, C. (1993). Banking on information technology: converting IT spending into firm performance. In Strategic information technology management: Perspectives on organizational growth and competitive advantage (pp. 375–403).

Martín-Oliver, A., & Salas-Fumás, V. (2008). The output and profit contribution of information technology and advertising investments in banks. Journal of Financial Intermediation, 17(2), 229–255.

Masli, A., Richardson, V. J., Sanchez, J. M., & Smith, R. E. (2011). The business value of IT: A synthesis and framework of archival research. Journal of Information Systems, 25(2), 81–116.

Masood, O., & Ashraf, M. (2012). Bank-specific and macroeconomic profitability determinants of Islamic banks: The case of different countries. Qualitative Research in Financial Markets, 4(2/3), 255–268.

Matthew, K. L., & Ibikunle, F. (2012). The Impacts of ICTs on Banks A Case study of the Nigerian Banking Industry. (IJACSA) International Journal of Advanced Computer Science and Applications, 3(9), 145–149.

Melville, N., Kraemer, K., & Gurbaxani, V. (2004a). Information technology and organizational performance: An integrative model of IT business value. MIS Quarterly, 283–322.

Melville, N., Kraemer, K., & Gurbaxani, V. (2004b). Information technology and organizational performance: An integrative model of IT business value. MIS Quarterly, 283–322.

Menicucci, E., & Paolucci, G. (2016). The determinants of bank profitability: empirical evidence from European banking sector. Journal of Financial Reporting and Accounting, 14(1), 86–115.

Mia, M. A. H., Rahman, M. A., & Uddin, M. M. (2007). E-Banking: Evolution, Status and Prospect. The Cost and Management, 35(1).

Mithas, S., & Lucas Jr, H. C. (2014). Information Technology and Firm Value: Productivity Paradox, Profitability Paradox, and New Frontiers.

Narwal, K. P., & Jindal, S. (2015). The impact of corporate governance on the profitability: An empirical study of Indian textile industry. International Journal of Research in Management, Science & Technology, 3(2), 81–85.

Oikonomou, M., Pierri, N., & Timmer, Y. (2023). IT shields: Technology adoption and economic resilience during the COVID-19 pandemic. Labour Economics, 81, 102330.

Ou, C.-S., Hung, S.-Y., Yen, D. C., & Liu, F.-C. (2009). Impact of ATM intensity on cost efficiency: An empirical evaluation in Taiwan. Information & Management, 46(8), 442–447.

Ozili, P. K. (2018). Impact of digital finance on financial inclusion and stability. Borsa Istanbul Review, 18(4), 329–340.

Piccoli, G., & Ives, B. (2005). IT-dependent strategic initiatives and sustained competitive advantage: a review and synthesis of the literature. MIS Quarterly, 747–776.

Pierri, M. N., & Timmer, M. Y. (2020). Tech in fin before fintech: Blessing or curse for financial stability? International Monetary Fund.

Porter, M. E. (1985). The information revolution is tranforming. Harvard Business Review, 17(3–4), 1–24.

Rajan, R. G. (1992). Insiders and outsiders: The choice between informed and arm's-length debt. The Journal of Finance, 47(4), 1367–1400.

Reddy, A. A., & Malik, D. P. (2011). A review of SHG-Bank linkage programme in India. Indian Journal of Industrial Economics and Development, 7(2), 1–10.

Reed, W. R., Rogers, C. L., & Skidmore, M. (2011). On estimating marginal tax rates for US states. National Tax Journal, 64(1), 59–84.

Ross, J. W., Beath, C. M., & Goodhue, D. L. (1996). Develop long-term competitiveness through IT assets. MIT Sloan Management Review.

Roy, N. C., & Thangaraj, V. (2020). INVESTMENT IN TECHNOLOGY DOES IT PROLIFERATE THE PROFITABILITY AND PERFORMANCE OF THE INDIAN BANKS? Research in Finance, 36, 19–44. https://doi.org/10.1108/S0196-382120200000036002

Rozhkova, D., Rozhkova, N., & Tozhihonov, S. (2020). Electronic banking and financial performance of the Russian Bank. International Conference on Comprehensible Science, 227–237.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003a). Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. MIS Quarterly, 237–263.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003b). Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. MIS Quarterly, 237–263.

Saunders, A., & Brynjolfsson, E. (2016a). Valuing information technology related intangible assets. Mis Quarterly, 40(1), 83–110.

Saunders, A., & Brynjolfsson, E. (2016b). Valuing information technology related intangible assets. Mis Quarterly, 40(1), 83–110.

Scholtens, B. (2009). Corporate social responsibility in the international banking industry. Journal of Business Ethics, 86(2), 159–175.

Sheth, J. N., Jain, V., Roy, G., & Chakraborty, A. (2022). AI-driven banking services: the next frontier for a personalised experience in the emerging market. International Journal of Bank Marketing, 40(6), 1248–1271.

Shu, W., & Strassmann, P. A. (2005). Does information technology provide banks with profit? Information & Management, 42(5), 781–787.

Singh, A., & Sharma, A. K. (2016). An empirical analysis of macroeconomic and bank-specific factors affecting liquidity of Indian banks. Future Business Journal, 2(1), 40–53.

Soh, C., & Markus, M. L. (1995). How IT creates business value: a process theory synthesis. ICIS 1995 Proceedings, 4.

Sretenovic, M., & Kovacic, B. (2020). Model payment order in the SEPA system. International Journal of Business Information Systems, 33(4), 531–548.

Stella, P. (2010). Central bank financial strength and macroeconomic policy performance. In The Capital Needs of Central Banks (pp. 67–88). Routledge.

Swierczek, F. W., & Shrestha, P. K. (2003). Information technology and productivity: a comparison of Japanese and Asia-Pacific banks. The Journal of High Technology Management Research, 14(2), 269–288.

Taiminen, H. M., & Karjaluoto, H. (2015). The usage of digital marketing channels in SMEs. Journal of Small Business and Enterprise Development, 22(4), 633–651.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. Journal of Business Research, 122, 889–901.

Wade, M., & Hulland, J. (2004). The resource-based view and information systems research: Review, extension, and suggestions for future research. MIS Quarterly, 107–142.

Wadesango, N., & Magaya, B. (2020a). The impact of digital banking services on performance of commercial banks. Journal of Management Information and Decision Sciences, 23, 343–353.

Wadesango, N., & Magaya, B. (2020b). The impact of digital banking services on performance of commercial banks. Journal of Management Information and Decision Sciences, 23, 343–353.

Wang, L., Liu, S., & Xiong, W. (2022). The impact of digital transformation on corporate environment performance: evidence from China. International Journal of Environmental Research and Public Health, 19(19), 12846.

Wijayanti, R. P., Al Azizah, U. S., Daulay, Y., & Nugroho, A. W. (2021). The effect of digital banking innovation on the perfromance of conventional commercial banks in Indonesia. International Journal Economic and Business Applied, 2(2), 1–14.

Xin, M., & Choudhary, V. (2019). IT investment under competition: The role of implementation failure. Management Science, 65(4), 1909–1925.

Zhai, H., Yang, M., & Chan, K. C. (2022a). Does digital transformation enhance a firm's performance? Evidence from China. Technology in Society, 68, 101841.

Zhai, H., Yang, M., & Chan, K. C. (2022b). Does digital transformation enhance a firm's performance? Evidence from China. Technology in Society, 68, 101841.

Zhao, Q., Tsai, P.-H., & Wang, J.-L. (2019a). Improving financial service innovation strategies for enhancing china's banking industry competitive advantage during the fintech revolution: A Hybrid MCDM model. Sustainability, 11(5), 1419.

Zhao, Q., Tsai, P.-H., & Wang, J.-L. (2019b). Improving financial service innovation strategies for enhancing china's banking industry competitive advantage during the fintech revolution: A Hybrid MCDM model. Sustainability, 11(5), 1419.

Ansarullah, S. I., Saif, S. M., Andrabi, S. A. B., Kumhar, S. H., Kirmani, M. M., & Kumar, D. P. (2022). An intelligent and reliable hyperparameter optimization machine learning model for early heart disease assessment using imperative risk attributes. Journal of Healthcare Engineering, 2022. https://doi.org/10.1155/2022/9882288.

Kumhar, S. H., Ansarullah, S. I., Gardezi, A. A., Ahmad, H., Abd Elgawad, A. E. E., & Shafiq, M. (2023). Translation of English Language into Urdu Language Using LSTM Model. Computers, Materials & Continua, 74(2), 3899-3912. https://doi.org/10.32604/cmc.2023.032290.

G. S. P. Ghantasala et al., "Tech-Enabled Banking Revolt:The Transformational Era of IT in the Financial Sector," 2023 Seventh International Conference on Image Information Processing (ICIIP), Solan, India, 2023, pp. 133-136, doi: 10.1109/ICIIP61524.2023.10537647.

Shaik, R. B., Banu, S. B., Siddiqui, S. A., Jyothi, M. K., Bhaumik, A., Chandini, S., & Aarif, M. (2023). Organizational Commitment Of Employee A Rising Risk In The Educational Sector. Boletin de Literatura Oral-The Literary Journal, 10(1), 2496-2505.

Banu, S. R., Banu, S. B., Shaik Chandini, D. V., Jyothi, M. K., & Nusari, M. S. (2022). Assessment of research skills in undergraduates students. Journal of Positive School Psychology, 6938-6948.

S. B. Banu, S. W. Akhtar, S. Arshad, S. R. Banu, S. Chandini and G. P. Ghantasala, "High Heels Are No More an Accessory of Fashion for Women- A Study Unrevealing the Health Effects of Wearing High Heels," 2024 10th International Conference on Communication and Signal Processing (ICCSP), Melmaruvathur, India, 2024, pp. 406-410, doi: 10.1109/ICCSP60870.2024.10543799.

Sahu, G., Anant, M., & Tiwari, S. The Impact of Social Media on the Positive Development of Teenagers in the Contemporary age

Sahu, G., Anant, M., Tiwari, S., & Gupta, T. C. (2024). SEZ-Led Economic Growth: Evaluating The Impact Of Export Promotion Policies On Developing Countries, With A Focus On India–An Analytical Study. Educational Administration: Theory and Practice, 30(4), 1215-1220.

Sahu, G., Anant, M., & Tiwari, S. (2023). Information and Communication Technology (ICT) in the context of Rural Women Empowerment. The journal of contemporary issues in business and government, 29(3), 323-329.

Sahu, G., Anant, M., & Tiwari, S. The Impact of Social Media on the Positive Development of Teenagers in the Contemporary age.

Malik, A., Gautam, S., Abidin, S., & Bhushan, B. (2019, July). Blockchain technology-future of IoT: including structure, limitations and various possible attacks. In 2019 2nd international conference on intelligent computing, instrumentation and control technologies (ICICICT) (Vol. 1, pp. 1100-1104). IEEE.

Abidin, S., Swami, A., Ramirez-Asís, E., Alvarado-Tolentino, J., Maurya, R. K., & Hussain, N. (2022). Quantum cryptography technique: A way to improve security challenges in mobile cloud computing (MCC). Materials Today: Proceedings, 51, 508-514.

Abidin, S., Vadi, V. R., & Rana, A. (2021). On confidentiality, integrity, authenticity, and Freshness (CIAF) in WSN. In Advances in Computer, Communication and Computational Sciences: Proceedings of IC4S 2019 (pp. 87-97). Springer Singapore.

Sucharitha, Y., Vinothkumar, S., Rao Vadi, V., Abidin, S., & Kumar, N. (2021). Wireless communication without the need for pre-shared secrets is consummate via the use of spread spectrum technology. J Nucl Ene Sci Power Generat Techno, 10(9), 2.

Abidin, S. (2019). Enhancing security in WSN by artificial intelligence. In International Conference on Intelligent Data Communication Technologies and Internet of Things (ICICI) 2018 (pp. 814-821). Springer International Publishing.

Bhoopathy, V., Behura, A., Reddy, V. L., Abidin, S., Babu, D. V., & Albert, A. J. (2021). WITHDRAWN: IOT-HARPSECA: A SECURE DESIGN AND DEVELOPMENT SYSTEM OF ROADMAP FOR DEVICES AND TECHNOLOGIES IN IOT SPACE.

Abidin, S. (2017). Greedy Approach for Optimizing 0-1 Knapsack Problem. Communications on Applied Electronics, 7(6), 1-3.

ajid, M., Jawed, M. S., Abidin, S., Shahid, M., Ahamad, S., & Singh, J. Capacitated Vehicle Routing Problem Using Algebraic Harris Hawks Optimization Algorithm. In Intelligent Techniques for Cyber-Physical Systems (pp. 183-210). CRC Press.

Abidin, S., Raghunath, M. P., Rajasekar, P., Kumar, A., Ghosal, D., & Ishrat, M. (2022, July). Identification of disease based on symptoms by employing ML. In 2022 International Conference on Inventive Computation Technologies (ICICT) (pp. 1357-1362). IEEE.

Malik, A., Parihar, V., Srivastava, J., Kaur, H., & Abidin, S. (2023, March). Prognosis of diabetes mellitus based on machine learning algorithms. In 2023 10th International Conference on Computing for Sustainable Global Development (INDIACom) (pp. 1466-1472). IEEE.

Vadi, V. R., Abidin, S., Khan, A., & Izhar, M. (2022). Enhanced Elman spike neural network fostered blockchain framework espoused intrusion detection for securing Internet of Things network. Transactions on Emerging Telecommunications Technologies, 33(12), e4634.

Abidin, S., Dhariwal, M. K., Rane, K. P., Sivakumar, G., Babu, D. V., & Kumar, I. R. (2021). Development and Organize of Wireless Sensor Network in Home Management using IoT. International Journal of Aquatic Science, 12.

Chadha, S., Mittal, S., & Singhal, V. (2020). Ancient text character recognition using deep learning. International Journal of Engineering Research and Technology, 3(9), 2177-2184.

Chadha, S., Mittal, S., & Singhal, V. (2019). An insight of script text extraction performance using machine learning techniques. International Journal of Innovative Technology and Exploring Engineering, 9(1), 2581-2588.

Gupta, N., Chauhan, R., & Chadha, S. (2020). Unmanned Aerial Vehicle (UAV) for Parcel Delivery. Int. J. Eng. Res. Technol, 13(10), 2824-2830.

Chadha, S., Chauhan, R., & Gupta, N. (2022). Flood Prediction And Rainfall Analysis Using LightGradient Boosted Machine. NeuroQuantology, 20(9), 1690.

Makkar, I. S., & Chadha, S. (2024, March). Unsupervised Emotion Matching for Image and Text Input. In 2024 IEEE International Conference on Interdisciplinary Approaches in Technology and Management for Social Innovation (IATMSI) (Vol. 2, pp. 1-6). IEEE.

Gupta, N., Chadha, S., Chauhan, R., & Singhal, P. (2023, December). Damage Evaluation Following Natural Disasters Using Deep Learning. In International Advanced Computing Conference (pp. 90-103). Cham: Springer Nature Switzerland.

Gupta, N., Chadha, S., Srivastava, G., & Chauhan, R. (2021, October). Mortality Rate Extrapolation Based on Symptomatic Symptoms of Novel Corona Virus. In 2021 5th International Conference on Information Systems and Computer Networks (ISCON) (pp. 1-5). IEEE.

ShikhaChadha, D. S., & Singhal, V. Ancient Text Character Recognition Using Deep Learning.

Verma, S., Gupta, N., Anil, B. C., & Chauhan, R. (2022). A Novel Framework for Ancient Text Translation Using Artificial Intelligence. ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal, 11(4), 411-425.

Mandala, V. (2018). From Reactive to Proactive: Employing AI and ML in Automotive Brakes and Parking Systems to Enhance Road Safety. International Journal of Science and Research (IJSR), 7(11), 1992–1996. https://doi.org/10.21275/es24516090203

Mandala, V. (2019). Optimizing Fleet Performance: A Deep Learning Approach on AWS IoT and Kafka Streams for Predictive Maintenance of Heavy - Duty Engines. International Journal of Science and Research (IJSR), 8(10), 1860–1864. https://doi.org/10.21275/es24516094655

Mandala, V. (2019). Integrating AWS IoT and Kafka for Real-Time Engine Failure Prediction in Commercial Vehicles Using Machine Learning Techniques. International Journal of Science and Research (IJSR), 8(12), 2046–2050. https://doi.org/10.21275/es24516094823

Mandala, V., & Surabhi, S. N. R. D. (2024). Integration of AI-Driven Predictive Analytics into Connected Car Platforms. IARJSET, 7(12). https://doi.org/10.17148/iarjset.2020.71216

Mandala, V. Towards a Resilient Automotive Industry: AI-Driven Strategies for Predictive Maintenance and Supply Chain Optimization.

Mandala, V., & Surabhi, S. N. R. D. (2021). Leveraging AI and ML for Enhanced Efficiency and Innovation in Manufacturing: A Comparative Analysis.

Mandala, V. (2021). The Role of Artificial Intelligence in Predicting and Preventing Automotive Failures in High-Stakes Environments. Indian Journal of Artificial Intelligence Research (INDJAIR), 1(1).

Mandala, V., & Surabhi, S. N. R. D. Intelligent Systems for Vehicle Reliability and Safety: Exploring AI in Predictive Failure Analysis.

Mandala, V., & Kommisetty, P. D. N. K. (2022). Advancing Predictive Failure Analytics in Automotive Safety: AI-Driven Approaches for School Buses and Commercial Trucks.

Mandala, V., & Mandala, M. S. (2022). ANATOMY OF BIG DATA LAKE HOUSES. NeuroQuantology, 20(9), 6413.

Mandala, V., Premkumar, C. D., Nivitha, K., & Kumar, R. S. (2022). Machine Learning Techniques and Big Data Tools in Design and Manufacturing. In Big Data Analytics in Smart Manufacturing (pp. 149-169). Chapman and Hall/CRC.

Mandala, V. (2022). Revolutionizing Asynchronous Shipments: Integrating AI Predictive Analytics in Automotive Supply Chains. Journal ID, 9339, 1263.

Mandala, V., & Surabhi, S. N. R. D. (2024). Machine Learning Algorithms for Engine Telemetry Data: Transforming Predictive Maintenance in Passenger Vehicles. IJARCCE, 11(9). https://doi.org/10.17148/ijarcce.2022.11926

Surabhi, S. N. R. D., Mandala, V., & Shah, C. V. AI-Enabled Statistical Quality Control Techniques for Achieving Uniformity in Automobile Gap Control.

Shah, C. V., Surabhi, S. N. R. D., & Mandala, V. ENHANCING DRIVER ALERTNESS USING COMPUTER VISION DETECTION IN AUTONOMOUS VEHICLE.

Mandala, V., Jeyarani, M. R., Kousalya, A., Pavithra, M., & Arumugam, M. (2023, April). An Innovative Development with Multidisciplinary Perspective in Metaverse Integrating with Blockchain Technology with Cloud Computing Techniques. In 2023 International Conference on Inventive Computation Technologies (ICICT) (pp. 1182-1187). IEEE.

Mandala, V., Rajavarman, R., Jamunadevi, C., Janani, R., & Avudaiappan, T. (2023, June). Recognition of E-Commerce through Big Data Classification and Data Mining Techniques Involving Artificial Intelligence. In 2023 8th International Conference on Communication and Electronics Systems (ICCES) (pp. 720-727). IEEE.

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