Journal of Medicine, Nursing & Public Health

Influence of Technological Factors on Performance of Electronic Queue Management Systems Among Outpatients in Radiant Group of Hospitals, Nairobi City County, Kenya

Chepkemoi Naomi, Dr. Peter Kithuka, PhD & Dr. Emma Kabeu, PhD

ISSN: 2706-6606

Stratford Peer Reviewed Journals and Book Publishing
Journal of Medicine, Nursing & Public Health
Volume 8||Issue 3 ||Page 1-11||August|2025|
Email: info@stratfordjournals.org ISSN: 2706-6606

Influence of Technological Factors on Performance of Electronic Queue Management Systems Among Outpatients in Radiant Group of Hospitals, Nairobi City County, Kenya

[1*]Chepkemoi Naomi, [2]Dr. Peter Kithuka, PhD & [3]Dr. Emma Kabeu, PhD
[1]Master's student, Department of Health Management and Informatics, Kenyatta University
[2&3]Lecturers, Department of Health Management and Informatics, Kenyatta University
***Email of the Corresponding Author: chepsnaomi.cn@gmail.com**

How to cite this article: **Naomi, C., Kithuka, P., & Kabeu, E. (2025). Influence of Technological Factors on Performance of Electronic Queue Management Systems Among Outpatients in Radiant Group of Hospitals, Nairobi City County, Kenya.** ***Journal of Medicine, Nursing & Public Health*****, 8 (3), 1-11. https://doi.org/10.53819/81018102t5376**

Abstract

Long waiting times and congested queues in healthcare facilities worldwide have led to the adoption of Electronic Queue Management Systems (EQMS) to streamline service delivery, but their effectiveness depends critically on the performance of underlying technological components. Thus, this study sought to examine the influence of perceived technological factors on the performance of EQMS among outpatients at the Radiant Group of Hospitals in Nairobi City County. The study employed a cross-sectional design anchored on the Technology Acceptance Model (TAM) and Queue Management Theory (QMT), targeting patients in the outpatient department. A stratified proportionate sampling approach was used to select 335 respondents from a population of 1,460 patients, while key informants were identified purposively. Data were collected through structured questionnaires and key informant interviews and analyzed using both quantitative and qualitative methods, with findings presented in tables, charts, and narratives. The results revealed that technological factors significantly influenced EQMS performance. Key positive determinants included system capacity (OR=1.589, p=0.002), adherence to queue discipline (OR=0.923, p=0.043), and reduced waiting time delays (OR=1.129, p=0.021). Conversely, technical challenges such as system malfunctions (OR=1.509, p=0.052) and unreliable internet connectivity (OR=0.826, p=0.001) emerged as notable barriers to effective system use. The study concludes that the success of EQMS is highly dependent on its technological robustness, reliability, and user-friendliness. The study recommends the integration of a mobile application for real-time queue updates, the introduction of multilingual interfaces to improve accessibility for diverse patient demographics and the incorporation of voice-guided instructions and braille signage to support patients with special needs.

Keywords: *Electronic Queue Management System, Technological Factors, System Usability, Healthcare Technology, Patient experience, Service Automation*

1.0 Background to the Study

Patient satisfaction has long been recognized as a key indicator of healthcare quality and overall system responsiveness (Manzoor et al., 2019). Among the multiple factors influencing satisfaction, waiting time stands out as one of the most critical, as extended delays not only affect patient perceptions but also increase indirect costs of care such as time lost from work and travel expenses (Ng & Luk, 2019). To address these inefficiencies, the World Health Organization (WHO) advocates for responsive health systems that prioritize timely service delivery and patient-centered care (Larson et al., 2019). Achieving these objectives requires well-coordinated processes, reliable information systems, and effective service delivery mechanisms (WHO, 2010; Orton, 2018). However, when patients spend prolonged periods in waiting areas, it often signals inefficiencies in health system operations, which in turn negatively impacts trust and overall patient experience (Lolonyo, 2017; Yang & Takakuwa, 2017). Globally, long queues and overcrowding in outpatient departments remain a pressing challenge in healthcare service delivery. In high-income countries such as the United States, it is estimated that Americans collectively spend 37 billion hours annually waiting in lines, including in healthcare facilities (Weiss et al., 2020).

In low- and middle-income countries, the problem is more severe due to structural limitations in health systems, contributing to extended waiting times in outpatient clinics (Kelen et al., 2021). For example, a study in Iran identified physician delays as a significant contributor to increased outpatient waiting times (Aeenparast et al., 2019), while research in Nigeria and Ghana reported that public hospitals face the worst scenarios where patients wait for hours without accessing care (Aniete et al., 2021). This global challenge underscores the urgent need for interventions such as EQMS to improve patient flow, reduce congestion, and enhance overall efficiency in outpatient departments. In Kenya, studies have documented similar challenges in outpatient service delivery, highlighting long queues and extended waiting times as persistent concerns in both public and private healthcare facilities (Abdulle, 2021; Mueni et al., 2019).

Congestion in outpatient waiting areas consumes significant hospital space and inconveniences patients, many of whom could have benefited from scheduled appointments at more convenient times. While the adoption of EQMS in some Kenyan hospitals has improved queue organization and patient engagement, its performance largely depends on technological reliability. System capacity, internet connectivity, and the ability to deliver real-time notifications are essential for EQMS to function effectively. When these components fail, hospitals risk undermining service efficiency and patient trust in digital solutions. Therefore, investigating the role of technological factors in the success of EQMS implementation is critical for enhancing patient satisfaction and achieving operational efficiency in outpatient care settings.

1.1 Statement of the Problem

The introduction of EQMS in healthcare facilities aims to optimize patient flow, minimize waiting times, and enhance patient satisfaction in outpatient clinics. Radiant Group of Hospitals adopted an EQMS to achieve these objectives, but the system's success heavily depends on technological elements such as hardware reliability, software functionality, and internet connectivity. Limited studies have explored how technological factors influence system performance within outpatient settings. Although EQMS has demonstrated benefits in improving service delivery globally, research in Kenya has been sparse, with most studies focusing on its application in non-healthcare sectors like banking (Genga, 2018; Okello et al., 2019). The few health-related studies, such as that by Kegoro and Ochieng (2021), only examined automated queue systems during the Covid-19

pandemic in public hospitals, without addressing specific technological aspects critical to system efficiency and patient experience. This lack of localized evidence underscores the need for further research into how technological components affect the functionality of EQMS in private hospital settings. Consequently, this study aims to examine the technological factors influencing the performance of the Electronic Queue Management System in the outpatient department of Radiant Group of Hospitals, Nairobi County.

1.2 Research Objective

The purpose of this study was to assess the influence of technological factors on the performance of the Electronic Queue Management System in the outpatient department of Radiant Group of Hospitals, Nairobi City County.

1.3 Significance of the Study

The study is expected to be significant in providing evidence-based guidance for healthcare administrators, policymakers, and technology implementers across Kenya and similar healthcare contexts by establishing clear relationships between technological factors and EQMS performance in outpatient settings. The research will also fill a critical knowledge gap in African healthcare technology literature, where studies on queue management systems remain scarce, particularly in private hospital settings, thereby offering practical recommendations for system optimization including mobile integration, multilingual interfaces, and accessibility features that will directly benefit patient experience and operational efficiency. Additionally, healthcare institutions will gain valuable understanding of which technological components - such as system capacity, internet reliability, and user interface design - have the greatest impact on patient satisfaction and service delivery, enabling more strategic resource allocation and informed investment decisions in queue management technology. The findings will also serve as a foundation for future research on healthcare technology adoption in resource-constrained environments while providing Radiant Group of Hospitals and other healthcare facilities with actionable strategies to enhance patient flow, reduce waiting times, and improve overall service quality through technological improvements. Furthermore, the study will contribute to healthcare system optimization by demonstrating how proper EQMS implementation can strengthen workflow efficiency, enhance patient trust in digital health solutions, and ultimately improve healthcare outcomes through better service delivery mechanisms that prioritize patient-centered care and operational sustainability.

2.0 Literature Review

Studies have shown that many technological factors have significant influence on patients' healthcare experiences. Queue management systems uses software and hardware technology to help manage guest capacity, admissions, and movements within your venue (Guarte et al., 2022). Numerous organizations implemented queue systems to control queues of people in various settings. These systems mostly used are manual and suitable for smaller spaces with simple flows or automated for more extensive areas with complex flows. Automated queue management systems have mostly been employed in places such as hospitals, banks, post offices, and clinics to help streamline and manage customer flow. In another study, Bylayat et al., (2011) developed a microcontroller-based electronic queue control system designed to effectively manage queues with order and efficiency.

Additionally, Austria (2015) emphasized that electronic queue management systems enabled service providers to prevent service blockages at the counters by managing arrival times. They also

promoted fairness by allowing new customers to join existing queues. On the other hand, Dold & Khadjavi (2017) explored the concept of queue jumping by setting up lab-based simulations with groups of three people. In these scenarios, the person at the end of the line was given the option to pay the first person in order to move ahead and exit the experiment at the same time, effectively saving 20 minutes. Sadfar et al., (2020) introduced a queue management system which was optimized designed to enhance patient movement, particularly in situations where appointment systems were not in place. The researchers noted lack of appointment systems to an unpredictable pattern of patient arrivals. Furthermore, busy departments experienced sudden and substantial patient overloads, leading to the rapid formation of massive queues. For instance, in the Specialist Outpatient Department, which is the busiest, the hospital experienced an exceptionally high patient load on busy days. The queue situation severity was highlighted by the fact that many patients approximately 50-60 patients arrived early in the morning between 7-7:30 am.

Kuaban et al., (2020) also highlighted that, when the patient queue reached its capacity, other patients arriving at the hospital might opt not to join the queue, a phenomenon known as "patient balking." Additionally, even if patients chose to join the queue and then experienced lengthy waiting times or dissatisfaction with the healthcare services, they might choose to depart from the queue without obtaining the desired service, a behavior referred to as "patient reneging." Although EQMS offered numerous advantages, at times the system might not be reliable due to downtime or server failures due to internet strength. As noted by Farayibi (2016), system downtimes led customers to develop negative perceptions about the quality of services provided by the organization. The research further suggested provision of timely information to customers to enhance customer experience in the organization. Similarly, Yaduvanshi et al., (2019) noted queue delays might be caused by lack of a proper system for informing first-time visitors about registration, technical errors like printer problems and receptionists taking appointments over the phone.

Finally, the system response influence how long patients wait and how satisfied they are with the service. Titarmare et al., (2018) & Dianawati, (2019) emphasized that the overall efficiency of an entire service process, in terms of speed, starting from patient registration to the final discharge, played a crucial role in the formation of queues. Moreover, Okello et al., (2019) study on the capabilities of the EQMS and customer satisfaction in selected commercial banks within Nairobi County revealed that the speed at which services were delivered through EQMS was likely to influence how customers were satisfied which could be applicable to the healthcare sector as well.

3.0 Research Methodology

This study employed a cross-sectional research design to assess the influence of technological factors on the performance of an EQMS at Radiant Group of Hospitals in Nairobi County, Kenya. The target population comprised patients aged 18 years and above attending various outpatient service points at Radiant Group of Hospitals. A sample of 335 participants was drawn using stratified proportionate and systematic random sampling, while key hospital staff were purposively selected as informants. Data collection involved structured questionnaires with a 5-point Likert scale administered to patients, and semi-structured interviews conducted with selected hospital staff. Research instruments were developed based on the study objectives and pretested at a comparable facility to ensure clarity and internal consistency. Validity was ensured through expert review and pretesting, while reliability was assessed using Cronbach's Alpha, with all constructs achieving acceptable thresholds (≥0.7). Research assistants were trained to support the data collection process, and informed consent was obtained from all participants following ethical clearance from relevant

authorities. Quantitative data were analyzed using SPSS (version 29) to generate descriptive statistics and inferential results through chi-square tests and logistic regression to compute odds ratios and p-values. Qualitative data from interviews were analyzed thematically and used to enrich the quantitative findings. Ethical considerations were strictly adhered to, including approvals from Kenyatta University, NACOSTI, and the hospital's IRB, as well as ensuring voluntary participation, anonymity, and culturally sensitive communication.

4.0 Findings

The findings are presented in sections.

4.1 Response rate and composition of study participants

The study achieved a robust response rate of 91% with 304 out of 335 questionnaires returned fully completed and suitable for analysis, while 31 questionnaires were returned unfilled. This high response rate can be attributed to the researcher's clear communication to respondents about the study's purpose, the use of questionnaires designed for ease of completion, and systematic follow-ups to encourage participation from target respondents regarding their experiences with EQMS performance at Radiant Group of Hospitals in Nairobi City County. The demographic composition of participants demonstrated diverse age representation, with the largest proportion (28%) aged between 31-40 years, followed by those aged 21-30 years (26%) and 41-50 years (22%), while smaller percentages were aged above 60 years (12%), below 20 years (6%), and within the 51-60 age bracket (5%), indicating significant participation from youthful and middle-aged categories. Educational attainment analysis revealed that the majority of respondents had completed higher levels of education, with 40% holding university degrees, 37% having tertiary college education, 18% having attained secondary education, and only 5% having primary education as their highest level of schooling. Employment status showed that 58% of respondents were employed while 42% were not engaged in formal employment, creating a demographic composition that represents a well-educated sample with both working and non-working individuals across different age groups, thereby enhancing the validity and representativeness of the study findings.

4.2 Technological factors

The study's third objective was to assess how technological factors influence the performance of EQMS among outpatients at Radiant Group of Hospitals. Findings revealed that the majority of patients believed the system effectively handles the patient load, with 61% agreeing and 22% strongly agreeing that EQMS performs efficiently. A similarly high proportion (75%) supported the system's adherence to queue discipline, although a small portion (10%) expressed skepticism, likely due to inconsistent experiences or occasional technical issues. In terms of system delays, 61% of respondents disagreed that they experienced long waiting times due to EQMS capacity limitations, suggesting that most patients did not perceive this as a critical concern. However, 24% did report some delays, possibly due to temporary system overloads or staffing inefficiencies. On reliability, most respondents (60%) did not experience significant delays from technical failures. Still, 22% reported such issues, while 17% remained neutral, pointing to occasional reliability challenges. Internet connectivity was another concern—while 36% disagreed that it posed a problem, a sizable portion (31%) acknowledged unreliable connectivity, and 32% were unsure, indicating mixed user experiences. Positively, EQMS was perceived as fast and responsive, with 71% affirming the system's efficiency in providing timely visit-related information. Only a minimal 4% found it slow or unresponsive. Overall satisfaction was high, with 90% expressing approval of the system's ability

to manage patient load, speed, and reliability. These insights show that despite minor issues, the system is broadly accepted and considered effective by most outpatients.

The logistic regression analysis supported these observations, revealing statistically significant associations between technological variables and EQMS performance. System efficiency in handling patient load had a strong positive effect ($p = 0.002$, OR = 1.589), while poor queue discipline negatively impacted perceived performance ($p = 0.043$, OR = 0.923). Experience of delays due to capacity limitations also significantly affected user perception ($p = 0.021$, OR = 1.129). Technical downtimes were marginally significant ($p = 0.052$), while unreliable internet strongly decreased satisfaction ($p = 0.001$, OR = 0.826), emphasizing the critical role of connectivity in EQMS effectiveness. Further, system responsiveness ($p = 0.014$) and overall technological satisfaction ($p = 0.003$) were both significant predictors of EQMS performance. Patients who reported high satisfaction with these aspects were about 1.5 times more likely to view the system positively. These results underscore the importance of investing in reliable, fast, and well-structured technological infrastructure to sustain system performance and user satisfaction. This is summarized in table 1.

Table 1: Technological factors prediction on EQMS performance

Variable	Estimates	Odds Ratio (OR)	95% Confidence Level		P-value
Intercept	1.362	0.219	0.894	1.993	0.076
The electronic queue management system efficiently handles the number of patients it serves.	2.062	1.589	0.795	2.993	0.002
The EQM system follows the queue discipline when handling capacity - the first person who arrived will be served first	-1.209	0.923	0.884	1.693	0.043
I have experienced delays or long waiting times due to EQMS not having enough capacity to handle the patient load	1.121	1.129	0.694	0.983	0.021
There are instances we have to wait as hospital staff fixes technical issues in the EQMS	-1.742	1.509	1.294	1.393	0.052
The strength of internet is not reliable at times	1.327	0.826	0.871	1.294	0.001
The EQMS is fast and responsive when providing information about my visit	0.948	0.911	1.194	2.893	0.014
Generally, I am satisfied with how the EQMS handle the patient load, its speed and its reliability	1.629	1.501	0.994	1.799	0.003

4.3 Qualitative results from KII

The success of EQMS performance was also linked to its technological factors and the period since its implementation. In the key informant interview, several interviewees expressed confidence in EQMS since the time it was commissioned. The interviewees reported that the EQMS was installed at Radiant Group of Hospital 6 years ago and has been able to manage long queues and maintain order of services.

> "*I know this technology was installed and commissioned in 2019 and since then, I have seen patients entering and sitting down waiting for the machine to call their identification numbers allocated to them as they enter the hospital reception."*

Although the system was praised for its speed and efficiency, some challenges like system downtime and power issues were highlighted.

> "*Here, system downtime due to technical hitches and power failure has been an issue. Most of our clients are very impressed with how fast the services are offered to them, while a few tend to complain on delays especially, when we are experiencing internet breakdown or blackouts."*

Staff acknowledged improved workflow, reduced crowding, and enhanced order within the outpatient department as key benefits of EQMS.

> *"Like here, there is no pressure on nurses or security guards organizing patients to follow the queue since everyone who enters the reception area begins with the machine to get a waiting card. It takes a very short time to stand and get a ticket."*

Discipline in service delivery was also noted, particularly due to the first-come-first-served principle enforced through the EQMS. Another respondent noted:

> *"There has been equality in giving out services which has been based on the arrival time and first come first served principle except in cases of emergencies. This principle has instilled discipline to patients while queuing as they know they will be served in the order they arrived."*

These key informant interviews confirmed that EQMS was introduced in 2019 and has improved outpatient management by reducing queues, enhancing discipline through a first-come-first-served approach, and streamlining workflow. While system downtime and power issues occasionally disrupted operations, staff acknowledged the overall positive impact, including faster service delivery, minimal congestion, and equitable access to care. This qualitative evidence reinforces the quantitative results, emphasizing that technological efficiency, reliability, and responsiveness are central to the successful performance of EQMS in outpatient settings.

5.0 Discussion

This study examined the influence of technological factors on performance of EQMS among outpatients at Radiant Group of Hospitals. Technological performance of EQMS was generally rated positively by respondents, with 83% affirming it efficiently handles patient flow. Statistical analysis validated these perceptions (OR = 1.589, p = 0.002). Furthermore, 75% confirmed adherence to queue discipline, while a breakdown in discipline was linked to reduced satisfaction (OR = 0.923, p = 0.043). Though a portion of patients reported delays, those experiencing them were more likely to report poor system performance (OR = 1.129, p = 0.021). These results align

with prior findings by Sadfar et al. (2020) and Kuaban et al. (2020), emphasizing the risks posed by patient overload and unpredictable flows. While EQMS contributes to managing patient load, its impact can be undermined by technical setbacks and system bottlenecks.

The study established that EQMS was effective in managing patient flow, maintaining queue discipline, and handling patient load. Descriptive analysis indicated 83% of the respondents agreed that the EQMS efficiently handles the number of patients it serves. Further statistical tests affirmed that patients who believed the EQMS handles patient load efficiently were 1.6 times more likely to report better system performance ($p = 0.002$, Odds Ratio=1.589). In relation to queue discipline, 75% of the patients reported having followed the first come first served basis which was further supported by statistical results which indicated that lack of queue discipline negatively influences the patients experience and reduces performance ($p=0.043$, Odds Ratio=0.923). Moreover, many patients were in a disagreement that they have been experiencing long waiting times due to EQMS inability to handle patient load. Statistical tests indicated otherwise that patients who experienced delays were more likely to report poor system performance ($p=0.021$, Odds Ratio=1.129). These findings were in support with the previous researches that patient flow can be disrupted by unpredictable arrivals, patient overloads, and long waiting times (Sadfar et al., 2020 & Kuaban et al., 2020).

While the majority of respondents expressed satisfaction with EQMS efficiency, occasional technical disruptions, internet instability, and system failures were identified as challenges. Statistical test further revealed such challenges. Technical issues ($p=0.052$, Odds Ratio=1.509) were found to increase the likelihood of a negative experience by 50.9%. Unreliable internet lowers satisfaction and reduces system effectiveness by 17.4% ($p = 0.001$, Odds Ratio = 0.826). Some patients experienced delays due to these issues, though they were not widespread. Farayibi (2016) and Yaduvanshi et al., (2019) aligned with the study's findings on technical disruptions, noting that system downtimes, server failures, and lack of proper guidance can negatively affect service efficiency and patient satisfaction.

6.0 Conclusion

The study concludes that perceived technological factors strongly influence the performance of Electronic Queue Management Systems in outpatient settings at Radiant Group of Hospitals, Nairobi City County. Critical elements such as system reliability, capacity to manage patient flow, user-friendliness, and enforcement of queue discipline were found to significantly determine operational efficiency and patient satisfaction levels. The results underscore the importance of investing in robust and intuitive technological solutions that ensure consistent functionality and ease of use, thereby promoting effective adoption and utilization of EQMS in healthcare environments. The research demonstrates that when technological components function optimally, EQMS can successfully streamline patient flow, reduce waiting times, and enhance overall service delivery quality in outpatient departments. The findings reveal that system capacity to handle patient load, adherence to queue discipline principles, and reliable internet connectivity are fundamental determinants of EQMS success, while technical malfunctions and connectivity issues pose significant barriers to system effectiveness and user satisfaction. The study establishes that healthcare institutions must prioritize technological infrastructure reliability and user-centered design to maximize the benefits of EQMS implementation and achieve sustainable improvements in patient care delivery and operational efficiency.

7.0 Recommendation

The study recommends several technological enhancements to improve EQMS performance in healthcare settings. First, hospitals should enhance the system's reliability and responsiveness to minimize disruptions and ensure smooth patient flow, while incorporating multilingual options such as Kiswahili and designing more intuitive interfaces that cater to patients with varying literacy levels. Second, hospitals should integrate visible and audible queue notifications, voice-guided instructions, and Braille signage to make the system accessible to patients with visual or hearing impairments, ensuring inclusive service delivery for all patient populations. Third, hospitals should consider integrating a mobile application linked to the EQMS to improve convenience by allowing patients to manage appointments remotely, check queue status in real-time, and receive notifications about their turn without being physically present in waiting areas. Additionally, healthcare institutions should invest in reliable internet infrastructure and backup power systems to address connectivity issues and system downtime that negatively impact EQMS performance and patient satisfaction. The study also recommends regular system maintenance, staff training on troubleshooting technical issues, and continuous monitoring of system performance to identify and resolve potential problems before they affect patient experience. Future research should investigate specific technological design elements and usability factors that influence EQMS adoption and efficiency, explore cost-effectiveness of different technological configurations, and examine long-term sustainability of EQMS implementations in resource-constrained healthcare environments.

REFERENCES

Abdulle, F. A. (2021). *Evaluation of the impact of electronic queue management system on customer service in hospitals in Kenya: A case of Premier Hospital, Mombasa, Kenya*. (Doctoral dissertation). United States International University-Africa.

Aeenparast, A., Farzadi, F., Maftoon, F., & Yahyazadeh, H. (2019). Patient flow analysis in general hospitals: How clinical disciplines affect outpatient wait times. *Hospital Practices and Research*, 4(4), 128–133. https://doi.org/10.15171/hpr.2019.27

Aniete, P. A., & Efiok, N. J. (2021). Queue management benchmark for modelling patients' flow in Nigerian public hospitals. *Journal of Economics, Management and Trade*, 27(8), 17–27. https://doi.org/10.9734/jemt/2021/v27i830378

Austria, L. (2015). Queue management practices of quick service restaurants (QSR) in Lipa City. *Asian Pacific Journal of Multidisciplinary Research*, 3(5), 87–95.

Bylayat, M. H., Nahid, M. H., Moqbull, M. H., & Habibur, M. R. (2011). Design and development of microcontroller-based electronic queue control systems. In Students' Technology Symposium (pp. 4244–8943). IEEE. https://doi.org/10.1109/TechSym.2011.5783802

Dianawati, D. K. K. (2019). Pelayanan geriatri tingkat sederhana dalam upaya peningkatan kualitas hidup pasien geriatri di RS Tugu Ibu. *Indonesian Journal of Health Development*, 1(2), 35–39.

Dold, M., & Khadjavi, M. (2017). Jumping the queue: An experiment on procedural preferences. *Games and Economic Behavior*, 102, 127–137. https://doi.org/10.1016/j.geb.2016.11.002

Farayibi, A. O. (2016). Investigating the application of queue theory in the Nigerian banking system. https://econpapers.repec.org/paper/pramprapa/73614.htm

Genga, K. (2018). *Electronic queueing management system and customer service in commercial banks in Kenya: A case study of Kenya Commercial Bank* (Doctoral dissertation). University of Nairobi.

Guarte, E. S., Elsayed, F. F., & Khalil, S. I. (2022). Effect of queue management system on quality of nursing care and patient satisfaction. *Benha Journal of Applied Sciences*, 7(4), 181–192.

Kegoro, H. O. D., & Ochieng, J. (2021). Automated queue management systems on service delivery in public hospitals in Kenya during the Covid-19 era: A meta-analysis. http://librarycatalog.kwust.ac.ke:2051/xmlui/handle/123456789/312

Kelen, G. D., Wolfe, R., D'Onofrio, G., Mills, A. M., Diercks, D., Stern, S. A., & Sokolove, P. E. (2021). Emergency department crowding: The canary in the health care system. *NEJM Catalyst Innovations in Care Delivery*, 2(5). https://doi.org/10.1056/CAT.21.0117

Kuaban, G. S., Kumar, R., Soodan, B. S., & Czekalski, P. (2020). A multi-server queuing model with balking and correlated reneging with application in health care management. IEEE Access. https://doi.org/10.1109/ACCESS.2020.3007195

Larson, E., Sharma, J., Bohren, M. A., & Tunçalp, Ö. (2019). When the patient is the expert: Measuring patient experience and satisfaction with care. *Bulletin of the World Health Organization*, 97(8), 563–569. https://doi.org/10.2471/BLT.18.225201

Lolonyo, L. (2017). Assessing the effect of waiting times on restaurant service delivery in the Ho Municipality, Ghana. *European Business and Management*, 3(6), 113–119.

Manzoor, F., Wei, L., Hussain, A., Asif, M., & Shah, S. (2019). Patient satisfaction with health care services: An application of physician's behavior as a moderator. *International Journal of Environmental Research and Public Health*, 16(18), 3318. https://doi.org/10.3390/ijerph16183318

Mueni, S., Wanyonyi, S., Marangu, D., & Mong'are, D. (2019). Determinants and management of patient waiting time in the general outpatient department in Kibabii University Health Clinic, Kenya. *British Journal of Biomedical Science*, 2(4), 45016.

Ng, J. H., & Luk, B. H. (2019). Patient satisfaction: Concept analysis in the healthcare context. *Patient Education and Counseling*, 102(4), 790–796. https://doi.org/10.1016/j.pec.2018.11.013

Okello, N., & Nzuki, D. (2019). Electronic queue management system capability and customer satisfaction in selected commercial banks in Nairobi City County, Kenya. *International Journal of Arts and Commerce*, 8(8), 51–60.

Orton, M., Agarwal, S., Muhoza, P., Vasudevan, L., & Vu, A. (2018). Strengthening delivery of health services using digital devices. Global Health: Science and Practice, 6(Suppl 1), S61–S71. https://doi.org/10.9745/GHSP-D-18-00223

Safdar, K., Emrouznejad, A., & Dey, P. (2020). An optimized queue management system to improve patient flow in the absence of appointment system. *International Journal of Health Care Quality Assurance*, 33(7–8), 477–494. https://doi.org/10.1108/IJHCQA-03-2020-0048

Titarmare, N., & Yerlekar, A. (2018). A survey on patient queue management system. International *Journal of Advanced Engineering, Management and Science,* 4(4), 229–232. https://doi.org/10.22161/ijaems.4.4.3

Weiss, D. J., Nelson, A., Vargas-Ruiz, C. A., Gligorić, K., Bavadekar, S., Gabrilovich, E., & Gething, P. W. (2020). Global maps of travel time to healthcare facilities. *Nature Medicine,* 26(12), 1835–1838. https://doi.org/10.1038/s41591-020-1059-1

World Health Organization. (2010). Health system building blocks. WHO.

Yaduvanshi, D., Sharma, A., & More, P. (2019). Application of queuing theory to optimize waiting-time in hospital operations. Operations and Supply Chain Management: *An International Journal*, 12(3), 165–174. https://doi.org/10.31387/oscm0390230

Yang, W. H., & Takakuwa, S. (2017). Modeling and analysis of the customer checkout process with flexible servers for a retail store. In Proceedings of the 23rd International Conference on Industrial Engineering and Engineering Management 2016 (pp. 301–304). Atlantis Press. https://doi.org/10.2991/978-94-6239-070-5_61