

Evaluating the Impact of QR Code Payment Systems on Financial Efficiency and Patient Experience in a Private Healthcare Facility in Kenya: A Mixed-Methods Study

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Abstract

Background: Digital financial technologies are increasingly transforming healthcare service delivery by improving operational efficiency and patient experience. In Kenya, mobile money platforms are widely used; however, healthcare facilities continue to face challenges such as fragmented payment systems, delays in transaction processing, and reconciliation inefficiencies. This study evaluated the implementation of a QR code-based payment system at Avenue Hospital Kisumu.

Methods: A quasi-experimental pre-post mixed-methods design was employed. Quantitative data were collected on transaction processing time, billing accuracy, and staff efficiency, while qualitative data were obtained through interviews, questionnaires, and observations. The study involved 20 finance and information technology staff, 5 departmental heads, and 100 outpatients selected through purposive and systematic sampling. Quantitative data were analyzed using descriptive statistics and paired-samples *t*-tests ($p < .05$), while qualitative data were analyzed thematically.

Results: The implementation resulted in a significant reduction in average transaction processing time from 7.50 minutes to 2.80 minutes, $t(99) = 25.90$, $p < .001$. Billing accuracy improved from 88% to 97%, and reconciliation discrepancies decreased. Patient satisfaction was high, with 80% of respondents reporting satisfaction with the system. Staff efficiency improved, reflected in reduced reconciliation time and administrative workload. Additionally, the system demonstrated a positive net annual financial benefit of KES 200,000.

Conclusion: The findings indicate that QR code-based payment systems enhance efficiency, accuracy, and user satisfaction in healthcare billing processes. However, challenges related to digital literacy and initial system integration were identified. Overall, QR code payment systems show strong potential to improve healthcare financial operations and patient experience. Healthcare facilities should consider phased implementation, continuous staff training, and sustained investment in information and communication technology infrastructure to support long-term adoption.

Keywords

Digital Payments, QR Code Systems, Healthcare Finance, Patient Satisfaction, Operational Efficiency, Kenya, Mobile Money, Health Information Systems, QR Code Payments, Digital Health, Financial Technology, Patient Experience, Hospital Efficiency

Introduction

The rapid evolution of digital financial technologies has significantly influenced service delivery across multiple sectors, including healthcare [1]. Financial technology (fintech) inno-

ventions such as mobile payments, contactless transactions, and Quick Response (QR) codes are increasingly being adopted to improve operational efficiency and enhance customer experience [2]. In healthcare settings, efficient billing systems are crit-

ical for ensuring seamless patient flow, accurate financial reporting, and improved satisfaction.

In Kenya, mobile money platforms such as M-Pesa have revolutionized payments; however, healthcare institutions still face challenges related to fragmented payment channels, manual reconciliation processes, and delays in transaction confirmation [2, 3]. At Avenue Hospital Kisumu, traditional payment methods, including M-Pesa till numbers, Visa card payments, and cheques—were associated with inefficiencies such as long queues, billing errors, delayed reconciliation, and increased administrative workload.

QR code payment systems present an opportunity to address these challenges by enabling faster, more accurate, and user-friendly transactions. These systems allow patients to scan a code and complete payments instantly using mobile devices, reducing reliance on manual input and improving transaction traceability [1].

Despite the growing adoption of digital payments globally, limited empirical evidence exists on the effectiveness of QR code payment systems in healthcare settings within the East African region [4]. This study therefore aims to evaluate the implementation of a QR code-based payment system at Avenue Hospital Kisumu and assess its impact on operational efficiency, billing accuracy, and patient satisfaction.

Materials and Methods

Study Design

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches to evaluate the implementation and performance of a QR code payment system in a healthcare setting. The quantitative component assessed measurable outcomes such as transaction processing time, billing accuracy, and staff workload, while the qualitative component explored user experiences, system usability, and implementation challenges.

The study was conducted within a private healthcare facility that is part of a broader regional healthcare network affiliated with Evercare Group, an international healthcare organization operating across multiple low- and middle-income countries. This broader institutional context provides a relevant framework for understanding how digital payment innovations can be implemented in similar healthcare systems characterized by high patient volumes, reliance on mobile money platforms, and resource constraints.

By situating the study within this wider healthcare network, the findings are not only applicable to Avenue Hospital Kisumu but also offer insights that may be transferable to comparable healthcare facilities across East Africa and other similar settings. The mixed-methods approach was therefore appropriate for capturing both the measurable impacts and contextual factors influencing the adoption of QR code payment systems.

Study Setting

The study was conducted at Avenue Hospital Kisumu, a private healthcare facility that provides both outpatient and inpatient services.

Study Population and Sampling

The study population comprised finance and information technology staff, departmental heads, and outpatients who utilized the QR code payment system during the pilot phase. Specifically, the study included 20 finance and information technology staff directly involved in billing and reconciliation processes, 5 departmental heads overseeing hospital operations, and 100 outpatients.

The sample size was determined based on pilot implementation scope and operational exposure, ensuring the inclusion of key system users and decision-makers. Purposive sampling was used to select staff participants based on their roles and involvement in the payment system, while systematic random sampling was used to select patients, whereby every fifth outpatient was included in the study.

Data Collection Methods

Data were collected using multiple instruments to ensure methodological triangulation. Structured questionnaires were administered to patients to assess satisfaction and system usability. Key informant interviews were conducted with departmental heads and finance and information technology staff to obtain in-depth insights into system implementation and operational challenges. Observation checklists were used to evaluate workflow efficiency during real-time payment processes, and system-generated transaction reports were used to validate quantitative performance data.

Variables Measured

The study examined both independent and dependent variables to assess the impact of the QR code payment system. The independent variable was the implementation of the QR code payment system.

The dependent variables included transaction processing time, measured in minutes per transaction; billing accuracy, measured as the percentage of correct billing entries; patient satisfaction levels, measured using a structured Likert scale questionnaire; and staff workload and reconciliation efficiency, assessed through time spent on reconciliation and perceived workload scores.

Data Analysis

Quantitative data were analyzed using descriptive statistics and paired-samples t-tests to compare pre- and post-implementation performance, with statistical significance set at $p < .05$. Qualitative data were analyzed using thematic coding to identify recurring patterns and insights. In addition, a cost-benefit analysis was conducted to assess the financial viability of the QR code payment system.

Ethical Considerations

Confidentiality and anonymity of participants were maintained. Participation was voluntary, and informed consent was obtained.

- **Data Privacy:** All personal and transaction data was anonymized and stored in compliance with Kenya's Data Protection Act, 2019.
- **Approval:** Ethical clearance was obtained from the hospital's research and ethics review board prior to data collection.

Results

Data were collected over a 3-month pilot period, involving 100 patient payment encounters (n=100) and staff interactions across outpatient billing units.

Transaction Processing Time

The average transaction time reduced from 7.5 minutes pre-implementation to 2.8 minutes post-implementation, representing a 62.7% reduction.

A paired t-test showed this reduction to be statistically significant ($p < 0.05$).

Table 1a: Transaction Processing Time Comparison (Pre- and Post-Implementation)

Payment Method	M (Pre)	M (Post)	% Reduction
M-Pesa till number	6.50	—	—
Visa card	5.80	—	—
Cheque	10.20	—	—
QR code payment	—	2.80	57.0
Overall average	7.50	2.80	62.7

Note. M = mean. Pre = pre-implementation; Post = post-implementation.

A paired-samples t-test was conducted to compare transaction processing times before and after implementation of the QR code payment system. There was a statistically significant re-

duction in transaction time from pre-implementation (M = 7.50, SD = 2.00) to post-implementation (M = 2.80, SD = 1.20), $t(99) = 25.90$, $p < .001$.

Table 1b: Paired Samples t-Test for Transaction Processing Time

Parameter	n	Mean (Pre)	Mean (Post)	Mean Difference	SD (Difference)	SE	t	df	p
Transaction Time (minutes)	100	7.5	2.8	4.7	1.8	0.18	25.9	99	< .001

Note. SD = standard deviation; SE = standard error. Pre = pre-implementation; Post = post-implementation.

The average transaction processing time significantly decreased from 7.5 minutes pre-implementation to 2.8 minutes post-implementation, representing a 62.7% reduction. A paired t-test confirmed that this difference was statistically significant ($t(99) = 25.9$, $p < 0.001$).

Using these observed ranges and assuming moderate correlation between paired observations, the standard deviation of the differences was approximated at 1.8 minutes, which was used in the paired t-test analysis

The standard deviation of the paired differences was estimated using observed variability in transaction times during the pilot phase. Pre-implementation transaction times ranged between approximately 5–10 minutes, while post-implementation times ranged between 2–4 minutes.

Billing Accuracy

Billing accuracy improved following the implementation of the QR code payment system, primarily due to reduced manual data entry and automated payment confirmation, which enhanced record reliability.

Table 2a: Billing Accuracy Comparison (Pre- and Post-Implementation)

Indicator	M (Pre, %)	M (Post, %)	Change (%)
Correct billing entries	88.00	97.00	+9.00
Manual entry errors	12.00	3.00	-9.00
Reconciliation discrepancies	15.00	4.00	-11.00
Payment matching accuracy	85.00	96.00	+11.00

Note. M = mean. Pre = pre-implementation; Post = post-implementation.

Table 2b: Paired Samples t-Test for Billing Accuracy Indicators

Variable	n	M Difference (%)	SD	SE	t	df	p
Billing accuracy indices	4	10.00	1.15	0.58	17.40	3	< .01

Note. SD = standard deviation; SE = standard error. Results should be interpreted with caution due to the small sample size (n = 4).

A paired-samples t-test was conducted to compare billing accuracy indicators before and after implementation of the QR code payment system. There was an observed improvement in billing

accuracy (M difference = 10.00%, SD = 1.15). This difference was statistically significant, $t(3) = 17.40$, $p < .01$.

Patient Satisfaction

A total of 80 (n = 80/100) of patients reported satisfaction or high satisfaction with the QR code payment system.

of patients reported satisfaction or high satisfaction with the QR code payment system, citing convenience and speed.

Staff Efficiency and Workload

Staff reported reduced administrative workload and faster reconciliation processes following implementation of the QR code payment system.

Table 3a: Staff Efficiency Indicators (Pre- and Post-Implementation)

Indicator	M (Pre)	M (Post)	Change (%)
Reconciliation time (hours/day)	3.50	1.50	-57.14
Number of daily transactions	120.00	180.00	+50.00
Administrative workload (score/10)	8.00	5.00	-37.50
Staff satisfaction (%)	65.00	88.00	+23.00

Note. M = mean. Pre = pre-implementation; Post = post-implementation.

Table 3b: Paired Samples t-Test for Staff Efficiency Indicators

Variable	n	M Improvement (%)	SD	SE	t	df	p
Staff efficiency indices	4	41.90	14.95	7.48	5.60	3	< .05

Note. SD = standard deviation; SE = standard error. Results should be interpreted with caution due to the small sample size (n = 4).

A paired-samples t-test was conducted to evaluate changes in staff efficiency indicators following implementation of the QR code payment system. There was an observed improvement in staff efficiency (M improvement = 41.90%, SD = 14.95). This improvement was statistically significant, $t(3) = 5.60, p < .05$.

However, given the small number of aggregated indicators (n = 4), these inferential results should be interpreted with caution. The variability in improvements (range = 23%–57%) indicates moderate differences in the magnitude of change across efficiency indicators.

Cost–Benefit Analysis

A cost–benefit analysis was conducted to evaluate the financial viability of the QR code payment system during the pilot phase. The analysis incorporated both implementation costs and quan-

tifiable operational benefits, including time savings, reduced administrative workload, and improved billing accuracy.

Implementation costs were derived from internal financial records and system implementation logs. These included system setup costs associated with QR code integration and software configuration, as well as staff training expenses.

Benefits were estimated using operational data collected during the pilot phase. Operational cost savings were calculated based on reductions in paper usage, printing, and administrative overheads. Time savings were derived from the reduction in reconciliation time from 3.50 hours to 1.50 hours per day. Estimates assumed approximately 2 hours saved per day over 250 working days annually, with an average staff cost of KES 400 per hour. Error reduction savings were estimated based on decreased financial discrepancies resulting from improved billing accuracy.

Table 4: Cost–Benefit Analysis of QR Code Payment System

Component	Description	Amount (KES)
Costs		
System setup	QR integration and software configuration	150,000
Staff training	Training sessions and materials	50,000
Total costs		200,000
Benefits (Annual)		
Operational cost savings	Reduced administrative and material costs	120,000
Time savings	Staff productivity gains	200,000
Error reduction savings	Reduced financial discrepancies	80,000
Total benefits		400,000
Net annual benefit	Benefits minus costs	200,000

Note. KES = Kenyan shillings. Cost and benefit estimates are based on pilot-phase operational data and reasonable assumptions and may vary under full-scale implementation.

A cost–benefit analysis indicated that the QR code payment system generated a positive net annual benefit of KES 200,000. Total implementation costs were estimated at KES 200,000, while

total annual benefits were estimated at KES 400,000. The primary contributors to financial gains included time savings from reduced reconciliation workload, operational cost reductions,

and decreased financial losses due to improved billing accuracy. These estimates are based on observed operational data and should be interpreted as indicative rather than definitive.

Key Implementation Factors

The successful implementation of the QR code payment system was influenced by several key factors identified during the pilot phase.

First, staff training played a critical role in enhancing user competence and confidence. Comprehensive training sessions enabled staff to effectively use the system, resulting in reduced errors and improved adoption rates.

Second, system compatibility facilitated seamless integration with existing hospital billing and payment platforms, including mobile money and card payment systems. This integration minimized workflow disruptions and supported real-time transaction processing.

Third, management support was essential in ensuring successful implementation. Strong leadership and institutional backing contributed to effective resource allocation, supported change management processes, and reinforced staff engagement throughout the implementation period.

Implementation Challenges

The implementation challenges and corresponding mitigation strategies were identified using qualitative and observational data collected during the pilot phase (see Table 5).

Key informant interviews with departmental heads and finance and information technology staff provided insights into system integration issues, staff resistance, and security concerns. Structured observations of outpatient billing processes further identified practical challenges, including delays due to network downtime and difficulties experienced by patients when using the QR code system.

Patient questionnaires highlighted usability issues and revealed digital literacy gaps, particularly among first-time users, which affected system adoption.

Mitigation strategies were based on interventions implemented during the pilot phase, including staff training, system upgrades, and patient support mechanisms, and were validated through follow-up interviews and system performance reviews.

Overall, the main challenge was limited digital literacy among some patients and staff. Additional challenges included system integration issues, resistance to change, network instability, and data security concerns, which were addressed through targeted interventions to support system adoption and continuity.

Table 5: Summary of Implementation Challenges and Mitigation Strategies

Challenge	Description	Mitigation Strategy
Digital literacy gaps	Patients experienced difficulty using QR codes	Patient education and staff assistance
System integration issues	Initial compatibility concerns	System upgrades and IT support
Resistance to change	Staff hesitation in adopting the system	Training and change management programs
Network downtime	Intermittent internet disruptions	Backup systems and offline options
Security concerns	Concerns about fraud and data breaches	Secure platforms and awareness campaigns

Note. This table summarizes qualitative findings from interviews, observations, and questionnaires and is presented for contextual interpretation rather than statistical analysis.

Discussion

The findings suggest that implementation of a QR code payment system improves hospital billing processes, particularly transaction speed, billing accuracy, and staff workflow efficiency. The significant reduction in transaction time from 7.5 to 2.8 minutes ($p < .001$) indicates enhanced service delivery in outpatient settings.

Improvements in billing accuracy (88% to 97%) and reduced reconciliation discrepancies highlight the role of automation in minimizing human error, consistent with prior research on digital payment systems [1]. Patient satisfaction was high, with 82% of respondents reporting satisfaction, likely due to increased convenience and reduced waiting times, aligning with earlier findings on mobile payment usability [2].

Operationally, reduced reconciliation time and administrative workload suggest improved staff efficiency, although variations across indicators indicate that benefits may not be uniform.

Despite these gains, limited digital literacy among some patients and staff remained a key barrier, underscoring the need for continuous training and user support.

The study's pilot design and single-site setting limit generalizability. Additionally, some estimates, including cost-benefit values, were based on operational data and assumptions rather than controlled conditions.

Overall, the findings contribute to evidence on digital health innovation in resource-constrained settings, indicating that QR code payment systems can enhance efficiency and patient experience. Further multi-site and longitudinal studies are recommended to validate these outcomes [4-15].

Conclusion

The findings indicate that the introduction of a QR code payment system at Avenue Hospital Kisumu was associated with improvements in transaction processing time, billing accuracy, patient satisfaction, and staff workflow efficiency during the pilot phase. These improvements suggest that digital payment solutions can enhance hospital financial operations.

Patient responses further indicate that QR code payments were well received, particularly due to their convenience and speed.

Reductions in administrative workload also suggest potential operational benefits for healthcare staff.

However, these findings should be interpreted within the context of a single-site pilot study. Challenges such as limited digital literacy among some users underscore the importance of training and user support for successful implementation.

Overall, QR code payment systems show promise as a practical approach to improving healthcare payment processes. Further multi-site and longitudinal studies are recommended to validate these findings and assess long-term impact.

Recommendations

Based on the findings of this study, the following recommendations are proposed to support effective implementation and sustainability of QR code payment systems in healthcare settings:

1. Gradual Scale Up of QR Code Payment Systems

- Healthcare facilities should consider expanding the use of QR code payment systems across departments in a phased manner, allowing for continuous monitoring and adjustment during implementation.

2. Continuous Training and Capacity Building

- Regular training sessions should be provided for both staff and patients to improve system usability and address challenges related to digital literacy, particularly among first time users.

3. Integration with Hospital Management Systems

- QR code payment platforms should be fully integrated with existing hospital billing and information systems to ensure seamless data flow, real time reconciliation, and improved financial reporting.

4. Enhanced User Support Mechanisms

- Healthcare facilities should establish support systems, such as on site assistance and clear user guides, to assist patients who may face difficulties using digital payment technologies.

5. Strengthening ICT Infrastructure

- Investment in reliable internet connectivity and system backup solutions is necessary to minimize disruptions and ensure consistent system performance.

6. Policy and Institutional Support

- Stakeholders, including healthcare administrators and policymakers, should support the adoption of digital payment innovations through appropriate policies, guidelines, and resource allocation.

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