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A COMPARATIVE ASSESSMENT OF MANUAL AND DIGITAL REGISTRATION SYSTEMS AND THEIR EFFECTS ON HEALTHCARE DELIVERY IN TERTIARY HOSPITALS IN KOGI STATE, NIGERIA

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ABSTRACT: *The effectiveness of patient registration systems is increasingly recognized as an important factor influencing healthcare delivery. In Nigeria, many tertiary hospitals operate both manual and digital registration systems despite limited empirical evidence on their comparative performance. This study assessed the comparative effects of manual and digital registration systems on healthcare delivery in tertiary hospitals in Kogi State, Nigeria. A facility-based cross-sectional comparative study was conducted among healthcare workers in two tertiary hospitals. A total of 452 respondents were selected using stratified random sampling. Data were collected using a structured questionnaire developed from previous literature and validated through expert review and pilot testing. Data were analysed using descriptive statistics, independent samples t-tests, and Structural Equation Modeling (SEM) in IBM SPSS AMOS. Independent samples t-tests were used to compare operational efficiency between manual and digital registration systems, while SEM was used to examine the direct and indirect effects of registration system type on healthcare delivery outcomes through perceived data quality, waiting time, service flow, and patient satisfaction. Statistical significance was set at $p < 0.05$. The results showed that 30.31% of respondents were aged 25–29 years, 67.70% were female, 57.08% held a bachelor's degree, and 23.01% had 20 years or more of professional experience. Digital registration systems recorded a significantly higher operational efficiency score (2.78 ± 0.26; 95% CI: 2.73–2.83) than manual registration systems (2.55 ± 0.42; 95% CI: 2.49–2.62) ($p < 0.001$). SEM results further showed that digital registration had significant positive effects on perceived data quality ($\beta = 0.239$, 95% CI: 0.148–0.330, $p < 0.001$) and patient satisfaction ($\beta = 0.421$, 95% CI: 0.308–0.534, $p < 0.001$). Digital registration systems were therefore associated with improved operational efficiency and better healthcare delivery outcomes compared with manual registration systems.The study concludes that strengthening digital registration infrastructure, improving workforce capacity, and providing sustained technical support are essential for maximizing the benefits of digital registration systems and enhancing healthcare delivery in tertiary hospitals in Nigeria.*

KEYWORDS: Digital health; Health information management; Healthcare delivery; Operational efficiency; Patient registration systems; Tertiary hospitals.

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INTRODUCTION

The digitisation of healthcare systems has increasingly transformed the management of patient information and healthcare service delivery across the world [1–3]. Central to this transformation is the shift from traditional paper-based registration processes to digital registration systems integrated with electronic health information technologies [2,4]. Effective registration systems support accurate patient identification, facilitate continuity of care, and enhance administrative efficiency within healthcare institutions [5,6].

Traditionally, many healthcare facilities, particularly in low- and middle-income countries, have relied on manual registration systems involving paper-based forms, handwritten patient records, and physical filing systems [7,8]. These systems have historically been preferred because of their simplicity, low technological requirements, and relatively affordable operational costs for smaller healthcare facilities [9]. However, evidence suggests that manual registration systems are often associated with several operational limitations, including delays in patient processing, difficulties in record retrieval, duplication of information, incomplete documentation, and increased susceptibility to human error [10–12]. Handwritten records may become illegible, misplaced, or damaged over time, thereby compromising the accuracy and continuity of patient care [13]. In addition, the physical storage of records creates challenges related to space management, confidentiality, and long-term data preservation [14,15].

The introduction of digital registration systems has been widely recognised as an important strategy for improving healthcare administration and service delivery [16,17]. Digital systems enable electronic capture, storage, retrieval, and sharing of patient information, thereby supporting faster registration processes, improved data accuracy, and enhanced coordination of healthcare services [18,19]. Features such as automated data entry, electronic verification processes, real-time access to patient history, and integration with electronic health records contribute to improved workflow efficiency and reduced administrative burden on healthcare workers [20,21]. Digital registration systems may also reduce duplication of patient information, minimise waiting time, and improve patient satisfaction through more streamlined service delivery processes [22,23].

In Nigeria, the transition from manual to digital health information systems has progressed unevenly across healthcare institutions [24,25]. Although national policies increasingly promote the adoption of digital health technologies, many tertiary hospitals continue to operate hybrid systems that combine paper-based and electronic registration processes [26]. Consequently, healthcare institutions often experience persistent administrative inefficiencies, fragmented patient records, and delays in service delivery [27]. Existing evidence indicates that manual registration systems in Nigerian hospitals contribute to prolonged patient waiting times, reduced staff productivity, and challenges in coordinating patient care across departments [28,29].

Kogi State, like many other states in Nigeria, continues to experience challenges related to healthcare administration and patient information management within tertiary healthcare institutions. While some hospitals have introduced digital registration technologies, the extent of implementation and the effectiveness of these systems vary considerably across facilities. In many instances, manual registration methods remain predominant, thereby limiting the efficiency gains associated with digital health innovations [30,31]. The coexistence of manual

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and digital systems has also created inconsistencies in patient data management and healthcare workflow processes [32].

Although previous studies in Nigeria have examined the adoption of electronic health records and other digital health technologies, most have focused on implementation experiences, user acceptance, and the general benefits and challenges of digital health systems [24,25,33]. Comparatively little attention has been given to patient registration systems, which constitute the entry point for healthcare delivery and play a critical role in patient flow, information management, and service coordination. Furthermore, few studies have directly compared manual and digital registration systems within the same healthcare context to determine how differences in registration approaches influence operational efficiency and healthcare delivery outcomes.

This evidence gap is particularly evident in Kogi State, where tertiary hospitals operate varying combinations of manual and digital registration systems. Despite ongoing investments in digital health technologies, there is limited empirical evidence on whether digital registration systems provide measurable advantages over manual systems in terms of operational efficiency and healthcare delivery performance within these institutions. Addressing this gap is important for informing evidence-based decisions on health information management, resource allocation, and digital transformation strategies in tertiary healthcare facilities. Therefore, this study comparatively assesses manual and digital registration systems and their effects on healthcare delivery in tertiary hospitals in Kogi State, Nigeria, with particular emphasis on operational efficiency and healthcare delivery outcomes.

MATERIALS AND METHODS

Study Setting

This study employed a facility-based cross-sectional comparative design and was conducted in two tertiary healthcare institutions in Kogi State, North-Central Nigeria: Federal Teaching Hospital Lokoja (FTHL) and Prince Abubakar Audu University Teaching Hospital Clinical Complex (PAAUTH), Anyigba. Both hospitals serve as major referral centres for Kogi State and neighbouring states and provide specialised clinical services, medical training, and health research activities.

Kogi State, popularly known as the “Confluence State,” is located at the confluence of Rivers Niger and Benue in Lokoja, the state capital. The state occupies a strategic geographic position linking northern and southern Nigeria and has an estimated population of over five million people (NPC, 2023). Healthcare delivery in the state follows Nigeria’s three-tier health system structure comprising primary, secondary, and tertiary levels of care.

Federal Teaching Hospital Lokoja operates as a tertiary referral facility with specialised departments including internal medicine, surgery, paediatrics, obstetrics and gynaecology, family medicine, and emergency medicine. The hospital also maintains units responsible for patient registration and health information management, including the Medical Records and Information and Communication Technology (ICT) departments. Similarly, PAAUTH Anyigba provides specialised and teaching healthcare services while supporting undergraduate and postgraduate medical training.

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Both institutions operate within a transitional health information management environment characterised by the coexistence of manual and digital patient registration systems.

Study Population

The study population comprised healthcare professionals working in the selected tertiary hospitals in Kogi State who were directly involved in patient registration, documentation, and healthcare information management processes. These included health information management personnel, nurses, medical doctors, pharmacists, laboratory scientists, and administrative staff who routinely interacted with manual and digital registration systems during healthcare delivery. The estimated total study population across the two hospitals was 2500.

The inclusion criteria comprised healthcare professionals who were directly involved in patient registration, documentation, or health information management activities and had worked in the selected hospitals for at least six months prior to the study. Healthcare workers who were on leave during the data collection period, newly employed staff with less than six months of work experience, and personnel not involved in patient registration or health information management processes were excluded from the study.

Sample Size

The sample size for the study was determined using the formula for a single population proportion:

$$n = \frac{Z^2 \alpha P(1-P)}{d^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where:

n = minimum sample size

Z = standard normal deviate at 95% confidence level = 1.96

P = estimated proportion of healthcare workers engaged in registration systems; based on a similar Nigerian hospital setting, this was set at 50% (0.50) for maximum variability

d = margin of error = 5% (0.05)

Therefore $n = \frac{Z^2 x\ P(1-P)}{d^2}$ ……2

$= \frac{1.96^2 x\ 0.50(1-0.50)}{0.05^2} = 384.16$

To adjust for a non-response rate of 15%, the final sample size was calculated using: nq

Where: n= sample size

$q = \frac{1}{1-f}$ ……..3

f = estimated nonresponse rate.

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Taking f = 0.15, then: q = 1.18

Therefore, minimum sample size: 384 X 1.18 = 452.

Therefore, a minimum of 452 participants were targeted for the quantitative survey.

Sampling Technique

A multistage sampling technique was employed for this study.

At the first stage, a stratified sampling approach was used to organise the study population into relevant strata based on institutional affiliation and professional roles. Healthcare professionals in tertiary healthcare facilities in Kogi State were stratified according to their areas of practice, particularly those directly involved in patient registration and service delivery, including Clinical Services, Nursing, and Health Information Management units.

At the second stage, proportional allocation was applied to determine the number of participants selected from each stratum, ensuring that units with larger staff strength contributed a proportionately higher number of respondents. In the final stage, simple random sampling was used to select eligible participants within each stratum, thereby ensuring that all individuals had an equal probability of selection.

Method of Data Collection

Data were collected using a structured questionnaire developed from relevant literature on health information systems, electronic health records, and healthcare service delivery. The instrument was guided by the Technology Acceptance Model (TAM) and consisted of sections on respondents' socio-demographic characteristics, registration system use, operational efficiency, and healthcare delivery outcomes. Content validity was established through expert review by specialists in Health Information Management and Public Health. A pilot study was conducted among healthcare workers in a tertiary health facility outside the study area, and the instrument demonstrated acceptable internal consistency with a Cronbach's alpha coefficient (α) of 0.87.

The questionnaire comprised mainly closed-ended questions structured using Likert-scale and multiple-choice response formats. Data was collected through self-administered questionnaires distributed by the researcher and trained research assistants. Completed questionnaires were checked for completeness and consistency before analysis.

Methods of Data Analysis

Data was coded and analysed using Statistical Package for the Social Sciences (SPSS) version 26 and Analysis of Moment Structures (AMOS) version 26. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise respondents' characteristics and study variables.

To compare the operational efficiency of manual and digital registration systems, an independent samples t-test was employed.

The test statistic is expressed as:

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$$t = \frac{\bar{X}_d - \bar{X}_m}{\sqrt{\frac{s_d^2}{n_d} + \frac{s_m^2}{n_m}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where:
$\bar{X}_d$= mean operational efficiency score for digital registration systems

$\bar{X}_m$= mean operational efficiency score for manual registration systems

s_d^2, s_m^2= variances of the respective groups

n_d, n_m= sample sizes for digital and manual systems.

A statistically significant t-value indicates a meaningful difference in operational efficiency attributable to the type of registration system used.

To examine the direct and indirect effects of registration system type on healthcare delivery outcomes, Structural Equation Modeling (SEM) was performed using IBM SPSS AMOS. The model specified digital registration as the predictor variable, perceived data quality, waiting time, service flow, and patient satisfaction as mediating variables, and perceived health outcome as the outcome variable. Path analysis was used to estimate the magnitude and significance of direct and indirect relationships among the study variables. Standardized regression coefficients (β), 95% confidence intervals, and p-values were used to assess the strength and significance of the pathways. Statistical significance was set at $p < 0.05$.

Ethical Consideration

Ethical approval for this study was obtained from the Rivers State University, Health Research Ethics Committee (RSUHREC) (Approval No. RSU/FMBS/REC/25/263), as the study formed part of an academic research programme conducted under Rivers State University. Administrative permission was subsequently obtained from the management of the selected tertiary hospitals in Kogi State before data collection commenced.

Informed consent was obtained from all participants prior to questionnaire administration. Participation was voluntary, and respondents were assured of confidentiality and anonymity. No personal identifiers were collected, and all information obtained was used solely for research purposes.

RESULTS

Table 1 below presents the socio-demographic and professional characteristics of respondents included in the study. The age distribution shows that respondents aged 25–29 years accounted for the highest proportion (30.31%), while those aged below 25 years (23.23%). The sex distribution indicates that females constituted the majority of respondents (67.70%), while males accounted for 32.30%. The findings further revealed that more than half of the respondents were Christians (57.08%), while Muslims constituted 42.92%. Most respondents were married (76.99%), while less than one-quarter (23.01%) were unmarried.

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Furthermore, educational and professional qualifications reveal that a large proportion of respondents possessed a bachelor's degree (57.08%), while 22.12% had obtained a master's degree. Similarly, most of the respondents earned above ₦131,000 (72.35%), while smaller proportions earned below ₦70,000 (16.15%) or between ₦71,000 and ₦130,000.

Additionally, nurses and midwives formed the largest professional group (44.25%), followed by health information and records officers (23.23%) and medical doctors (13.27%). Most respondents were permanently employed (72.35%), while others were on temporary (24.34%) or contract appointments (3.32%). The distribution further shows that respondents with 20 years and above professional experience accounted for 23.01%, while those with less than five years of experience accounted for 20.80%.

However, me respondents worked at the Federal Teaching Hospital, Lokoja (83.85%), while 16.15% were affiliated with Prince Abubakar Audu University Teaching Hospital, Anyigba.

Table 1: Socio-Demographic and Professional Characteristics of Respondents

Variables	Frequency (n=452)	Percentage (%)
Age (years)		
Less than 25	105	23.23
25–29	137	30.31
30–34	133	29.42
35–39	52	11.50
40–44	13	2.88
45–49	6	1.33
50 and above	6	1.33
Sex		
Female	306	67.70
Male	146	32.30
Religion		
Christianity	258	57.08
Islam	194	42.92
Marital Status		
Married	348	76.99
Unmarried	104	23.01
Highest Professional Qualification		
Diploma	90	19.91
Bachelor'Degree (B.Sc/B.NSc/B.Mid/MBBS/B.Pharm/BMLS)	258	57.08
Master'sDegree (M.Sc/M.NSc/MPH/MHA/MBA)	100	22.12
Doctorate Degree (PhD)	4	0.88
Monthly Income (₦)		
Below ₦70,000	73	16.15
₦71,000–₦100,000	10	2.21
₦101,000–₦130,000	42	9.29
Above ₦131,000	327	72.35
Professional Cadre		

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Medical Doctor	60	13.27
Nurse/Midwife	200	44.25
Health Information/Records Officer	105	23.23
Others	87	19.25
Current Employment Status		
Permanent	327	72.35
Contract	15	3.32
Temporary	110	24.34
Years of Professional Experience		
Less than 5 years	94	20.80
5–9 years	74	16.37
10–14 years	86	19.03
15–19 years	94	20.80
20 years and above	104	23.01
Years Using Hospital Registration System		
Less than 1 year	82	18.14
1–3 years	86	19.03
4–6 years	63	13.94
More than 6 years	221	48.89
Hospital Affiliation		
Federal Teaching Hospital, Lokoja	379	83.85
Prince Abubakar Audu University Teaching Hospital, Anyigba	73	16.15
Years of Experience in Current Hospital		
Less than 5 years	130	28.76
5–9 years	81	17.92
10–14 years	62	13.72
15 years and above	179	39.60
Primary Unit/Department		
Accident and Emergency	30	6.64
Clinics	51	11.28
Medical Records	193	42.70
Nursing Station/Ward	75	16.59
Outpatient Department (OPD)	103	22.79

Figure 1 below presents the distribution of respondents by type of registration system used and their years of experience with manual and digital registration systems. The figures show that the hybrid registration system, which combines both manual and digital processes, was the most commonly used, accounting for 40.27% of respondents. Manual paper-based systems were used by 37.61% of respondents, while fully digital or electronic systems were used by 22.12%.

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Figure 1: Type of Registration System Used

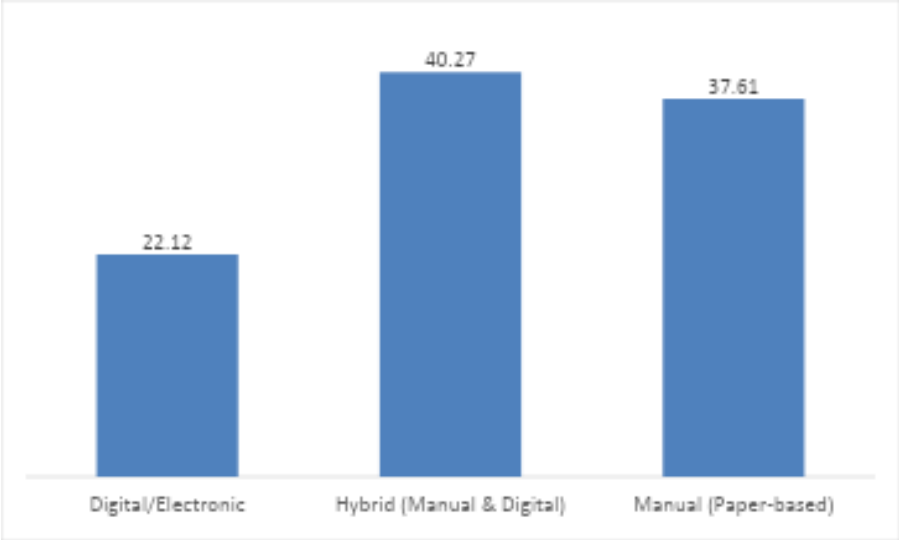

Table 2 presents respondents' perceptions of operational efficiency indicators associated with the registration systems used in the study hospitals. The findings show that a large proportion of respondents perceived the registration system as easy to operate, with 49.56% strongly agreeing that the registration system was easy to operate and 41.37% agreeing. Most respondents also affirmed that registration procedures are clearly defined. Over half of the respondents (52.65%) strongly agreed, while 40.04% agreed. A small proportion of respondents (4.87%) disagreed, and 2.43% remained undecided. Patient record retrieval was viewed positively by the majority of respondents, with about 42.04% strongly agreed that patient records can be retrieved quickly, while 43.81% agreed. However, 9.96% disagreed, and 4.20% strongly disagreed, showing that some respondents still experienced challenges with record retrieval.

More than half of the respondents (55.53%) agreed, while 36.50% strongly agreed. Only 5.53% disagreed, and 2.43% strongly disagreed that the system supports smooth day-to-day operations.

A total of 86.29% of respondents either strongly agreed (38.72%) or agreed (47.57%) that manual registration causes more delays, while 6.86% disagreed and 3.32% strongly disagreed. Similarly, 45.58% strongly agreed, and 46.46% agreed that manual registration is time-consuming, with only a small proportion expressing disagreement. Over half of the respondents (55.31%) strongly agreed, while 42.92% agreed that digital registration served as a means of improving coordination.

Despite the perceived inefficiencies of manual systems, many respondents acknowledged their reliability during system outages. About 40.93% strongly agreed, and 49.12% agreed that manual registration remains dependable during outages, while 6.42% disagreed and 3.54% were undecided.

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Table 2. Operational Efficiency Indicators

Operational Efficiency	Strongly Agree n (%)	Agree n (%)	Undecided n (%)	Disagree n (%)	Strongly Disagree n (%)
Registration system is easy to operate	224 (49.56)	187 (41.37)	9 (1.99)	32 (7.08)	–
Registration procedures are clearly defined	238 (52.65)	181 (40.04)	11 (2.43)	22 (4.87)	–
Patient records can be retrieved quickly	190 (42.04)	198 (43.81)	–	45 (9.96)	19 (4.20)
System supports smooth day-to-day operations	165 (36.50)	251 (55.53)	–	25 (5.53)	11 (2.43)
Manual registration causes more delays	175 (38.72)	215 (47.57)	16 (3.54)	31 (6.86)	15 (3.32)
Digital registration improves coordination	250 (55.31)	194 (42.92)	8 (1.77)	–	–
Manual registration is time-consuming	206 (45.58)	210 (46.46)	–	8 (1.77)	28 (6.19)
Manual registration is dependable during outages	185 (40.93)	222 (49.12)	16 (3.54)	29 (6.42)	–

Table 3 presents the comparison of mean outcome scores across registration system types. The findings show that respondents using digital registration systems recorded the highest mean outcome score of 2.78 ±0.26 (CI: 2.73 – 2.83), while those using manual registration systems recorded a lower mean score of 2.55 ±0.42 (CI: 2.49 – 2.62). Respondents exposed to both systems recorded a combined mean score of 2.64 ±0.39 (CI: 2.59 – 2.68). The difference in mean outcome scores between the manual and digital registration systems was statistically significant, with a p-value of less than 0.001.

Table 3: Comparison of Operational efficiency of registration systems types: Mean Outcome Scores

Registration System	Mean ±SD	p-value	95% Confidence Interval
Manual	2.55 ± 0.42	<0.001	2.49 – 2.62
Digital	2.78 ± 0.26		2.73 – 2.83
Combined	2.64 ± 0.39		2.59 – 2.68

A statistically significant difference was observed between manual and digital registration systems in the Federal Teaching Hospital, Lokoja ($p < 0.001$). A similar pattern was observed in Prince Abubakar Audu University Teaching Hospital, Anyigba, although the magnitude of difference was smaller.

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Table 4: Comparison of Operational efficiency of registration systems types: Mean Outcome Scores by Hospital

Hospital	Registration System	Mean ± SD	p-value	95% CI
FTH Lokoja	Manual	2.52 ± 0.44	<0.001	2.45 – 2.59
FTH Lokoja	Digital	2.76 ± 0.28		2.70 – 2.82
PAAUTH Anyigba	Manual	2.75 ± 0.25	0.005	2.65 – 2.85
PAAUTH Anyigba	Digital	2.84 ± 0.12		2.78 – 2.89

Table 5 presents the effect of registration type on selected mediating variables using linear regression, with manual registration as the reference category. Digital registration shows a statistically significant positive effect on perceived data quality (β = 0.239, 95% CI: 0.148–0.330, p < 0.001). Digital registration also demonstrates a significant association with waiting time (β = 0.099, 95% CI: 0.039–0.159, p = 0.001).

A strong and significant positive effect is observed for patient satisfaction (β = 0.421, 95% CI: 0.308–0.534, p < 0.001), showing substantially higher satisfaction scores among facilities using digital registration systems.

Table 5. Potential Mediators Causal Pathways

Outcome Variable	Predictor	β (Coef.)	95% CI	p-value
Perceived Data Quality	Digital registration	0.239	0.148 – 0.330	<0.001***
	Constant	2.722	2.666 – 2.777	<0.001***
Waiting Time	Digital registration	0.099	0.039 – 0.159	0.001**
	Constant	2.071	2.035 – 2.108	<0.001***
Service Flow	Digital registration	−0.015	−0.139 – 0.108	0.807
	Constant	3.007	2.933 – 3.083	<0.001***
Patient Satisfaction	Digital registration	0.421	0.308 – 0.534	<0.001***
	Constant	2.909	2.841 – 2.978	<0.001***

Reference category: Manual registration

Figure 2 presents the structural relationships between digital registration, key mediating variables, and overall health outcomes. The results indicate that digital registration has significant direct effects on several mediators. Specifically, digital registration is positively associated with perceived data quality (β = 0.239, 95% CI: 0.148–0.329, p < 0.001) and patient satisfaction (β = 0.421, 95% CI: 0.309–0.533, p < 0.001).

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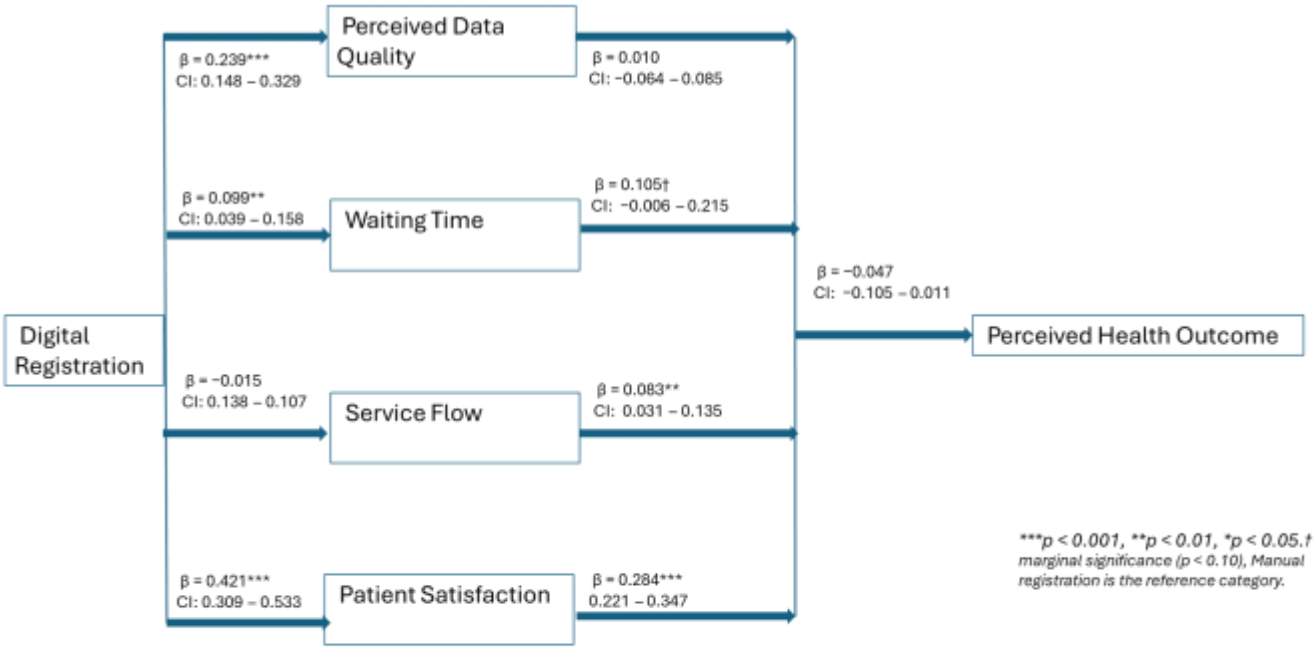

Fig 4.3: Structural Equation Model (SEM) Path Estimates

DISCUSSION

The findings suggest that healthcare workers generally considered the registration procedures used in their hospitals to be easy to operate and clearly defined. This is somewhat anticipated given that most respondents had several years of experience using hospital registration systems. Familiarity with established procedures often enables staff to adapt to existing workflows, regardless of whether the system is manual or digital. Similar observations have been reported in Nigerian tertiary hospitals where staff gradually adjusted to digitized processes despite infrastructural and operational constraints [32,33]. However, unlike studies that portray digitalization as a complete solution to administrative inefficiencies [17,21,34], the present findings indicate that clarity of procedures and user familiarity may be just as important as the technology itself in shaping day-to-day operational experiences.

Although respondents generally reported positive experiences with registration processes, manual registration was still widely perceived as time-consuming and more prone to delays. This finding is consistent with previous studies that identified physical record handling, repeated documentation, and lengthy retrieval processes as major limitations of paper-based systems [10, 35]. Nevertheless, the continued reliance on manual registration in many departments suggests that these systems may still serve functions that digital platforms have not fully replaced [36,37]. In resource-constrained settings, paper records often remain an important backup mechanism during power failures, network disruptions, and system downtime [9, 38]. This may explain why many respondents continued to regard manual registration as dependable despite acknowledging its operational limitations.

The overall advantage observed for digital registration systems aligns with evidence showing that electronic systems can improve access to patient information and support more coordinated service delivery [18,20, 39]. However, the magnitude of this advantage was relatively modest.

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This may reflect the reality that both study hospitals operate within a hybrid environment where manual and digital processes coexist. In such settings, the benefits of digitalization may not be fully realized because staff frequently move between paper and electronic platforms. Previous studies have similarly reported that hybrid systems often create duplication of tasks and additional documentation requirements that can dilute the expected efficiency gains of digital technologies [25,31].

The positive relationship between digital registration and data quality is also consistent with the broader literature on health information systems [14,32]. Electronic systems are generally designed to standardize data entry and reduce common documentation errors. However, improvements in data quality should not be assumed to occur automatically following digitalization. Studies from several low- and middle-income countries have shown that poorly designed electronic systems can generate incomplete records, duplicate entries, and inaccurate information when users receive insufficient training or technical support [34, 39]. It is therefore possible that the benefits observed in this study reflect not only the registration platform itself but also the efforts of hospital staff who have adapted to the system over time.

An interesting finding is that digital registration appeared to be associated with better patient satisfaction. While this may partly reflect shorter administrative processes and easier access to information, patient satisfaction is influenced by many factors beyond registration activities alone. Waiting time, provider attitude, availability of services, and treatment outcomes all contribute to how patients evaluate their healthcare experiences [22]. Consequently, the observed relationship should be interpreted cautiously, as registration systems represent only one component of a much broader healthcare delivery process.

The findings reinforce the view that digital registration systems can support more efficient healthcare administration, but they also highlight that technology alone does not determine performance. The effectiveness of any registration system is likely to depend on how well it fits existing workflows, the level of staff engagement, and the organisational environment in which it is implemented. This may explain why some healthcare facilities report substantial benefits following digitalization, while others experience more modest improvements despite adopting similar technologies [34, 39].

CONCLUSION

This study found that digital registration systems were associated with better operational performance than manual registration systems in tertiary hospitals in Kogi State. The findings suggest that digital registration can support more efficient management of patient information and contribute to improved healthcare delivery processes. However, the benefits of digital systems appear to depend on how effectively they are integrated into existing hospital workflows and practices. The study adds to the growing evidence supporting the role of digital health technologies in strengthening health information management and service delivery in resource-constrained healthcare settings.

Strengths and Limitations

This study provides empirical evidence on the comparative effects of manual and digital registration systems using data obtained directly from healthcare professionals involved in

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patient registration, documentation, and information management processes within tertiary hospitals. The inclusion of multiple professional groups offered practical insights into operational experiences associated with both registration systems. In addition, the use of descriptive and inferential statistical analyses enabled a comprehensive assessment of differences in operational efficiency, data quality, patient service flow, and staff satisfaction across the two systems.

However, some limitations should be acknowledged. The cross-sectional nature of the study limits the ability to establish causal relationships between registration system type and healthcare delivery outcomes. The study also relied largely on self-reported responses, which may be subject to recall bias and social desirability bias. Furthermore, the study was conducted in selected tertiary hospitals in Kogi State, which may limit the generalisability of the findings to other healthcare settings with different administrative structures, technological capacities, and levels of digital health implementation.

Practical Implications

The findings of this study highlight the importance of strengthening digital registration systems to improve operational efficiency and healthcare delivery processes in tertiary hospitals. Since digital registration systems were associated with faster record accessibility, reduced administrative delays, and improved workflow coordination, healthcare institutions may benefit from sustained investment in information and communication technology (ICT) infrastructure, reliable internet connectivity, and stable power supply to support efficient system performance.

The study also highlights the importance of continuous staff training and institutional support during the transition from manual to digital registration systems. Improving user competence and system familiarity may enhance workflow consistency, reduce operational inefficiencies, and maximize the direct and indirect benefits of digital registration on healthcare delivery outcomes.

Importantly, this study provides context-specific evidence from tertiary hospitals in Kogi State on the operational implications of manual and digital registration systems. The findings may assist hospital administrators, policymakers, and health information managers in developing strategies aimed at improving registration efficiency, strengthening patient information management, and enhancing healthcare service delivery within tertiary healthcare settings.

Abbreviations

EHR	Electronic Health Record
EMR	Electronic Medical Record
FMoH	Federal Ministry of Health
FTHL	Federal Teaching Hospital Lokoja
HIM	Health Information Management
ICT	Information and Communication Technology
KSSH	Kogi State Specialist Hospital
NPC	National Population Commission
PAAUTH	Prince Abubakar Audu University Teaching Hospital

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PHC Primary Healthcare Centre
WHO World Health Organization

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Author Contributions

- **Olutunde Samuel Michael:** Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review & editing
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Conflicts of Interest

The authors have declared that no competing interests exist.

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