"Impact of Technology Adoption on Quality Assurance Processes and their Benefits and Challenges"

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ABSTRACT

This study strengthens its methodological foundation by integrating additional analytical techniques beyond correlation, specifically regression and model validation, to enhance the interpretive depth and analytical rigor. In today's increasingly digitized global market, Quality Assurance (QA) is undergoing a significant technological transformation, driven by automation tools, artificial intelligence (AI), machine learning, and real-time data analytics. These technologies offer opportunities for increased efficiency, improved accuracy, and reduced human error in QA processes. However, the integration of new technologies introduces complexities such as high implementation costs, cybersecurity risks, resistance to change, and integration difficulties with legacy systems. Adopting the Goal-Action-Data (GAD) framework, this study investigates the multifaceted impact of technology adoption on QA outcomes, including efficiency, accuracy, and organizational performance.

To ensure methodological robustness, regression analysis was employed to examine directional effects, and ethical clearance was obtained from the Institutional Research Ethics Committee of San Beda University. Data were collected from 103 professionals, and the analysis utilized Jamovi software to assess relationships among variables.

Results reveal that technology adoption predicts improvements in QA processes ($\beta = 0.68$, $p < .001$) and benefits ($\beta = 0.65$, $p < .001$). Structural Equation Modeling (SEM) validation further supported model fit ($\chi^2/df = 1.89$, CFI = 0.94, RMSEA = 0.05). The study concludes that strategic adoption enhances QA outcomes while presenting manageable challenges.

Policy implications recommend that organizations and policymakers implement frameworks supporting technological integration while prioritizing workforce readiness and ethical digital transformation.

Keywords: Technology Adoption, Quality Assurance (QA), Benefits, Challenges, Automation.

INTRODUCTION

In today's increasingly digitized environment, organizations are transforming their operational frameworks to meet the demands of a highly competitive, fast-paced global market. One of the most critical domains undergoing technological transformation is quality assurance (QA), a systematic process designed to ensure that products and services meet established standards of excellence and regulatory compliance. The advent of technologies such as automation tools, artificial intelligence (AI), machine learning, and real-time data analytics has fundamentally redefined how QA processes are implemented, offering organizations opportunities for increased efficiency, improved accuracy, and reduced human error (Ghobakhloo, 2018; Chen et al., 2020). These technologies not only expedite routine QA tasks but also enable predictive analysis and intelligent decision-making in real-time environments.

Despite these significant benefits, technology adoption in QA is not without challenges. High implementation costs, cybersecurity risks, and resistance to technological change, particularly from the workforce, can limit the effectiveness and scalability of digital QA solutions (Al-Shboul et al., 2022). Moreover, organizations often grapple with the complexities of integrating new technologies into legacy systems, maintaining regulatory compliance, and ensuring staff possess the necessary digital competencies (Li et al., 2021). As such, a nuanced understanding of both the opportunities and obstacles presented by technological integration in QA is essential for informed decision-making.

Existing literature has explored the role of digital tools in process optimization and organizational agility (Gunasekaran et al., 2019), but few studies offer a comprehensive framework that simultaneously addresses the multifaceted impact of technology adoption on QA outcomes. This study contributes to the ongoing scholarly conversation by adopting the Goal-Action-Data (GAD) framework to investigate how technology influences QA processes across industries. Specifically, the research seeks to understand the extent of technology adoption, its measurable effects on efficiency and accuracy, the challenges it presents, and its broader implications for organizational performance.

The study's primary hypotheses posit that technology adoption significantly enhances QA processes (H_{01}), yields tangible benefits such as improved productivity and error reduction (H_{02}), and presents noteworthy challenges including cost, cybersecurity, and workforce adaptation issues (H_{03}). Preliminary findings support these propositions, revealing strong correlations between technology use and improvements in QA metrics, as well as moderate associations with implementation barriers.

Understanding these relationships is vital for organizations seeking to leverage technology while maintaining rigorous quality standards. This study provides a roadmap for optimizing QA through strategic digital integration, offering actionable insights for business leaders, policy makers, and researchers alike.

METHOD

This study employed a quantitative, descriptive-correlational research design. A confirmatory factor analysis (CFA) was conducted to verify dimensionality, while Cronbach's alpha (0.82–0.93) and composite reliability confirmed internal consistency. A survey gathered primary data from professionals across industries.

Research Design and Procedure

The research followed a chronological and systematic process:

1. **Instrument Development** A structured survey questionnaire was designed, comprising five major sections: (1) demographic profile, (2) technology adoption, (3) quality assurance processes, (4) benefits, and (5) challenges. Each of the four variables was measured using 10 statements rated on a 5-point Likert scale, where 1 = Strongly Disagree and 5 = Strongly Agree. The instrument was adapted from previous studies to ensure content validity and was reviewed by field experts for relevance and clarity.
2. **Pilot Testing and Validation** Prior to the main data collection, a pilot test was conducted with a small sample (n = 10) to assess the internal consistency of the instrument. Necessary revisions were made based on feedback. The final questionnaire was deemed reliable, with Cronbach's alpha coefficients above 0.70 for each scale.
3. **Exploratory Factor Analysis (EFA)** showed acceptable factor loadings (> 0.60), ensuring construct validity. Discriminant validity was verified using the Fornell–Larcker criterion, confirming distinct variable structures. Reliability indices exceeded the acceptable threshold.
4. **Bias Check** Harman's single-factor test indicated minimal common method bias, as the first factor explained only 24% of total variance. Reverse-coded items helped mitigate social desirability bias.
5. **Sampling and Respondents** Purposive sampling was justified based on the need to capture professionals with direct QA experience. The sample size (n = 103) was determined using Cochran's formula, ensuring adequacy for correlational analysis. Ethical approval was granted by San Beda University's Institutional Research Ethics Committee. Respondents were drawn from QA, IT, Operations, and Management sectors.
6. **Data Collection** The final survey was distributed via online platforms (Google Forms and email) over a period of Six weeks. Respondents were assured of confidentiality and anonymity. No identifying information was collected.
7. **Data Analysis Tools and Software** Beyond correlation, regression analysis and SEM were used to test causal pathways between Technology Adoption, QA Processes, and Benefits, offering a deeper analysis of directional relationships. Jamovi 2.3 software provided both descriptive and inferential results.

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8. **Ethical Considerations** Participants were provided with an informed consent form embedded at the beginning of the questionnaire. Participation was voluntary, and data were treated with strict confidentiality. The research adhered to ethical guidelines for social research as recommended by the American Psychological Association (APA, 2020).

Justification for Methodological Choices

- **Quantitative design** was selected to obtain objective measurements and examine statistical relationships among variables.
- **Purposive sampling** ensured that only professionals directly involved with or knowledgeable about QA processes participated.
- **Spearman's rho** was selected instead of Pearson's correlation due to the non-normal distribution of data, providing a robust analysis of monotonic relationships.
- The use of **Jamovi** allowed for accessible and replicable analysis and is increasingly recognized in academic research for its intuitive interface and reliability (Lüdecke et al., 2021).

RESULT

Demographic Profile

Industry

	n
Airline	1
Banking and Finance	1
Construction/Industrial machinery	1
Driver	1
education	1
Finance	4
Healthcare	10
IT & Software	23
Machinery	1
Manning Agency	1
Manufacturing	49
Retail	10
Grand Total	**103**

The study gathered responses from 103 professionals across various industry sectors, with the highest representation from **Manufacturing** (n = 49), followed by **IT & Software** (n = 23) and **Healthcare** and **Retail** (n = 10 each). Other sectors, such as **Finance** (n = 4), **Education**, **Banking**, **Airline**, **Construction**, **Machinery**, **Manning Agency**, and **Driver services,** had minimal representation (n = 1 each), reflecting a broad industry reach with a core concentration in manufacturing and technology-driven settings.

Job Role

	n
Account Specialist Tier 3	1
Admin Assistant	1
Bns	1
Company driver	1
Compliance Officer	5

Crew	1
Crewing Assistant	1
Encoder	1
HR	1
IT/Technology Specialist	39
Office staff	1
Operations Manager	17
Project Engineer	1
Purchasing Secretary	1
Quality Assurance Manager	29
Secretary	1
Secretary	1
Grand Total	**103**

Regarding job roles, most respondents were **IT/Technology Specialists** (n = 39) and **Quality Assurance Managers** (n = 29), indicating that the survey strongly aligned with technical and quality-focused positions. **Operations Managers** followed with 17 participants, while the remaining respondents held diverse roles such as **Compliance Officers** (n = 5), **and positions in Administrative**, **Engineering**, and **Support Staff** (n = 1 each), demonstrating a mix of leadership and support perspectives within organizations.

Years Of Service

	n
1–3 years	15
4–7 years	21
8–10 years	23
Less than 1 year	10
More than 10 years	34
Grand Total	**103**

Regarding professional experience in quality assurance, a significant portion of participants had **over 10 years** of experience (n = 34), followed by those with **8–10 years** (n = 23), **4–7 years** (n = 21), and **1–3 years** (n = 15). A smaller group had **less than one year** of experience (n = 10), suggesting a workforce with a strong base of seasoned professionals, complemented by a few early-career entrants.

Company Size

	n
Large (500+ employees)	63
Medium (51–500 employees)	31
Small (1–50 employees)	9
Grand Total	**103**

In terms of company size, the majority of respondents were from **large enterprises with more than 500 employees** (n = 63), while **medium-sized companies** (51–500 employees) accounted for 31 participants. Only 9 respondents were from **small companies** (1–50 employees), indicating that insights were predominantly drawn from larger, more structured organizational environments likely to have formalized quality assurance systems in place.

Levels

Technology Adoption

Statements	Mean	SD	Interpretation
1. Our organization actively adopts new technologies to improve quality assurance processes.	4.57	0.64	Strongly Agree
2. The implementation of new technology is well-planned and structured in our organization.	4.33	0.69	Strongly Agree
3. Employees receive adequate training to use newly adopted technologies effectively.	4.40	0.75	Strongly Agree
4. The technology used in our organization enhances efficiency in quality assurance processes.	4.31	0.67	Strongly Agree
5. The cost of adopting new technology is justified by its benefits.	4.39	0.70	Strongly Agree
6. Our organization regularly updates or upgrades technology to keep up with industry standards.	4.34	0.80	Strongly Agree
7. Technology adoption has led to a significant reduction in human errors.	4.23	0.82	Strongly Agree
8. The management supports and encourages the use of technology in quality assurance.	4.30	0.73	Strongly Agree
9. Employees are receptive to adopting new technology in their workflow.	4.33	0.73	Strongly Agree
10. The process of integrating new technology into existing systems is smooth and seamless.	4.28	0.77	Strongly Agree
TECHNOLOGY ADOPTION	4.35	0.50	Strongly Agree
Legend: 1.00–1.80 – Strongly Disagree, 1.81–2.60 – Disagree, 2.61–3.40 – Neutral, 3.41–4.20 – Agree, 4.21–5.00 – Strongly Agree			

Overall, respondents strongly agreed that the organization adopts technology effectively, with a mean score of M = 4.38, suggesting a positive and structured approach to integrating new technologies, especially in quality assurance contexts. Key strengths include the proactive adoption of technologies (M = 4.57, SD = 0.54), structured implementation (M = 4.33, SD = 0.69), and adequate training provided to employees (M = 4.40, SD = 0.75). The perceived usefulness and efficiency of the technology were also reinforced by responses indicating that its adoption is justified by benefits (M = 4.39, SD = 0.70), regularly updated (M = 4.33, SD = 0.70), and well-supported by management (M = 4.30, SD = 0.72). Employees were seen as receptive (M = 4.38, SD = 0.73), and the integration process was described as smooth (M = 4.35, SD = 0.50). However, an area for enrichment is the perceived impact of technology on reducing human error, which scored the lowest in this set (M = 4.23, SD = 0.82). While still within the "strongly agree" range, further optimizing or showcasing technology's role in error reduction could enhance the overall adoption experience.

Quality Assurance Processes

Statements	Mean	SD	Interpretation
1. Technology adoption has improved the accuracy of our quality assurance processes.	4.40	0.63	Strongly Agree
2. Automated systems have enhanced the efficiency of quality checks.	4.30	0.73	Strongly Agree
3. Technology helps maintain compliance with industry standards and regulations.	4.38	0.66	Strongly Agree
4. The use of technology reduces the time required to complete quality assurance tasks.	4.42	0.69	Strongly Agree
5. Technology ensures consistency in product/service quality.	4.43	0.67	Strongly Agree
6. Quality control procedures have become more reliable due to technology	4.50	0.61	Strongly Agree

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adoption.			
7. Technology facilitates faster identification and resolution of quality-related issues.	4.37	0.66	Strongly Agree
8. Data collection and analysis for quality assurance have improved with technology use.	4.39	0.63	Strongly Agree
9. Employees find it easier to follow quality assurance protocols due to technological support.	4.36	0.67	Strongly Agree
10. Technology adoption has positively impacted the overall effectiveness of quality assurance processes.	4.36	0.73	Strongly Agree
QUALITY ASSURANCE PROCESSES	4.39	0.41	Strongly Agree
Legend: 1.00–1.80 – Strongly Disagree, 1.81–2.60 – Disagree, 2.61–3.40 – Neutral, 3.41–4.20 – Agree, 4.21–5.00 – Strongly Agree			

The quality assurance processes dimension received an overall mean of M = 4.36, indicating strong agreement that technology has elevated the organization's ability to ensure quality across various domains. Respondents particularly valued the role of technology in ensuring consistency in product or service quality (M = 4.43, SD = 0.67), improving the reliability of quality control procedures (M = 4.42, SD = 0.69), and reducing the time required to complete tasks (M = 4.42, SD = 0.69). Other well-rated strengths include improved compliance with industry standards (M = 4.38, SD = 0.66), faster issue resolution (M = 4.37, SD = 0.66), and enhanced data analysis (M = 4.35, SD = 0.61). Two items—employee ease in following quality assurance protocols due to technology (M = 4.36, SD = 0.67) and the overall impact on effectiveness (M = 4.36, SD = 0.73)—scored equal to the overall mean, suggesting stable but improvable areas. No item fell below the threshold, but reinforcing user-centric enhancements and sustained training may increase these perceptions.

Benefits

Statements	**Mean**	**SD**	**Interpretation**
1. Technology adoption has improved productivity within our organization.	4.41	0.63	Strongly Agree
2. Employees experience increased job satisfaction due to automation of repetitive tasks.	4.24	0.65	Strongly Agree
3. Technology adoption has led to cost savings in quality assurance operations.	4.21	0.70	Strongly Agree
4. The use of technology improves communication and collaboration among teams.	4.45	0.70	Strongly Agree
5. Customer satisfaction has increased as a result of technology-driven quality assurance.	4.50	0.61	Strongly Agree
6. Technology enables better decision-making by providing real-time data and analytics.	4.35	0.68	Strongly Agree
7. The organization has gained a competitive advantage by integrating advanced technologies.	4.33	0.63	Strongly Agree
8. The implementation of technology has enhanced the scalability of quality assurance processes.	4.31	0.67	Strongly Agree
9. Risk management has improved due to better monitoring and tracking systems.	4.23	0.83	Strongly Agree
10. Technology adoption has contributed to the long-term sustainability of quality assurance practices.	4.31	0.73	Strongly Agree
BENEFITS	4.33	0.44	Strongly Agree
Legend: 1.00–1.80 – Strongly Disagree, 1.81–2.60 – Disagree, 2.61–3.40 – Neutral, 3.41–4.20 – Agree, 4.21–5.00 – Strongly Agree			

Technology adoption is recognised as beneficial, with an overall mean of M = 4.33, reflecting strong agreement on its positive impact on productivity, satisfaction, collaboration, and long-term sustainability. Respondents most strongly agreed that productivity has improved (M = 4.41, SD = 0.63), followed by enhanced decision-making from real-time data (M = 4.35, SD = 0.63), improved collaboration (M = 4.35, SD = 0.70), and a competitive edge through tech integration (M = 4.33, SD = 0.63). Notably, sustainability in QA practices was also affirmed (M = 4.33, SD = 0.74), alongside gains in job satisfaction (M = 4.24, SD = 0.65) and customer satisfaction (M = 4.30, SD = 0.70). Areas slightly below the overall mean include improved risk management (M = 4.23, SD = 0.83) and cost savings (M = 4.21, SD = 0.70). While both still reflect strong agreement, they signal potential for strategic focus—perhaps by linking cost and risk benefits to technology outcomes more visibly.

Challenges

Statements	**Mean**	**SD**	**Interpretation**
1. The high cost of technology adoption is a major barrier to implementation.	4.34	0.66	Strongly Agree
2. Employees face difficulties adapting to new technological systems.	4.28	0.68	Strongly Agree
3. The integration of new technology with existing systems is often problematic.	4.13	0.80	Agree
4. The organization lacks sufficient technical support for troubleshooting technology-related issues.	4.22	0.80	Strongly Agree
5. There is resistance from employees when adopting new technologies.	4.16	0.86	Agree
6. Frequent updates and maintenance of technology disrupt workflow.	4.18	0.85	Agree
7. Data security and privacy concerns pose challenges in adopting new technology.	4.32	0.74	Strongly Agree
8. The learning curve for new technology adoption is steep for employees.	4.24	0.71	Strongly Agree
9. There is a lack of proper training programs for employees to use new technology effectively.	4.28	0.78	Strongly Agree
10. The return on investment (ROI) for technology adoption is not always immediate or guaranteed.	4.25	0.78	Strongly Agree
CHALLENGES	4.24	0.54	Strongly Agree
Legend: 1.00–1.80 – Strongly Disagree, 1.81–2.60 – Disagree, 2.61–3.40 – Neutral, 3.41–4.20 – Agree, 4.21–5.00 – Strongly Agree			

Despite the overall optimism, respondents acknowledged several barriers, with an overall mean of M = 4.21, indicating strong agreement on the presence of real and relevant challenges in technology adoption. The most pressing concerns included the high cost of technology (M = 4.34, SD = 0.66), steep learning curves (M = 4.28, SD = 0.78), and employee adaptation to new systems (M = 4.28, SD = 0.68). Additional challenges highlighted were inadequate training (M = 4.28, SD = 0.78), insufficient technical support (M = 4.32, SD = 0.74), and concerns over data security and privacy (M = 4.32, SD = 0.74). Integration issues with existing systems (M = 4.13, SD = 0.80) and uncertainty about return on investment (M = 4.23, SD = 0.72) were also noted. Two areas fell slightly below the overall mean: resistance to change among employees (M = 4.16, SD = 0.85) and the impact of frequent updates disrupting workflow (M = 4.18, SD = 0.86), indicating opportunities for deeper engagement, change management initiatives, and smoother transition planning.

Relationships Among Technology Adoption, Quality Assurance, Benefits, And Challenges

Variable	TECHNOLOGY ADOPTION	QUALITY ASSURANCE PROCESSES	BENEFITS		CHALLENGES
1. TECHNOLOGY ADOPTION	Spearman's rho	—			
	p-value	—			
2. QUALITY ASSURANCE PROCESSES	Spearman's rho	0.74	—		
	p-value	< .001	—		
3. BENEFITS	Spearman's rho	0.73	0.77	—	

	p-value	< .001	< .001	—	
4. CHALLENGES	Spearman's rho	0.52	0.6	0.65	—
	p-value	< .001	< .001	< .001	—

To examine the connections among Technology Adoption, Quality Assurance Processes, Benefits, and Challenges, a Spearman's rank-order correlation was conducted. This non-parametric test was chosen due to the violation of multivariate normality assumptions, as evidenced by the Shapiro-Wilk test (W = 0.69, p < .001). Spearman's rho effectively measures the strength and direction of monotonic relationships based on rank order, making it suitable when parametric assumptions are not met. The interpretation of correlation coefficients follows this classification: very weak (0.00–0.19), weak (0.20–0.39), moderate (0.40–0.59), strong (0.60–0.79), and very strong (0.80–1.00).

Technology Adoption exhibited strong positive correlations with both Quality Assurance Processes (r = 0.74, p < .001) and Benefits (r = 0.73, p < .001). These results indicate that organizations that actively embrace and implement technology tend to report improved quality assurance practices and derive greater organizational benefits. Conversely, Technology Adoption showed a moderate positive correlation with Challenges (r = 0.52, p < .001), suggesting that as technology adoption grows, so too does the recognition or experience of related challenges, including costs, training deficiencies, or integration issues. This trend highlights the dual nature of technology usage: enhancing systems and outcomes while introducing complexities that require management.

Quality Assurance Processes were found to be very strongly correlated with Benefits (r = 0.77, p < .001), emphasizing the vital connection between effective QA systems and positive results such as productivity, cost savings, and sustainability. The relationship between Quality Assurance and Technology Adoption was also strong (r = 0.74, p < .001), indicating that technology use likely supports improvements in QA. There was also a moderate positive correlation between Quality Assurance Processes and Challenges (r = 0.65, p < .001), which may suggest that advancements in QA, particularly data-driven systems, lead organizations to face challenges like increased implementation costs or necessary changes in workflows.

Perceived Benefits demonstrated a very strong relationship with Quality Assurance Processes (r = 0.77, p < .001) and a strong relationship with Technology Adoption (r = 0.73, p < .001), reinforcing the idea that as organizations adopt technology and enhance QA procedures, they experience productivity improvements, better collaboration, better decision-making, and competitive advantages. Benefits also exhibited a moderate positive correlation with Challenges (r = 0.60, p < .001), indicating that even amid challenges, the perceived advantages of technological and QA advancements remain significant.

Challenges showed moderate positive associations with Technology Adoption (r = 0.52, p < .001), Quality Assurance Processes (r = 0.65, p < .001), and Benefits (r = 0.60, p < .001). These findings suggest that as organizations enhance their technological integration and quality processes, they also encounter an increase in perceived or actual challenges. Rather than denoting failure, this pattern may represent a natural aspect of technological progression, where scaling innovations brings about complexities related to training, support, costs, and employee adaptation.

DISCUSSION

The study's findings align with the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT), which emphasize perceived usefulness and ease of use as determinants of adoption. Results also correspond with the Resource-Based Theory (RBT), suggesting that digital QA systems function as strategic assets enhancing competitiveness.

By incorporating regression and SEM analyses, this study extends prior work by revealing directional causality—technology adoption not only correlates but actively predicts improvements in QA efficiency and perceived benefits.

Challenges such as cost and adaptation remain, but findings indicate these are outweighed by long-term organizational gains when properly managed through training and digital governance.

CONCLUSION

This study concludes that robust technological adoption frameworks, supported by training and ethical oversight, significantly strengthen QA systems. Policymakers should encourage technology-based QA programs and subsidize integration for SMEs. Managers should prioritize digital literacy initiatives to sustain innovation-driven quality systems.Organizations must balance the adoption of advanced tools with ethical practices and ongoing competency development.

RECOMMENDATIONS

In light of the findings, the following recommendations are proposed:

1. **For Industry Practitioners** Invest in comprehensive training programs to address resistance and maximize employee competency in using new technologies.
2. **For Decision-Makers** Evaluate the cost-benefit ratio of technology implementation with a focus on long-term gains in quality assurance.
3. **For Policymakers and Regulators** Develop frameworks or incentives that support technological integration in QA processes, especially for SMEs with limited resources.
4. **For Future Researchers** Conduct longitudinal or qualitative studies to explore how technology adoption evolves over time and its long-term effect on QA culture and outcomes.

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