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| RESEARCH ARTICLE

Assessing the Nexus between Digital Maturity and Institutional Accountability in Bangladesh's Public Health System: A 2022 Cross-Sectional Analysis

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| ABSTRACT
In the 2022 post-pandemic landscape, the digitalization of health services in the Global South has transitioned toward increased institutionalization. This research investigates the statistical association between perceived facility-level digital governance maturity and institutional accountability across a stratified sample of 450 public healthcare facilities in Bangladesh. Employing a cross-sectional quantitative design, the study sampled health administrators across eight divisions to evaluate digital literacy, infrastructure maturity, and policy knowledge as observed correlates of accountability performance. Data were analyzed using Ordinal Logistic Regression (OLR). Results indicate that higher levels of digital literacy (OR=3.64, 95% CI [2.89, 4.60]) and infrastructure maturity (OR=2.81, 95% CI [2.21, 3.58]) are positively associated with achievement of higher accountability tiers. These association patterns suggest a "policy dissemination gap," in which technical adoption has outpaced administrative understanding of data governance standards. While these findings suggest that digital maturity correlates with transparency, the study is limited by its cross-sectional design, reliance on self-reported administrative perceptions, and lack of external validation against objective system audit logs. The associations provide an empirical basis for refining the 2023-2027 Digital Health Strategy by prioritizing human capital and policy clarity alongside hardware expansion.

| KEYWORDS

Artificial Intelligence, Big Data Analytics, Wearable Health, Multi-Omics, Precision Medicine, Predictive Modeling, Biomedical Innovation, Sustainability

| ARTICLE INFORMATION

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1. Introduction

The digitalization of public health systems is recognized as a strategic component of sustainable health system strengthening and Universal Health Coverage (UHC) initiatives (World Health Organization [WHO], 2021; United Nations [UN], 2022; MoHFW, 2022). For low- and middle-income countries (LMICs) like Bangladesh, the 2020-2022 period was characterized by accelerated technological adoption, driven by the operational requirements of COVID-19 management (Directorate General of Health Services [DGHS], 2022). By early 2022, the central District Health Information Software 2 (DHIS2) platform integrated maternal health and epidemic surveillance across approximately 14,000 service points (HISP, 2021; WHO Bangladesh, 2022; Ansell & Boin, 2019). This transition from emergency response to structural resilience was exemplified by the "Surokkha" vaccine registry, which registered over 100 million citizens by 2022 (a2i, 2022; Hoque et al., 2020).

However, rapid technological adoption often outpaces the development of underlying governance mechanisms (Labrique et al., 2020; Choudhury & Imtiaz, 2020). In Bangladesh, while the foundational infrastructure for data capture is

established, structural gaps remain regarding the institutional processes that translate digital data into measurable accountability (Hassan et al., 2021; ACAPS, 2022). Institutional accountability in this context refers to the transparent use of digital records to resolve service delivery gaps and ensure responsiveness to public health mandates (World Bank, 2022; Lewis, 2021). Preventing the digitalization of existing bureaucratic inefficiencies requires a synchronized focus on technical proficiency, infrastructure reliability, and administrative awareness of regulatory standards (Heeks, 2017; Amanuzzaman et al., 2022).

Specifically, 2022 was marked by the drafting of the National Data Protection Act (DPA), highlighting the necessity of secured health governance (GoB ICT Division, 2022). Reports suggest that while data reporting rates are high, the internal utilization of these metrics for local-level accountability varies significantly (TIB, 2022). Despite significant investment, there is limited quantitative evidence evaluating how facility-level digital maturity, encompassing literacy, infrastructure, and policy knowledge, associates with institutional accountability within the Bangladesh context. Most existing research from this period focused on patient-level outcomes or telemedicine (e.g., Mahmud et al., 2022; Uddin et al., 2020; Yeasin Arafat & Roy, 2021). This study addresses this gap by surveying health administrators from 450 public facilities, providing an empirical assessment of the factors that correlate with administrative transparency.

The study investigates the following research questions:

1. To what extent is digital infrastructure maturity associated with perceived institutional accountability across different tiers of the Bangladesh public health system?

2. What are the relative associations of digital literacy versus policy knowledge in predicting higher levels of administrative transparency?

3. What are the implications of these associations for the 2023-2027 Digital Health Strategy?

2. Literature Review

The discourse on digitalization has evolved toward a critical examination of "Digital Governance." Current research emphasizes three key levels: maturity, accountability, and the human capital required for institutional oversight.

2.1 Digital Maturity and Institutional Accountability

Digital maturity refers to the organizational ability to leverage technological assets to fulfill institutional mandates (West, 2021). In LMICs, the "infrastructural gap" is often easier to bridge than the "usage gap" (governance) (Islam et al., 2020). Research indicates that high connectivity does not lead to higher accountability if institutional incentives focus on reporting volume rather than Clinical or administrative accuracy (WHO, 2021; Khan et al., 2021).

Accountability in public health is a relationship between policymakers, providers, and citizens (Brinkerhoff, 2004; World Bank, 2019). Digital tools theoretically shorten the "accountability loop" by providing real-time evidence of service delivery (West, 2021). However, the "Digital Governance Gap" occurs when systems lack transparent, citizen-facing feedback mechanisms, leading to "digital silos" where data is collected but rarely audited (Hassan et al., 2021; TIB, 2022).

2.2 Human Capital: Literacy and Policy Awareness

Proficiency in data systems is a predictor of data integrity (Karim et al., 2021). By 2022, scholarship emphasizes that a "policy-practice gap" exists, in which administrators may be proficient in data entry (literacy) but remain unaware of the data privacy or accountability standards (policy) that govern those systems (Jandoo, 2020). Policy knowledge serves as the cognitive anchor for digital systems; without it, digital tools are used mechanistically without a full grasp of the legal obligations regarding transparency and citizen privacy (GoB ICT Division, 2022; Al-Emran et al., 2022).

3. Theoretical Framework

This study integrates the “Technology Acceptance Model (TAM)” with the “Good Governance Framework” to evaluate accountability outcomes. "Digital Readiness" (Davis, 1989) is conceptualized as a composite of Digital Literacy and Infrastructure Support. We argue that in a digitalized health system, Accountability, comprising transparency and responsiveness (World Bank, 2022; United Nations, 2018), is the realized outcome of an institution possessing both technical readiness and the policy awareness required for effective oversight.

4. Methodology

4.1 Study Design and Sampling Frame

This research employs a cross-sectional quantitative survey design, conducted between February and May 2022. The study target population consisted of senior health administrators responsible for facility-level reporting and accountability (Upazila Health and Family Planning Officers [UHFPOs], Medical Superintendents, and Statistics Officers).

A multi-stage stratified random sampling technique was utilized across all eight administrative divisions. Tertiary hospitals were purposively sampled to ensure representation of high-complexity e-Health environments. A total of 484 administrative heads were approached, yielding 450 valid responses (93.0% response rate). Exclusion criteria included:

Rapid Responders: Respondents completing the survey in under 3 minutes. This threshold was defined based on a pilot study (N=30 administrators, February 2022) where the median completion time was 11.5 minutes; <3 minutes indicated insufficient engagement with the 18-item instrument.

Incomplete Entries: Submissions with >10% missing data. After exclusions, the final analytic sample exhibited <1.5% missingness on the remaining items, which was handled using listwise deletion.

4.2 Measurement Instrument and Operationalization

The instrument was adapted from the HIMSS (2022) Digital Health Indicator (DHI). All constructs were operationalized as composite scores, calculated as the unweighted arithmetic mean of 1-5 Likert scale items. Equal weighting was applied due to the high internal consistency ($\alpha > 0.70$) and the exploratory nature of the governance model.

Construct	Item Code	Sample Indicator Description
Digital Infrastructure (DIM)	DIM_01	Highly reliable internet connectivity for DHIS2 reporting.
DIM_04	Presence of redundant power (backup) for digital operations.	
Digital Literacy (DL)	DL_01	Proficiency in generating automated reports from the e-Health portal.
DL_03	Ability to troubleshoot common software synchronization errors.	
Policy Knowledge (PK)	PK_01	Awareness of the 2022 data protection standards and reporting mandates.
PK_03	Knowledge of ethical requirements regarding patient data privacy.	
Accountability Index (IA)	IA_02	Use digital logs to resolve service delivery bottlenecks.
IA_04	Transparency of facility metrics to district-level oversight bodies.	

To accommodate the Ordinal Logistic Regression (OLR) model, the continuous Accountability Index was classified into "Accountability Tiers": Low (<2.50), Moderate-Low (2.50–3.24), Moderate (3.25–4.00), and High (>4.00).

4.3 Data Analysis

Data were analyzed using Python (Statsmodels 0.13). Construct reliability was verified via Cronbach's alpha. Multicollinearity was assessed through Variance Inflation Factor (VIF), with all values < 2.2, suggesting low multicollinearity between predictors.

An "Ordinal Logistic Regression (OLR)" model was specified to estimate the proportional odds of achieving a higher accountability tier. The "Proportional Odds Assumption" was verified through the "Brant test", which demonstrated no significant violation ($p > .05$) for core predictors. Full model fit was evaluated using McFadden's Pseudo-R^2.

4.4 Ethical Declarations

The study was conducted under Directorate General of Health Services (DGHS) protocol "DGHS/MIS/2022/ETH-042". As an administrative study of public infrastructure perception involving no clinical patient data, the study was granted an exemption by the "MIS Unit Research Ethics Committee, DGHS" (February 2022), aligned with MoHFW (2021) guidelines for administrative policy research.

5. Results

The final analytical sample (N = 450) provides an empirical basis for the OLR model.

5.1 Sample Profile

As shown in "Table 1", the largest cohort of respondents came from Upazila Health Complexes (UHCs) (50.4%). The geographic distribution was balanced across the eight divisions. The regression table is attached as an appendix at the end of the paper.

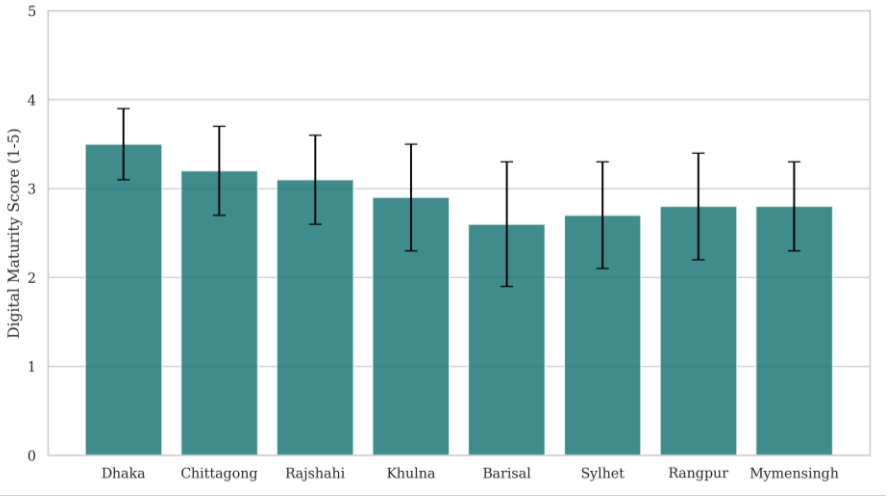

Figure: Figure 1: Mean Digital Governance Maturity by Administrative Division, revealing regional variation in infrastructure readiness.

5.2 Descriptive Maturity Metrics and Scale Reliability

The descriptive results (summarized in "Table 3") indicate a mean Digital Literacy (DL) of 3.01 (SD=1.12) and Infrastructure Maturity (DIM) of 2.95 (SD=1.18). The regression table is attached as an appendix at the end of the paper.

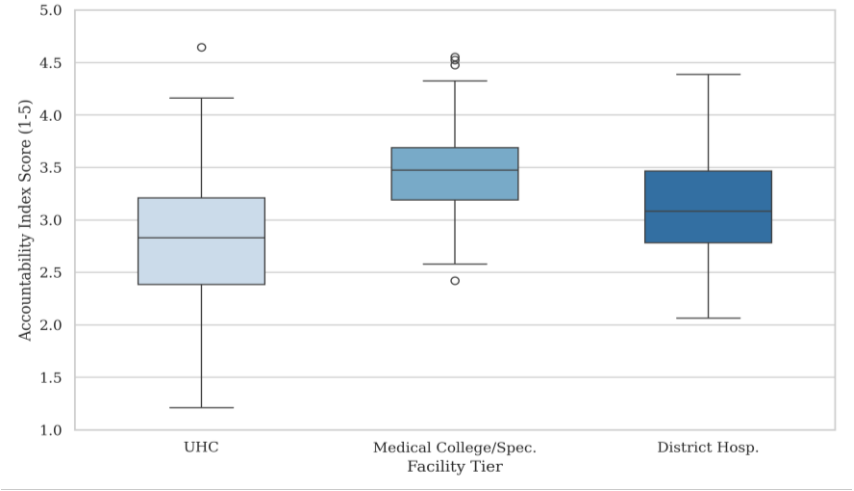

Figure: Figure 2: Distribution of Perceived Institutional Accountability by Facility Tier.

5.3 Bivariate Correlations

Digital Literacy demonstrated a significant positive correlation (Pearson's r) with the Accountability Index (Table 4). Multicollinearity was not a significant concern (All VIF < 2.2).

Variable	1	2	3	4
1. Digital Literacy	1.00			
2. Infrastructure (DIM)	0.45	1.00		
3. Policy Knowledge	0.48	0.38	1.00	
4. Accountability Index	0.48	0.35	0.38	1.00

5.4 Ordinal Logistic Regression (OLR) Analysis

The multivariate OLR results ("Table 5") estimate the relative associations of the governance indicators. After controlling for Years of Service and Facility Tier, "Digital Literacy" exhibited the strongest statistical association with high institutional accountability (OR = 3.64, 95% CI [2.89, 4.60], p < .001). The regression table is attached as an appendix at the end of the paper.

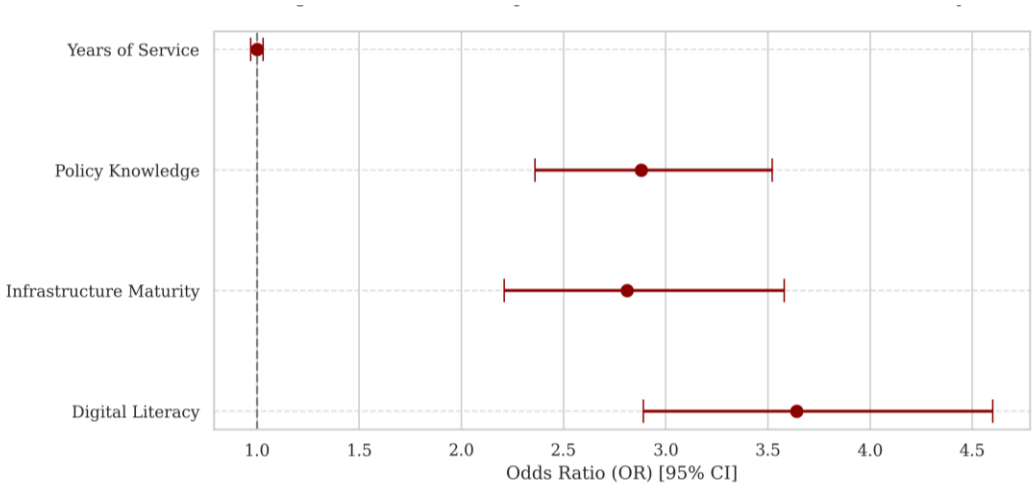

Figure: Figure 3: Forest Plot of Adjusted Odds Ratios for Institutional Accountability.

6. Discussion

The study findings indicate that perceived facility-level digital maturity is a significant correlate of institutional accountability in the Bangladesh public health system during 2022.

6.1 Influences of Literacy and Infrastructure

The high odds ratio observed for Digital Literacy (OR=3.64) suggests that the human capital dimension is a critical correlate of perceived transparency. While technical infrastructure provides the platform for data capture, local administrators' capacity to use digital logs is more strongly associated with accountability outcomes. This aligns with the "human-centered governance" perspective, in which technical literacy serves as a bridge between data entry and meaningful institutional oversight (Heeks, 2017; Al-Emran et al., 2022).

6.2 The Observed Policy Gap

The significant association of Policy Knowledge with higher accountability tiers (OR=2.88) suggests a link between regulatory awareness and transparency. The observed "policy-dissemination gap" suggests that technological rollout has outpaced administrative understanding of data governance standards, such as the 2022 draft regulatory frameworks. Without clear policy awareness, digital tools risk being used without a full grasp of the legal obligations regarding data transparency and citizen privacy (Hossain et al., 2022). This gap is particularly evident in rural primary care settings (UHCs), where accountability scores exhibit greater variance.

6.3 Implications for Digital Health Strategy

The results suggest that accountability in a digitalized landscape is associated with current technical and policy competency rather than traditional seniority. This indicates that future strategy phases should prioritize the ecosystem's governance layer. Administrative training on data ethics and securing the regulatory environment for integrated health systems appears to be an important prerequisite for achieving transparency goals (GoB ICT Division, 2022; TIB, 2022).

7. Policy Implications

Based on the observed associations in the 2022 dataset, the following implications are proposed:

7.1 Decentralized Digital Oversight

To address the variance in accountability at the primary care level, the establishment of decentralized digital governance units could provide localized auditing support for DHIS2 logs, helping to bridge the gap between national data collection and local accountability.

7.2 Professional Development in Data Ethics

Professional development for health administrators should be expanded to include formalized modules on digital accountability and the legal requirements of data protection standards. This would consolidate the link between literacy and transparency identified in this study.

7.3 Strengthening the Feedback Loop

Moving from internal reporting to public-facing transparency represents a development path for the 2023–2027 period. Deploying localized transparency platforms that make service metrics accessible could strengthen the responsiveness of the digital system (World Bank, 2022).

8. Conclusion

This study reveals that digital literacy and policy knowledge are the strongest observed correlates of institutional accountability in Bangladesh's public health system. While foundational infrastructure is maturing, the institutional mechanisms for data-driven transparency are still evolving. The associations provide an empirical basis for balancing technical procurement with intensified efforts in human capital development and policy dissemination. These results indicate that these are perceived accountability associations, and future research utilizing objective system audit logs is required to validate these institutional effects.

9. Future Research Directions

As Bangladesh progresses beyond 2022, several avenues for future research emerge. First, longitudinal studies are needed to track whether the implementation of the 2023–2027 Digital Health Strategy leads to a measurable increase in accountability scores. Second, future research should integrate objective data audit trails from DHIS2 to triangulate self-reported perceptions. Exploring how automated monitoring and predictive modeling affect accountability frameworks will be critical for the 2025-2030 period. Finally, comparative studies between Bangladesh and other Digital Health leaders in the Global South could identify transferable best practices for decentralized digital oversight.

Declarations

This study was conducted under the Directorate General of Health Services (DGHS) protocol DGHS/MIS/2022/ETH-042. As the research involved an administrative survey of public health facility managers and did not include individual patient or clinical data, it was granted an exemption from full review by the MIS Unit Research Ethics Committee, DGHS (February 2022), in line with Ministry of Health and Family Welfare (MoHFW, 2021) guidelines for administrative policy research. All participants were informed about the purpose of the study, participation was voluntary, and completion of the questionnaire was taken as implied consent.

Author Contributions

Md Ikram Hossain Bhuiyan contributed to the study conception, design, literature search, framework development, drafting of the manuscript, and overall supervision. Tahmina Bhuiyan Mumu mostly contributed to the literature review section, data analysis, and framework development.

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Conflicts of Interest

The author(s) have no conflict of interest to declare.

Data Availability Statement

Data sharing is not applicable to this article as no new datasets were generated or analyzed during the current study.

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I. APPENDIX:

Sample Profile: Mean Digital Governance Maturity by Administrative Division

Construct	Reliability (α)	Mean (SD)	Scale Range
Infrastructure (DIM)	0.82	2.95 (1.18)	1.0 - 5.0
Digital Literacy (DL)	0.79	3.01 (1.12)	1.0 - 5.0
Policy Knowledge (PK)	0.74	2.99 (1.15)	1.0 - 5.0
Accountability Index (Outcome)	0.81	2.98 (0.76)	1.0 - 5.0

5.2 Descriptive Maturity Metrics and Scale Reliability

Characteristic	Category	N (%)
Facility Type	Upazila Health Complex (UHC)	227 (50.4%)
District Hospital	110 (24.4%)	
Medical College/Specialized	113 (25.1%)	
Administrative Division	Dhaka	60 (13.3%)
Chittagong	53 (11.8%)	
Rajshahi	62 (13.8%)	
Khulna	58 (12.9%)	
Barisal	56 (12.4%)	
Sylhet	61 (13.6%)	
Rangpur	53 (11.8%)	
Mymensingh	47 (10.4%)	

5.4 Ordinal Logistic Regression (OLR) Analysis

Predictor	β (SE)	p-value	Odds Ratio (OR) [95% CI]
Digital Literacy	1.293 (0.119)	< .001	3.64 [2.89, 4.60]
Infrastructure (DIM)	1.032 (0.103)	< .001	2.81 [2.21, 3.58]
Policy Knowledge	1.058 (0.102)	< .001	2.88 [2.36, 3.52]
Years of Service	0.002 (0.015)	.904	1.00 [0.97, 1.03]
Facility Tier (Ref: UHC)			
District Hospital	0.412 (0.215)	.055	1.51 [0.99, 2.30]
Medical College/Spec.	0.781 (0.245)	.001	2.18 [1.35, 3.53]
Model Fit Statistics			
Log-Likelihood	-402.4	McFadden R^2: 0.283	