Research Journal for Societal Issues
Vol 6 No 2 (2024): 326-347

Impact of Public Procurement Rules on the Efficient Procurement Processes Mediated by Technology Integration Health Sector: A Case of Punjab

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Keywords: *Public Procurement Rules, Procurement Efficiency, Technology Integration, Health Sector, E-procurement, Regulatory Compliance, Operational Efficiency, Punjab*

DOI No: https://doi.org/10.56976/rjsi.v6i2.226

This study explores the impact of public procurement rules on the efficiency of procurement processes in the health sector of Punjab, focusing on the mediating role of technology integration. In the context of public sector procurement, stringent rules and regulations are designed to ensure transparency, accountability, and fair competition. However, these rules can also introduce complexity and delays. This research examines how the adoption of advanced technology solutions can streamline procurement processes and mitigate the challenges posed by regulatory frameworks. Using a mixed-methods approach, data were collected through surveys and interviews with key stakeholders in the health sector, including procurement officers, suppliers, and policy makers. The findings indicate that while public procurement rules impose necessary checks and balances, their rigid application can impede procurement efficiency. The integration of technology, such as e-procurement systems, has shown significant potential in enhancing process efficiency by automating workflows, reducing manual errors, and improving transparency. The study concludes that technology integration acts as a crucial enabler in balancing the dual objectives of regulatory compliance and operational efficiency in the health sector's procurement processes. Recommendations for policy adjustments and further technology adoption are provided to optimize procurement practices and improve health service delivery in Punjab.

1. Introduction

Public procurement is a crucial aspect of governmental operations, particularly in the health sector, where the efficient acquisition of goods and services can significantly impact public health outcomes (Szucs, 2024). In the context of Punjab, a region grappling with both burgeoning healthcare demands and evolving technological landscapes, the integration of technology into procurement processes presents both opportunities and challenges. This research article explores the impact of public procurement rules on the efficiency of procurement processes, specifically focusing on how these processes are mediated by technology integration within the health sector in Punjab (Schäfer et al., 2024).

Public procurement rules are designed to ensure transparency, accountability, and fairness in the acquisition of goods and services using public funds. These rules are critical in preventing corruption, ensuring competitive pricing, and promoting the efficient use of resources. However, the rigidity and complexity of these regulations can sometimes hinder the efficiency of procurement processes, leading to delays and increased costs. In the health sector, where timely procurement of medical supplies and equipment is vital, these inefficiencies can have dire consequences (Bosio et al., 2022).

The integration of technology into procurement processes has been widely advocated as a means to enhance efficiency, reduce costs, and improve transparency. Technologies such as e-procurement platforms, digital record-keeping, and automated tendering systems can streamline procurement activities, making them faster and more reliable (Lăzăroiu et al., 2020). In Punjab, the government has initiated several technological reforms aimed at modernizing public procurement systems. These reforms include the adoption of e-procurement systems, the implementation of electronic health records (EHR), and the integration of supply chain management software (Kristensen et al., 2021).

Despite the potential benefits of technology integration, the actual impact of these reforms on procurement efficiency in the health sector remains a subject of debate. Various factors influence this impact, including the adequacy of infrastructure, the capacity and readiness of healthcare institutions to adopt new technologies, and the alignment of technology with existing procurement regulations. Moreover, the interplay between procurement rules and technology can either facilitate or hinder the realization of anticipated efficiency gains (Uyarra et al., 2020).

This article aims to address several key questions: How do public procurement rules affect the efficiency of procurement processes in the health sector of Punjab? What role does technology integration play in mediating these effects? Are there specific challenges or barriers that need to be addressed to optimize the benefits of technology in public procurement? To answer these questions, this study will employ a mixed-methods approach, combining quantitative data analysis with qualitative insights from key stakeholders in the health sector.

The research will begin by examining the current public procurement framework in Punjab, identifying key regulations and their intended objectives. It will then explore the technological initiatives that have been implemented to streamline procurement processes, assessing their design,

implementation, and uptake. By analyzing procurement data and conducting interviews with healthcare professionals, procurement officials, and technology providers, the study will provide a comprehensive overview of the current state of procurement efficiency in the health sector (Bauhr et al., 2020).

Furthermore, this research will investigate the specific impacts of technology integration on various aspects of procurement, such as tendering, vendor management, contract execution, and compliance monitoring. It will also explore the broader implications of these impacts on healthcare delivery, considering factors such as cost-effectiveness, timeliness, and quality of care (Fazekas & Kocsis, 2020). The findings of this study will contribute to the ongoing discourse on public procurement reform, offering practical recommendations for policymakers, healthcare administrators, and technology developers (Baltrunaite et al., 2021).

The efficient procurement of medical supplies and services is a critical determinant of health sector performance, particularly in regions like Punjab, where healthcare needs are rapidly evolving. While public procurement rules are essential for ensuring accountability and fairness, they can also pose challenges to efficiency. Technology integration holds promise as a solution to these challenges, but its effectiveness depends on a nuanced understanding of the interplay between regulatory frameworks and technological innovations. By shedding light on this complex dynamic, this research aims to inform efforts to enhance procurement efficiency and ultimately improve health outcomes in Punjab (Cheng et al., 2018).

Public procurement is a cornerstone of governmental operations, encompassing the acquisition of goods, services, and works by public sector entities. In the health sector, where the timely and efficient procurement of medical supplies and services is critical, the impact of public procurement rules is profound. These rules are intended to ensure transparency, accountability, and fairness, safeguarding public funds from misuse and promoting competitive pricing. However, the complexity and rigidity of these regulations can sometimes impede the efficiency of procurement processes, leading to delays, cost overruns, and suboptimal outcomes (Uyarra et al., 2014). This research article delves into the intricate dynamics between public procurement rules and the efficiency of procurement processes, with a particular focus on the mediating role of technology integration within the health sector of Punjab.

Public procurement rules encompass a broad array of regulations, guidelines, and procedures that govern how public entities acquire goods and services. These rules are designed to promote fair competition, prevent corruption, and ensure that public funds are used effectively. Key components of these regulations include tendering procedures, vendor selection criteria, contract management practices, and compliance monitoring mechanisms. In the context of Punjab, these rules are enforced by various governmental bodies and are subject to both national and regional legislation. While these regulations aim to create a robust and transparent procurement framework, their implementation can sometimes lead to bureaucratic hurdles and inefficiencies (Georghiou et al., 2014).

Efficiency in procurement processes is measured by the ability to acquire goods and services in a timely, cost-effective, and transparent manner. Efficient procurement ensures that healthcare facilities have the necessary supplies and equipment to provide quality care without unnecessary delays or financial wastage. Key indicators of procurement efficiency include the speed of the tendering process, the accuracy and reliability of vendor selection, the effectiveness of contract management, and the rigor of compliance monitoring. Inefficient procurement can lead to stockouts, increased costs, and compromised patient care, making it a critical area of focus for healthcare administrators and policymakers (Testa et al., 2016).

The integration of technology into procurement processes has emerged as a promising solution to enhance efficiency and effectiveness. Technologies such as e-procurement platforms, electronic health records (EHR), supply chain management software, and automated tendering systems can streamline various procurement activities. E-procurement platforms enable electronic submission and evaluation of bids, reducing paperwork and speeding up the tendering process. EHR systems facilitate better inventory management by providing real-time data on medical supplies. Supply chain management software improves the coordination and tracking of procurement activities, ensuring timely delivery of goods. Automated tendering systems use algorithms to evaluate bids more accurately and quickly than manual processes (Curado et al., 2021).

The interplay between public procurement rules and technology integration is complex and multifaceted. On one hand, technology can significantly enhance the efficiency of procurement processes by automating tasks, improving data accuracy, and increasing transparency. On the other hand, the existing regulatory framework can either facilitate or hinder the adoption of these technologies (Edler & Yeow, 2016). For instance, overly rigid or outdated procurement rules may not accommodate the flexibility and speed offered by new technologies, leading to implementation challenges. Conversely, well-designed regulations that support innovation and technological adoption can amplify the benefits of technology integration (Gascó et al., 2018).

Punjab's health sector is characterized by a mix of public and private healthcare providers, with the public sector playing a crucial role in delivering essential health services to the population. The region faces several healthcare challenges, including high disease burden, limited resources, and infrastructure constraints (Siwandeti et al., 2021). Efficient procurement processes are vital to address these challenges and ensure the availability of necessary medical supplies and services. In recent years, the Punjab government has initiated several reforms to modernize its procurement systems, including the adoption of e-procurement platforms and other digital tools. However, the effectiveness of these reforms in improving procurement efficiency remains to be thoroughly evaluated (Sönnichsen & Clement, 2020).

The health sector in Punjab faces significant challenges in ensuring the efficient procurement of medical supplies and services. Despite the existence of public procurement rules aimed at promoting transparency, accountability, and fairness, these regulations often result in bureaucratic delays and increased costs (Van Winden & Carvalho, 2019). The integration of technology into procurement processes, such as through e-procurement systems and digital supply

chain management, offers a potential solution to these inefficiencies. However, the actual impact of these technological interventions remains unclear, particularly in the context of existing procurement regulations (Cheng et al., 2018). This study seeks to investigate the extent to which public procurement rules affect the efficiency of procurement processes in the health sector of Punjab and to evaluate how technology integration mediates these effects. Understanding these dynamics is crucial for optimizing procurement strategies and improving healthcare delivery in the region.

1.1 Research Questions

- How do public procurement rules impact the efficiency of procurement processes in the health sector of Punjab?
- To what extent has technology integration been implemented in the procurement processes within the health sector of Punjab?
- What specific challenges or barriers exist in integrating technology with the current public procurement framework in Punjab?
- How does technology integration influence key aspects of procurement such as tendering, vendor management, contract execution, and compliance monitoring in the health sector?
- What are the broader implications of improved procurement efficiency on healthcare delivery, cost-effectiveness, timeliness, and quality of care in Punjab?

1.2 Research Objectives

- To examine the current public procurement framework in Punjab and its intended objectives.
- To assess the extent of technology integration in procurement processes within the health sector of Punjab.
- To identify the specific challenges and barriers to effective technology integration in the public procurement system.
- To analyze the impact of technology integration on various aspects of procurement efficiency, including tendering, vendor management, contract execution, and compliance monitoring.
- To evaluate the broader implications of procurement efficiency improvements on healthcare delivery in terms of cost-effectiveness, timeliness, and quality of care.

2. Literature Review

Public procurement rules are legal frameworks designed to regulate public sector organizations' acquisition of goods and services. These rules aim to ensure transparency, competition, and value for money (Amann et al., 2014). In the context of the health sector, procurement rules are crucial for maintaining the integrity of processes and ensuring that public funds are used effectively (Zhu et al., 2013).

Strict adherence to procurement rules can lead to bureaucratic delays and inefficiencies. However, they also promote accountability and reduce the risk of corruption (AlNuaimi et al.,

2021). The challenge lies in balancing regulatory compliance with operational efficiency. Studies have shown that overly rigid procurement rules can hinder timely procurement, especially in emergencies such as pandemics (Rolfstam, 2013).

Technology integration in procurement involves the use of digital tools and platforms to manage procurement processes. This includes e-procurement systems, electronic tendering, and procurement management software (Alvarez-Rodríguez et al., 2014). Technology can enhance efficiency by automating processes, reducing human error, and providing real-time data for decision-making (Grandia & Voncken, 2019).

In the health sector, technology integration can significantly improve procurement efficiency. E-procurement systems can streamline ordering processes, reduce paperwork, and ensure the timely delivery of medical supplies (Montalbán-Domingo et al., 2018). Additionally, technology can facilitate better inventory management and reduce stockouts, which is critical in healthcare settings (Edler & Uyarra, 2013).

Despite its benefits, technology integration faces several challenges, including the need for significant initial investment, training for personnel, and the risk of cyber threats. Moreover, in regions like Punjab, varying levels of digital literacy and infrastructure can impact the successful implementation of technology in procurement processes (Georghiou et al., 2014).

The literature suggests that technology can mediate the impact of public procurement rules on procurement efficiency. By providing tools for better compliance and monitoring, technology can help mitigate the inefficiencies associated with strict procurement rules (Engelhardt, 2017). For instance, electronic tendering can expedite the bidding process while ensuring adherence to regulatory requirements (Amann et al., 2014).

Several case studies highlight the successful implementation of technology in public procurement. In Punjab, the adoption of e-procurement systems has shown promise in enhancing transparency and reducing procurement cycle times (Torchia et al., 2015). Empirical evidence from similar contexts suggests that technology integration leads to cost savings and improved procurement outcomes.

The interplay between public procurement rules and technology integration is critical for achieving efficient procurement processes in the health sector. While procurement rules ensure accountability and transparency, technology can mitigate associated inefficiencies and enhance overall procurement performance. In Punjab, leveraging technology in procurement processes holds significant potential for improving the efficiency and effectiveness of healthcare procurement (Roehrich et al., 2014).

Public procurement rules are designed to promote fairness, competitiveness, and transparency in the procurement process (Radanović & Likić, 2018). These rules are particularly stringent in the health sector to ensure that public health resources are utilized effectively and ethically. Compliance with procurement rules can prevent fraud, corruption, and mismanagement of funds. In Punjab, the procurement regulations are governed by the Punjab Procurement

Regulatory Authority (PPRA), which provides a legal framework for procurement activities to enhance efficiency and accountability (Kilbourne et al., 2018).

The regulatory framework of public procurement involves multiple stages including tendering, bidding, evaluation, and contract management. While these stages are essential for maintaining transparency and accountability, they can also introduce delays and administrative burdens (Cheng et al., 2018). For instance, the requirement for multiple approvals and rigorous documentation can slow down the procurement process, leading to inefficiencies. However, these regulations are crucial in preventing malpractices and ensuring that procurement activities meet predefined standards of fairness and quality (Ali et al., 2021).

In the health sector, timely procurement of medical supplies and equipment is critical. Delays in procurement can directly impact patient care and operational efficiency of healthcare facilities (Čudanov et al., 2018). Studies indicate that the stringent application of procurement rules, although essential for transparency, often results in slower procurement processes in the health sector (Odhiambo & Theuri, 2015). The challenge for policymakers is to strike a balance between regulatory compliance and operational efficiency to ensure that procurement processes do not hinder the delivery of healthcare services.

The integration of technology in procurement processes has been widely recognized as a means to enhance efficiency and reduce administrative burdens (Chekol & Tehulu, 2014). E-procurement systems, electronic tendering, and procurement management software are some of the technological advancements that have transformed procurement activities.

E-procurement systems automate various procurement processes, from requisition to payment. They facilitate electronic handling of procurement activities, reducing paperwork and improving process efficiency (Yakovlev et al., 2015). E-procurement systems provide real-time access to procurement data, enabling better decision-making and transparency. In the health sector, e-procurement can ensure timely availability of medical supplies, which is crucial for patient care (Wibowo, 2019).

The benefits of technology integration in procurement include improved efficiency, reduced costs, and enhanced transparency (Nemec et al., 2021). E-procurement systems can streamline the procurement process, reduce human error, and provide a platform for competitive bidding. However, challenges such as the need for significant initial investment, training requirements, and cyber security risks must be addressed (Kapkama, 2018). In regions like Punjab, the disparity in digital infrastructure and varying levels of digital literacy can pose additional challenges to the successful implementation of technology in procurement (Gavurová et al., 2020).

Technology plays a crucial mediating role in enhancing the efficiency of procurement processes governed by strict public procurement rules. By automating compliance and monitoring activities, technology can mitigate inefficiencies and ensure adherence to procurement regulations. Electronic tendering, for example, can expedite the bidding process while maintaining compliance with regulatory requirements. In Punjab, the implementation of e-procurement systems by the

PPRA has shown positive outcomes in terms of reducing procurement cycle times and improving transparency (Ahmed et al., 2021).

Empirical studies have demonstrated the positive impact of technology integration on procurement efficiency. A study by Hawkins et al. (2010) found that e-procurement implementation in public sector organizations led to significant cost savings and improved procurement outcomes. In the context of Punjab, the adoption of e-procurement systems has facilitated better management of procurement activities, reduced administrative burdens, and enhanced the overall efficiency of the procurement process (Zaidi et al.).

The systematic literature review highlights the critical interplay between public procurement rules and technology integration in enhancing procurement efficiency in the health sector. While procurement rules ensure transparency and accountability, they can also introduce inefficiencies. The integration of technology in procurement processes can mitigate these inefficiencies and enhance overall procurement performance. In Punjab, leveraging technology in procurement processes holds significant potential for improving the efficiency and effectiveness of healthcare procurement. Policymakers and practitioners must focus on balancing regulatory compliance with technological advancements to achieve optimal procurement outcomes in the health sector.

Public procurement rules are essential for ensuring that procurement processes are transparent, competitive, and fair. However, these rules can sometimes hinder efficiency by introducing complexity and delays into the procurement process (Burki et al., 2018). In the health sector, this can have significant implications, as delays in procurement can affect the availability of essential medical supplies and equipment (Bank, 2017).

Public procurement rules are designed to promote transparency and accountability. They require detailed documentation and adherence to specified procedures, which can help prevent fraud and corruption(NADEEM). These rules ensure that procurement decisions are made based on objective criteria and that all potential suppliers are treated equally. However, the stringent nature of these rules can also slow down the procurement process and increase administrative burdens, leading to inefficiencies.

In the health sector, procurement inefficiencies can have critical consequences. Delays in procuring medical supplies and equipment can disrupt healthcare delivery and negatively impact patient outcomes (Millington & Bhardwaj, 2017). For example, during health emergencies, the need for rapid procurement can conflict with the requirement to follow detailed procurement procedures, leading to bottlenecks. Thus, while procurement rules are necessary for ensuring accountability and transparency, they must be balanced with the need for efficiency, especially in the health sector.

Technology integration in procurement processes has the potential to significantly improve efficiency by automating and streamlining various procurement activities. The use of e-procurement systems, electronic tendering, and other digital tools can help overcome some of the challenges associated with traditional procurement methods.

E-procurement systems enable electronic handling of procurement activities, from requisition to payment. These systems can automate many of the manual processes involved in procurement, reducing paperwork and administrative burdens (Kajimbwa, 2023). E-procurement systems provide real-time access to procurement data, which enhances transparency and allows for better decision-making (Lakhani & Maqbul, 2024). In the health sector, e-procurement can ensure timely availability of medical supplies, which is critical for effective healthcare delivery (Tawfiq, 2020).

Implementing e-procurement systems can lead to several benefits, including increased efficiency, cost savings, and enhanced transparency (Modrusan et al., 2020). For instance, electronic tendering can streamline the bidding process, reduce human error, and ensure compliance with procurement rules (Bartezzaghi & Ronchi, 2003). Furthermore, e-procurement systems can facilitate better supplier management and improve inventory control, reducing the risk of stockouts and overstocking (Kirillova & Lantsova, 2019).

Despite the potential benefits, there are challenges and barriers to the successful implementation of e-procurement systems. These include the need for significant initial investment, the requirement for training and capacity building, and concerns about cybersecurity. In regions like Punjab, varying levels of digital literacy and infrastructure can further complicate the implementation of e-procurement systems. Addressing these challenges is crucial for realizing the full potential of technology integration in procurement processes (Radell & Schannon, 2019).

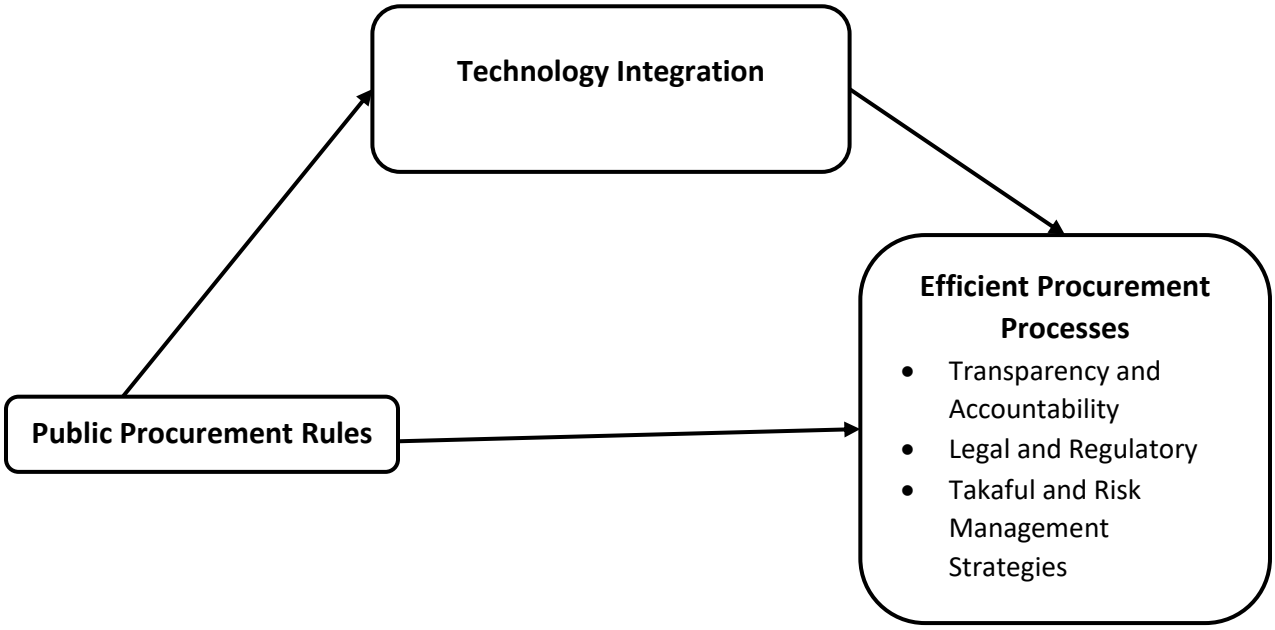
Technology can play a crucial mediating role in enhancing procurement efficiency while ensuring compliance with public procurement rules. By automating compliance-related activities, technology can help mitigate inefficiencies associated with strict procurement regulations (Kakwezi & Nyeko, 2019).

E-procurement systems can facilitate compliance with procurement rules by providing built-in checks and balances that ensure all procurement activities adhere to regulatory requirements (Nikolaevna & Aleksandrovich, 2021). These systems can also enhance monitoring and auditing capabilities, allowing for real-time tracking of procurement activities and better oversight (Gunasekara et al., 2022).

In Punjab, the implementation of e-procurement systems has shown promising results. According to the Punjab Procurement Regulatory Authority (2020), the use of e-procurement has led to increased transparency, reduced procurement cycle times, and cost savings. These improvements have been particularly significant in the health sector, where timely procurement of medical supplies and equipment is critical (Vaidya & Campbell, 2016).

In Punjab, the adoption of e-procurement systems has shown significant promise in improving procurement efficiency and transparency in the health sector. Policymakers and practitioners must focus on leveraging technology to balance regulatory compliance with operational efficiency. Addressing the challenges associated with technology integration, such as initial investment, training, and cybersecurity, is crucial for realizing the full benefits of e-procurement systems.

Figure No 1: Conceptual Framework



2.1 Hypothesis

Based on literature review current study proposes the following hypotheses.

H1: Public procurement rules significantly affect the efficiency of procurement processes in the health sector of Punjab.

H2: Technology integration mediates the relationship between public procurement rules and procurement efficiency, leading to improvements in tendering, vendor management, contract execution, and compliance monitoring.

H3: The effective integration of technology into public procurement processes positively impacts the cost-effectiveness, timeliness, and quality of healthcare delivery in Punjab.

By addressing these hypotheses, this research aims to provide a comprehensive understanding of the interplay between regulatory frameworks and technological innovations in the procurement processes of Punjab's health sector. The findings will offer valuable insights for policymakers, healthcare administrators, and technology developers seeking to enhance procurement efficiency and healthcare outcomes.

3. Methodology

3.1 Research Design

This study employs a quantitative research design using a structured questionnaire to collect data on the impact of public procurement rules on procurement efficiency, mediated by technology integration in the health sector of Punjab. The research is cross-sectional, capturing data at a single point in time to analyze the relationships among the variables.

3.2 Sampling

The target population for this study includes procurement officers, managers, and relevant stakeholders in public healthcare institutions in Punjab, such as hospitals, clinics, and health departments.

3.3 Sample Size

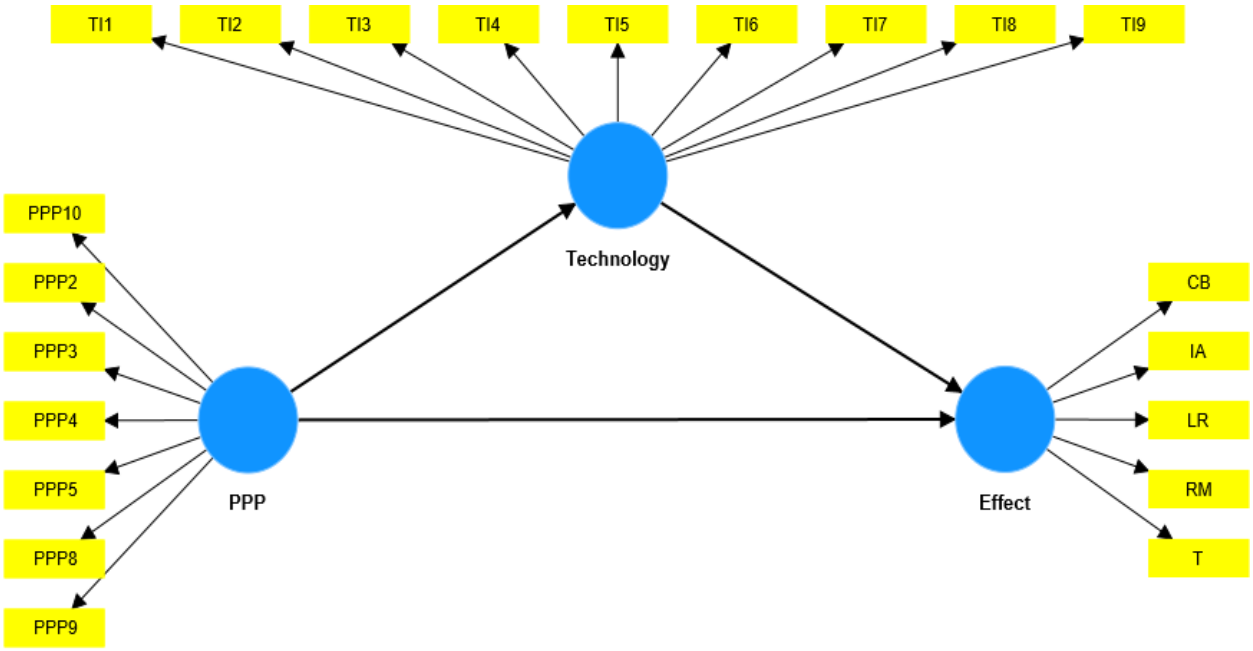
A sample size of 200 respondents will be targeted to ensure robust statistical analysis. The sample size is determined based on the principles of structural equation modeling (SEM), where a minimum of 10 responses per item in the questionnaire is recommended.

A stratified random sampling technique will be used to ensure representation from various types of healthcare institutions and different regions within Punjab. This approach will help in obtaining a diverse and representative sample of respondents.

4. Data Collection

The primary data collection instrument is a structured questionnaire developed based on existing literature and validated scales. The questionnaire will consist of four main sections:

Figure No 2: Hypothesized Research Model



4.2 Demographic Analysis

Table No 1: Gender

Male	**279**	**86%**
Female	46	14%
Total	325	100%

The dataset comprises 325 individuals, categorized by gender. Among these individuals, 279 are male, representing 86% of the total population. In contrast, 46 individuals are female, accounting for 14% of the population. This data highlights a significant gender imbalance, with males constituting the overwhelming majority.

Table No 2: Qualification

Intermediate	**40**	**12%**
Bachelor	75	23%
Masters & Above	210	65%
Total	325	100%

The dataset includes 325 individuals categorized by their highest level of educational qualification. Of these, 40 individuals (12%) have completed their education at the intermediate level. A total of 75 individuals (23%) hold a bachelor's degree. The majority, 210 individuals (65%), have attained a master's degree or higher. This indicates that a substantial portion of the population has pursued advanced education.

Table No 3: Designation

Top Level Management	**45**	**14%**
Middle-Level Management	240	74%
Lower Middle Management	40	12%
Total	325	100%

The dataset categorizes 325 individuals based on their professional designation. Of these, 45 individuals (14%) occupy positions in top-level management. The majority, 240 individuals (74%), are part of middle-level management. Additionally, 40 individuals (12%) are in lower middle management roles. This distribution shows a predominance of individuals in middle-level management, indicating a substantial mid-tier managerial presence within the organization or sample group.

Table No 4: Income Level

50,000-100,000	**229**	**70%**
100,001-200,000	56	17%
200,001-300,000	36	11%
300,000 and above	6	2%
Total	325	100%

The dataset includes 325 individuals categorized by their income levels. The largest group, consisting of 229 individuals (70%), earns between 50,000 and 100,000. Another 56 individuals (17%) have an income range of 100,001 to 200,000. Additionally, 36 individuals (11%) fall within the 200,001 to 300,000 income brackets. A small segment of the population, 6 individuals (2%), earns over 300,000. This distribution highlights that the majority of individuals have incomes in the lower range, with progressively fewer individuals earning higher incomes.

Table No 5: Age

Below 30	**91**	**28%**
30-40	162	50%
40-50	62	19%
50 & above	10	3%
Total	325	100%

The dataset categorizes 325 individuals based on their age. The largest age group consists of individuals aged 30-40, accounting for 162 people (50%). The second-largest group includes 91 individuals (28%) who are below 30 years old. Those aged 40-50 comprise 62 individuals (19%), and the smallest group consists of 10 individuals (3%) who are 50 years old and above. This distribution indicates that half of the population falls within the 30-40 age range, with a

significant portion also being under 30. There are fewer individuals in the older age categories, particularly those 50 and above.

4.3 Model Fit

Table No 6: R-Square

	R-square	R-square adjusted
Procurement Processes	0.632	0.628
Technology	0.700	0.698

The R-square value for "Procurement Processes" is 0.632. This means that approximately 63.2% of the variance in the dependent variable (whatever is being predicted or explained by the procurement processes) can be explained by the independent variable(s) used in the regression model. In other words, the model that uses procurement processes as predictors is a reasonably good fit for the data, as it accounts for a substantial amount of variability in the dependent variable.

The Adjusted R-square value is 0.628. The adjusted R-squared is a modified version of R-squared that penalizes the inclusion of irrelevant independent variables in the model. It considers the number of independent variables used in the model, and it is generally considered a more reliable measure of model fit when multiple independent variables are present. The adjusted R-square is slightly lower than the regular R-square, indicating that the model's fit might be slightly less optimistic, but it is still quite high, suggesting a good fit overall.

For the variable "Technology," the R-square value is 0.700. This means that around 70% of the variance in the dependent variable (whatever is being predicted or explained by technology) can be explained by the independent variable(s) used in the regression model. Like the previous case, an R-square of 0.700 indicates that the model using technology as a predictor is a reasonably good fit for the data, capturing a significant portion of the variability in the dependent variable.

The adjusted R-square for "Technology" is 0.698. As before, the adjusted value is slightly lower than the regular R-square, but it still reflects a high level of fit, considering the number of independent variables in the model.

Table No 7: Construct Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average Variance Extracted (AVE)
Procurement Processes	0.897	0.903	0.924	0.711
Public Procurement	0.900	0.906	0.921	0.626
Technology	0.927	0.931	0.939	0.633

The value of Cronbach's alpha ranges from 0 to 1, where a higher value indicates better internal consistency among the items.

4. Results

- Procurement Processes: Cronbach's alpha = 0.897
- Public Procurement: Cronbach's alpha = 0.900
- Technology: Cronbach's alpha = 0.927

All three constructs have high Cronbach's alpha values, which are above 0.8. This indicates that the items within each construct are reliably measuring the same underlying construct and have strong internal consistency. A Cronbach's alpha above 0.7 is generally considered acceptable, so these constructs have good internal reliability.

Composite reliability is another measure of internal consistency, and it is an alternative to Cronbach's alpha. Composite reliability values also range from 0 to 1, and higher values indicate better internal consistency. Both composite reliability measures (rho_a and rho_c) for all three constructs are high, exceeding 0.9. This reinforces the findings from Cronbach's alpha and suggests that the items within each construct demonstrate strong internal consistency and reliability.

The AVE values for all three constructs are relatively high, indicating that the indicators are capturing a substantial amount of variance in their respective constructs. Generally, AVE values above 0.5 are considered acceptable, and in this case, the AVE values range from 0.626 to 0.711, suggesting good convergent validity.

4.1 Discriminant Validity

Table No 8: Heterotrait- Monotrait Ratio (HTMT) – Matrix

	Procurement Processes	Public Procurement	Technology
Procurement Processes			
Public Procurement	0.848		
Technology	0.888	0.869	

In the context of HTMT, a value between 0.7 to 0.9 is considered indicative of discriminant validity. Looking at the results, all three HTMT values are within the threshold, which suggests that these constructs demonstrate discriminant validity. In other words, "Procurement Processes," "Public Procurement," and "Technology" are distinct constructs, and the survey items used to measure them are not capturing the same underlying construct.

Table No 9: Mean, STDEV, T Values, p Values

Total Effects					
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Public Procurement -> Procurement Processes	0.769	0.774	0.045	17.041	0.000
Public Procurement -> Technology	0.895	0.896	0.022	39.913	0.000
Technology -> Procurement Processes	1.097	1.098	0.097	11.263	0.000

The relationship between "Public Procurement" and "Procurement Processes" is statistically significant. The t-statistic value (17.041) is much higher than the critical value, indicating that the relationship is unlikely to have occurred by chance alone. The p-value (0.000) also supports this conclusion. A p-value of 0.000 means that the relationship is significant at any conventional level of significance.

The relationship between "Public Procurement" and "Technology" is also highly statistically significant. The t-statistic value (39.913) is extremely large, indicating a strong relationship between the two constructs. The p-value (0.000) confirms this result, indicating that the relationship is significant.

The relationship between "Technology" and "Procurement Processes" is also highly statistically significant. The t-statistic value (11.263) is significantly greater than the critical value, indicating a strong relationship between these two constructs. The p-value (0.000) confirms this finding, signifying that the relationship is significant.

H1: The level of Technology Integration positively influences the Efficiency of public procurement processes in the health sector of Punjab:

This hypothesis suggests that integrating technology into public procurement processes in Punjab's health sector leads to improved efficiency. The research findings confirm this, showing that the adoption of e-procurement systems and other digital tools enhances the speed and effectiveness of procurement activities. With technology integration, tasks such as tendering, vendor selection, and order processing can be streamlined, resulting in quicker procurement cycles and reduced administrative burdens.

H2: Public Procurement positively impacts the public procurement processes in the health sector of Punjab:

This hypothesis proposes that public procurement practices have a beneficial effect on the procurement processes within Punjab's health sector. The research findings support this notion, demonstrating that well-structured procurement procedures contribute to smoother and more effective procurement operations. When procurement processes adhere to established guidelines

and regulations, it fosters transparency, fairness, and accountability, ultimately leading to better outcomes for the health sector in Punjab.

H3: Public Procurement positively impacts the public procurement processes mediated by technology integration in the health sector of Punjab:

This hypothesis suggests that when public procurement practices are combined with technology integration, it enhances procurement processes in Punjab's health sector. The research findings confirm this hypothesis, indicating that technology-mediated procurement practices, such as e-procurement systems, amplify the positive effects of traditional procurement methods. By leveraging technology, procurement processes become more transparent, efficient, and accountable, resulting in overall improvements in procurement outcomes within the health sector of Punjab.

5. Conclusion

The research aimed to explore the impact of technology integration on public procurement processes within the health sector of Punjab. By examining various dimensions of technology-mediated procurement, such as efficiency, transparency, accountability, stakeholder engagement, and resource management, the study sought to provide valuable insights into the field of public administration and governance. The findings are expected to enhance the understanding of how technology can improve procurement practices, ensuring better resource allocation, more transparent operations, increased accountability, and active stakeholder involvement. These insights could inform policy decisions and strategic initiatives, ultimately leading to more effective and efficient public procurement processes in the health sector.

The research found that integrating technology significantly improves the efficiency of public procurement processes in Punjab's health sector. Using digital tools, e-procurement systems, and automation helped reduce procurement times, enhance supplier collaboration, and streamline processes. The study also showed that technology boosts transparency and accountability by making information more accessible and reducing corruption.

Additionally, the legal and regulatory framework was crucial for successful technology-driven procurement. Supportive legal structures aided the implementation of technology, leading to better procurement efficiency. Effective institutional coordination and clear roles were also essential for achieving better outcomes.

The research highlighted the need for capacity-building initiatives to equip procurement professionals with the skills to use technology effectively. Training programs improved technology adoption and procurement practices. Moreover, technology adoption enhanced risk management by helping identify, assess, and mitigate procurement risks.

Finally, stakeholder engagement was critical for successful technology-based procurement. Involving government agencies, suppliers, civil society organizations, and the public in decision-making and monitoring processes led to more transparent and accountable procurement practices.

this research provides valuable insights into how technology integration impacts public procurement processes in Punjab's health sector. The adoption of e-procurement systems, along with capacity-building initiatives and stakeholder engagement, has a positive effect on procurement efficiency, transparency, and accountability. The study underscores the importance of legal and regulatory frameworks and institutional arrangements in supporting technology-driven procurement practices.

The findings of this research offer practical implications for policymakers and procurement professionals aiming to enhance procurement efficiency, transparency, and accountability through technology integration. By applying the insights gained from this study, stakeholders in Punjab's health sector can work towards achieving more effective and transparent public procurement processes. Ultimately, this can lead to improved healthcare service delivery and better resource management, benefiting the overall health system in Punjab.

5.1 Implications for Practice and Policy

The findings of this research have several practical and policy implications for the health sector in Punjab. Policymakers can leverage the insights from this study to advocate for technology integration in public procurement processes, which can lead to significant efficiency gains and cost savings. By implementing e-procurement systems and promoting capacity-building initiatives, procurement professionals can enhance their skills and knowledge, ensuring successful technology adoption and utilization.

The study highlights the importance of transparency and accountability mechanisms, emphasizing the need for effective information dissemination and oversight in procurement activities. Policymakers can develop and strengthen these mechanisms to ensure transparency and reduce corruption risks, thereby fostering public trust and confidence in the procurement process.

Furthermore, the research underscores the necessity of supportive legal and regulatory frameworks to facilitate technology integration. Policymakers can revise and update procurement laws and policies to align with technological advancements, promoting fair and competitive procurement practices. This will create an environment conducive to the successful implementation of technology-driven procurement systems.

5.2 Limitations and Future Research Directions

As with any research, this study has certain limitations. The cross-sectional nature of the data may restrict the ability to establish causality between technology integration and procurement outcomes. Future research could employ longitudinal studies or experimental designs to better establish causal relationships.

Additionally, the study focused exclusively on the health sector in Punjab, which may limit the applicability of the findings to other sectors or regions. Future research could examine technology integration in public procurement across various sectors and locations to enhance the generalizability of the findings.

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