



Investigating the Role of Technology in Enhancing the Regulatory Compliance Efficacy in Indian Banks

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Abstract. A pivotal and crucial role is played by technology and technology driven solutions in modernizing compliance processes within the Banking Sector (BS) spanning across various product segment (asset, liability and banking services) and monitoring systems. Technology-driven solutions are replacing traditional compliance approach at an increasing pace, offering enhanced efficiency, accuracy to endure and align with regulatory framework which is dynamic and evolving. While numerous prevailing studies have highlighted that implementing technology plays a vital and crucial role in the banking industry, only a few limited studies have explored the impact of implementing technology in improving Regulatory Compliance (RC) within the BS. Therefore, the present study aims to examine the impact of technology implementation in augmenting the efficiency of RC in the BS. The sample has been taken from 450 managers and employees from public and private sector banks using a random sampling technique from five major cities of India, namely Kolkata, Mumbai, Bangalore, Hyderabad, and Pune. The hypotheses are investigated by using regression analysis. The findings indicate that, there is a key relationship between technology implementation and RC with Organizational Readiness (OR) as a mediator. Also, for enhancing the efficacy of RC, cost and time efficiency, transaction monitoring, and information technology infrastructure are found to be the critical determinants.

Keywords: Regulatory Compliance, Technology Implementation, Efficiency, Banking, and Organizational Readiness.

1 Introduction

Over the last couple of decades, the banking landscape has changed significantly and is evolving with increased pace of globalization in financial world and particularly in Banking industry. Owing to the huge advancement and integration of technologies, the banking industry is undergoing a significant transformation. Banks began using technology to help with RC when the regulatory environment was less complex [(Abikoye et al., 2024)-, (Johan von Solms, 2021), and (Benita Bommi Felicia Jeyasingh, 2023)].

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The integration of technology in compliance functions signifies a shift from traditional methods to more innovative, technology-driven approaches. Traditional compliance mechanisms are made inefficient and untenable by the cost and complexity of RC in the BS [(Adeyelu et al., 2024), (Olawale et al., 2024)]. Integrating technology into the BS is not merely a technological advancement but a strategic necessity for the core functions of RC systems. It can help banks with customer due diligence, identity verification, and continual risk assessments. In the financial sector, RC encompasses adhering to (i) laws, (ii) regulations, (iii) guidelines, and (iv) specifications relevant to particular business processes [(Jain et al, 2024), (Nzeako et al., 2024)]. Also, it plays a key role in maintaining BS's integrity and stability. For navigating RC's complex landscape successfully, collaborative efforts between regulators, industry stakeholders, and technology innovators are essential. In Figure 1, the key benefits of RC are shown.

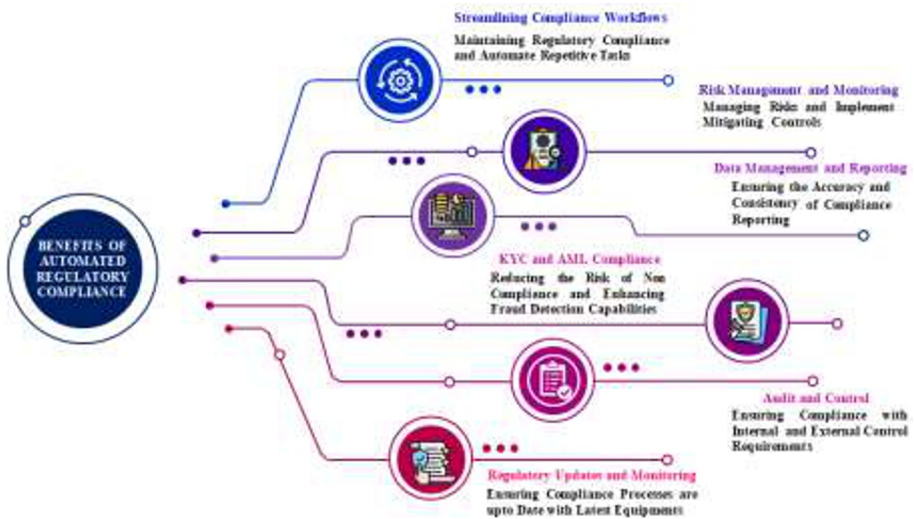


Fig. 1. Benefits of Regulatory Compliance

Still, the use of technology for RC is in the early stages of development and adoption. However, there is a growing demand for these technologies as organizations face increasing regulatory burdens. The evidence from various studies suggests that, the implementation of technology has a key role in the banking industry; nevertheless, the relationship between technology implementation and RC has not been studied [(Adeniran et al., 2024), (Obeng et al., 2024), and (Mathur, 2021)]. Moreover, only a small number of research described and deliberate on the impact of implementing technology on enhancing RC. In accordance with these research gaps, analyzing the role and effect of technology implementation on improving the efficiency of RC in the BS is the key goal. Examining the key factors influencing RC in the banking industry is essentially the objective of this study. Also, the study explores the relationship between technology implementation and RC with OR as a mediator.

Following the Introduction section, a brief summary of the related literature review is outlined in Section 2. The research method, data collection, and analysis are explained in Section 3. The result is presented and discussed in Section 4. Lastly, Section 5 concludes by discussing the findings, limitations, and implications for future research and practice.

2 Related Literature Review

Meaad Turki et al. (2020), scrutinized the effect of adopting Regulatory Technology (RegTech) in banks. The sample was taken from 100 bank employees in Bahrain through a questionnaire survey. For the analysis, the study used descriptive statistics. Also, for analyzing the relation between the variables, a correlation coefficient was employed. As per the study's findings, there was a significant relation between money laundering prevention effectiveness and cost and time efficiencies. Yet, the study only focused on a smaller population.

Ravish Tillu et al. (2023) examined Artificial Intelligence (AI) impact on RC and risk management in the financial sector. Through case studies and interviews with experts, the data was collected. By using the qualitative method, the study was analyzed. Ensuring the accuracy along with the reliability of AI algorithms and the interpretability and transparency of AI models were found as the major challenges for implementing AI in RC. Yet, the study was designed based on qualitative design, which might not provide accurate results.

Parveen M et. al. (2024) discovered AI and Machine Learning (ML) influence on the banking industry. The investigation used a mixed-method approach. Primary data was collected through tailored questionnaire surveys. For analyzing the demographic variables, descriptive statistics were deployed. By using the chi-square test, the hypothesis was investigated. As per the study's findings, the integration of AI in banking operations enhanced efficiency. The study collected data only through surveys and not interviews.

Shetty et al. (2022) evaluated information technology's impact on the BS. The research was based on a descriptive study. The study utilized secondary sources of data from research papers newspapers, journals, and websites. As per the study, information technology had a significant impact on the profitability, efficiency, and customer service of banking. Also, lack of reliable internet access was found as the major factor affecting the scope of digital banking in India. The usage of secondary data might result in bias. Vugec et al.(2017) inspected the reasons for adopting information technology governance in bank and insurance companies. The research utilized a case study approach. The data had been collected from 40 participants from 2 banks and 2 insurance companies through semi-structured interviews. As per the outcome, companies with domestic ownership structures and subsidiaries had different motivations to improve information technology governance. Nevertheless, the sample size was limited, which affected the accuracy of the result.

Mittal et al. (2019) examined the Regulatory standard explained by BCSBI along with the actual compliance by the banks. The data had been collected from 570 respondents from 8 public and private sector banks through the questionnaire. The study used statistical analysis to analyze the data. As per the study, overall adherence to the dimension of the code was not in sync with the objective of the code. The study was limited only to 8 banks. Also, it concentrated only on the retail customer segment.

Olabiyi (2024) scrutinized the regulatory challenges in implementing ML in banking operations. The data points and information required for investigation was collected through case studies, document analysis, and expert interviews. By using thematic analysis, the data was analyzed. As a result, there was a pressing need for more flexible, adaptive regulatory policies that allow innovation while ensuring accountability, transparency, and fairness in ML-driven banking operations. The research relied on publicly available case studies and expert opinions, which did not always reflect the proprietary practices used by banks.

Bansal, N. (2019) evaluated the effects of the 2016 demonetization on bank liquidity, the surge in digital transactions, compliance risks, financial inclusion (through PMJDY accounts), and the overall transformation in the governance of Indian banking

Wu, W., et al. (2022) analyzed how the steep reduction in cash availability after demonetization led to changes in adoption of alternative payment systems and compliance routines for microfinance and banking.

Chodorow-Reich, G., et al. (2018) explored compliance changes, bank credit, and payment system adoption after the demonetization in November 2016, and its effects on financial sector behavior and compliance.

Gupta, S., & Saini, N. (2022) examined demonetization's effects on banking sector compliance, redistribution, and digital inclusion using satellite and bank data.

IAMAI. (2023) Covers RBI compliance, the impact of India's new data protection regime on banking operations, consent management, data retention, and IT/cybersecurity compliance in Indian banks post-bill.

3 Methodology

3.1 Research Design

Examining the role and impact of implementing technology on enhancing the efficiency of RC in the banking industry is the core objective of present research. Also, the study investigates the relationship between technology implementation and RC with a mediating role of OR. For analyzing technology implementation's effect on RC, the present study utilizes the quantitative research method. In Figure 2, the conceptual framework's diagrammatic representation is shown.

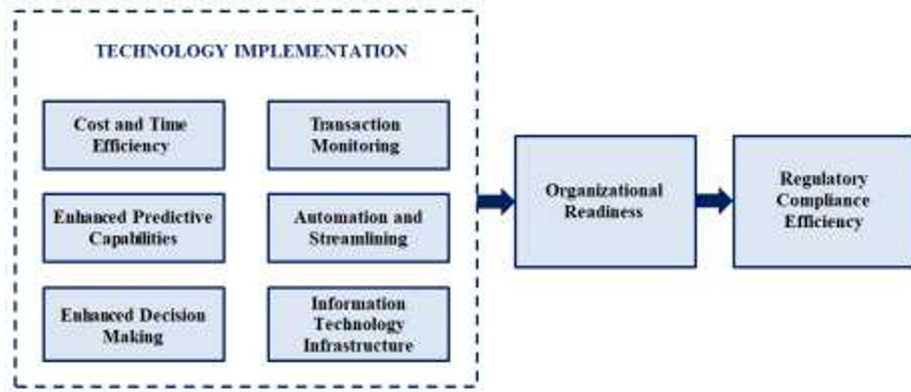


Fig. 2. Conceptual Framework

3.2 Data Collection

Here, primary and secondary sources of data are utilized. Information that researchers collect directly from participants through surveys and interviews is the Primary data. Secondary data is gathered from government publications, websites, books, and journal articles related to the study settings; secondary data is gathered. Data is directly collected from the participants through a questionnaire survey for the present study. The participants of the study include the managers and employees of public and private sector banks in the major cities of India, namely Kolkata, Mumbai, Bangalore, Hyderabad, and Pune. A random sampling technique, which is a probability sampling method, is utilized to select the participants for the study. The questionnaire is distributed to 450 participants. Here, the closed-ended questionnaires have been included. The study details are clearly explained, and verbal consent is obtained by the researcher from the participants before distributing the questionnaire.

3.3 Measurement of Variables

Here, cost and time efficiency, transaction monitoring, enhanced predictive capabilities, automation streamlining, enhanced decision-making, and information technology infrastructure are taken as independent variables. OR is taken as a mediating variable and RC efficiency is taken as a dependent variable.

3.4 Data Analysis

By employing statistical analysis like descriptive and inferential statistical techniques, the quantitative data gathered via the questionnaire is analyzed. To analyze the demographic data and the Likert-type data, descriptive statistics like mean, Standard Deviations (SD), percentages, and frequencies are used. Inferential statistical techniques like correlation and regression analysis are applied to understand the relationships between

variables, including cost and time efficiency, transaction monitoring, enhanced predictive capabilities, automation streamlining, enhanced decision-making, information technology infrastructure, OR, and RC efficiency.

4 Results and Discussion

The confirmatory factor analysis of technology implementation, RC efficiency, and OR is determined in the present study. Likewise, the study examined the relationship between technology implementation and RC efficiency with OR as a mediator. The linear relationship between the variables has been explored and discussed by using correlation analysis.

4.1 Impact of technology implementation on regulatory compliance

To assess the relationship between the variables, such as technology implementation, OR, RC, and their latent constructs, the confirmatory factor analysis is employed. Technology implementation includes cost and time efficiency, transaction monitoring, enhanced predictive capabilities, automation streamlining, enhanced decision-making, and information technology infrastructure [Jahan et al. (2024), Wibowo et al. (2024)9]. Therefore, in Table 1, the measurement of the validity of constructs is given.

Table 1. Confirmatory Factor Analysis

Variables	Mean	Standard Deviation	Item loadings	CA	CR
Cost and Time Efficiency (CTE)					
Technology can provide faster access to services	4.74	0.911	0.771	0.949	0.838
Technology can reduce the costs associated with maintenance	4.78	0.926	0.763		
Transaction Monitoring (TM)					
Technology uses systems to monitor transactions in real-time and generate alerts	4.82	0.948	0.758	0.962	0.853
Technology helps to detect and report suspicious activity	4.87	0.953	0.749		
Enhanced Predictive Capabilities (EPC)					
Technology can provide better predictive insights	4.12	0.817	0.894	0.873	0.732
Technology can predict potential risks and trends	4.17	0.828	0.887		
Automation Streamlining (AS)					
Technology can automate manual procedures	4.52	0.873	0.799	0.929	0.794
Technology can lead to paperless transactions	4.43	0.859	0.808		
Enhanced Decision Making (EDM)					
Technology enhances the ability to make informed decisions	4.19	0.832	0.863	0.892	0.758
Technology improves the accuracy and consistency of decision-making	4.26	0.848	0.858		
Information Technology Infrastructure (IT)					
Technology ensures that digital information is safeguarded	4.98	0.982	0.718	0.978	0.863
Technology helps links automatic and streamline compliance processes	4.98	0.978	0.732		
Organization of Readiness (OR)					
Ensuring employees are informed and trained on relevant regulations	4.31	0.849	0.841	0.911	0.773
Reducing errors during complex compliance procedures by automation	4.37	0.856	0.826		
Regulatory Compliance Efficiency (RCE)					
Technology enhances the quality of regulatory reporting	4.68	0.904	0.784	0.936	0.816
Technology reduces the risk of non-compliance and enhances fraud detection capabilities	4.58	0.895	0.778		

Cronbach's Alpha (CA) has been used to compute the reliability of the constructs. The coefficient of CA is not acceptable if the CA is less than 0.70. As per the analysis, all items demonstrate strong internal consistency, with CA values ranging from 0.873 to 0.978, exceeding the threshold for reliability. Also, the analysis finds the Composite

Reliability (CR) of the variables. Moreover, Information Technology Infrastructure has achieved the highest CA and CR values of 0.978 and 0.863, respectively. Furthermore, the study highlights that Cost and Time Efficiency, Transaction Monitoring, and Information Technology Infrastructure are critical determinants for the efficacy of RC.

4.2 Challenges in implementing technology in the banking sector for regulatory compliance

Several key challenges hinder banking institutions from adopting technologies for improving RC. In Table 2, some of the challenges faced by the BS in implementing technology are provided.

Table 2. Challenges faced by the banking sector in implementing technology

Challenges	Percentage of Participants (%)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Technical Complexity	5%	9.1%	8.9%	29.2%	48.2%
Integration Challenge	3.4%	8%	11.2%	36%	41.4%
Circular Shifts and Barriers	25.3%	32.5%	4.7%	18.5%	19%
Data Privacy	9%	19%	4%	26%	42%
Talent and Skill Gap	23.8%	33.2%	14%	17%	12%

The challenges faced by manufacturing organizations, which are estimated based on the Likert scale model ranging from strongly disagree to strongly agree, are depicted in Table 1. As per the table, the major problems with adopting technology in banking organizations are technical complexity, integration challenges, and data privacy. 77.4% of participants agree that implementing technology leads to technical complexity and integration challenges. In Figure 3, a graphical illustration of the challenges faced by banking institutions in adopting technology is shown.

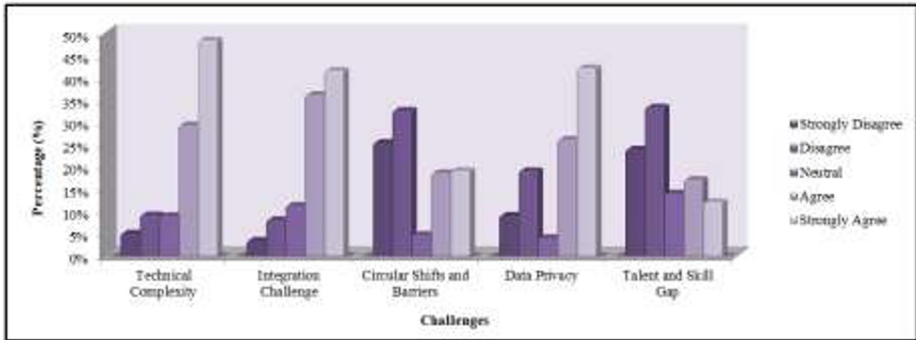


Fig. 3. Graphical representation of challenges faced by banking institutions

4.3 Descriptive statistics of variables

For the variables, including cost and time efficiency, transaction monitoring, enhanced predictive capabilities, automation streamlining, enhanced decision making, information technology infrastructure, OR, and RC efficiency, the descriptive statistics like mean, SD, frequency, and percentage have been measured, which is depicted in Table 3.

Table 3. Analysis of descriptive statistics

Variables	Mean	Standard Deviation	Frequency	Percentage (%)
Cost and Time Efficiency	4.76	0.918	450	100%
Transaction Monitoring	4.84	0.950	450	100%
Enhanced Predictive Capabilities	4.14	0.822	450	100%
Automation Streamlining	4.47	0.866	450	100%
Enhanced Decision Making	4.22	0.840	450	100%
Information Technology Infrastructure	4.96	0.978	450	100%
Organizational Readiness	4.35	0.852	450	100%
Regulatory Compliance Efficiency	4.62	0.899	450	100%

As per the analysis, the mean ranges between 4.14 and 4.96, and the SD ranges between 0.822 and 0.978. A mean value of 4.96 suggests that the implementation of technology in banks enhances RC regarding Information Technology Infrastructure. Also, 0.978 is the SD of Information Technology Infrastructure. An SD value of less than 1 indicates

that the data are closely clustered around a more reliable mean. In Figure 4, a graphical representation of statistical analysis is depicted.

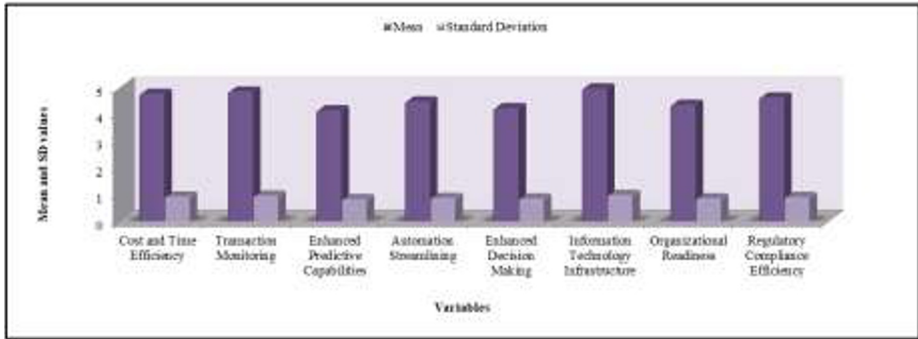


Fig. 4. A graphical illustration of descriptive statistical analysis of constructs

4.4 Hypothesis development

H1: There is a positive and significant relationship between technology implementation and RC with OR as a mediator.

H2: There is no positive and significant relationship between technology implementation and RC with OR as a mediator.

Table 4. Hypothesis Testing

Variance Source	Total squares	df	Avg. squares	R	R ²	t-value	β - coefficient	P-value	Result
H1									
Regression	84.82	17	19.08	.512	.378	3.121	.785	.029	Significant
Residual	74.13	433	6.96						
H2									
Regression	43.00	17	5.07	.438	.268	1.825	-1.017	.052	Not significant
Residual	64.64	433	5.47						

The result of the generated hypotheses is depicted in Table 4. The generated hypotheses have been analyzed and tested by using regression analysis. Regression, residual, total squares, degrees of freedom (df), average squares, R, R², t-value, β-coefficient, and p-

value have been determined for each hypothesis. The variable that obtains t-statistics of 2 or above is considered a positive and significant relation. Therefore, the H2 has been rejected, and H1 is accepted. As per the hypothesis testing, there is a positive and significant relation between technology implementation and RC with a mediating role of OR. 0.785 is the β -coefficient of H1.

4.5 Correlation analysis

It is conducted for examining the relation between variables, particularly focusing on the relations between cost and time efficiency, transaction monitoring, enhanced predictive capabilities, automation streamlining, enhanced decision-making, information technology infrastructure, OR, and RC efficiency. In Table 5, the correlation between the above-mentioned variables is given.

Table 5. Correlation Analysis of Variables

	CTE	TM	EPC	AS	EDM	ITI	OR	RCE
Cost and Time Efficiency	1							
Transaction Monitoring	0.867	1						
Enhanced Predictive Capabilities	0.646	0.628	1					
Automation Streamlining	0.753	0.759	0.678	1				
Enhanced Decision Making	0.779	0.728	0.694	0.838	1			
Information Technology Infrastructure	0.848	0.846	0.749	0.841	0.775	1		
Organizational Readiness	0.821	0.803	0.762	0.858	0.783	0.835	1	
Regulatory Compliance Efficiency	0.882	0.826	0.742	0.793	0.768	0.874	0.886	1

To quantify the direct relationship between two variables, correlation is used. It is considered as a strong correlation if two variables have a high correlation coefficient, and it is considered as a weak correlation if two variables have a low correlation coefficient. As per the analysis, RC efficiency has attained a high correlation value of 0.886 with OR, 0.882 with cost and time efficiency, and 0.874 with information technology infrastructure. Enhanced predictive capabilities have a low level of correlation with all the variables.

5 Managerial and Policy Implications

Managers can significantly improve regulatory compliance efficiency by prioritizing strategic technology investments, identify high impact areas like IT infrastructure and tools for transaction monitoring which show strong correlations with positive outcomes [0.874 and 0.826 respectively]. Investing in technologies that deliver immediate operational savings while enhancing compliance is also key outcome, as Cost and Time Efficiency show the highest correlation with compliance outcomes [0.882]. Organizational change management is vital aspect, which required significant investment in assessments of readiness, employee training, and cultural transformation before technology implementation is rolled out across verticals of organization. Addressing talent and skill gaps (identified as a challenge by 29% of participants) through comprehensive programs. A phased implementation approach over defined time period is preferred over complete replacement, is recommended, especially given integration challenges experienced by a majority of participants (77.4%).

Regulatory framework modernization initiatives where technology-neutral regulation which can seamlessly operate over various technology framework may be adopted with adoption of digital compliance reporting and monitoring can be enhanced. 68% of participants identified data privacy as a significant challenge, therefore regulators need to establish implementable guidelines for data handling in BS. Common compliances challenges can be resolved by collaborative effort between technology provider, Banks and Regulator as also to promote sharing of best practices for the common objective of achieving compliances efficiency. Since the study covers different cities, the regulator can carry out due diligence considering regional guidelines and infrastructure availability.

6 Limitations and Future Research

The current study faces certain limitations that has bearing on the generalizability of its findings. Methodologically, the cross-sectional design captures over small time frame which is not sufficient to establish relationships between technology implementation and compliance outcomes. While the sample of 450 respondents is substantial, it may not fully represent India's vast banking network, particularly rural operations. The reliance on self-reported perceptions introduces potential response and social desirability biases.

The study treats "technology" as a broad concept without examining specific solutions like AI, blockchain, or RegTech platforms in detail. The study measures regulatory compliance efficiency through perceptions and not objective metrics. Additionally, the analysis of Organizational Readiness as a mediator lacks comprehensive examination of other potential mediating factors. Further, temporally, the study has not considered recent regulatory changes and disruptions, such as India's Digital Personal Data Protection Act 2023 or post-COVID banking regulations, which may significantly impact compliance requirements and pattern of technology adoption.

Future research should prioritize longitudinal studies to track long-term technology implementation effects pre-post implementation of the model and solution. Technology-specific research focusing on AI, machine learning, RegTech platforms etc. will provide deeper insights into effectiveness of specific solution/ technology for BS. Expanded coverage should include pan-India studies covering Tier-2 and Tier-3 cities, cooperative banks, regional rural banks, and international comparative analyses with other emerging economies.

These further research directions would address current limitations while exploring emerging trends in the rapidly evolving BS and RC, providing policymakers and practitioners with evidence-based perceptions for effectively designing compliance strategies.

7 Conclusion

Here, the impact of implementing technology in the banking industry is examined to enhance RC. Similarly, the study explored the relationship between technology implementation and RC with a mediating role of OR. By using regression analysis, the hypotheses were developed and analyzed. As per the hypothesis testing, there was a positive and significant relationship between technology implementation and RC. 0.785 was the β -coefficient of H1. As per the study, major challenges in adopting technology for enhancing the efficacy of RC are technical complexity, integration challenges, and data privacy. Also, RC efficiency was highly correlated with OR, cost and time efficiency, and information technology infrastructure. Nevertheless, the study was only conducted in five cities in India. Besides, for the research, limited constructs were chosen. Thus, the study will consider other regions and cities in India in the future and inspect more factors influencing RC.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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