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EFFECTS OF ELECTRONIC PROCUREMENT ON EFFICIENCY AND TRANSPARENCY IN HEALTH SECTOR PROJECTS: EVIDENCE FROM PRIMARY HEALTH CARE FACILITY UPGRADING IN DELTA STATE, NIGERIA

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ABSTRACT

Public procurement in developing countries has long been undermined by inefficiency, weak transparency and limited accountability, and these weaknesses are especially costly in the health sector, where procurement outcomes translate directly into the availability of medicines, equipment and functioning facilities. Electronic procurement (e-procurement) has been widely promoted as a governance response, yet empirical evidence on its influence within sector-specific, sub-national health projects in Nigeria remains limited. This study assessed the effect of e-procurement adoption on procurement efficiency and transparency in the ongoing upgrading of Primary Health Care (PHC) facilities in Delta State, Nigeria. A quantitative cross-sectional survey design was adopted. From an accessible population of 174 procurement-related personnel across six health-related Ministries, Departments and Agencies, a stratified random sample yielded 104 valid responses to a structured, five-point Likert-scale questionnaire (Cronbach's alpha 0.78-0.86). Data were analysed using descriptive statistics and Pearson Product Moment Correlation, corroborated by Spearman's rho and Kendall's tau-b, at the 0.05 significance level. E-tendering, e-bidding, e-invoicing/e-payment and e-contracting each showed a statistically significant positive relationship with procurement efficiency and transparency outcomes ($p < 0.01$), with e-invoicing/e-payment recording the strongest effect on financial governance indicators. ICT infrastructure and digital readiness correlated significantly with some components but not others, indicating that infrastructure alone does not guarantee effective implementation. The study concludes that e-procurement components meaningfully improve efficiency and transparency in health-sector project delivery, but that these gains are constrained by uneven ICT infrastructure and staff digital competence, which require complementary institutional investment.

Keywords: E-Procurement; Procurement Efficiency; Procurement Transparency; Primary Health Care; Public Sector Reform; Delta State

1 INTRODUCTION

Public procurement is a fundamental pillar of governance and public service delivery, and within the health sector it is even more consequential: the timely acquisition of medicines, diagnostic equipment and hospital infrastructure translates directly into lives saved or lost. Global public procurement spending was estimated at approximately US\$11 trillion in 2019, equivalent to roughly 12% of global Gross Domestic Product [1], and such large sums make procurement one of the public expenditure processes most exposed to inefficiency and corruption: analysis of transnational bribery-enforcement data found that more than half of all prosecuted cases involved a public procurement contract, with bribery alone estimated to raise contract costs by at least 10% and cost an estimated US\$400 billion globally each year [2].

In many low- and middle-income countries this exposure has translated into persistent structural weakness. Procurement has traditionally relied on paper-based processes and fragmented communication, producing lengthy approvals, weak audit trails and vulnerability to bid manipulation; across many such economies, roughly a quarter of firms report that they expect to make informal payments to secure a government contract [3]. Electronic procurement (e-procurement) applies information and communication technologies to automate the procurement cycle - tendering, bidding, contracting, invoicing and payment - on a centralized platform, with the intention of standardizing procedures, reducing discretion, and enabling real-time oversight [4]. Where fully institutionalized, the gains are substantial: the Republic of Korea's online procurement system processes more than 90% of public procurement transactions electronically, with marked reductions in processing time and administrative cost [5]. Adoption across Africa has nonetheless remained slower, constrained by inadequate ICT infrastructure, limited investment, weak digital skills among procurement personnel and uneven regulatory enforcement [6].

Nigeria illustrates this tension between reform and persistent practice. The Public Procurement Act of 2007 established the Bureau of Public Procurement as regulator, yet the country's Corruption Perceptions Index score remained low, at 26 out of 100 and ranked 140th of 180 countries assessed in 2024 [7], and investigations continue to document contract inflation, ghost contractors and abandoned projects that undermine public investment in health infrastructure [8]. Digital reform has become one avenue through which Nigeria has sought to close this gap: at the sub-national level, states such as Edo have piloted e-procurement platforms for capital projects [9]. The stakes of this reform are highest in the health sector, illustrated by the World Bank's US\$570 million Primary Healthcare Provision Strengthening Programme approved in 2024 to support maternal, child and adolescent health service delivery nationwide [10], and by the experience of countries such as Rwanda and Kenya, whose established e-procurement platforms allowed coordinated, transparent procurement of personal protective equipment and emergency healthcare infrastructure during the COVID-19 pandemic [11]. Delta State's ongoing upgrading and revitalization of 118 Primary Health Care (PHC) facilities across the state's 25 Local Government Areas provides a timely setting in which to examine how e-procurement is functioning where national policy intentions meet project-level implementation.

Despite these reforms, procurement in Nigeria's health sector remains one of the most corruption-prone government processes: over 60% of the corruption cases investigated by the Independent Corrupt Practices and Other Related Offences Commission at the local-government level involve diversion of funds meant for healthcare and infrastructure [12], and the health sector received only about 5% of Nigeria's total government budget in 2025 [13], leaving little room for resources to be lost to inefficiency or diversion. E-procurement has been credited elsewhere with reducing procurement costs by 15 to 20% while improving auditability and supplier competition [14], but what remains unclear is whether such gains have taken root specifically within Nigeria's health sector, where procurement is simultaneously time-sensitive and life-critical.

Existing Nigerian procurement research has concentrated on the general public sector or on non-health capital projects. Studies on e-procurement adoption in Nigeria have examined barriers in the construction and building industries [15,16,17], readiness of public institutions generally [18], and organizational performance outcomes [19], while broader assessments of e-procurement's contribution to transparency and cost efficiency in Nigeria have likewise been pitched at the level of general public administration rather than a specific, life-critical sector [20,21,22]. Where health-sector procurement has been studied internationally, the literature has tended to isolate single themes - regulatory frameworks [23], qualitative accounts of adoption barriers [24], cost savings [25], or the general transparency dividend of digital systems [26,27] - without empirically disaggregating e-procurement into its constituent components (e-tendering, e-bidding, e-invoicing/e-payment, e-contracting) to determine which components drive which outcomes, and without situating the analysis within a Nigerian sub-national health-infrastructure programme where procurement decisions are most consequential for service delivery.

This study addresses that gap by examining the influence of e-procurement - specifically e-tendering, e-bidding, e-invoicing/e-payment, e-contracting, and ICT infrastructure/digital readiness - on procurement efficiency and transparency in the implementation of Delta State's PHC upgrading and revitalization projects.

The specific objectives were to:

- examine the impact of e-tendering on procurement efficiency;
- assess how e-bidding influences procurement transparency;
- evaluate the role of e-invoicing/e-payment systems in enhancing procurement efficiency;
- assess how e-contracting influences procurement transparency; and
- investigate how ICT infrastructure and digital readiness affect the successful implementation of e-procurement in health-sector projects.

Corresponding to these objectives, five null hypotheses were tested:

- H₀₁: e-tendering has no significant effect on procurement efficiency;
- H₀₂: e-bidding has no significant influence on procurement transparency;
- H₀₃: e-invoicing does not significantly enhance procurement efficiency;
- H₀₄: e-contracting has no significant influence on procurement transparency; and
- H₀₅: ICT infrastructure has no significant effect on e-procurement implementation.

2 MATERIALS AND METHODS

2.1 Research Design

The study adopted a quantitative, cross-sectional survey design incorporating both descriptive and correlational elements, considered appropriate because the study sought to measure observable relationships between distinct variables and test statistically verifiable hypotheses.

2.2 Study Area

The research was conducted within six health-related Ministries, Departments and Agencies (MDAs) in Delta State, Nigeria, the Ministry of Health, the Ministry of Economic Planning, the State Primary Health Care Development Agency, the Office of the Accountant-General (Ministry of Finance), the State Tenders Board, and the State Public Procurement Commission - selected because they jointly represent the regulatory, planning, financial, evaluative and supervisory dimensions of health-sector procurement in the state.

Figure 1 shows the location of Delta State's twenty-five Local Government Areas, within which the study's six participating MDAs and the Primary Health Care facilities undergoing upgrading are situated.

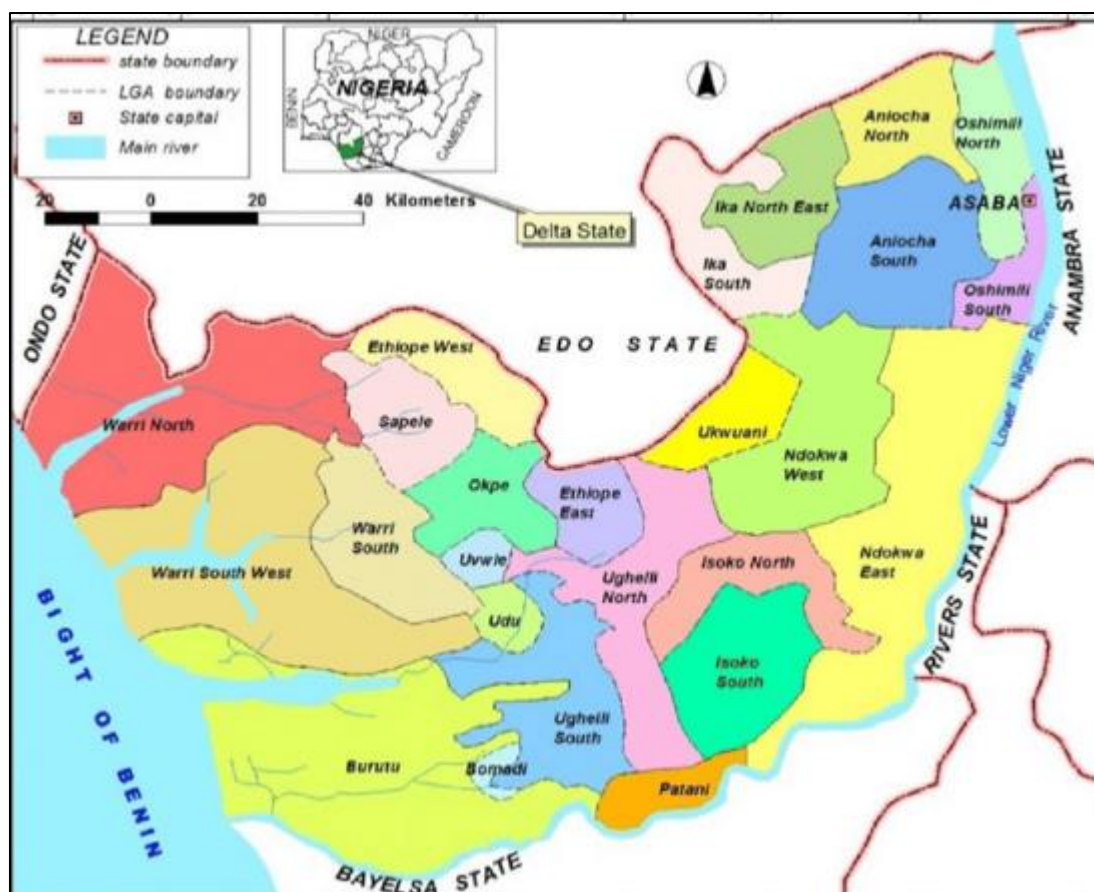


Figure 1: Map of Delta State showing the 25 Local Government Areas within which the study's participating MDAs and PHC upgrading projects are situated.

2.3 Study Population, Sample Size and Sampling Technique

The accessible population comprised 174 procurement officers, accountants, ICT personnel, project managers and senior administrative staff involved in procurement planning, contract processing, payment authorization, and monitoring and evaluation within the selected MDAs. Sample size was determined using established Taro Yamane's formula for finite populations [28] at a 5% margin of error, yielding a required sample of 121; in view of response-rate and administrative constraints, a final working sample of 100-110 was targeted, and 104 valid responses were obtained. A stratified random sampling technique ensured proportional representation across professional categories (procurement, finance, ICT, administration and project management), with simple random sampling applied within each stratum.

2.4 Data Collection

Data were collected using a structured questionnaire organized into three sections: respondent demographic and professional background; extent of adoption of e-tendering, e-bidding/e-sourcing, e-invoicing/e-payment and e-contract management; and perceived procurement outcomes (efficiency and transparency) arising from e-procurement use. Items in the latter two sections were rated on a five-point Likert scale (Strongly Agree = 5 to Strongly Disagree = 1), consistent with standard practice in quantitative social-science survey research [29]. Content and face validity were established through expert review by the researchers' supervisors and two experienced procurement and monitoring-and-evaluation practitioners, and the instrument was piloted among comparable personnel outside the main study sample. Internal consistency, assessed via Cronbach's alpha computed from pilot data, returned coefficients of 0.78-0.86 across constructs, exceeding the conventional 0.70 threshold [30,31]. The questionnaire was administered electronically via Google Forms. Participation was voluntary and informed consent was obtained from all respondents and no personally identifying information was collected. Also, completed instruments were coded numerically and analysed strictly in aggregate.

2.5 Data Analysis

Data were analysed in SPSS. Descriptive statistics (frequencies, percentages, means and standard deviations) characterized respondent demographics and the level of perceived adoption/effect of each e-procurement component, using the scale midpoint of 3.00 as the benchmark separating low from high adoption or effect. Hypotheses were tested

using Pearson Product Moment Correlation (PPMC), corroborated by Spearman's rho and Kendall's tau-b to check robustness to non-normality and outliers [30,31,29], at a 5% level of significance (H_0 rejected where $p \leq 0.05$).

3 RESULTS

Of 105 respondents approached, 104 returned valid and complete responses. Table 1 summarizes their demographic and professional profile. Female respondents outnumbered male respondents (74% versus 26%); the sample was concentrated among personnel holding an HND/BSc as highest qualification (65.4%) and aged over 40 (85.6% combined across the 41-50 and above 50 bands); Procurement Officers and Administrators together accounted for two-thirds of respondents; and the majority (56.7%) had more than 15 years of public-procurement experience, drawn predominantly (83.7%) from Primary Health Care institutions, consistent with the study's focus on PHC upgrading projects.

Table 1: Demographic and professional profile of respondents (N = 104)

Characteristic	Category	n	%
Gender	Male	27	26.0
	Female	77	74.0
Age	21-30 years	4	3.8
	31-40 years	11	10.6
	41-50 years	48	46.2
	Above 50 years	41	39.4
Educational qualification	ND/NCE	9	8.7
	HND/BSc	68	65.4
	MSc/MBA	26	25.0
	PhD	1	1.0
Designation	Procurement Officer	35	33.7
	Administrator	34	32.7
	Project Manager	18	17.3
	ICT Officer	13	12.5
	Accountant	4	3.8
Years of public-procurement experience	1-5	16	15.4
	6-10	16	15.4
	11-15	13	12.5
	Above 15	59	56.7
Organization type	Primary Health Care	87	83.7
	Ministry of Health	7	6.7
	Health Agency	6	5.8
	General Hospital	3	2.9
	Teaching Hospital	1	1.0

Table 2 presents the descriptive statistics for the five e-procurement constructs. All constructs recorded mean scores above the 3.00 acceptance benchmark, indicating general agreement that each component is present and effective, with e-tendering ($M = 4.34$) rated highest and ICT infrastructure/digital readiness ($M = 3.76$) rated comparatively lowest.

Table 2: Descriptive statistics of e-procurement constructs (N = 102-103)

Construct	Mean	SD
Impact of e-tendering on procurement efficiency	4.335	0.576
Influence of e-bidding on procurement transparency	4.222	0.593
Role of e-invoicing/e-payment in enhancing efficiency	4.288	0.528
Influence of e-contracting on procurement transparency	4.116	0.565
ICT infrastructure and digital readiness	3.759	0.671

Table 3 presents the item-level means underlying each construct. The single highest-rated item overall was e-tendering's contribution to improved documentation and record retrieval ($M = 4.44$, $SD = 0.725$), while the lowest-rated item overall was the adequacy of available ICT infrastructure ($M = 3.33$, $SD = 1.037$) - still above the acceptance benchmark, but indicative of the comparative weakness of the enabling-infrastructure dimension relative to the four procurement-process components. Within the ICT infrastructure/digital readiness construct specifically, organizational digital readiness ($M = 4.33$) and stable connectivity ($M = 4.08$) were rated well above staff digital skills ($M = 3.54$), regular ICT training ($M = 3.51$) and infrastructure adequacy ($M = 3.33$), suggesting that the perception gap lies less in awareness of digital readiness as a principle and more in its practical, on-the-ground realization.

Table 3: Item-level means and standard deviations by construct

Construct	Item	Mean	SD
E-tendering → efficiency	Improves documentation and record retrieval	4.44	0.725
	Promotes faster evaluation of supplier proposals	4.42	0.735
	Reduces time spent preparing/submitting bids	4.40	0.784
	Enhances timely completion of projects	4.28	0.763
	Reduces administrative costs	4.23	0.628
E-bidding → transparency	Improves accountability in procurement decisions	4.32	0.733
	Provides equal access to tender information	4.29	0.791
	Minimizes human interference/manipulation	4.25	0.724
	Enhances public confidence in the process	4.13	0.757
	Ensures fair competition among suppliers	4.12	0.749
E-invoicing/e-payment → efficiency	Ensures prompt, transparent fund disbursement	4.38	0.704
	Facilitates better financial tracking/audit control	4.37	0.716
	Minimizes errors and duplication	4.34	0.652
	Enhances overall project-execution efficiency	4.25	0.727
	Reduces payment-processing time	4.09	0.960
E-contracting → transparency	Provides clear record of contract terms/obligations	4.22	0.669
	Increases transparency, reduces disputes	4.20	0.614
	Reduces risk of contract manipulation	4.14	0.829
	Improves accountability among contractors	4.11	0.819
	Enhances compliance with procurement laws	3.95	0.860
ICT infrastructure/digital readiness	Success depends on organizational digital readiness	4.33	0.665
	Stable connectivity supports effective use	4.08	0.841
	Staff possess required digital skills	3.54	0.982

	Organization provides regular ICT training	3.51	1.022
	Adequate ICT infrastructure is available	3.33	1.037

Table 4 presents the Pearson Product Moment Correlation matrix among the five constructs. E-tendering, e-bidding, e-invoicing/e-payment and e-contracting were all significantly and positively inter-correlated ($p < 0.01$): e-tendering with e-invoicing/e-payment ($r = 0.626$), e-tendering with e-bidding ($r = 0.574$), e-bidding with e-contracting ($r = 0.601$), e-invoicing/e-payment with e-contracting ($r = 0.437$), and e-tendering with e-contracting ($r = 0.393$). ICT infrastructure and digital readiness correlated significantly, but more-weakly, with e-bidding ($r = 0.294$, $p < 0.01$) and e-contracting ($r = 0.205$, $p < 0.05$), but not significantly with e-tendering ($r = 0.148$, $p = .137$) or e-invoicing/e-payment ($r = 0.162$, $p = .103$). Spearman's rho and Kendall's tau-b analyses corroborated this pattern in direction and significance (e.g. Spearman's rho of 0.652 between e-tendering and e-bidding), indicating that the results are robust across parametric and non-parametric methods.

Table 4: Pearson Product Moment Correlation matrix among e-procurement constructs

Construct	1	2	3	4	5
1. E-tendering → efficiency	1				
2. E-bidding → transparency	0.574**	1			
3. E-invoicing/e-payment → efficiency	0.626**	0.563**	1		
4. E-contracting → transparency	0.393**	0.601**	0.437**	1	
5. ICT infrastructure/digital readiness	0.148	0.294**	0.162	0.205*	1

** Correlation significant at the 0.01 level (2-tailed). * Correlation significant at the 0.05 level (2-tailed).

On this basis, the null hypotheses that e-tendering, e-bidding, e-invoicing/e-payment and e-contracting each have no significant relationship with procurement efficiency or transparency (H_{01} - H_{04}) were rejected: each component showed a strong, statistically significant positive relationship with procurement outcomes ($p < 0.01$). The hypothesis concerning ICT infrastructure and digital readiness (H_{05}) was only partially rejected: infrastructure and digital readiness related significantly to some components (e-bidding, e-contracting) but not to others (e-tendering, e-invoicing/e-payment), suggesting that ICT infrastructure is a necessary but not, on its own, a sufficient determinant of effective e-procurement implementation. Table 5 summarizes the hypothesis-testing decisions.

Table 5: Summary of hypothesis-testing decisions

Hypothesis	Relationship tested	Decision
H_{01}	E-tendering – procurement efficiency	Rejected (significant, $p < 0.01$)
H_{02}	E-bidding – procurement transparency	Rejected (significant, $p < 0.01$)
H_{03}	E-invoicing/e-payment – procurement efficiency	Rejected (significant, $p < 0.01$)
H_{04}	E-contracting – procurement transparency	Rejected (significant, $p < 0.01$)
H_{05}	ICT infrastructure/digital readiness – e-procurement implementation	Partially rejected (significant for some components only)

4 DISCUSSION

The finding that e-tendering significantly enhances procurement efficiency, chiefly through improved documentation and faster bid evaluation, is consistent with Adebayo and Yusuf [32], who found that e-tendering improves documentation, enhances bid processing and reduces procurement cycle time in Nigeria's public sector, and with Adeyemi and Salami [33], who reported that electronic tendering minimizes administrative delays. The strong association between e-bidding and transparency - through improved accountability and more equal access to tender information - corroborates evidence that e-bidding systems reduce discretionary manipulation and widen supplier access to procurement information [20,34].

The particularly strong effect of e-invoicing and e-payment on efficiency indicators is consistent with evidence that electronic financial-transaction systems improve fund-disbursement speed, audit control and duplication error rates in

public procurement [35,25], and with broader digital-governance evidence that automation of financial processes enhances accountability [26]. The significant relationship between e-contracting and transparency - through clearer contract documentation and reduced disputes - aligns with the international procurement literature on digital contract management reducing manipulation risk and strengthening compliance [36,37].

The partial, uneven relationship between ICT infrastructure/digital readiness and the other e-procurement components is broadly consistent with technology-adoption theory, which holds that system use depends jointly on perceived usefulness, ease of use, and the readiness of the adopting organization and its personnel [38,39,40]. It also echoes findings that inadequate ICT infrastructure remains a major constraint on e-procurement adoption in developing-country public institutions [41], and Nigeria-specific evidence that institutional readiness for e-procurement is uneven across public agencies [18]. Taken together, the results suggest that while digitized tendering, bidding, invoicing/payment and contracting processes are already delivering measurable efficiency and transparency gains in Delta State's PHC upgrading programme, the comparatively lower and more unevenly-related scores on ICT infrastructure and digital readiness represent the binding constraint on realizing the full benefits of e-procurement reform - a pattern consistent with observations elsewhere that technological investment must be matched by sustained training and institutional capacity building to translate digital tools into procurement performance [27,19].

5 CONCLUSION

This study examined the influence of e-procurement on efficiency and transparency in the implementation of Delta State's Primary Health Care upgrading and revitalization projects. Descriptive and correlational analysis of responses from 104 procurement-related personnel across six health-related MDAs showed that e-tendering, e-bidding, e-invoicing/e-payment and e-contracting are each perceived as effective and are each significantly and positively associated with procurement efficiency and transparency outcomes, with e-invoicing/e-payment showing the strongest association with financial-governance indicators. ICT infrastructure and digital readiness, while positively regarded overall, were rated comparatively lower and related significantly to only some of the other components, indicating that infrastructure and digital capacity remain the principal constraint on translating e-procurement adoption into fuller procurement performance gains. The study contributes sector-specific, sub-national empirical evidence to a literature that has so far concentrated on Nigeria's general public sector, and supports the continued expansion and institutional strengthening of e-procurement in health-sector project delivery.

Recommendations

- Government authorities should pursue mandatory, consistent adoption of e-procurement systems across all health-sector institutions.
- Sustained investment should be directed at ICT infrastructure, including stable internet connectivity and secure digital procurement platforms.
- Regular training and capacity-development programmes should be organized to strengthen the digital skills of procurement personnel.
- E-tendering and e-bidding platforms should be continuously improved for security, usability and automation.
- E-invoicing and electronic payment systems should be more fully integrated into procurement workflows to reduce payment delays and strengthen financial accountability.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that no conflict of interests exists amongst them.

Statement of informed consent

Informed consent was obtained from every respondent prior to participation in the study.

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