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DIGITAL HEALTH GOVERNANCE AND SERVICE DELIVERY QUALITY IN PUBLIC HOSPITALS: THE MEDIATING ROLE OF ORGANIZATIONAL EFFICIENCY

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Abstract
Digital Health Governance (DHG) has become an important tool in enhancing service quality in public health systems, especially in developing countries like Pakistan, where resources are limited. The aim of this study was to investigate the effect of DHG on Service Delivery Quality (SDQ) in public hospitals of Pakistan with Organizational Efficiency (OE) as a mediator and Administrative Leadership Competence (ALC) as a moderator. A structured questionnaire was used to collect the data from healthcare professionals in all three provinces of Punjab, Sindh, and Khyber Pakhtunkhwa, and was analyzed by using the Partial Least Squares Structural Equation Modeling (PLS-SEM 4.0) with bootstrapping of 5,000 resamples. Results show that DHG has a significant and positive effect on SDQ (beta = 0.31, $p < 0.001$), and that DHG has a substantial effect on OE ($R2 = 0.42$), and that the relationship between DHG and SDQ is partially mediated by OE. This pathway is greatly enhanced by Administrative Leadership Competence. The study brings together governance, efficiency, and leadership in a single explanatory framework and provides useful policy and management advice for those who wish to institutionalize digital health reforms and enhance service outcomes in resource-constrained public hospital environments.

1. Introduction

1.1 Background

The healthcare system in Pakistan is a combination of public and private providers, with public hospitals being the primary providers for the majority of the population (Khan et al., 2023). National health facilities are often overcrowded, underfunded, and technologically outdated, leading to significant disparities between the need and supply for quality health care (Hafeez et al., 2023). In this context, Digital Health Governance is a relatively new but important institutional change. DHG is a set of policies, institutional arrangements, regulatory frameworks, and technologies that shape the adoption, supervision, and accountability of a digital health system in an organization (Engvall & Flak, 2022).

In order to eliminate administrative delays and enhance coordination among departments in public hospitals, Electronic Medical Records, Hospital Management Information Systems, and Telemedicine platforms are being introduced in Pakistani public hospitals (Bilal et al., 2022). But the introduction of technology is not enough to achieve better results; digital tools must be integrated into effective organizational processes and backed by competent administrative leadership to be able to show measurable improvements in the quality of services (Brommeyer et al., 2024). The study sees

Organizational Efficiency as the pathway through which governance reforms are translated into improved patient outcomes, and Administrative Leadership Competence as a contextual factor that influences the strength of this pathway (Laukka et al., 2022).

1.2 Problem Statement

Although investments have been made in digital health infrastructure, its implementation in public hospitals in Pakistan is still fast, uneven, and disproportionate (Malik et al., 2021). There is a significant underutilization of existing systems, such as telemedicine rooms that remain unused and Hospital Management Information Systems that are only partially adopted into the working flow. The gap is often due to non-standardized governance policies, inadequate human resources capacity, and the lack of administrative leadership in digital health planning and implementation (Mahmood et al., 2023). Previous studies have focused on governance, efficiency, and leadership as discrete factors affecting healthcare performance, rather than as a system. Therefore, there is still limited empirical evidence explaining how governance reforms are translated into improved quality of service delivery, and under which leadership conditions this translation is best (Mumtaz et al., 2023). This is because this study aims to examine the integrated mediation-moderation approach in the context of a public hospital in Pakistan.

1.3 Research Objectives

This study pursues the following objectives:

- To test the direct impact of Digital Health Governance on Service Delivery Quality in public hospitals.
- To examine whether Organizational Efficiency mediates the relationship between Digital Health Governance and Service Delivery Quality.
- To investigate whether Administrative Leadership Competence moderates the strength of the governance-efficiency-quality pathway.

1.4 Research Questions

The study is guided by the following research questions:

- Does Digital Health Governance significantly affect Service Delivery Quality in Pakistani public hospitals?
- Does Organizational Efficiency mediate the relationship between Digital Health Governance and Service Delivery Quality?
- Does Administrative Leadership Competence moderate the relationship between Digital Health Governance, Organizational Efficiency, and Service Delivery Quality?

1.5 Significance of the Study

The study makes three contributions. In theory, it brings together governance, efficiency, and leadership constructs into one explanatory model, bridging the gap in the previous literature that studied these variables individually. In practice, it provides hospital leaders and ministry of health officials with evidence-based advice on the best sequence of governance reform, workflow redesign, and leadership development for the greatest return on digital health investment. In context, it addresses the lack of empirical studies on digital health governance in Pakistan and delivers findings that are directly relevant to the policy makers working in health systems in developing countries with similar resource constraints.

2. Literature Review

In the literature, Digital Health Governance is defined as the interplay between institutional policies, regulatory frameworks, and technological systems that shape the uptake, monitoring, and maintenance of digital health tools in healthcare settings (Engvall & Flak, 2022; Ghaffari Heshajin et al., 2024). In this context, governance is not just about the introduction of technology, but also about data privacy protection, interoperability protocols, and transparency around institutional responsibility. The lack of a unified governance structure has long been cited as a risk to the unproductive use of digital health investments,

their departmental siloing, and inconsistent data management practices (Milakovich, 2021).

In Pakistan, in particular, digital health governance is defined as an uneven and emergent institutional transition. In major cities, the implementation of Electronic Medical Records (EMR) and Hospital Management Information Systems (HMIS) has started in public hospitals, but the studies show that there are still several challenges in their implementation, such as the lack of regulation standardization, the lack of human resource capacity, and the lack of coordination between the federal and provincial health departments (Malik et al., 2021; Naeem et al., 2022). Similarly, Mahmood et al. (2023) reported that the health data ecosystem of Pakistan is characterized by multiple ownership and a lack of uniformity in data governance procedures, which impacts the trustworthiness of digital systems in decision-making. Overall, these results indicate that DHG in Pakistan is still in a very nascent stage of institutional maturity when compared with the more digitally mature health systems.

In health care, Organizational Efficiency is usually translated into measures like workflow optimization, resource utilization, process automation, and the elimination of administrative delays (Al-Eisawi et al., 2021; Mbau et al., 2023). A streamlined hospital can leverage digital investments more effectively into operational benefits, as the processes are more efficient and less redundant, enabling staff to devote more time to patient care and less to administrative tasks. The nexus between governance and efficiency has been increasingly studied, with evidence suggesting that effective governance structures, such as formal procedures and accountability systems, can yield tangible improvements in public sector efficiency (Ali et al., 2021; Chen & Ye, 2024).

Organizational Efficiency is theorized to be related to Digital Health Governance via the mechanism of less friction in information flow. For example, EHRs are demonstrated to significantly reduce referral delays and duplicate testing by consolidating patient data across departments (Gatiti et al., 2021). Likewise, the cybersecurity and governance features incorporated into digital systems have been shown to enhance the efficiency of the institutions, as they decrease the likelihood of data breaches and rework caused by corrupted or inconsistent records (Abbas et al., 2022). These results confirm the theoretical hypothesis, which assumes that governance acts as an upstream factor of efficiency, not as a parallel or independent one.

Administrative Leadership Competence includes decision-making skills, communication skills, and the ability to encourage technology use among employees (Gilli et al., 2023; Laukka et al., 2022). The ability of leaders to demonstrate competence has been identified as a key driver of digital transformation on many occasions, especially when it comes to staff resistance to new systems and ensuring policy is being followed across departments. Brommeyer et al. (2024) identified that the benefits of digital health transformation are either not realized in practice or are limited to policy documents, with organizational factors such as leadership engagement playing a significant role. The theoretical position of leadership as a moderating condition was also supported by Khan et al. (2025), who found that digital leadership contributes to increased employee empowerment and engagement with technology at work in public health institutions.

The moderating effect of leadership competence is hypothesized to be mediated by enhancing the link between the governance mechanisms and the organizational outcomes. The efficiency benefits of implementing DHG are likely to be significantly greater if the administrative leaders are actively enforcing governance policies, ensuring that digital initiatives are aligned with departmental priorities, and supporting staff in the adoption process. However, if leadership and governance are lacking, the effectiveness of efficiency gains from reforms can be limited as they are not consistently implemented, and staff resistance is not addressed (Johari et al., 2022).

Timeliness, accuracy, patient satisfaction, and error reduction are common dimensions used to measure the quality of Service Delivery in public hospitals (Alumran et al., 2021; Aladwan et al., 2021). Comparative studies have identified that these are areas where public hospitals may not perform as well as private hospitals and are more

related to the lack of resources and inefficient administration than to the lack of clinical skills. This indicates that a better quality of service cannot be secured by investing in clinical improvements alone and that administrative and governance changes are needed.

In a few recent studies, the relationship between Digital Health Governance and Service Delivery Quality has been directly analyzed, with a majority reporting a positive association, though the strength of this relationship seems to be dependent on contextual and organizational factors (Khatri et al., 2025; Borges do Nascimento et al., 2023). Challenges to achieving this connection involve the lack of a consistent adoption of technology by healthcare providers, inadequate training, and increased documentation workload that balances the benefits of the technology (Mumtaz et al., 2023). All of these barriers suggest that the relationship between DHG and SDQ is not likely to be a completely direct one, providing theoretical justification for the introduction of Organizational Efficiency as a mediator.

The literature review identified three important gaps. First, most of the previous studies focus on governance, efficiency, and leadership as separate predictors and not as a unified causal chain. Second, empirical evidence specific to the public hospital sector in Pakistan is still limited, and most of the literature is based on the context of the Gulf, East Asian, or Sub-Saharan Africa, where institutional conditions vary significantly. Third, there have been only a few studies that have tested mediation and moderation in the same model to explain the mechanism and boundary conditions of the DHG-SDQ relationship. Given these gaps, this study proposes an integrated framework that illustrates the direct and indirect effects of DHG on SDQ through OE, and that the latter is further enhanced in environments of high ALC. Therefore, the study tests the following hypotheses: H1 - DHG has a significant positive effect on SDQ; H2 - DHG has a significant positive effect on OE; H3 - OE has a significant positive effect on SDQ; H4 - OE mediates the relationship between DHG and SDQ; and H5 - ALC moderates the relationship between DHG and OE/SDQ.

3. Methodology

The design of this study was mixed methods, using a qualitative semi-structured interview design to gain depth and a quantitative survey design to gain statistical rigor. The quantitative component assessed the hypothesized structural relationships between Digital Health Governance, Organizational Efficiency, Administrative Leadership Competence, and Service Delivery Quality, and the qualitative component provided a more in-depth understanding of how these relationships are lived by hospital staff in practice. The data were gathered by a structured questionnaire from the healthcare professionals of public hospitals in three provinces of Punjab, Sindh, and Khyber Pakhtunkhwa to have geographic and institutional diversity. A total of 200-300 valid responses were gathered using stratified random sampling, which included representation from administrative, clinical, and information-technology staff. The respondents' professional experience and first-hand experience of digital health systems gave them a unique opportunity to assess governance practices, efficiency outcomes, and service quality in their own hospital. To complement the quantitative results, 12 semi-structured interviews were also held with hospital administration, the IT director, physicians, nurses, pharmacists, the operations manager, and quality assurance officers.

The data were screened for missing values, outliers, and violations of normality before structural analysis. The amount of missing data was less than 2% and was dealt with by mean replacement; multivariate outliers were identified by standardized residuals and Mahalanobis distance. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used for quantitative data analysis by applying the two-stage method recommended by Hair et al. (2019) for reflective measurement models: first, the reliability and validity of the measurement model were tested, and then the hypothesized structural paths were tested. The choice of PLS-SEM was made because the model is complex with multiple

mediating and moderating relationships, there are moderate sample sizes, and bootstrapping procedures are available for robust significance testing of indirect and interaction effects.

Cronbach's Alpha and Composite Reliability were used to assess reliability, and Average Variance Extracted was used to assess convergent validity, for which values of 0.50 or greater are deemed acceptable. The discriminant validity was tested by comparing the correlations of the indicators of each construct with the latent variable to which they belong with their correlations with the other latent variables in the model, using the Fornell-Larcker criterion. The structural model was then tested using path coefficients, coefficient of determination (R-squared), effect size (f-squared), and predictive relevance (Q-squared) with bootstrapping of 5,000 resampling performed to test the statistical significance of all direct, indirect, and interaction effects. Qualitative interview transcripts were analyzed thematically using a six-step process of familiarization, coding, theme searching, review, theme definition, and reporting, which enabled both explicit and latent themes to be identified in the accounts of the participants.

4. Results

All the constructs showed good reliability and validity in the measurement model. The items measuring organizational efficiency (workflow streamlining, resource utilization, process automation, and time management) had a high internal consistency with Cronbach's Alpha of 0.87. The Cronbach's Alpha for Service Delivery Quality was also high (0.88), suggesting that the indicators of timeliness, accuracy, patient satisfaction, and error reduction were closely related in terms of reliability. Constructs were all found to be above the recommended AVE threshold of 0.50, indicating good convergent validity, and the Fornell-Larcker criterion showed good discriminant validity between all latent variables.

Table 1: Reliability and Convergent Validity of Measurement Model

Construct	Cronbach's Alpha	Composite Reliability	AVE
Digital Health Governance	0.85	0.89	0.61
Organizational Efficiency	0.87	0.91	0.64
Administrative Leadership Competence	0.84	0.88	0.60
Service Delivery Quality	0.88	0.92	0.63

The structural model assessment revealed moderate to substantial explanatory power for the Digital Health Governance model for Organizational Efficiency (R-squared = 0.42) and the combined model of Digital Health Governance and Organizational Efficiency for Service Delivery Quality (R-squared = 0.56). The hypothesis H1 was supported by the results of the bootstrapping with 5,000 resamples, which showed that Digital Health Governance has a significant positive effect on Service Delivery Quality (beta = 0.31, $p < 0.001$). DHG also had a significant positive effect on Organizational Efficiency (H2), and Organizational Efficiency in turn had a significant positive effect on Service Delivery Quality (H3).

Table 2: Direct and Interaction Effects (Bootstrapped, n = 5,000 resamples)

Path	Beta	t-value	p-value
DHG -> SDQ	0.31	6.42	< 0.001
DHG -> OE	0.65	11.08	< 0.001
OE -> SDQ	0.44	8.17	< 0.001
DHG x ALC -> OE/SDQ	0.19	3.24	0.001

To test H4, the mediation analysis was performed using bootstrapped indirect effects, and the results indicated that Organizational Efficiency had a significant mediation effect between Digital Health Governance and Service Delivery Quality. As both direct and indirect effects were statistically significant, the results suggest partial, not full mediation, which is to say, DHG also improves service quality directly, in addition to the efficiency gains it creates. The interaction between Digital Health Governance and Administrative Leadership Competence was also positive and significant, as found in the moderation analysis, which supported H5 and suggested that competent leadership enhances the pathway between Digital Health Governance and Administrative Leadership efficiency and quality.

Using the f-squared analysis, the substantive effect of Digital Health Governance on Organizational Efficiency was large (f-squared = 0.73), whereas the substantive effect of Digital Health Governance on Service Delivery Quality was medium (f-squared = 0.17), and the substantive effect of Organizational Efficiency on Service Delivery Quality was medium to large (f-squared = 0.29). The interaction term of the moderator was very small (f-squared = 0.08). The results presented below are summarized and confirm that the efficiency mediated pathway is a significant portion of the overall pathway, and that all five hypotheses were supported by the Structural Equation Modeling analysis.

Figure 1: Effect Sizes of Structural Paths

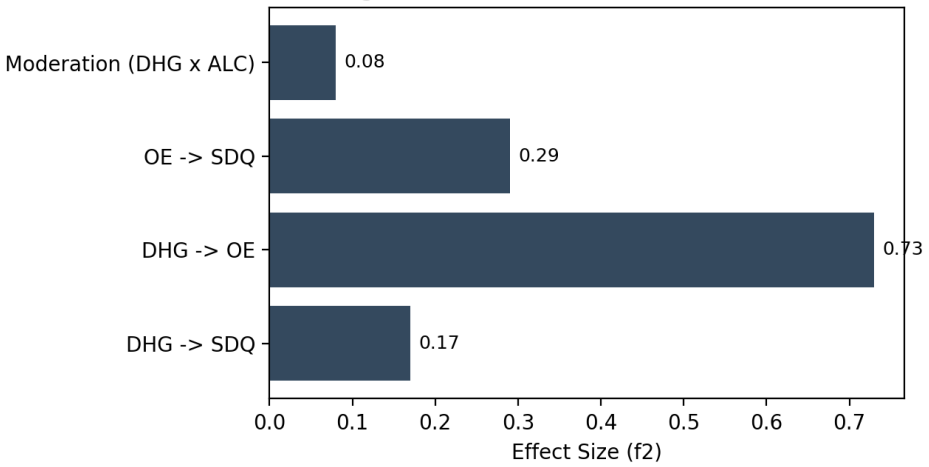


Figure 1: Effect Sizes (f2) of Structural Paths in the Model

5. Discussion

The results align with the theoretical assumption that DHG has a positive impact on SDQ in public hospitals in Pakistan, as structured governance frameworks, standardized data protocols, and clear institutional accountability are expected to directly influence the quality of patient-facing services. This finding is consistent with previous studies that found that governance mechanisms help to minimize fragmentation and enhance uniformity of service provisioning within public sector institutions (Khatri et al., 2025; Ali et al., 2021). However, the impact of this direct effect was limited, indicating that governance alone does not guarantee significant improvements in service quality without the support of complementary organizational processes.

Partial mediation of Organizational Efficiency confirms the hypothesis that governance reforms act primarily through their impact on the internal processes and resource use. Digital Health Governance was found to account for a substantial proportion of the variance in Organizational Efficiency, consistent with the results of other studies, which found that electronic records and standardized digital processes lead to reduced administrative delay and duplicate effort (Gatiti et al., 2021; Abbas et al., 2022). It means that, if

hospitals want to use governance investments for improved patient outcomes, they need to work on redesigning workflows and automating processes, as well as developing policies, not just as a regulatory process.

The administrative leadership competence plays an important moderating effect, which confirms previous studies that showed that leadership is crucial for the successful implementation of digital transformation projects (Brommeyer et al., 2024; Gilli et al., 2023). Leaders seem to overcome resistance from staff, ensure governance procedures are followed consistently, and ensure that digital activities are linked to the day-to-day running of the school. This discovery implies that leadership development should be viewed as a side-stream investment, alongside technological investments, in order to sustain digital transformations, especially in public hospitals where staff turnover and resource limitations can otherwise compromise the sustainability of digital changes.

Theoretically, this study adds an integrated model that encompasses the relationship between governance, efficiency, and leadership, which has largely been dealt with separately in the literature. On the practical side, the results suggest that digital health reform should be implemented in three phases: defining digital health governance requirements, integrating these requirements into effective operational processes, and developing the skills and competencies of the administrative leadership to ensure compliance. Long-term improvement in service quality in the public hospital sector in Pakistan will probably require ongoing monitoring of governance performance and organizational learning processes.

There are some limitations to this study. The cross-sectional design precludes causal inferences, and the sample that was geographically diverse among the three provinces may not fully reflect variation in rural and tertiary-care facilities. Longitudinal designs should be considered in future research to track the development of governance maturity over time and to explore the extent to which the mediating and moderating mechanisms found in this study apply to other health systems in the developing world that are struggling with similar resource limitations.

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