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Optimizing Electronic Medical Records Workflows in Outpatient Clinics through Business Process Management: Evidence from Muhimbili National Hospital

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Abstract

The adoption of electronic medical records (EMRs) in developing countries, particularly Tanzania, has significantly enhanced healthcare delivery systems. However, persistent inefficiencies, including prolonged patient waiting times, continue to undermine service quality, patient satisfaction, and adherence to treatment. This study applied business process management (BPM) to optimize EMR workflows at Muhimbili National Hospital (MNH), with a focus on improving outpatient service efficiency and reducing waiting times. A cross-sectional design was employed using simple random sampling, involving 200 outpatient patients and 80 healthcare providers engaged in registration, consultation, and laboratory workflows. The study utilized the Six Sigma DMAIC (define, measure, analyze, improve, control) methodology to identify and address process inefficiencies. The findings revealed that 98.5% of patients, particularly first-time visitors, experienced difficulties in understanding hospital process flows. Moreover, follow-up patients faced disproportionately longer registration waiting times compared with new patients, highlighting systemic workflow inefficiencies despite prior familiarity. The study concludes that routine evaluation and optimization of EMR workflows are critical for enhancing operational efficiency and patient-centered care in resource-constrained healthcare settings.

Contribution to Sustainable Development Goals (SDGs)

SDG 3 – Good Health and Wellbeing

This research applies business process management (BPM) to optimize EMR workflows at Muhimbili National Hospital (MNH), with a focus on improving outpatient service efficiency and reducing waiting times.

1. Introduction

The rapid evolution of science and technology has significantly transformed healthcare systems, with the integration of electronic medical records (EMRs) playing a critical role in enhancing patient care and embedding performance measures in clinical practice [1]. EMR systems improve efficiency by enabling accurate data generation, facilitating easy access to patient information, and providing automated reminders that reduce errors in clinical decision-making. They also lower operational costs associated with paper-based records and alleviate the workload of limited healthcare providers (HCPs), allowing more time for patient management. Consequently, EMRs adoption has been associated with improved service delivery and increased patient satisfaction [2].

Healthcare systems involve diverse users, including nurses, doctors, data clerks, laboratory technologists, and pharmacists, whose utilization of EMR functions varies. Evidence from developed countries, including the United States and the United Kingdom, highlights the effectiveness of EMR in improving patient safety and health outcomes through standardized and interoperable systems [3]. In developing countries, EMRs adoption remains essential for improving healthcare delivery, though its success depends heavily on active involvement of HCPs and the reliability of the systems in minimizing human errors.

Despite these benefits, existing studies indicate that EMR implementation often focuses on automating manual processes without critically evaluating their efficiency [4]. As a result, inefficient workflows are digitized rather than improved, perpetuating systemic challenges, such as prolonged patient waiting times. For example, patient waiting times at Mwananyamala Hospital (Dar es Salaam, Tanzania) range from 167 to 243 minutes [5]. Similarly, despite the implementation of the JEEVA EMR system at Muhimbili National Hospital (MNH), extended waiting times continue to affect service quality [6].

Addressing these challenges requires a shift from automation to process optimization. Business process management (BPM) offers a systematic approach to analyzing and improving workflows by identifying inefficiencies, inconsistencies, and process bottlenecks [8]. BPM has demonstrated effectiveness in enhancing healthcare service quality through process re-engineering and optimization [9]. Therefore, this study applies BPM to examine and optimize EMR workflows at MNH, with a specific focus on reducing patient waiting times and improving overall efficiency and quality of outpatient healthcare services in resource-constrained settings [7].

2. Method

This study employed the Six Sigma DMAIC (define, measure, analyze, improve, control) methodology within a BPM framework to systematically evaluate and optimize healthcare processes supported by the EMR system. DMAIC provides a structured approach for defining, measuring, improving, and continuously controlling workflows [10, 11]. Integrating BPM with EMR enabled identification of duplicate or inefficient processes, guided workflow redesign, and established performance evaluation standards for sustained quality improvement.

To assess workflow efficiency, process activities were classified into value-adding (VA), business-value-adding (BVA), and non-value-adding (NVA) categories. This approach allowed systematic evaluation of patient registration, consultation, and laboratory processes, distinguishing tasks that directly enhance patient care, those required for operational compliance, and those representing inefficiencies or waste. This classification, informed by the Lean Six Sigma literature [12, 13], structured both qualitative and

quantitative analyses and guided workflow redesign to reduce patient waiting times and improve service effectiveness.

Data were collected using structured questionnaires administered to patients and healthcare providers. Questionnaires were selected as an effective tool for capturing targeted information to address the research objectives [14]. Collected data informed process mapping, including data flow diagrams and supplier-input-process-output-customer (SIPOC) models, providing a high-level understanding of EMR workflows and supporting informed decision-making [15].

The DMAIC methodology guided workflow improvement through five key phases. In the *define* phase, research objectives, scope, and success criteria were established, and the current (As-Is) EMR processes were mapped to identify areas for improvement. The *measure* phase quantified workflow performance and categorized activities into VA, BVA, and NVA. The *analyze* phase applied tools such as cause-and-effect diagrams to identify root causes of inefficiencies. In the *improve* phase, workflows were redesigned (To-Be model) to prioritize value-adding activities and reduce patient waiting times. Finally, the *control* phase established performance standards and process monitoring mechanisms to ensure sustained improvements and ongoing optimization of EMR-supported healthcare processes.

2.1 Sampling and Approach

MNH has eight directorates: medical services, surgical services, clinical support services, nursing and housekeeping, technical services, finance and planning, information and communication technology, and human resources. In this study, BPM was applied in the medical, surgical, clinical support, and information and communication technology domains, which oversee outpatient registration, consultation, and laboratory processes. Accordingly, the sample was drawn from staff and patients involved in these workflows.

The sample size was determined using Taro Yamane's formula at a 95% confidence level and a 0.05 precision level, based on simple random sampling [16]. The targeted staff population comprised 50 medical doctors, 15 medical recorders, 15 cashiers, and 20 laboratory technicians. Using the formula, a staff sample size of 80 was obtained (as proportional sample of 40 doctors, 24 cashier/recorders and 16 technicians). In addition, with an estimated 500 outpatient visits per day, the patient sample size was calculated as 200 patients. Thus, the study involved 80 staff members and 200 outpatient patients. All participants were recruited after providing informed consent and being fully informed about the purpose of the study.

2.2 Data Analysis

Quantitative data were analyzed to describe participants' experiences and perceptions of the registration, consultation, and laboratory processes. Questionnaire responses were cleaned, coded, and analyzed using SPSS version 21.0. Descriptive statistics metrics, specifically frequencies, percentages, means, medians, and standard deviations, were used to summarize participant characteristics and healthcare process measures. Frequencies and percentages were used for categorical variables, while means and standard deviations were used for continuous variables; medians were used for ordinal or non-normally distributed measures. The analysis focused on characterizing current process performance and identifying patterns in patient experiences and workflow characteristics rather than testing statistical associations or differences between groups.

Process durations at the registration, consultation, and laboratory service points were assessed using self-reported estimates obtained through the structured questionnaire. For each service point, respondents were asked to estimate the typical time required to complete or undergo the respective service. For example, patient registration was assessed using the question *"How long (in minutes) do you typically take to complete the patient registration?"* Respondents provided their own estimate of the typical duration. These measures, therefore, represented self-reported process durations rather than objectively recorded waiting or service times and may be subject to recall and perception bias. Patients who did not proceed to or require a particular service point were excluded from the corresponding analysis.

The quantitative findings supported the *Measure* and *Analyze* phases of the DMAIC methodology by characterizing current process performance, identifying potential sources of delay and workflow inefficiency, and classifying process activities as value-adding, business-value-adding, or non-value-adding.

Qualitative data from open-ended questionnaire responses were reviewed and analyzed thematically to identify key issues related to the healthcare processes and their implementation within the EMR system. The quantitative and qualitative findings were subsequently integrated to establish performance evaluation standards for the selected healthcare processes and to identify opportunities for workflow improvement.

3. Results

3.1 Participants Demographics

The study included 200 outpatient patients and 80 HCPs at MNH. Among patients, 78.5% were follow-up visits and 21.5% were new patients, reflecting a predominance of ongoing care. The sample was 55.8% male and 44.2% female, with the majority (71.5%) categorized as private patients (cash or insured), while 28.5% were under public cost-sharing schemes (Table 1).

HCPs comprised cashiers/medical recorders, doctors, and laboratory personnel, providing a comprehensive view of outpatient workflows (Table 1). The cashier/medical recorder group showed balanced gender distribution and was largely composed of bachelor's degree holders. Doctors represented diverse roles, including medical officers, specialists, and physiotherapists, with varied educational backgrounds ranging from diploma to PhD level. Similarly, the laboratory cadre included technicians, technologists, and scientists with mixed levels of training and specialization.

The study population reflects a diverse and multidisciplinary cohort, enabling comprehensive insights into healthcare process performance and identifying areas for workflow improvement. Note also that the population comprised predominantly follow-up patients and a multidisciplinary HCP workforce with varied roles and educational backgrounds, providing a comprehensive basis for evaluating healthcare workflows.

3.2 Existing Healthcare Processes

The existing outpatient workflows at MNH were characterized through surveys of patients and HCPs, covering visit patterns, patient volumes, process durations, and workflow familiarity. The outpatient EMR process interactions are presented in Figure 1, providing a baseline for identifying workflow inefficiencies and optimization opportunities. Follow-up visits predominated (78.5%), with patients averaging 5.95 visits (median = 5; range = 1–20). Mean waiting times were 15.57 minutes for registration (median = 13.5; mode = 10; SD = 9.50; range = 2–45), 21.71 minutes for consultation (median = 20; mode = 20;

Table 1. Summary of participant demographics (Patients and HCPs).

Category	Variable	Key Distribution (%)
Patients (N=200)	Visit Type	Follow-up (78.5), New (21.5)
	Gender	Male (55.8), Female (44.2)
	Payment Category	Private (71.5), Public/Cost-sharing (28.5)
HCPs (N=80)	Cadre Composition	Cashiers/Recorders (24), Doctors (40), Laboratory Personnel (16)
	Gender(overall trend)	Predominantly male across cadres
	Education	Majority Bachelor's, followed by Diploma and few Master's/PhD
	Professional Roles	Doctors (medical officers, specialists, physiotherapists); Laboratory staff (technicians, technologists, scientists)

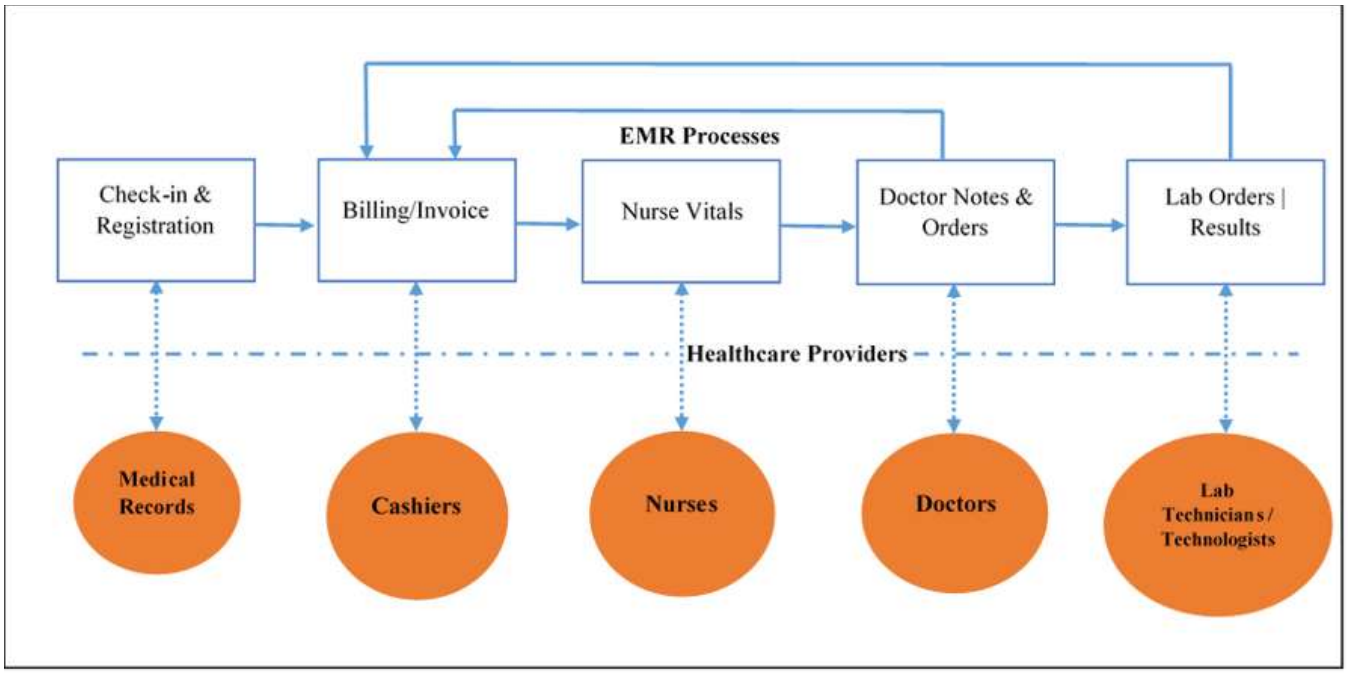


Figure 1. A sketchy view of MNH outpatient EMR processes.

SD = 14.74; range = 6–180), and 12.97 minutes for laboratory services (median = 10; mode = 5; SD = 12.47; range = 3–60).

As shown in Table 2, 55% of patients waited ≤15 minutes for registration, compared with 61.5% for laboratory services and only 24.5% for consultation; nearly half waited 16–30 minutes for consultation. Table 2 demonstrate considerable variability across outpatient processes, with consultation emerging as the principal bottleneck and therefore a priority area for BPM-driven process optimization.

Note: Although the study included 200 patients, the number of valid observations varied across

workflow stages. This variation was attributable to two circumstances: some patients did not proceed to or require a particular service point, while some questionnaires contained incomplete responses for specific measures. Consequently, 160 valid observations were available for registration, while 157 were available for consultation and laboratory measurements. Analyses were, therefore, conducted using the valid observations applicable to each workflow stage, with the corresponding sample size (n) reported in Table 2. The reduced analytical sample may affect the precision and interpretation of the estimates and was consideredwhen interpreting the findings.

3.3 Patient and HCP Perspectives in the Current Healthcare Processes

Patient experiences with outpatient registration, consultation, and laboratory workflows, together with HCP experience in their current positions, were examined to describe the current healthcare processes. Patients were asked about their understanding of the healthcare process during treatment. Results showed that 98.5% of patients reported difficulty understanding the process during their first visit, while only 1.5% reported that they found it easy. This finding indicates a substantial challenge in patients' understanding of the healthcare process and highlights the need for clearer guidance and communication during initial patient encounters.

HCPs' experience in current positions is summarized in Table 3. A substantial proportion of front-line staff reported having less than five years of experience, including 58.6% of cashiers/medical recorders, 38.0% of doctors, and 34.0% of laboratory staff. These findings provide a descriptive indication of the experience profile of staff involved in different stages of the outpatient process. However, because the study used descriptive analysis and did not perform inferential tests, the findings do not establish a statistical relationship between HCP experience and patient understanding, waiting time, satisfaction, or other patient outcomes. The observed experience profile may, nevertheless, help explain how patients receive guidance and navigate the healthcare process. Its relevance warrants further investigation.

Table 2. Summary of outpatient visits and waiting times.

Process/Metric	N (Valid)	Mean (min)	Median (min)	Mode (min)	SD (min)	Range (min)	≤15 min (%)	16–30 min (%)	31–60 min (%)	Notes
Patient Revisits (Follow-up)	160	5.95	5	5	3.01	1–20	–	–	–	Shows visit frequency and variability
Registration	160	15.57	13.5	10	9.50	2–45	55	20	5	High variability contributes to waiting times
Consultation	157	21.71	20	20	14.74	6–180	24.5	47.5	5	Primary contributor to long waits
Laboratory	157	12.97	10	5	12.47	3–60	61.5	8	7	Mostly efficient, some delays exist

Table 3. HCP experience in current positions.

HCP Group	<5 years	>= 5 years	Total
Cashiers/Medical Recorders	58.6%	41.4%	100%
Doctors	38.0%	62.0%	100%
Laboratory Staff	34.0%	66.0%	100%

Despite the reported challenges in process comprehension, overall patient satisfaction with the healthcare process was high. As shown in Figure 2, 95.0% of patients reported satisfaction with the overall outpatient process, 87.5% with doctor appointments, 94.0% with treatment plans, 94.5% with process coordination, and 95.0% with time spent with the doctor. These findings indicate that high levels of reported satisfaction coexisted with substantial difficulties in understanding the healthcare process during initial visits. This observation suggests that patient satisfaction and process comprehension represent distinct aspects of the patient experience and should, therefore, be considered separately when evaluating and improving outpatient healthcare processes.

3.4 Improvement of Process Flow

To identify opportunities for enhancing outpatient services, patients were asked for feedback on reducing waiting times and improving the overall healthcare process. Responses were collected through open-ended questions and analyzed thematically. Key themes emerged from patient suggestions, highlighting long waiting times, inadequate communication, inefficient coordination among healthcare staff, and the need to revise or simplify service processes.

Table 4 summarizes the frequency and relative importance of these suggestions. The most prominent concern was reducing waiting time (31.9%), followed by improving overall services (21.8%), increasing the number of doctors and healthcare providers (17.1%), simplifying service processes (10.1%), and improving communication (6.4%). Minor suggestions related to privacy, patient support, and information systems were combined under a single theme category of ensure

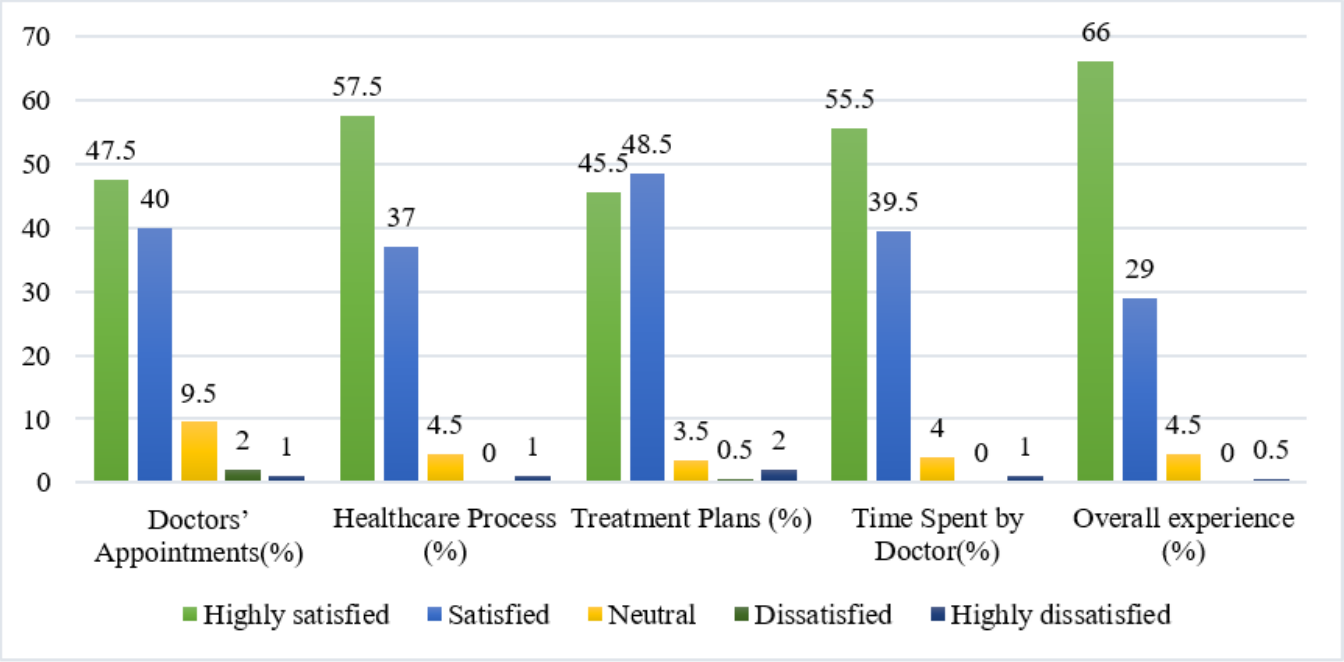


Figure 2. Satisfaction with healthcare process (N=200).

privacy / patient support / info systems (12.8%).

Table 4. Key patient suggestions for improving healthcare process flow

Key Theme / Suggestion	Frequency	Percent (%)
Reduce waiting time	60	31.9
Improve overall services	41	21.8
Increase number of doctors / HCPs	32	17.1
Revise / simplify service process	19	10.1
Improve communication	12	6.4
Ensure privacy / patient support / info systems	24	12.8

Note from Table 4 that minor individual suggestions, such as training staff to expert levels, establishing an information center, and cost reduction are incorporated under "Ensure privacy / patient support / info systems" for clarity. These findings underscore the need to adopt BPM to streamline EMR workflows, optimize staff coordination, and enhance patient experience at MNH. Addressing these areas through strategic planning, resource allocation, and process optimization can improve service efficiency, reduce waiting times, and ensure patient-centered care that meets the expectations of both new and follow-up patients.

3.5 Identification of Value-Added, Business Value-Added, and Non-Value-Added Activities

According to the Lean Six Sigma principles, VA activities are those that directly enhance patient care and service quality, while NVA activities represent inefficiencies that do not contribute to patient outcomes [17]. The outpatient workflows were analyzed to classify VA, BVA, and NVA activities across registration, consultation, and laboratory processes, with the aim of reducing waiting times and improving healthcare service delivery (Tables 2 & 4, Figure 2).

In the registration process, VA activities included organized registration and accurate data capture through the EMR system, which enhance efficiency and patient experience. BVA activities were reflected in EMR-enabled workflow integration and improved service accessibility. However, NVA activities, such as multiple registration entry points and post-registration billing, introduced redundancy and delays. This is supported by patient perceptions in Table 5, where 32.5% expressed dissatisfaction with the single-entry registration system despite high ratings for service accessibility (60.5%) and organization (53.0%). These inefficiencies contribute to variability in registration time (mean = 15.57 minutes) (Table 2), indicating opportunities for workflow simplification.

In the consultation process, VA activities included meaningful doctor–patient interaction, active listening, and effective treatment planning, which are essential for quality care delivery. BVA activities involved streamlined workflows that maintain a median waiting time of 20 minutes (Table 4), supporting operational efficiency. NVA activities were identified in redundant documentation and separate billing procedures for laboratory and radiology services. As shown in Table 5, high satisfaction levels were reported for time spent with doctors (55.5%) and overall experience (66.0%), aligning with overall satisfaction levels exceeding 95% (Figure 2). However, patient feedback highlighted the need for additional doctors (Table 4), indicating capacity-related constraints that may affect service efficiency.

For the laboratory process, VA activities included timely testing, accurate results, and rapid turnaround, which support effective diagnosis and treatment. BVA activities were linked to EMR integration of laboratory orders and results, enhancing coordination and continuity of care.

NVA activities included redundant cashier billing for tests already processed through EMR, leading to unnecessary delays. Although laboratory waiting times were relatively shorter (mean = 12.97 minutes) (Table 2), observed variability suggests further opportunities for process optimization.

Overall, the integration of patient perception data (Table 5), waiting time metrics (Table 2), and patient feedback (Table 4) demonstrates that while VA and BVA activities contribute to high patient satisfaction (Figure 2), persistent NVA activities—particularly redundant processes and fragmented workflows—limit system efficiency. Consistent with Lean Six Sigma principles, eliminating these inefficiencies through BPM can streamline workflows, reduce waiting times, and enhance patient-centered healthcare delivery [17].

Hence, while patient satisfaction remains high, the persistence of NVA activities—particularly in registration and billing—highlights the need for workflow integration and simplification. Addressing these inefficiencies through BPM aligns with Lean Six Sigma principles and is essential for improving operational efficiency and reducing waiting times [17].

3.6 Healthcare Process Model

Continuous improvement of healthcare processes is essential for reducing waiting times, improving service quality, and strengthening operational efficiency. Within the DMAIC framework, assessment of the existing As-Is outpatient process at MNH provided the basis for developing a refined To-Be model. The SIPOC analysis (Figure 3) provided a high-level view of suppliers, inputs, process activities, outputs, and customers, while the cause-and-effect analysis (Figure 4) identified the root causes of process inefficiencies. Together with patient feedback summarized in Table 5, these analyses informed the As-Is process model (Figure 5) and identified bottlenecks across registration, consultation, and laboratory services.

Table 5. Patient perceptions of registration and consultation processes (N = 200).

Process	Indicator	Strongly Agree / Highly Satisfied (%)	Agree / Satisfied (%)	Neutral (%)	Dissatisfied (%)
Registration	Service information availability	63.0	29.0	4.5	3.5
	Reasonable registration time	44.0	44.0	8.5	3.5
	Organized registration process	53.0	39.5	6.0	1.5
	Single-entry registration system	28.0	31.5	8.0	32.5
	Service accessibility	60.5	29.0	5.5	5.0
Consultation	Doctor's appointment	47.5	40.0	9.5	3.0
	Process coordination	57.5	37.0	4.5	1.0
	Treatment effectiveness	45.5	48.5	3.5	2.5



Figure 3. SIPOC diagram.

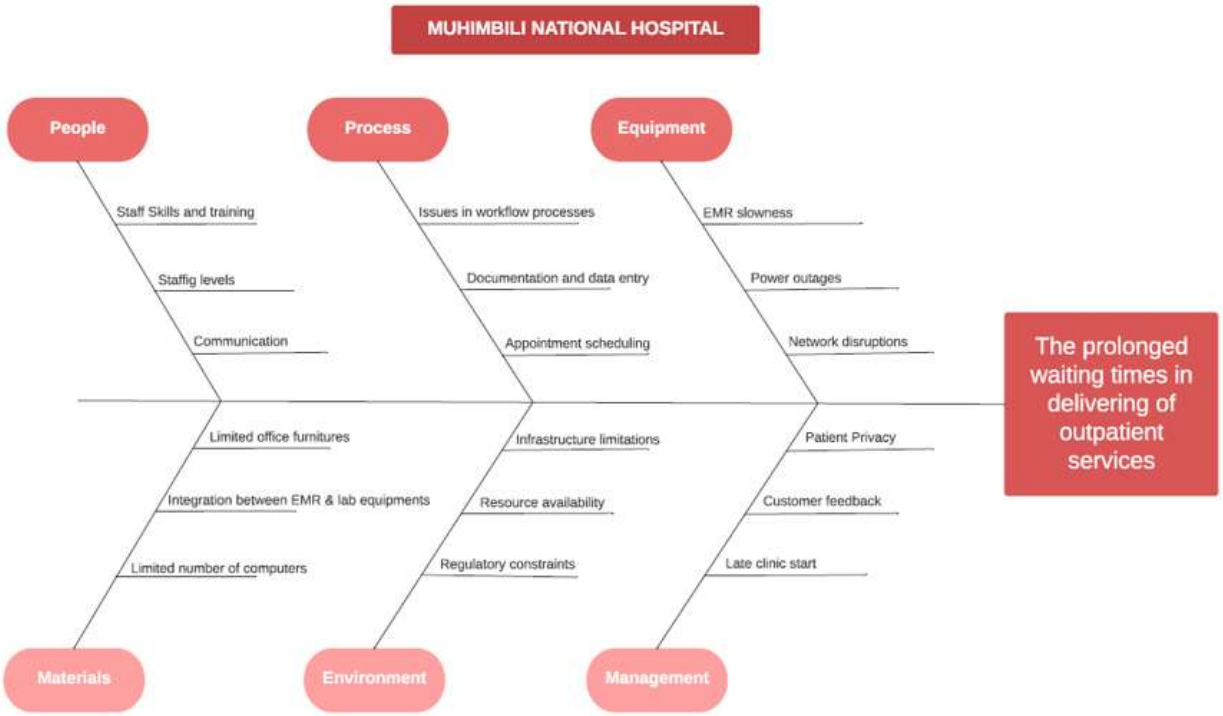


Figure 4. Cause and effect diagram.

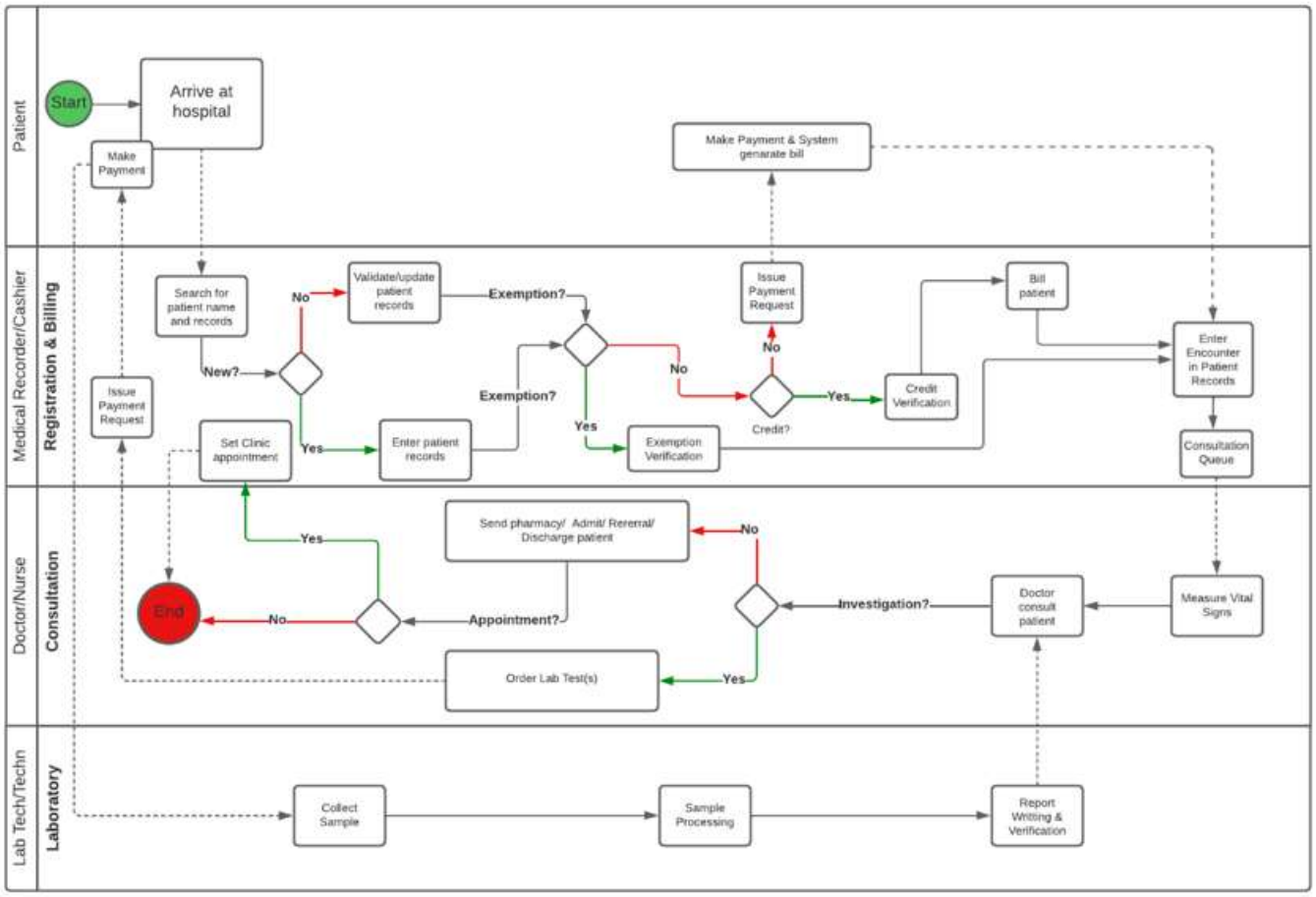


Figure 5. Existing healthcare process model (As-Is Model).

The As-Is workflow, largely supported by the JEEVA EMR, revealed duplication of roles, fragmented communication, multiple process entry points, and redundant billing activities. At registration, duplication between medical recorders and cashiers contributed to redundant billing steps and a mean waiting time of approximately 15 minutes. During consultation, although EMR access to patient history supported clinical decision-making, appointment scheduling and billing required patients to return to registration, creating additional delays. Laboratory services benefited from EMR-supported test processing and reporting, but redundant billing procedures remained. Based on these findings, the To-Be model (Figure 6) was designed to eliminate non-value-added activities, consolidate related functions, and improve EMR-supported coordination.

Key changes include integrating registration and billing into a single activity performed by medical recorders, introducing a unique patient identifier generated and managed within the hospital's EMR system to facilitate rapid record retrieval and prevent duplicate registrations [18]. This identifier would support consistent identification and linkage of patient records across registration, consultation, laboratory, billing, and appointment processes while reducing duplicate

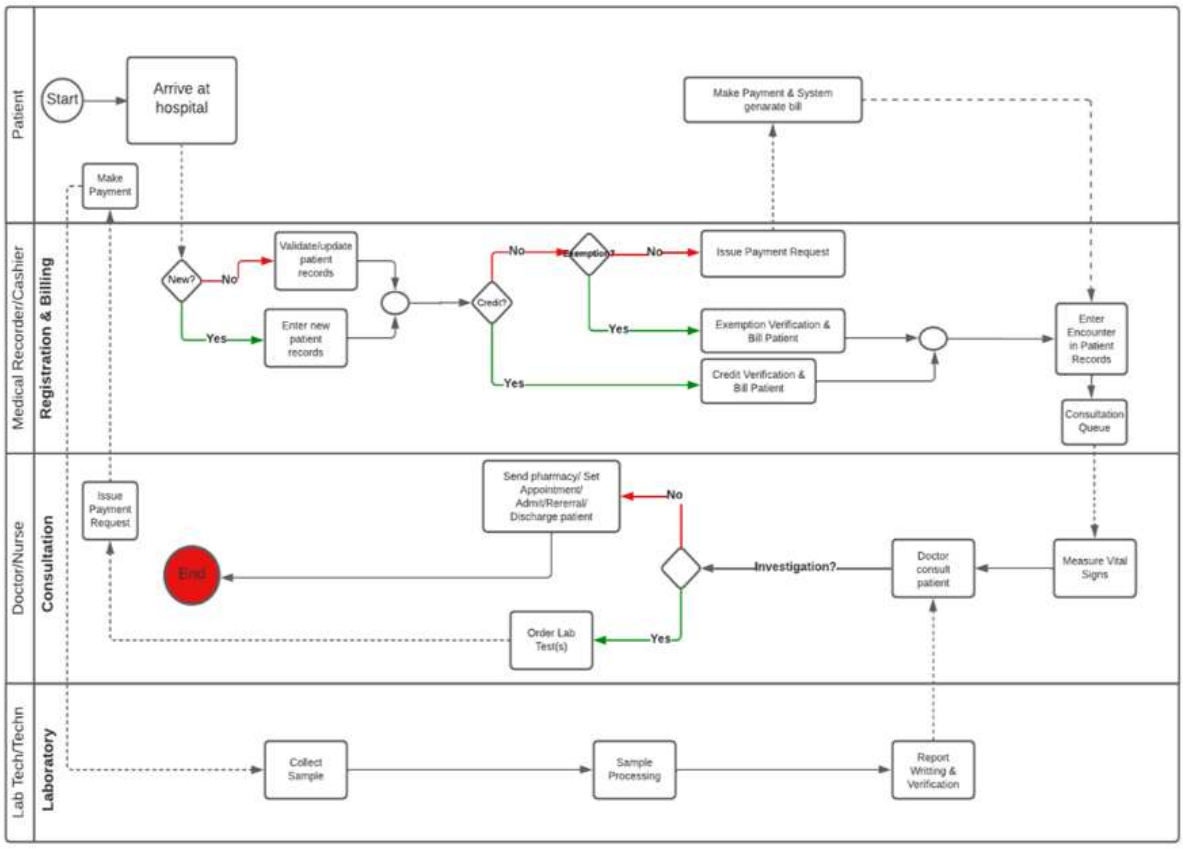


Figure 6. Refined healthcare process (To-Be Model).

registration and unnecessary collection or sharing of personal identifiers. Access to identifiable patient information should remain subject to appropriate role-based access controls, confidentiality requirements, audit trails, and applicable health-information and data-protection policies, enabling doctors to schedule appointments and initiate billing directly through the EMR [19], and strengthening laboratory integration through turnaround-time (TAT) monitoring [20]. Overall, the transition from As-Is to To-Be (Figures 5 and 6) incorporates the inefficiencies identified through Figures 3–4 and Table 5, while streamlining process steps, reducing unnecessary patient movement and waiting, and strengthening coordination and operational efficiency within the MNH outpatient workflow.

4. Discussion

Prolonged patient waiting times remain a critical challenge in healthcare systems, negatively affecting service quality, patient satisfaction, and workflow efficiency. HCPs consistently identify waiting time as a major operational burden, contributing to patient dissatisfaction and disruptions in service delivery [21]. Addressing this challenge requires a sustained commitment to continuous workflow improvement, which is recognized as an ongoing and systematic approach to enhancing healthcare quality and outcomes [22]. The study demonstrates the value of integrating BPM with EMR to optimize outpatient workflows at MNH. Consistent with existing literature, BPM facilitates the identification and elimination of inefficiencies, enabling healthcare providers to

focus on delivering patient-centered care while improving operational efficiency [23].

The findings revealed significant inefficiencies in the registration process, particularly among follow-up patients, where a substantial proportion of the patients experienced waiting times exceeding 30 minutes. This inefficiency highlights that familiarity with the system does not necessarily translate into faster service, underscoring structural workflow limitations. These findings are consistent with evidence from Nigeria, where a majority of patients spend over two hours before receiving medical care [24]. Additionally, dissatisfaction with multiple registration points (32.5%) indicates the need for process simplification and integration.

Prior studies emphasize that centralized registration systems can significantly reduce delays and improve patient flow [25]. Similarly, the presence of redundant activities, such as separate billing procedures after consultation, contributes to non-value-added processes that increase waiting times and workload. The proposed To-Be model addresses these inefficiencies through workflow integration, task consolidation, and enhanced EMR utilization. Consistent with prior research, successful implementation of such models requires continuous monitoring, process evaluation, and staff capacity building [26]. Overall, the findings reinforce the importance of BPM-driven interventions in improving healthcare efficiency, reducing waiting times, and strengthening patient-centered service delivery.

The proposed To-Be workflow should be regarded as an evidence-informed process redesign rather than an empirically validated intervention. Although it addresses bottlenecks identified in the As-Is process, its effects on patient waiting time, throughput, resource utilization, and operational efficiency remain to be established. Moreover, implementation may require EMR software modification, revised authorization and access structures, staff training, infrastructure investment, and organizational change. These technical, financial, organizational, and implementation considerations, including feasibility, staff readiness, adoption, fidelity, usability, acceptance, and potential resistance to change, were not systematically evaluated in the present study.

Future implementation should therefore be preceded by a feasibility and prospective evaluation study comparing baseline and post-implementation performance. Key measures should include total patient waiting time, time spent at individual process stages, queue length, patient throughput, process completion time, and resource utilization. Implementation outcomes should additionally assess feasibility, adoption, fidelity, usability, and staff acceptance, while cost analysis should be undertaken where feasible to determine the resources required to implement and sustain the redesigned workflow. Statistical comparison of pre- and post-implementation measures would provide empirical evidence of whether the proposed workflow produces measurable improvements beyond those identified through process modelling.

5. Study Limitations

Several limitations should be considered when interpreting the findings. First, process durations were based on respondents' self-reported estimates in minutes rather than objectively recorded timestamps. The reported durations may therefore be subject to recall and perception bias and may not precisely reflect actual waiting or service times. Future studies should complement self-reported measures with objective workflow data, such as EMR timestamps, direct observation, or time-motion studies.

Second, the study identified workflow inefficiencies and proposed process improvements but did not undertake a detailed feasibility or implementation assessment. The costs and

requirements associated with EMR modification, infrastructure, staff training, authorization structures, organizational readiness, and change management, as well as potential implementation risks, were not evaluated. Prospective feasibility and implementation studies are, therefore, needed to establish the technical, organizational, and resource requirements.

Finally, the study was conducted at a single tertiary healthcare facility, MNH, during one study period. The findings are, therefore, context-specific and should not be assumed to be statistically generalizable to other hospitals, where patient volumes, staffing, organizational arrangements, EMR maturity, infrastructure, and workflow configurations may differ. Validation of the proposed workflow across other healthcare settings and operational contexts is necessary before broader application.

6. Ethical Considerations

Ethical approval and research permission was obtained from the University of Dar es Salaam and the MNH Institutional Review Board (MNH-IRB) (Appendix). The study was conducted in accordance with the principles of the Declaration of Helsinki. Participants provided informed consent in either English or Kiswahili after being informed about the purpose of the study, the procedures involved, their voluntary participation, and their right to withdraw at any time without consequences. To protect confidentiality, participants were assigned unique identification codes, and no direct personal identifiers were included in the analytical dataset. Data were securely stored, with access restricted to authorized members of the research team.

7. Conclusion

This study demonstrated the value of applying BPM and DMAIC process improvement methodologies to systematically examine EMR-supported outpatient workflows at MNH. The analysis identified critical inefficiencies in registration, consultation, and laboratory processes, particularly redundant tasks, fragmented workflows, duplicated billing activities, and prolonged waiting times. Although patients reported generally high levels of satisfaction, the findings indicate that important process inefficiencies persist, particularly in registration for follow-up patients and in duplicated billing procedures. These non-value-added activities contribute to increased waiting times and constrain operational efficiency.

The proposed To-Be model provides an evidence-informed process redesign intended to address the identified bottlenecks through greater process integration, elimination of redundant steps, and improved use of existing EMR functionalities. Proposed changes, including consolidation of registration and billing, use of unique patient identifiers, and decentralization of appointment scheduling and billing, have the potential to reduce unnecessary process steps and improve workflow efficiency. However, because the To-Be model was not implemented and evaluated during the study period, its effects on waiting time, operational performance, cost, scalability, and sustainability cannot be established from the present study.

Overall, the study highlights the importance of continuous process assessment and optimization in EMR-supported healthcare environments. The findings provide a basis for prospective implementation and evaluation of the proposed workflow, including measurement of waiting times, process performance, resource requirements, implementation outcomes, and user experience before and after implementation. Such evaluation would provide evidence on the effectiveness, feasibility, scalability, and sustainability of the redesigned workflow and its adaptability to other healthcare settings.

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CONTRIBUTIONS OF CO-AUTHORS

William Stuart Chimwege		Data collection, analysis and initial paper draft
Godfrey Njulumi Justo	ORCID: 0000-0003-2003-3320	Draft paper review, formatting and finalization

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