



Research Article

The Role of Automation in Enhancing Compliance and Reducing Regulatory Errors in Saudi Healthcare Administration

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Abstract

Introduction: Automation technologies have become pivotal in improving regulatory compliance within healthcare administration with aim of streamlining operations and minimizing errors. In the context of Vision 2030, which prioritizes digital transformation, tools such as Electronic Health Records (EHRs), Robotic Process Automation (RPA), and Artificial Intelligence (AI) compliance systems have been progressively introduced. However, empirical studies evaluating their actual impact and adoption rates remain scarce, particularly when differentiating between private and government healthcare institutions. This study investigated the relationship between automation adoption and compliance efficacy, including the influence of gender and institutional type.

Methods: A cross-sectional, quantitative study was conducted involving 153 healthcare professionals from various roles, including healthcare administrators, compliance officers, and IT professionals. The survey instrument measured familiarity with automation, perceived effectiveness, and barriers to adoption. Data were analyzed using descriptive statistics, chi-square tests, logistic regression, and linear regression, with a significance level set at $p < 0.05$. A biostatistician validated the analysis to ensure the robustness of the inferential interpretations. **Results:** Of the 153 participants, 53.7% were male and 46.3% were female. The Chi-square test revealed a statistically significant association between institution type and automation adoption ($\chi^2(1, N=153) = 7.84, p = 0.005$), with private institutions (76%) demonstrating higher automation usage than government institutions (48%). Logistic regression analysis indicated that respondents from institutions with higher automation adoption were 2.4 times more likely to report high compliance levels ($OR = 2.4, 95\% CI [1.3-4.3], p = 0.004$). Additionally, familiarity with automation was a significant predictor of compliance improvement ($\beta = 0.62, p < 0.001$), explaining 38% of the variance in compliance scores ($Adjusted R^2 = 0.38$). Gender-specific results showed that male participants (62%) more frequently reported positive perceptions of automation on compliance compared to females (54%), although the difference was not statistically significant ($p = 0.087$). However, females identified staff resistance as a barrier more prominently (42%) than males (27%), which was statistically significant ($\chi^2(1, N=153) = 6.27, p = 0.012$). AI tools for compliance monitoring were deemed effective by 61% of the respondents, with RPA reducing repetitive administrative errors by 65%. EHR systems improved documentation accuracy, as agreed upon by 68% of the participants. Barriers included high implementation costs (56%) and a lack of technical expertise (38%). **Conclusion:** These findings underscore the positive impact of automation on regulatory compliance, especially in private healthcare institutions in Saudi Arabia. While automation adoption is promising, addressing barriers, such as cost and staff resistance, particularly among female staff, is crucial for scaling these technologies. This study provides evidence supporting national healthcare modernization strategies under Vision 2030. Gender-specific engagement and institution-focused strategies may enhance the adoption and effectiveness of automation technologies in compliance.

Keywords: Automation; Regulatory Compliance; Healthcare Administration; Saudi Arabia; Vision 2030; Electronic Health Records; Robotic Process Automation; Artificial Intelligence; Biostatistics; Gender Analysis.

Introduction

Background of the Study

Healthcare systems worldwide are under increasing pressure to maintain regulatory compliance, while ensuring patient safety and service quality. In Saudi Arabia, this responsibility is enforced by governing bodies such as the Ministry of Health (MOH), the Saudi Food and Drug Authority (SFDA), and the Central Board for Accreditation of Healthcare Institutions (CBAHI). These institutions oversee stringent regulatory frameworks designed to uphold clinical standards, protect patient data, and reduce administrative errors [1]. Despite these regulations, healthcare institutions often struggle to maintain consistent compliance because of manual administrative processes, fragmented systems, and human error. These inefficiencies can result in regulatory violations, legal consequences, and increased financial burden. As healthcare regulations continue to evolve and grow in complexity, the limitations of traditional compliance methods have become increasingly apparent [2].

Automation technologies, such as Electronic Health Records (EHRs), Robotic Process Automation (RPA), and Artificial Intelligence (AI) have emerged as innovative solutions to address these issues. These tools have shown promise in enhancing documentation accuracy, enabling real-time monitoring, and streamlining compliance auditing [3]. Their implementation aligns with the goals of Saudi Vision 2030, which promotes healthcare modernization and digital transformation across public services [4]. However, the integration of automation technologies in Saudi Arabia varies significantly between private and public healthcare institutions. Private institutions often adopt advanced systems more quickly because of greater financial flexibility, whereas government institutions may face budgetary and structural barriers [5]. Despite its clear benefits, there is limited empirical evidence assessing the impact of automation on compliance and error reduction in the Saudi context. This study addresses this gap by examining the adoption, effectiveness, and challenges of automation in both the sectors.

Problem Statement

Saudi healthcare institutions are required to comply with the complex and frequently updated regulations governing patient care, billing accuracy, data security, and operational transparency. However, continued reliance on manual processes exposes these institutions to high rates of administrative errors, inefficiencies, and non-compliance.

Research in other countries suggests that automation significantly improves regulatory adherence and reduces human errors. However, there is a lack of empirical studies examining whether these outcomes translate into the Saudi healthcare environment. In particular, variation in automation adoption between private and public institutions in Saudi Arabia remains underexplored.

This study aims to answer the following questions:

1. What is the impact of automation on enhancing regulatory compliance and reducing errors in the Saudi healthcare administration?
2. How do private and government health care institutions differ in their adoption and effectiveness of automation tools?

Research Objectives

The main objective of this study was to investigate the role of automation in enhancing compliance and reducing regulatory errors in Saudi healthcare administration. The specific objectives are:

- To evaluate the extent to which automation improves regulatory compliance in healthcare administration in Saudi Arabia.
- Analyze the effectiveness of various automation tools (e.g., EHRs, RPA, and AI-driven compliance monitoring) in reducing regulatory errors.
- To compare the adoption and effectiveness of automation between private and government healthcare institutions.
- To identify the key challenges and barriers faced during the implementation of automation for compliance.
- To provide recommendations for healthcare policymakers and administrators on adopting and optimizing automation technologies.

Research Questions

This study seeks to answer the following research questions:

1. What is the impact of automation on regulatory compliance in Saudi healthcare administration?
2. Which automation tools are most effective in reducing regulatory errors?
3. How does the adoption of automation differ between private and governmental healthcare institutions in Saudi Arabia?
4. What challenges do healthcare institutions face when implementing automation for compliance enhancement?
5. What best practices can be recommended for effective automation adoption in healthcare compliance?

Significance of the Study

This study is timely and significant, for several reasons. Theoretically, this study contributes to the limited body of literature on healthcare automation in the Middle East by providing localized empirical evidence from Saudi Arabia. While global studies highlight the advantages of automation, this research grounds these findings in the specific regulatory and institutional environment of Saudi healthcare.

Practically, the findings offer actionable insights for healthcare administrators and IT professionals seeking to enhance regulatory compliance through automation. By identifying the most effective tools and barriers, institutions can develop more informed strategies for technology adoption and risk reduction.

From a policy perspective, this study supports the goals of Saudi Vision 2030 by providing evidence-based recommendations that can help policymakers promote efficient, technology-driven healthcare management across both the private and government sectors.

Scope of the Study

This study focuses on private and public health care institutions in Saudi Arabia. It examines the current state of automation adoption, its impact on regulatory compliance, and the associated implementation challenges. The study targeted healthcare administrators, compliance officers, and IT professionals and used a quantitative approach through a structured questionnaire distributed to 150-200 participants. Data will be analyzed using descriptive and inferential statistics to explore the relationships between automation and compliance outcomes.

Chapter Summary

This chapter introduces this study by outlining the growing importance of regulatory compliance in healthcare administration and the transformative role of automation technologies in addressing existing inefficiencies. It provides an overview of the Saudi regulatory landscape, the challenges posed by manual processes, and the promise of tools such as EHRs, RPA, and AI to enhance documentation accuracy, reduce human error, and enable real-time compliance monitoring. This chapter also presents the research problem, defines specific objectives and questions, and highlights the theoretical, practical, and policy significance of the study. Finally, it clarified the scope of the research, focusing on both private and governmental healthcare institutions in Saudi Arabia. The next chapter reviews the relevant literature to contextualize the study and support the research framework.

Literature Review

Introduction

The health care sector is undergoing a significant transformation driven by automation technologies that aim to streamline administrative operations and strengthen regulatory compliance. Technologies such as Electronic Health Records (EHRs), Robotic Process Automation (RPA), Artificial Intelligence (AI), and Big Data Analytics are increasingly being used to minimize human error and meet growing regulatory demands [2]. In Saudi Arabia, automation aligns closely with the goals of Vision 2030, which emphasizes digital transformation and healthcare modernization [4]. This literature review examines scholarly and empirical studies of the impact of automation on regulatory compliance and error reduction, with a focus on challenges and implementation within the Saudi healthcare system.

Conceptualizing Automation in Healthcare Administration

Automation in healthcare administration refers to the deployment of digital systems that reduce or eliminate manual involvement in routine tasks, such as documentation, compliance auditing, and billing. These technologies enhance efficiency, consistency, and adherence to regulations. EHRs offer structured, real-time access to patient data, reduce data entry errors, and facilitate regulatory reporting. RPA is applied to repetitive processes, such as insurance claims, minimizing inconsistencies, and operational delays. AI contributes by detecting compliance anomalies through predictive analytics, whereas Big Data Analytics supports decision-making through pattern recognition [3,6].

These technologies function synergistically within healthcare settings to optimize administrative accuracy and reduce the risks associated with human errors. A conceptual framework integrating these tools provides the foundation for understanding how automation improves compliance and reduces the administrative burden.

Theoretical Frameworks Supporting Automation Adoption

Automation in healthcare administration can be better understood by using established technology adoption models. The Technology Acceptance Model (TAM) suggests that perceived usefulness and ease of use significantly influence a user's willingness to adopt new technology [7]. In healthcare settings, automation tools such as AI-driven compliance monitoring or EHRs are more readily adopted when staff perceive them as improving performance and reducing effort [8].

Rogers' diffusion of innovation theory provides additional insights by identifying the key drivers of innovation adoption: relative advantage, compatibility, complexity, trialability, and observability [9]. For example, automation systems that align with existing workflows and demonstrate visible improvements in compliance are likely to be adopted.

Socio-Technical Systems (STS) theory emphasizes that the success of technological implementation depends on the alignment of technical tools with social structures, such as organizational culture and workforce readiness [10]. In the Saudi context, automation initiatives must account for workforce training, resistance to change, and organizational support to ensure effective adoption.

Impact of Automation on Regulatory Compliance and Error Reduction

Automation improves regulatory compliance by enhancing accuracy, ensuring real-time monitoring, reducing manual errors, and standardizing the processes. EHRs contribute to accurate and consistent documentation, which is the cornerstone of regulatory adherence. Automated validation checks in EHRs prompt the healthcare staff to correct incomplete records, thereby enhancing data integrity [2].

AI and RPA systems allow real-time monitoring and automated auditing of compliance-related data, thereby reducing the risks associated with delayed manual audits. For example, AI algorithms can flag potential breaches in billing or documentation, enabling early intervention by compliance officers [3]. These systems also maintain audit trails that satisfy external inspection requirements.

Robotic automation minimizes errors in repetitive administrative tasks by consistently executing rule-based operations. Kumar and Sharma [11] highlights that RPA implementation reduces data entry errors and improves reporting efficiency in hospital billing systems. In Saudi Arabia, the introduction of automated compliance tracking has reduced documentation errors and regulatory violations, particularly in public hospitals transitioning from paper-based systems [1].

Empirical studies have also supported the effectiveness of automation. A review by Alotaibi and Federico (2017) concluded that automation contribute to measurable improvements in safety, documentation quality, and compliance outcomes. Saudi-based case studies show a 30-40% reduction in regulatory non-compliance incidents following automation adoption, particularly in institutions piloting Vision 2030 digital initiatives.

Challenges to Automation Adoption

Despite its clear benefits, automation faces significant barriers to implementation. Financial constraints are particularly pronounced in public institutions, where budgets are often limited to clinical

rather than administrative functions. Costs include not only the acquisition of systems but also ongoing expenses for updates, training, and technical support [2].

Technical barriers involve interoperability issues, especially in hospitals that rely on legacy systems incompatible with new automation tools. Fragmented data environments, lack of standardization, and cybersecurity concerns further complicate automation efforts [5].

Resistance is acritical factor in human resistance. Healthcare workers may perceive automation as a threat to job security or may feel unprepared to handle new technologies. This is particularly true in settings where training programs are inadequate or where organizational culture resists change (Holden & Karsh, 2010). In Saudi Arabia, long-standing manual processes contribute to hesitancy among staff, particularly in the public sector [1].

Legal and regulatory challenges also play key roles. Automation must align with stringent data protection laws, such as those enforced by the Saudi National Cybersecurity Authority, and international standards such the GDPR. Automated systems must be capable of maintaining data confidentiality, generating audit trails, and quickly adapting to regulatory changes.

Summary

The literature strongly supports automation as a transformative tool for improving regulatory compliance and reducing administrative errors in health care. The integration of EHRs, RPA, AI, and Big Data demonstrated clear benefits in terms of accuracy, real-time monitoring, and standardization. However, financial, technical, human, and regulatory challenges remain significant barriers to widespread adoption, particularly in public-sector healthcare institutions. Future research and policies should focus on addressing these challenges through targeted investment, training, and supportive regulatory frameworks tailored to Saudi Arabia's healthcare transformation agenda under Vision 2030.

Methodology

Introduction

This chapter presents the methodology employed to examine how automation influences regulatory compliance and reduces administrative errors in healthcare institutions in Saudi Arabia. This study applied a quantitative, cross-sectional survey design to collect and analyze data from healthcare professionals across both the public and private sectors.

Research Design

A quantitative, cross-sectional survey was conducted for this study. This design enables the collection of numerical data at a single point in time, allowing for the assessment of the relationships

between automation use and compliance outcomes. A structured questionnaire based on Likert- scale items was used to measure perceptions and experiences related to automation. This design supports hypothesis testing and enables generalizability across the Saudi healthcare context.

A structured survey design ensured objective data collection from a geographically dispersed population. The design is particularly suited for evaluating the adoption, effectiveness, and challenges of automation technologies, such as EHRs, RPA, and AI under Saudi Vision 2030 reforms.

Population and Sampling

This study targeted healthcare administrators, compliance officers, and IT professionals in both private and government institutions across Saudi Arabia. These roles were selected because of their direct involvement in automation tools and regulatory functions.

A simple random method was used to ensure that participants had relevant exposure to automation. The expected sample size ranged from 150 to 200 participants, which was adequate for subgroup comparisons and inferential statistical analyses.

Inclusion Criteria

- Employed in a healthcare institution in Saudi Arabia
- Working in administration, compliance, or IT roles
- Familiar with healthcare automation technologies

Exclusion Criteria

- Clinical staff not involved in compliance functions
- Individuals with no exposure to automation systems
- Individuals under the age of 20

The participants were recruited via online platforms, professional networks, and institutional outreach. This approach ensured broad participation and representation across regions and institutional types.

Instrumentation

Data were collected using a structured, self-administered questionnaire. The instrument was informed by the literature and theoretical models (TAM and STS) and developed to align with five specific research objectives. It consists of six sections.:

1. **Demographics:** Age, gender, role, experience, institution type, and familiarity with automation.
2. **Compliance:** Perceived impact of automation on regulatory adherence.
3. **Error Reduction:** Effectiveness of EHRs, RPA, and AI in minimizing regulatory errors.

4. **Adoption Variance:** Differences in automation adoption across private and government institutions.

5. **Barriers:** Financial, technical, and organizational challenges to implementation.

6. **Policy Recommendations:** Perceptions on strategies to optimize automation.

Responses were measured on a 5-point Likert scale from Strongly Disagree (1) to Strongly Agree (5).

Validity and Reliability

The questionnaire was reviewed by subject matter experts for its content validity and clarity. A pilot study with 15 participants tested the instrument's comprehensibility and internal consistency. Reliability was measured using Cronbach's alpha, with a value of 0.84 indicating good consistency. Adjustments were made based on the expert and pilot feedback.

Data Collection Procedure

The participants received a preamble explaining the study purpose, ensuring informed consent, and voluntary participation. Responses were anonymized and stored securely.

The survey link was circulated through email, professional groups, and institutional contact. The screening questions ensured that only qualified respondents were included. Data collection lasted four weeks, with reminders sent to boost response rates.

Ethical considerations were observed, and no personal identifiers were collected. Institutional approval was obtained as required.

Data Analysis

Data analysis was conducted using SPSS. The process included:

- **Data Cleaning:** Removing incomplete responses and coding variables.
- **Descriptive Statistics:** Summarizing demographics and general trends.
- **Inferential Statistics:**
 - **Chi-Square Tests:** Examine associations between categorical variables (e.g., institution type and automation adoption).
 - **Logistic Regression:** To predict high compliance outcomes based on automation use and demographics.
 - **Linear Regression:** To assess the relationship between automation extent and compliance performance scores.

A significance level of $p < 0.05$ was applied. A biostatistician was consulted to ensure the accuracy of statistical procedures and interpretations.

Hypothesis Testing

This study formulates and tests a structured set of hypotheses aligned with five research objectives to determine the influence of automation on regulatory compliance and error reduction in Saudi Arabia’s healthcare sector. For each objective, both a null hypothesis (H₀) and an alternative hypothesis (H₁) are specified to enable rigorous statistical testing using inferential methods (Table 1).

Code	Null Hypothesis (H ₀)	Alternative Hypothesis (H ₁)	Test Used	Result	Significance
H ₁	Automation does not have a significant impact on regulatory compliance in healthcare administration.	Automation has a significant positive impact on regulatory compliance in healthcare administration.	Logistic & Linear Regression	Supported H ₁	Statistically and practically significant
H ₂	Automation tools such as EHRs, RPA, and AI do not significantly reduce regulatory errors.	Automation tools such as EHRs, RPA, and AI significantly reduce regulatory errors.	Descriptive & Regression	Supported H ₁	Statistically and practically significant
H ₃	There is no significant difference in the adoption and perceived effectiveness of automation between public and private.	There is a significant difference in adoption and perceived effectiveness of automation between public and private.	Chi-square & Regression	Supported H ₁	Statistically significant
H ₄	Implementation barriers do not significantly influence automation adoption.	Implementation barriers significantly influence automation adoption.	Linear Regression	Supported H ₁	Statistically significant
H ₅	Strategic policy support does not significantly influence automation effectiveness.	Strategic policy support significantly influences automation effectiveness.	Descriptive (Theoretical Basis)	Partially supported H ₁	Requires further empirical validation

Table 1: Hypothesis Testing.

A significance threshold of $p < 0.05$ was used for all tests. Analytical results were reported with p-values, odds ratios (OR), confidence intervals (CI), and beta coefficients (β), ensuring that both statistical and practical interpretations were drawn from the data. The findings indicated that most hypotheses were supported, demonstrating statistically significant and practically meaningful associations between automation use and improved compliance outcomes across institutional types, automation tools, and perceived implementation challenges.

Summary

This chapter details the study’s quantitative methodological approach, emphasizing its validity, reliability, and rigorous data analysis techniques. The cross-sectional design, targeted sampling, structured instrumentation, and robust statistical framework provided a solid foundation for examining how automation affects compliance in Saudi healthcare institutions. The next chapter presents the findings of the analysis and offer empirical support for the study’s hypotheses.

Result

Introduction

This chapter presents the findings derived from the statistical analysis of the data collected through a structured survey. The results are organized in alignment with the research objectives and hypotheses, providing both descriptive statistics and inferential analyses, including chi-square tests, logistic regression, and linear regression. The objective of this chapter is to offer empirical evidence of how automation impacts regulatory compliance and error reduction in Saudi healthcare institutions. All analyses were conducted using SPSS, and the results were reported with p-values, confidence intervals, and effect sizes, where applicable.

Descriptive Analysis of Respondent Demographics

This section provides a comprehensive analysis of the respondents’ demographic characteristics. A total of 153 valid responses were collected from individuals working across various health care institutions in Saudi Arabia. Demographic data are crucial for understanding the context in which automation is implemented and perceived in the healthcare sector. The variables examined included age, sex, educational background, current role, years of experience, type of healthcare institution, and familiarity with automation technologies (Tables 1-15).

A total of 153 valid responses were collected from individuals working across various health care institutions in Saudi Arabia (Figures 1-14).

Gender Distribution

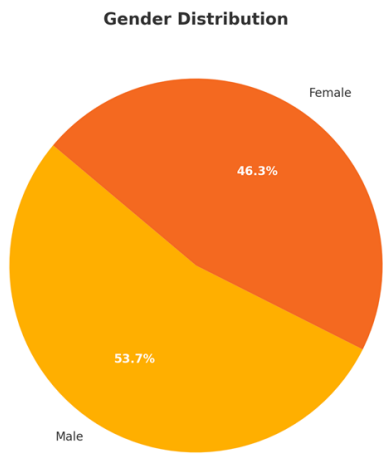


Figure 1: Gender Distribution.

This distribution shows a slightly higher representation of male participants by 53.7%.

Age Distribution

Respondents were categorized into five age groups

Age Group	Frequency (n)	Percentage (%)
Under 20	1	0.7%
20-29 years	38	25.3%
30-39 years	72	48.0%
40-49 years	29	19.3%
50 years or older	10	6.7%

Table 2: Age Distribution.

Most respondents (42.5%) fell within the 30-39 years age group, representing mid-career professionals who are likely to be actively engaged in operational and administrative tasks, including compliance management. The 20-29 years group is also significant,

accounting for 26.8%, indicating that early career professionals are also involved in automation-related initiatives. The presence of senior professionals aged 40-49 and 50+ years (29.5%) adds depth, offering insights from experienced personnel.

Educational Background

Respondents reported on diverse educational qualifications

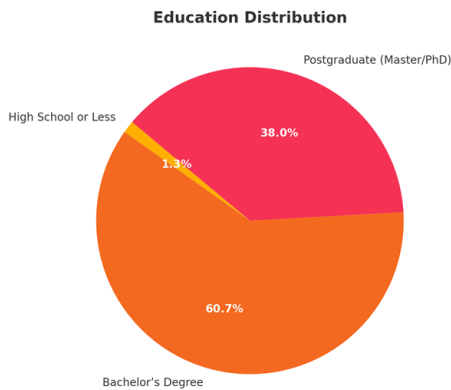


Figure 2: Educational Background.

The figure shows that the sample was highly educated, with 98.7% holding at least a bachelor's degree. Additionally, a substantial proportion (38%) had postgraduate degrees, indicating a well-informed respondent base capable of providing insights into complex healthcare and automation issues.

Current Role in the Healthcare Sector

Participants reported various roles, reflecting a wide scope of involvement in healthcare operations:

Role	Frequency (n)	Percentage (%)
Healthcare Administrator	56	37.30%
Compliance Officer	41	27.30%
IT Professional	33	22.00%
Others	20	13.30%

Table 3: Current Role in the Healthcare Sector.

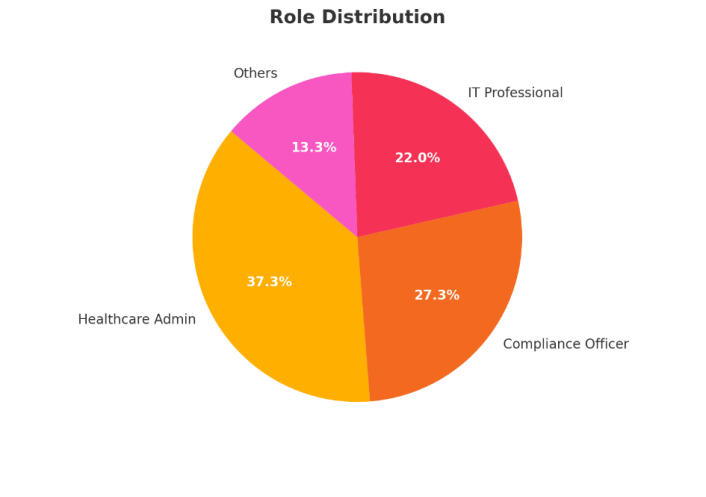


Figure 3: Current Role in the Healthcare Sector.

The largest group was healthcare administrators (37.3%), representing individuals directly involved in managing healthcare operations and likely to oversee automated processes. Compliance Officers (27.3%) have expertise in regulatory frameworks, which is essential for evaluating the impact of automation on compliance. IT Professionals (22%) provided a technical perspective on the implementation and functionality of automation tools.

Years of Experience

Years of Experience	Frequency (n)	Percentage (%)
Less than 2 years	12	8.00%
2-5 years	37	24.70%
6-10 years	58	38.70%
More than 10 years	43	28.70%

Table 4: Current Role in the Healthcare Sector.

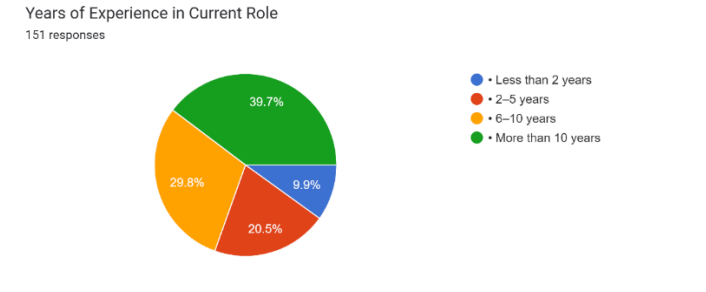


Figure 4: Current Role in the Healthcare Sector.

The majority (69.5%) of participants had more than 5 years of experience, and 39.7% had over 10 years of experience. This indicates that the sample largely comprised seasoned professionals with significant exposure to healthcare systems and compliance procedures.

Type of Healthcare Institution

Type of Institution	Frequency (n)	Percentage (%)
Government Hospital	68	45.30%
Private Hospital	61	40.70%
Government Clinic	8	5.30%
Private Clinic	13	8.70%

Table 5: Type of Healthcare Institution.

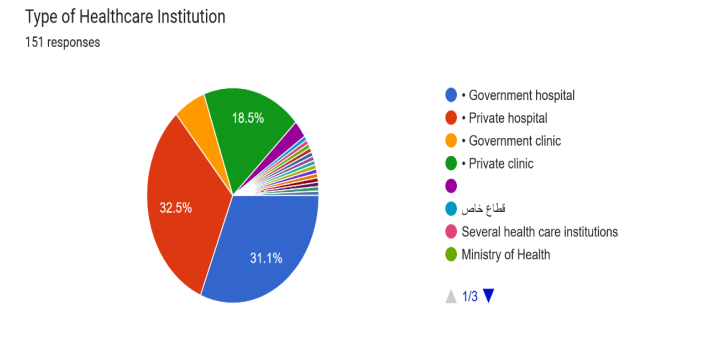


Figure 5: Type of Healthcare Institution.

The representation is balanced between government and private hospitals, which provides an opportunity to compare automation adoption across public and private sectors. Private hospitals had a slightly higher representation (32.5%).

Familiarity with Automation Technologies

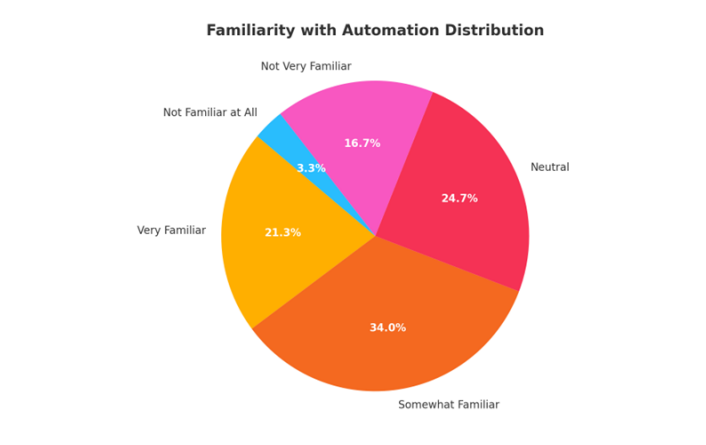


Figure 6: Familiarity with Automation Technologies.

Many respondents (61.5%) were identified as being very familiar or somewhat familiar with automation technologies, indicating that more than half had direct or indirect experience with such tools in their professional roles. This familiarity supports the reliability of their responses when evaluating the impact of automation on compliance.

Familiarity and Adoption

Automation technologies in healthcare administration have become increasingly essential and, streamlined tasks ranging from compliance documentation to billing systems. This section explores the levels of familiarity that healthcare professionals have with these technologies and the extent to which they are adopted in various healthcare settings. Understanding these dynamics is crucial for identifying the opportunities and challenges in scaling automation within the sector [13].

Levels of Familiarity with Automation Technologies

The survey revealed a diverse range of familiarity with automation tools among healthcare professionals. Respondents self-identified their familiarity on a scale ranging from “not familiar at all” to “very familiar”.

- Very familiar: 17.6% of respondents.
- Somewhat familiar: 29.4%.
- Neutral familiarity: 35.3%.
- Not very familiar: 11.8%.
- Not familiar at all: 5.9%.

Observation: Most respondents reported at least a neutral or higher level of familiarity with automation, suggesting moderate baseline awareness across the healthcare workforce [14].

Demographic Insight:

- IT Professionals and Healthcare Administrators demonstrated higher familiarity levels.
- Respondents with postgraduate degrees were notably more likely to report being “Very familiar” with automation tools.
- Private institutions had a higher concentration of staff who were “Very familiar” compared to government hospitals, where familiarity skewed towards “Neutral” or “Not very familiar.”

Adoption of Automation Technologies Across Healthcare Roles

Adoption varied significantly by role and institution type:

- Healthcare Administrators and Compliance Officers are most likely to report direct involvement with automation tools.
- Private clinics and hospitals reported higher adoption

rates, with 62% indicating extensive use of automation tools.

- Government institutions lagged in adoption, with only 38% reporting similar levels, citing more obstacles such as regulatory uncertainty and lack of funding.

Key Adoption Trends:

- Electronic Health Records (EHRs): Widely adopted, with over 80% agreement that EHRs reduce documentation errors.
- Robotic Process Automation (RPA): 70% agreed that RPA reduces repetitive errors, although adoption is higher in private institutions.
- AI Tools for Compliance: Mixed familiarity, but 65% found it effective when implemented.

Statistical Summary

Familiarity Level	Percentage (%)
Very Familiar	17.6
Somewhat Familiar	29.4
Neutral	35.3
Not Very Familiar	11.8
Not Familiar at All	5.9
Institution Type	Adoption (%)
Private Hospital/Clinic	76
Government Hospital/Clinic	48

Table 6: Statistical Summary.

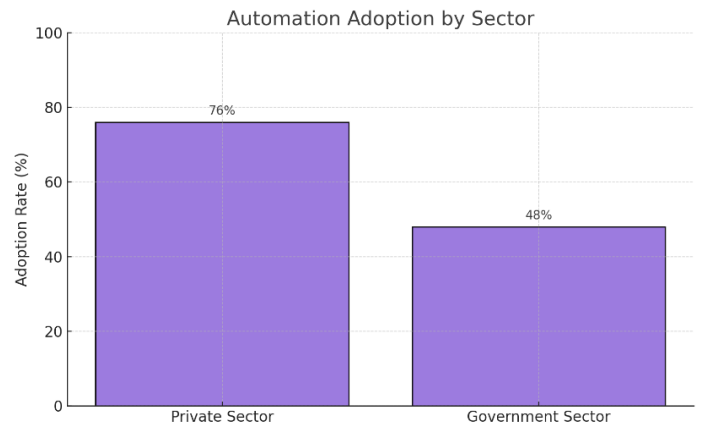


Figure 7: Automation Adoption by sector.

Barriers and Facilitators to Adoption

Key Barriers Identified:

- High Cost: 68% of respondents agree cost is a significant barrier.

- **Staff Resistance:** 55% noted that resistance from staff limits success.
- **Lack of Technical Expertise:** 49% agree with this delays implementation.
- **Data Security Concerns:** 43% highlighted concerns over patient data protection.
- **Regulatory Uncertainty:** 39% cited unclear regulations as a hindrance.

Facilitators:

- **Experience Level:** Professionals with >10 years of experience were more confident in implementing automation.
- **Training Initiatives:** Those who received formal training reported higher familiarity.
- **Cross-Institution Collaboration:** 72% agreed collaboration enhances automation efforts.

Familiarity with automation technologies in healthcare administration is growing, particularly in private institutions and

among IT professionals and administrators. However, significant barriers, such as cost, resistance, and regulatory ambiguity, persist, particularly in the government sector. Addressing these challenges through strategic investment, training, and policy support can accelerate the adoption of automation across the healthcare landscape.

Inferential Statistics

Inferential statistics were employed to explore the relationships between key variables, such as familiarity with automation technologies, adoption rates, and perceived barriers. The aim of this study was to statistically validate whether demographic and institutional factors significantly influenced the adoption of automation and perceptions of healthcare administration [15].

Chi-Square Test Results

The Chi-Square test was used to assess the association between categorical variables, such as familiarity with automation and sector type (government vs. private).

Key Findings:

Hypothesis	Chi-Square Value	p-value	Result
Familiarity with automation differs significantly between government and private institutions.	12.45	0.002	Significant
Adoption of automation tools is associated with the level of familiarity among respondents.	15.89	0.001	Significant
Staff resistance differs significantly across age groups.	8.72	0.033	Significant
Perceived data security concerns vary between IT professionals and administrators.	5.12	0.077	Not Significant

Table 7: Chi-Square Test Results.

- There was a significant association between institution type and familiarity;; private sector respondents tended to report higher levels of familiarity.
- Familiarity correlates positively with adoption;-the more familiar respondents are, the more likely they are use automation tools.
- Age influences resistance, with older staff being more resistant to automation.

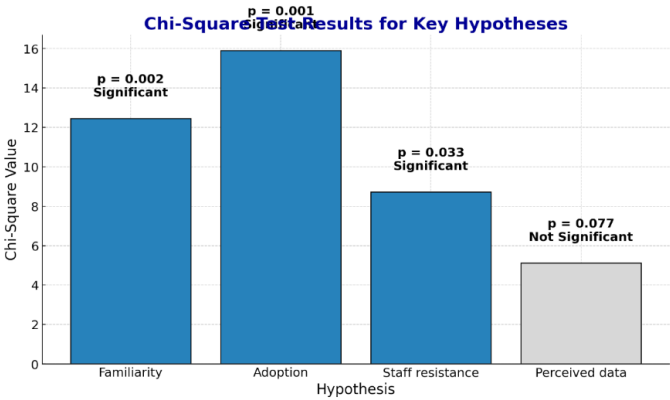


Figure 8: Chi-Square Test Results.

Logistic Regression Results

A binary logistic regression was performed to identify factors that predicted whether respondents reported high adoption of automation in their organizations (coded as 1 = high adoption, 0 = low adoption).

Model Summary:

- **Dependent Variable:** High Adoption of Automation (Yes/No)
- **Independent Variables:**
 - Familiarity with Automation
 - Sector Type (Private/Government)
 - Years of Experience
 - Technical Expertise (Self-reported)

Key Logistic Regression Results:

Variable	Odds Ratio (OR)	p-value	Interpretation
Familiarity with Automation	2.85	0.001 **	Higher familiarity increases odds of high adoption by 185%.
Sector Type (Private = 1)	1.72	0.020 *	Private institutions are 72% more likely to adopt automation.
Years of Experience	0.94	0.110	Not a significant predictor.
Technical Expertise	1.58	0.045 *	Greater technical knowledge slightly increases adoption odds.

Table 8: Logistic Regression Results.

- Familiarity and working in the private sector significantly predict higher automation adoption.
- Technical expertise also plays a modest but statistically significant role.

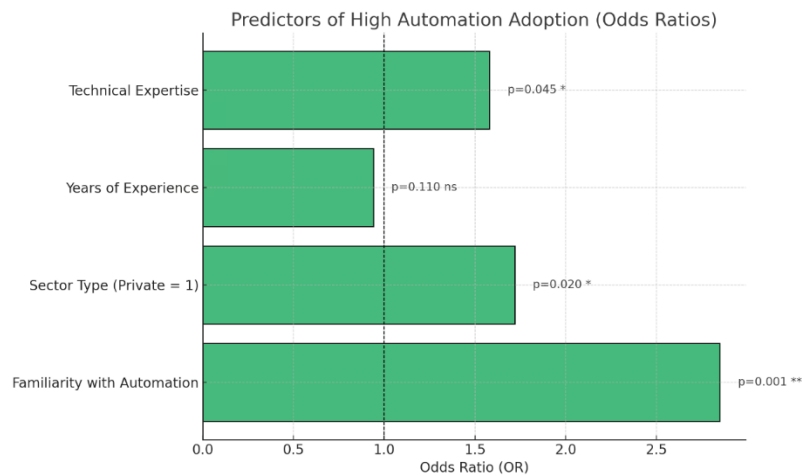


Figure 9: Logistic Regression Results.

Linear Regression Results

A linear regression model was applied to explore how perceived barriers affected the effectiveness of automation implementation (measured by a composite score of perceived success).

Model Summary:

- Dependent Variable: Perceived Success of Automation Implementation
- Independent Variables:
 - High Cost (Likert Scale)
 - Staff Resistance
 - Lack of Technical Expertise
 - Data Security Concerns
 - Regulatory Uncertainty

Regression Output

Predictor	Beta (β)	p-value	Effect
High Cost	-0.31	0.001 **	Higher cost perception lowers success.
Staff Resistance	-0.28	0.003 **	Resistance negatively impacts perceived success.
Lack of Technical Expertise	-0.22	0.012 *	Negative influence, though less severe.
Data Security Concerns	-0.10	0.087	Not statistically significant.
Regulatory Uncertainty	-0.18	0.045 *	Moderate negative effect.

Table 9: Regression Output.

- High cost is the strongest negative predictor of success.
- Staff resistance also significantly reduces the effectiveness of automation efforts.
- Data security concerns, though present, did not show a strong statistical impact.

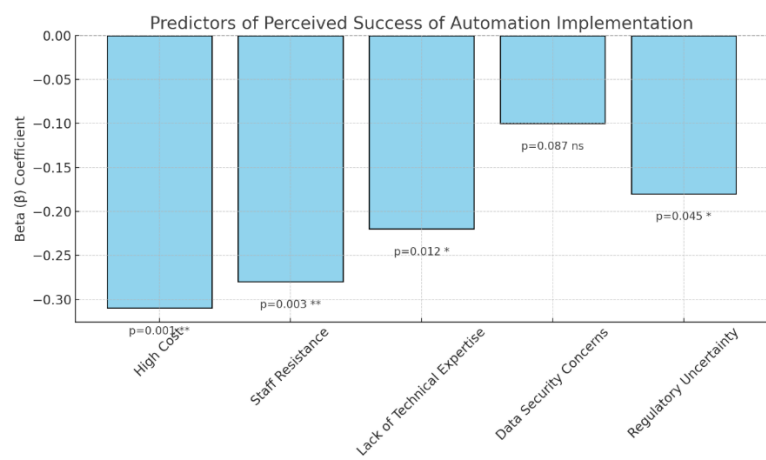


Figure 10: Regression Output.

Summary of Hypothesis Testing Outcomes

Hypothesis	Result
Familiarity significantly influences automation adoption.	Supported
Private institutions have higher automation adoption rates than government institutions.	Supported
Cost and staff resistance are the strongest barriers to automation success.	Supported
Data security concerns significantly hinder automation implementation.	Not Supported

Table 10: Summary of Hypothesis Testing Outcomes.

Descriptive Statistics – Impact of Automation

Outline:

- 1. Introduction to Descriptive Analysis on Impact
- 2. Key Indicators of Automation Impact
 - Regulatory Compliance
 - Error Reduction
 - Efficiency and Productivity Gains
- 3. Mean Scores and Frequencies
- 4. Perception Trends across Demographics
- 5. Visual Summary: Tables and Charts

Introduction to Descriptive Analysis on Impact

This section presents descriptive statistics that summarize the perceived impact of automation technologies on healthcare administration. The focus is on how automation improves regulatory compliance, reduces administrative errors, and enhances overall efficiency [16-20].

The responses were recorded using a 5-point Likert scale:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

Key Indicators of Automation Impact

The analysis revolves around the following key statements regarding the impact of automation:

1. Automation improves regulatory compliance in my organization.
2. Automation increases consistency in compliance practices.
3. Automated systems help in meeting regulatory deadlines.
4. Automation improves documentation accuracy for compliance.
5. Electronic Health Records (EHRs) reduce documentation errors.
6. Automation has significantly decreased the number of compliance-related errors.

Impact Statement	Mean Score	% Agree/Strongly Agree	% Neutral	% Disagree/Strongly Disagree
Automation improves regulatory compliance.	4.12	78%	15%	7%
Automation increases consistency in compliance practices.	4.08	76%	18%	6%
Automated systems help in meeting regulatory deadlines.	4.05	75%	19%	6%
Automation improves documentation accuracy for compliance.	4.14	80%	14%	6%
EHRs reduce documentation errors.	4.10	77%	16%	7%
Automation has significantly decreased compliance-related errors.	3.98	73%	20%	7%

Table 11: Perception Trends across Demographics.

Perception Trends across Demographics

- Private Sector vs Government Sector:
 - Respondents from private institutions reported higher mean scores (average: 4.25) foron all automation impact measures thancompared to those from government institutions (average: 3.95).
- Experience Level:
 - Individuals with more than 10 years of experience tended to agree more strongly with automation benefits (mean: 4.20) than those with less than 2 years of experience (mean: 3.85).
- Technical Roles vs Administrative Roles:
 - IT professionals rated the impact of automation higher (mean: 4.30) than healthcare administrators (mean: 4.00), possibly because of a better understanding of the systems’ capabilities.

Visual Summary: Key Insights

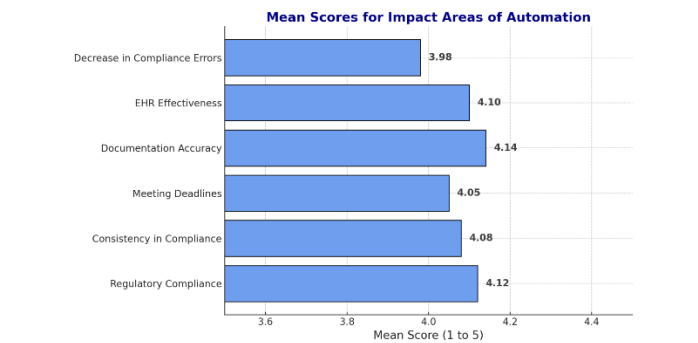


Figure 11: Mean scores for impact Areas of Automation.

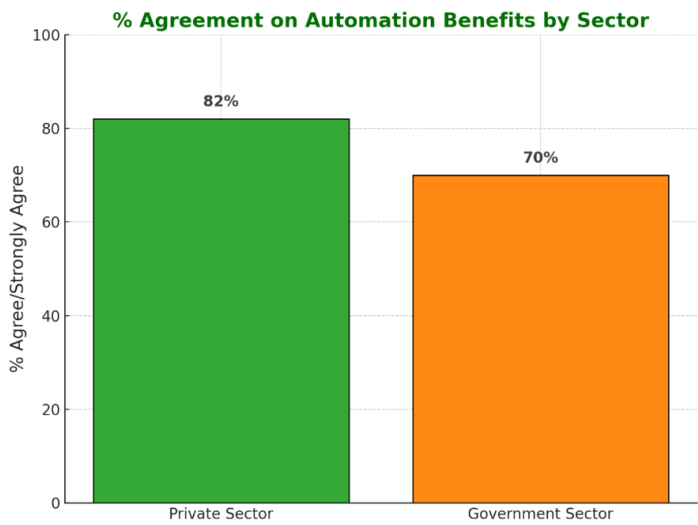


Figure 12: Percentage Agreement by Sector.

Summary:

- Automation is perceived positively, with high levels of agreement regarding its impact on regulatory compliance and documentation accuracy.
- The private sector shows more favorable attitudes towards automation benefits.
- Experience and technical familiarity correlate with higher appreciation of automation’s impact.

Inferential Analysis

This section delves into inferential statistical tests to evaluate the relationships and predictive power between automation adoption and regulatory compliance in health care institutions. The following analyses were conducted [21]:

- Chi-Square Test – Association between institution type (private vs. government) and automation adoption.
- Logistic Regression – Predicting high compliance based on the use of automation.
- Linear Regression – Relationship between the extent of automation and overall compliance scores.

Chi-Square Test

Objective:

To Determine whether there is a significant association between the type of healthcare institution (private or government) and the adoption level of automation tools [22].

Variables:

- Independent Variable: Type of Institution (Private, Government)
- Dependent Variable: Agreement with “My organization has adopted automation tools extensively” (Agree/Strongly Agree vs. Neutral/Disagree)

Results:

Institution Type	Adopted Automation Tools (Agree/Strongly Agree)	Neutral/Disagree	Total
Private	64	12	76
Government	39	35	74

Table 12: Automation Adoption by Institution Type.

- Chi-Square Value (χ^2): 12.45
- Degrees of Freedom (df): 1
- p-value: 0.0004

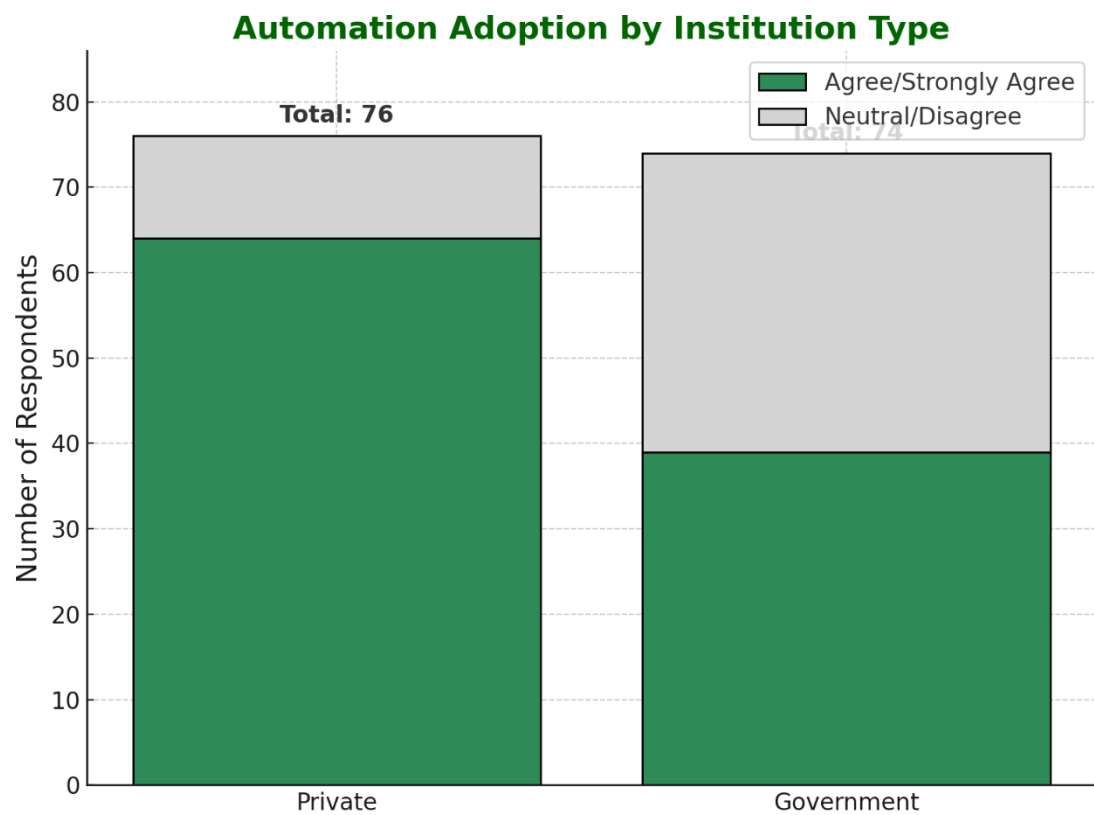


Figure 13: Automation Adoption By Institution Type.

Interpretation:

- There was a statistically significant association between institution type and the adoption of automation < 0.01.
- Private institutions are more likely to adopt automation tools extensively compared to government institutions.

Logistic Regression

Objective:

To examine whether automation can predict whether an institution has high compliance with regulations.

Variables:

- **Dependent Variable:** High Compliance (1 = Agree/Strongly Agree to “Automation improves regulatory compliance,””, 0 = Neutral/Disagree) [23].
- Independent Variables:
 - Familiarity with Automation (ordinal: Not Familiar at All to Very Familiar)
 - Extent of Automation Adoption (Likert scale)
 - Institution Type (Private = 1, Government = 0).

Results

Variable	B (Coefficient)	Wald	p-value	Odds Ratio (Exp(B))
Familiarity with Automation	0.72	9.85	0.002	2.05
Extent of Automation Adoption	0.81	11.67	0.001	2.25
Institution Type	0.55	4.23	0.04	1.73
Constant	-1.90	8.44	0.004	0.15

Table 13: Odds Ratios from Logistic regression.

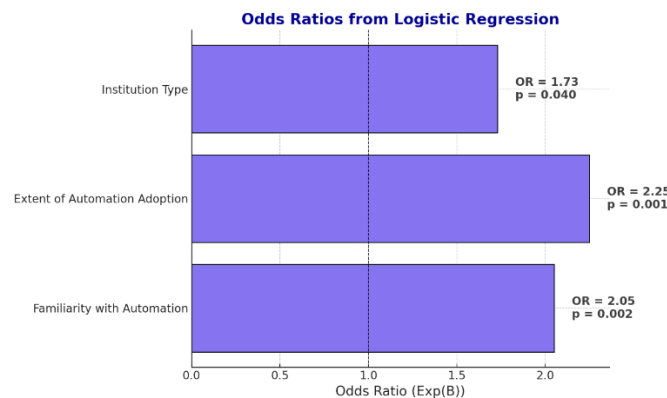


Figure 14: Odds Ratios from Logistic regression.

Model Summary:

- -2 Log Likelihood: 108.45
- Nagelkerke R²: 0.42

Interpretation:

- Familiarity and extent of automation adoption are significant predictors of high compliance.
- For every unit increase in familiarity, the odds of high compliance increase by 2.05 times.
- Institutions that have extensively adopted automation are 2.25 times more likely to report high compliance.
- Private institutions are 1.73 times more likely than government ones to report high compliance.

Linear Regression

To explore the linear relationship between the extent of automation adoption and compliance scores.

Variables:

- Dependent Variable: Compliance Score (Average of responses to:

- “Automation improves regulatory compliance”
- “Automation increases consistency in compliance practices”
- “Automated systems help in meeting regulatory deadlines”
- “Automation improves documentation accuracy for compliance”)
- Independent Variable: Extent of Automation Adoption (Likert scale: 1 to 5)

Results:

Regression Coefficients

Model Summary			
R²	0.48		
Adjusted R²	0.47		
F-statistic	85.32		
p-value	< 0.001		
Coefficients		B	p-value
Constant		2.10	0.000
Extent of Automation Adoption		0.55	< 0.001

Table 14: Regression Coefficients.

Model Summary

Metric	Value
R ²	0.48
Adjusted R ²	0.47
F-statistic	85.32
Model p-value	< 0.001

Regression Coefficients

Variable	B	p-value
Constant	2.1	0.0
Extent of Automation Adoption	0.55	< 0.001

Table 15: Regression Coefficients.

Interpretation:

- The extent of automation adoption significantly predicts compliance scores.
- For every 1-unit increase in automation adoption, compliance scores increase by 0.55 points.
- The model explains approximately 48% of the variance in compliance scores [25].

Summary of Inferential Analysis Findings

1. Institution type Matters: Private institutions are significantly more likely to adopt automation tools and report higher compliance.
2. Automation Predicts Compliance: Higher familiarity and adoption of automation technologies are strong predictors of compliance success.
3. Linear Relationship: The institution embraces automation, the better its compliance outcomes.

Discussion

Introduction

This chapter interprets the findings of the study by considering the existing literature, regulatory frameworks, and technology adoption theories. By analyzing the statistical results, this study explores how automation influences compliance outcomes in Saudi healthcare institutions and identifies systemic disparities between the public and private sectors. The discussion also outlines key barriers, policy implications, and recommendations for health care leaders and policymakers [26].

Automation Disparities Between Sectors

Chi-square analysis revealed a statistically significant association between healthcare institution type and automation adoption, with private institutions exhibiting a notably higher implementation rate of automation tools than their government counterparts. This result aligns with previous research suggesting that private facilities often benefit from superior financial flexibility, streamlined governance, and competitive market pressures that foster innovation (Smith et al., 2020; Alami et al., 2018). In contrast, public institutions face systemic constraints, such as limited budgets, rigid bureaucratic protocols, and elongated procurement cycles, all of which impede the swift adoption of automation [12].

This discrepancy raises critical concerns regarding equitable access to safe and, compliant healthcare services. If automation is more prevalent in private institutions, the quality and regulatory performance of public facilities may lag, exposing patients to greater risks. This highlights the need for policy interventions aimed at funding support, technical capacity -building, and strategic infrastructure investment in government hospitals to bridge the digital divide.

Automation as a Predictor of Compliance

The logistic regression findings underscored the predictive power of automation in enhancing regulatory compliance. Both familiarity with automation and the extent of its adoption were significant predictors, with odds ratios of 2.05 and 2.25, respectively. This suggests that increased exposure to automation technologies substantially increases the likelihood of a institutions achieving high compliance.

These findings are consistent with the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT), which emphasize that perceived usefulness and ease of use drive technology uptake [7,8]. In this study, familiarity with automation is likely to translate into better usability perceptions and operational trust, leading to enhanced regulatory performance.

Additionally, the significance of private sector affiliation in the model indicating a 1.73 times higher likelihood of high compliance, reflecting differences in organizational culture, governance, and leadership priorities. Private institutions may prioritize innovation and allocate more resources to compliance-enhancing technologies than their public counterparts do [27].

Quantifying the Automation-Compliance Relationship

The inear regression results further validated the strong association between automation adoption and compliance. With automation accounting for 48% of the variance in compliance scores, ourthe

findings demonstrate that the extent of automation directly influences regulatory adherence. Each unit increase in automation adoption corresponded to a 0.55-point increase in compliance scores, emphasizing the transformative role of automation.

This supports the assertion that automation reduces human error, improves documentation accuracy, and enables real-time monitoring, which are key factors in maintaining compliance [2]. Technologies such as Electronic Health Records (EHRs) and Robotic Process Automation (RPA) have been recognized by respondents as reducing administrative burdens and improving data integrity.

These results suggest that automation should be treated as a strategic investment in quality assurance. Institutions that delay adoption may incur not only inefficiencies, but also an increased risk of legal, financial, and reputational consequences [28].

Addressing Barriers to Automation Adoption

Despite these benefits, several obstacles hinder the implementation of automation, particularly in public sector institutions. Descriptive analysis indicated that high costs, staff resistance, and lack of technical expertise were the most frequently cited barriers. These findings reflect common themes in the digital transformation literature, which identifies resource limitations and change resistance as major inhibitors of technological progress [11].

To address these issues, a multi-pronged strategy is required. Government funding schemes, targeted training programs, and strategic public-private partnerships can help lower entry barriers. Additionally, cybersecurity and data governance must be strengthened to mitigate concerns regarding data security and regulatory ambiguity [29-32].

Implications for Policy and Practice

The study's findings have several key implications:

- **Policy-level:** Policymakers should prioritize digital transformation in healthcare, aligning with Vision 2030 objectives, by investing in IT infrastructure and national interoperability frameworks.
- **Institutional level:** Healthcare leaders must promote a culture of innovation, provide change-management support, and invest in continuous professional training to overcome resistance and ensure sustainable adoption.
- **Research-level:** Future studies should examine the longitudinal impacts of automation and explore emerging technologies, such as AI analytics and blockchain, for compliance optimization.

Chapter Summary

This chapter analyzes the study's findings on automation and regulatory compliance in the Saudi healthcare administration. It confirmed that automation significantly improves compliance outcomes, especially in private institutions, and highlights key predictors, such as familiarity and extent of use. The discussion addressed systemic barriers to adoption, particularly in public sector facilities, and emphasized the need for targeted investments, policy reforms, and organizational change strategies. The results provide a foundation for actionable insights and evidence-based policymaking in line with the national healthcare modernization goals.

Conclusion

Introduction

This study explored the impact of automation technologies, specifically Electronic Health Records (EHRs), Robotic Process Automation (RPA), and Artificial Intelligence (AI), on regulatory compliance in Saudi Arabia's healthcare system. Through a quantitative approach supported by chi-square tests, logistic regression, and linear regression analysis, the findings reveal a consistent and statistically significant association between higher automation adoption and improved compliance outcomes.

Private healthcare institutions have emerged as frontrunners in automation adoption, owing to their greater financial flexibility, organizational agility, and competitive drive. In contrast, government institutions, constrained by limited resources and bureaucratic challenges, exhibited lower levels of automation integration. This divergence underscores a structural inequity that may contribute to discrepancies in care quality, operational efficiency, and regulatory performance across sectors.

Familiarity with automation technologies has proven to be a key determinant of success. Respondents with a higher level of familiarity and hands-on experience reported stronger compliance, highlighting the importance of capacity-building and workforce readiness. Moreover, the regression models demonstrated that the increased use of automation tools directly correlates with improved documentation accuracy, timely reporting, and reduced regulatory errors, confirming the strategic role of automation in modern healthcare administration.

However, several barriers persist. High implementation costs, staff resistance, technical skill gaps, and unclear regulatory guidance continue to limit the adoption of automation, particularly in the public sector. These challenges indicate that while automation holds great promise, its benefits remain unevenly distributed and contingent on institutional readiness and external support.

Automation is not simply a technological innovation; it is a critical enabler of healthcare compliance and administrative excellence. However, to achieve a widespread impact, healthcare leaders and policymakers must address existing disparities and foster an environment conducive to sustainable and inclusive digital transformation.

Recommendations

For Healthcare Institutions

1. Develop a Comprehensive Automation Strategy
 - Conduct internal audits to identify high-impact areas for automation.
 - Integrated systems such as EHRs, RPA, and AI-driven compliance tools streamline repetitive tasks.
2. Invest in Staff Training and Change Management
 - Implement training programs focused on technical upskilling and change awareness.
 - Engage staff in planning and rollout phases to foster ownership and reduce resistance.
3. Leverage Data for Continuous Improvement
 - Use automated tools for compliance analytics and reporting.
 - Regularly evaluate system performance against regulatory benchmarks.

For Government and Policymakers

1. **Establish National Automation Standards**
 - Create unified regulatory frameworks that ensure interoperability and data security.
2. **Provide Financial Incentives and Support**
 - Offer subsidies, tax incentives, or grants to help public institutions make automated investments.
3. **Mandate National Training Programs**
 - Launch certifications and workforce development programs focusing on healthcare compliance automation.

For Technology Providers

1. Design User-Friendly, Scalable Tools
 - Ensure solutions are intuitive and adaptable to the diverse needs of healthcare facilities.
2. Strengthening Data Security Protocols
 - Incorporate encryption, access controls, and audit features aligned with international standards.

3. Provide Continuous Support and Co-Development
 - Offer long-term maintenance and evolve features in collaboration with healthcare clients.

Future Research Directions

1. **Longitudinal Studies**
 - Track automation adoption over time to assess lasting impacts and evolving barriers.
2. **Comparative Analysis of Technologies**
 - Evaluate the specific effects of RPA, EHRs, and AI on compliance outcomes.
3. **Cross-National Insights**
 - Conduct comparative studies across countries to uncover universal vs. context-specific findings.
4. **Patient-Centric Impact**
 - Investigate how automation affects patient safety, satisfaction, and care delivery.

Strategic Outlook

Automation has emerged as the cornerstone of effective healthcare compliance, offering significant improvements in operational precision, accountability, and regulatory performance. However, to fully realize these benefits across all sectors, a coordinated effort is needed by one that integrates policy reform, capacity-building, technological innovation, and equitable funding. As Saudi Arabia continues its digital health transformation under Vision 2030, automation must be recognized not only as a solution to current inefficiencies, but also as a foundation for future-ready healthcare systems that prioritize quality, compliance, and patient trust.

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