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Evaluating the Use and Functional Design of Electronic Pharmacy Information Systems in Tanzania: A Case Study from 44 Hospitals Based in Dar es Salaam

Erick S. Kinyenje[1,2]*, Jenifer T. Mbise[1], Joseph C. Hokororo[2], Eliudi S. Eliakimu[2], Daudi I. Msasi[3] Felix K. Sukums[1,4]

[1]School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania
[2]Health Quality Assurance Unit, Ministry of Health, Dodoma, Tanzania
[3]Pharmaceutical Services Unit, Ministry of Health, Dodoma, Tanzania
[4]Directorate of Information Communication and Technology, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania

***Corresponding author:**

Erick Kinyenje

Muhimbili University of Health and Allied Sciences

P. O. Box 65001

Dar es Salaam, Tanzania

Email: kinyenje2003@yahoo.com

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Abstract

Background

The effective use of well-designed electronic Pharmacy Information Systems (ePIS) is critical in supporting clinical decision-making and detecting medication errors in hospital settings. These systems play a vital role in preventing medication errors, a significant factor contributing to patient safety. Globally, 6% of hospitalizations result from such errors. In this study, we aimed to assess the design, usage level and predictors of ePIS adoption in hospitals in Dar es Salaam, Tanzania.

Methodology

A cross-sectional survey was conducted from November 2019 to January 2020 across 44 (86%) eligible hospitals in Dar es Salaam to assess the proportion meeting recommended ePIS standards. Functionalities were categorized into four classes: patient data, prescription, clinical decision support (including alerts for drug interactions, allergies, dosages, indications, and side effects), and dispensing and administration. Additionally, the usage level of these functionalities among healthcare providers was evaluated using a self-reported questionnaire. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) identified independent predictors of ePIS usage levels.

Results

About one-third of the assessed hospitals had ePIS with recommended functionalities. The most common were patient data (74%), followed by medication dispensing and administration (42.2%), and prescription (24.1%), with none supporting clinical decision-making. Utilization was high for patient data (64.9%), medication administration (47.2%), and prescription and dispensing (21.9%). No respondents used clinical decision support systems.

High ePIS usage was associated with receiving supportive supervision (AOR=1.91 [1.18-3.15]), using ePIS for over a year (AOR=2.35 [1.39-4.00]), working in a private hospital (AOR=1.77 [1.06-2.97]), being male (AOR=1.65 [1.02-2.66]), being a nurse (AOR=2.04 [1.16-3.59]), and working in a hospital with an ICT staff size of nine or more (AOR=2.22 [1.33-3.69])

Conclusion

Most adopted ePIS functionalities were not aimed at clinical decision-making, and their utilization is notably low. Adherence to established guidelines and regular monitoring of system and user performance are needed.

Keywords: *Electronic Pharmacy Information System, Information and Communications Technology, Electronic Medical Records; Computerized Provider Order Entry, Medication Use Processes, Medication Errors.*

Background

The effective use and functional design of Electronic Pharmacy Information Systems (ePIS) are pivotal for enhancing healthcare quality. ePIS is integral to electronic hospital information systems, managing all aspects of medication management and provision (1). Properly designed and utilised ePIS systems support various functionalities, including patient data management, prescription processing, and medication dispensing (2). They must also incorporate decision-support systems to improve clinical outcomes further (3).

Medication errors are a significant clinical outcome issue, contributing to up to 6% of hospitalizations worldwide (4). These errors can reduce patient satisfaction and lead to drug resistance, prolonged hospital stays, increased treatment costs, and higher rates of morbidity and mortality (5-8). Medication errors can occur due to harmful events that result in inappropriate medication use (9). These events may arise at any stage of the medication use process, including prescribing, transcribing, dispensing, and administration (10-12). To reduce these errors, it is crucial to optimize these processes through the use of well-designed electronic ePIS, ensuring accurate prescriptions that meet patient needs, in correct doses, and taken in appropriate durations (13).

Despite their potential, effective use of ePIS can be challenged by high staff workloads, insufficient computer literacy, resistance to technology, inadequate IT infrastructure, and poorly designed software interfaces (14). Addressing these challenges is crucial for maximizing the benefits of ePIS. International standards and frameworks, such as those provided by the Australian and American Societies of Health-System Pharmacists (ASHP), recommend integrating ePIS with comprehensive patient data, prescription details, and decision-support tools (3). These standards aim to enhance the functionality and effectiveness of ePIS systems.

In 2016, the Government of Tanzania issued guidelines for the implementation of hospital information systems to improve clinical services and administrative efficiency (15). However, the extent to which these guidelines have been effectively adopted in Tanzanian hospitals remains unclear. Evaluating the predictors of ePIS utilization and functionality is essential for making informed recommendations on system improvements and ensuring these systems meet their intended goals.

Methods

Study design and setting

This was a cross-sectional study conducted between November 2019 and January 2020 in Dar es Salaam region, Tanzania. Dar es Salaam is the largest city in the country, possessing

largest number of hospitals (16) with relatively longer experience in using the electronic information systems for various health care delivery processes (17, 18). The total number of hospitals in the region was 51 (16). All were approached for data collection, but only 44 hospitals could participate in this study, as listed in Appendix 1.

Sample size and procedure

The study targeted healthcare workers; clinicians, nurses, and pharmacy professionals; who used the electronic Pharmaceutical Information System (ePIS) to support medication use processes in hospitals within the Dar es Salaam region. A sample size of 410 participants was determined using standard methods (19) based on an expected 81% proportion of ePIS users (20), with a 95% confidence level, 5% relative precision, and a 10% allowance for non-response.

A stratified random sampling approach with proportional allocation was employed. Lists of ePIS users were obtained from each hospital, and participants were selected to ensure representation across professional roles using simple random sampling techniques. A lottery method was applied to finalize participant selection. Inclusion Criteria covered all eligible healthcare workers using ePIS in registered hospitals in Dar es Salaam (16), while exclusion criteria ruled out those on leave or using the system for non-medication-related purposes.

Data collection tools and techniques

The study used a self-administered questionnaire to collect data necessary to answer the stated objectives and an observational checklist to verify the availability of the recommended functionalities of the ePIS. The list of recommended functionalities (Table 1) was developed by adapting the recommendations by the American Societies of Health-System Pharmacists (ASHP) (3), World Health Organization (21) and Tanzania guidelines and standards for integrated health facility electronic management systems (15).

Table 1: The list of recommended functionalities for electronic pharmacy information systems and their classification

SN	Functionality assessed	Category
1.	Patient demographics	Patient data
2.	Patient disease/problem list	Patient data
3.	Patient allergies list	Patient data
4.	Medication histories	Patient data
5.	Drug formulary or standard treatment guideline	Prescription

SN	Functionality assessed	Category
6.	Drug-drug interaction/contraindication alerts	Decision-support system
7.	Drug– allergy alerts	Decision-support system
8.	Alerts on inappropriate dosage alerts	Decision-support system
9.	Alerts on drug-disease/condition contraindication	Decision-support system
10.	A check for minimum/maximum dosage	Decision-support system
11.	Support for paediatric dosage decision	Decision-support system
12.	A support a drug-to-indications linkage	Prescription
13.	Support to age precautions	Decision-support system
14.	A display to drug side effects	Decision-support system
15.	A support to get recommendation on any medication order you are about to make.	Dispensing and administration
16.	Support to the linkage between ePIS and Pharmacy stock to access the drug's stock status.	Dispensing and administration
17.	Support to check for drugs' expiration date	Dispensing and administration
18.	Support to print drug labels	Dispensing and administration
19.	Barcode technology for outpatient prescriptions	Dispensing and administration
20.	Receiving prescription orders at the pharmacy through the use of hospital information system	Prescription
21.	Medication administration records (MARs)	Dispensing and administration
22.	Barcode-assisted medication administration (BCMA) systems to verify patient identity and electronically check dose administration	Dispensing and administration
23.	Smart infusion pumps (delivery devices that use a combination of computer technology and drug libraries to limit the potential for dosing errors)	Dispensing and administration
24.	Electronic documentation of Medication administration records	Dispensing and administration

A self-administered questionnaire for ePIS users

The questionnaire was divided into major six sections. The first section was for official use information while section two gathered information on hospital characteristics. Section three collected socio-demographic information/host such as gender, age, professional role, education level, training on ePIS and years of experience in professional. Section four

gathered information on characteristics of the information system, while through section five; respondents were provided with the list of recommended ePIS functionalities and asked to use a 5-level Likert scale provided to rate their usage level on ePIS. The last section gathered information on additional factors affecting the use of ePIS.

Observational checklist

The observational checklist was used to assess the observable functionalities against the recommended standards and guidelines for the systems (3, 15, 21). The functionalities were categorized into four groups namely functionalities related to patient data, prescription, decision support and dispensing and administration of medicines (22). The list of the assessed functionalities is provided in Table 1.

Validity and reliability of the questionnaire

The questionnaire was constructed by adapting relevant questions from a previously published study and recommendations (3, 15, 21). Additionally, the final draft was given to experts to see if the questions had enough content validity. Furthermore, the questionnaire was administered to ePIS users at Muhimbili National Hospital to validate questions prior to the use in the study and modification were done accordingly after the completion of the pilot study. The reliability of the questionnaire was tested during data collection, whereby 10% of subjects were asked to fill in the same questionnaire during the main study and after two weeks. The paired data were analysed to ascertain the degree of correlation.

Data management

The questionnaire assessed ePIS usage on a five-level scale, which was dichotomized for analysis into "high use" and "low use" (23). Respondents were classified as having high usage if they used more than half of the available functionalities most or all of the time.

Socio-demographic factors and other variables such as age, sex, professional role, education, professional experience, ePIS experience, computer literacy, hospital ownership, hospital level, and the number of ICT staff were also assessed. Additional factors included training on ePIS, timing of the last training, and supportive supervision.

Professional roles were categorized as clinicians, nurses, and pharmacy professionals. Education levels were grouped into "college education" (Certificate and Diploma) and "university education" (Bachelor's and Master's degrees) (20). Experience was categorized by years, while ePIS experience was classified as ≤1 year or >1 year (20). Computer literacy was assessed as advanced, intermediate, or beginner. Hospitals were categorized by ownership (public or private) and level (district, regional, zonal, national) (16). The number of

ICT staff was dichotomized based on the national recommendation (15). Training on ePIS and supportive supervision were reported and categorized by time frames relevant to the national supportive guidelines (22, 24).

Data analysis

Data were entered, cleaned, and coded, in Microsoft Soft Excel 2013 version and then analysed by STATA computer software version 12.0 (Stata Corp., College Station, TX, USA). Data has been presented using frequency tables and cross-tabulations. Frequency distribution was done and proportions were compared using the Chi-square test at bivariate analysis. In the multivariate analysis using multiple logistic regression, the outcome variable was the use of ePIS while independent variables were gender, age categories, level of education, professional role, number of ICT staff, hospital level, hospital ownership, formal training on the use of ePIS, ever received supervision and when the last supervision was. Bivariate and multivariate binary logistic regression were used to identify factors associated significantly with the usage level of ePIS at p-value < 0.05 with their respective odds ratios and 95% confidence interval.

Ethical considerations

The study was approved by the Institutional Review Board of the Muhimbili University of Health and Allied Sciences (MUHAS) and permission to collect data was obtained from the President's Office-Regional Administrative and Local Government offices through Dar es Salaam's Regional Administrative Secretary Office. Respective Hospital Directors were requested to permit the conduct of the study at their specific hospitals. The interviewees were asked to sign a consent form before the interviews. All collected data were anonymized by removing any personally identifiable information, and were stored securely in password-protected files accessible only to the research team. Openness, honesty and confidentiality were highly observed during the study.

Results

Characteristics of study subjects

A total of 51 hospitals and 410 respondents were approached and included in the study conducted from November 2019 to January 2020. The response rates were 86% (44 hospitals) and 91% (373 respondents), respectively. As shown in Table 2, the majority of respondents were male (194, 52%), with a mean age of 34.8 ± 7.85 years and an average professional experience of 7.6 ± 5.98 years. The majority held either a bachelor's degree (173, 46.4%) or

a diploma (147, 39.4%), while a smaller proportion had a certificate (40, 10.7%) or a master's degree (13, 3.5%).

Most participating hospitals were at the district level (21, 47.7%), followed by regional (12, 27.3%), zonal (6, 13.6%), and national levels (5, 11.4%). Private hospitals constituted 31 (70.5%) of the total, while public hospitals comprised 13 (29.5%). The average number of ICT staff across all hospitals was 6.3 ± 3.73.

Availability of recommended ePIS functionalities

The availability of ePIS functionalities across all 44 visited hospitals is presented in Table 3 based on categories of the functionalities. Functionalities for patient data had an average availability of 74.5%, 24.4% for prescription, 42.2% for dispensing and administration while none of the functionality for decision support was available. Therefore; the average availability of all functionalities across hospitals visited was 35.3%.

Table 2: Characteristics of the study hospitals (N=44) and Respondents (N=373)

Variable	Number (%)
Gender	
Male	194(52%)
Female	178(48%)
Missing values	1
Number of Hospitals by Ownership	
Public	13(29.5%)
Private	31(70.5%)
Number of Hospitals by level	
District	21(47.7%)
Regional	12(27.3%)
Zonal	6(13.6%)
National	5(11.4%)
Number of respondents by Hospital level	
District	188(50.4%)
Regional	72(19.3%)
Zonal	53(14.2%)
National	60(16.1%)
Age (n=370)	
≤ 29 years old	114(30.8%)
30-39 years old	156(42.2%)
40-49 years old	80(21.6%)
≥50 years old	20(5.4%)
Missing	3
Mean age in years ± SD	34.8 ±7.85

Staff professional role	
Clinician	142(38.1%)
Nurse	129(34.6%)
Pharmacy professionals	102(27.3%)
Level of education	
Certificate	40(10.7%)
Diploma	147(39.4%)
Bachelor degree	173(46.4%)
Master degree	13(3.5%)
Professional experience	
below 6 years	172(46.7%)
6 to 10 years	115(31.3%)
above 10 years	81(22.0%)
Missing	5
Mean professional experience in years ± SD	7.6 ± 5.98
Level of computer literacy	
Beginner	66(17.7%)
Intermediate	179(48.8%)
Advanced	124(33.5%)
Missing	4
The average number of ICT staff ± SD	6.3 ± 3.73

Table 3: Availability of recommended ePIS functionalities in 44 hospitals

Availability of ePIS's functionalities for patients' data in the studied hospitals (N=44)		
Functionality	**Yes**	**No**
Patients Demographics	44(100%)	0
Patient disease/problem list	41(93.2%)	3(6.8%)
Patient allergies	4(9.1%)	40(90.9%)
Medication Histories	42(95.5%)	2(4.5%)
Average availability	**74.5%**	**25.5%**
Availability of ePIS functionalities for a prescription (N=44)		
Functionality	**Yes**	**No**
Drug formulary or standard treatment guideline	0	44(100%)
Support to drug-to-indications linkage	0	44(100%)
Receiving prescription orders at the pharmacy through	0	44(100%)
the use of hospital information system	43(97.7%)	1(2.3%)
Average availability	**24.4%**	**75.6%**
Availability of ePIS's Functionalities for Dispensing and Administration (N=44)		
Functionality	**Yes**	**No**

A support to get recommendations on any medication order you are about to make.	43(97.7%)	1(2.3%)
Support to the linkage between ePIS and Pharmacy stock to access the drug's stock status.	22(50.0%)	22(50.0%)
Support to check for drugs' expiration date	43(97.7%)	1(2.3%)
Support to print drug labels	0	44(100%)
A barcode technology for outpatient prescriptions	0	44(100%)
Medication administration records (MARs)	16(36.4%)	28(63.6%)
Barcode-assisted medication administration (BCMA) systems to verify patient identity and electronically check dose administration	0	44(100%)
Smart infusion pumps	0	44(100%)
Electronic documentation of Medication administration records	43(97.7%)	1(2.3%)
Average availability	**42.2%**	**57.8%**

None of the hospitals had been using the technologies for drug distribution, e.g., robot use, automated dispensing cabinets, carousel, and manual distribution. All hospitals were distributing drugs manually. Muhimbili National Hospital (Mloganzila branch) had a pneumatic tube used to transport laboratory specimens but not medicines.

Usage level of electronic pharmacy information system

The average proportions of respondents who used the available ePIS's functionalities for patient data, prescription and dispensing and administration of medications for the high level was 242 (64.9%), 81 (21.9%) and 176 (47.2%) respectively (Table 4). None of the respondents used clinical decision support systems (as were also not available to all ePIS).

Table 4: Usage Level of functionalities in electronic pharmacy information system among hospitals in Dar es Salaam

Usage level of ePIS functionalities required for Patients Data (N=373)		
	High	**Low**
Use of patient's demographic	341(91.7%)	31(8.3%)
Patient disease/ problem list	298(81.2%)	69(18.8%)
Use of patient allergies	22(6.0%)	347(94.0%)
Use of patient's medication histories	299(80.6 %)	72(19.4%)

Average usage level	**64.9%**	**35.1%**
Usage level of ePIS's functionalities required for Prescription (N=373)		
Receiving prescription orders at the pharmacy through the use of hospital information system	79(21.9%)	282(78.1%)
Use of ePIS Functionalities Required for Dispensing and Administration (N=373)		
A support to get recommendation on any medication order you are about to make	92(25%)	276(75.0%)
Support for the linkage between ePIS and Pharmacy stock to access the drug's stock status	101(27.2%)	271(72.8%)
Support to check for drugs' expiration date	152(41.6%)	213(58.4%)
Medication administration records (MARs)	108(29.8%)	254(70.2%)
Electronic documentation of Medication administration records	241(65.3%)	128(34.7%)
Average usage level	**47.22%**	**52.78%**

Predicators for using of Electronic Pharmacy Information System

As presented in Table 5; respondents whose hospitals had adequate number of ICT staff (i.e. 9 and above ICT staff) were more likely to use the system at a high level compared to those whose hospital had inadequate ICT staff (less than 9) (AOR=2.22[1.33-3.69] p=0.002). Respondents who received supportive supervision on ePIS were twice likely to use the system at a high level compared to those who received not (AOR=1.91[1.18-3.15] p=0.009) and among those receiving the supervision within the last 3 months were four times likely to use the system compared to those who did beyond 3 months (COR=4.28[1.21-15.1] p=0.024). Nurses were twice likely to use the system at a high level compared to clinicians (AOR=2.04, CI=1.16-3.59, p=0.014) while Pharmacy professionals had 31% decreased likelihood of using the system compared to clinicians; however, this association was not significant. There was no significant association between age categories; males were about twice as likely to use the system as females (AOR=1.65[1.02- 2.66] p=0.040).

There was no significant association between the level of hospitals and use level of ePIS, nevertheless, respondents from private hospitals were about twice likely to use the system compared to respondents from public hospitals (AOR=1.77[1.06-2.97] p=0.029). Respondents with one or more years' experience in using ePIS were twice likely to use the system at a high level compared to those using the system for the first year (AOR= 2.35, CI=1.39- 4.00, p=0.001).

Table 5: Factors associated with the usage level of ePIS among health workers in hospitals based in Dar es Salaam, Tanzania

		Bivariate analysis			Multivariate analysis		
Variable	**Categories**	**Cor**	**CI**	**p-value**	**aOR**	**95%CI**	**p-value**
Gender	Male	1.94	1.28-2.97	0.002	1.65	1.02- 2.66	0.040*
	Female	Ref					
Age	29-39	0.79	0.48-1.30	0.354	0.94	0.51-1.72	0.839
	Above 39	0.88	0.51-1.52	0.645	0.71	0.36-1.41	0.328
	Below 30	Ref					
Level of Education	College	2.15	1.41-3.29	<.001	1.48	0.85-2.56	0.164
	University	Ref					
Professional role	Nurse	2.55	1.56-4.18	<.001	2.04	1.16-3.59	0.014*
	Pharmacy professionals	0.64	0.36-1.12	0.119	0.69	0.37-1.28	0.238
	Clinician	Ref					
Size of ICT staff	9 and above	2.37	1.53-3.69	<.001	2.22	1.33-3.73	0.002*
	Below 9	Ref					
Hospital level	National	0.17	0.08-0.37	<.001	0.88	0.39-2.02	0.776
	Zonal	1.22	0.66-2.25	0.524	2.04	0.93-4.47	0.074
	Regional	0.42	0.23-0.76	0.004	0.92	0.26-3.26	0.892
	District	Ref					
Hospital ownership	Private	2.72	1.73-4.29	<.001	1.77	1.06-2.97	0.029*
	Public	Ref					
Experience in using ePIS	Above 1 year	1.44	0.92-2.27	0.111	2.35	1.39- 4.00	0.001*
	within 1 year	Ref					
Training on use of ePIS	Yes	1.97	1.27-3.04	0.002	1.31	0.75-2.27	0.345
	No	Ref					
Last time training on ePIS	above 1 year	9.00	3.24-25.0	<.001			**
	below 1 year	Ref					
Received supervision	Yes	2.12	1.37-3.26	0.001	1.93	1.18-3.15	0.009*
	No	Ref					
	Beyond 3 months	4.28	1.21-15.1	0.024			**

Last time received supervision	Within 3 months	Ref

**Factors whose association were found significant in the final logistic regression model*

***Variables were not included in the multivariate logistic model due to inadequate observations*

Discussion

This was a cross-sectional study that aimed to assess the design, usage level and predictors of ePIS adoption in hospitals in Dar es Salaam, Tanzania. The design of the ePIS was assessed across four functional groups: functionalities useful for patient data, prescription management, dispensing and administration, and clinical decision support.

Our findings show no hospital had ePIS equipped with clinical decision support systems. This absence means users could not receive alerts for drug-drug interactions or contraindications, drug-allergy warnings, inappropriate dosage alerts, drug-disease/condition contraindications, checks for minimum/maximum dosages, support for pediatric dosing, age precautions, or displays of drug side effects. These are critical issues to consider in system design to reduce the risk of human error and subsequent medication errors. These functionalities are recommended in both national and international guidelines (3, 15, 21).

Evidence shows that developing countries are slower to adopt these functionalities compared to developed ones. For instance, a study from the Islamic Republic of Iran revealed low adoption rates, with only 11 out of 74 hospitals equipped with decision support systems (25). In contrast, the adoption rate in U.S. hospitals was 95.6% (26). The low adoption rate in developing countries is not solely due to financial constraints in hospitals; poor adherence to national standard treatment guidelines among prescribers is another significant factor, as evidenced by studies from Tanzania and other developing countries (27-30). Currently, the use of drug formularies and standard treatment guidelines is not mandatory in Tanzania, which may partly explain why practitioners neglect adopting and using functionalities that enforce adherence to these guidelines. Making adherence to standard treatment guidelines mandatory could increase their adoption and use among prescribers.

The most commonly available functionalities were related to patient data, with approximately three-quarters of hospitals' ePIS systems equipped with them. It is not surprising that patient data management functionalities are the most widely adopted and used, as patient data is required by hospital management for administrative tasks such as billing, report generation, and claims submissions to third parties like health insurance companies. Studies from developing countries suggest that hospitals prioritize adopting and using functionalities that

address these administrative needs over those supporting clinical decisions (25,31). However, managing patient information remains crucial.

Only one-quarter of the hospitals had ePIS systems with functionalities that support prescriptions. However, among the three functionalities in this group, the only one widely available in all hospitals except one was the ability to receive prescription orders at the pharmacy through the hospital information system. The other two functionalities—access to treatment guidelines and linkage to drug indications—were absent in all hospitals' ePIS systems.

Nearly half of the hospitals had functionalities for dispensing and administering drugs, which are essential for delivering medications and medical supplies to patients. Among the nine functionalities assessed, all hospitals lacked four critical features in their ePIS systems: barcode technology for outpatient prescriptions, the ability to print drug labels, medication administration records, and barcode-assisted medication administration (BCMA) systems to verify patient identity and electronically check dose administration. The absence of these advanced technologies may be due to high investment costs and operational challenges (32). Nonetheless, we argue that the investment is worthwhile, as other studies have demonstrated a significant return on investment (33, 34).

The findings of this study show that users utilized ePIS functionalities in proportion to their availability. An exception was the low use of the functionality for receiving prescription orders at the pharmacy through ePIS (Computerized Provider Order Entry - CPOE), despite it being available in nearly all hospitals. These findings align with those of Mahalli et al., who found that even though all surveyed hospitals in Eastern Saudi Arabia had CPOE, only half of them used it (22). Hospitals in Saudi A rabia faced similar challenges in using the system, such as perceived loss of control over the treatment process by clinicians, lack of integration with other hospital information systems, poor knowledge of how to use CPOE, and difficulty in using it (35, 36). For hospitals and clients to fully realize the benefits of hospital information systems, all service delivery points, such as laboratories, inpatient wards, and specialized clinics, need to be integrated.

Respondents from hospitals with an adequate number of ICT staff (15) reported higher usage of ePIS. Adequate staffing is crucial for ensuring continuous system functionality through timely technical support to users. Similarly, a lack of timely technical assistance was a major reason for the low use of hospital information systems in neighboring Kenya (37).

On the other hand, the findings suggest that training in systems alone cannot predict the effective use of ePIS in hospitals. Other studies have found that training is influenced by factors such as users' computer literacy and language barriers (38). However, if these factors

are managed, training in computerized hospital systems can increase user confidence, system usage, and positive attitudes toward the systems (39, 40).

There is growing evidence of infrequent, inefficient, and ineffective supportive supervision across health facilities in Tanzania (41-45). Supervision is an effective approach to monitoring system usage in hospitals, promoting behavior change, increasing job motivation and satisfaction, and improve performance through on-the-spot technical advice (45, 46). Regular supervision enables users to overcome minor obstacles independently. It is recommended that health facilities be supervised at least quarterly (24, 47), which may explain why users from hospitals with quarterly supervision reported higher system usage. Our findings align with studies suggesting that improving technical support for hospital information system users would promote greater usage (48, 49).

Surprisingly, system usage was not related to the hospital's level but to its ownership. This may be because all hospitals had a majority of staff at the graduate level. Therefore, knowledge may not be a barrier to system usage; the difference may be due to the culture and management practices between private and public hospitals. Being more business and cost-conscious, private hospitals tend to have more effective system usage management, which motivates their management teams. Our findings contrast with those from Iran, where the opposite was true regarding hospital ownership (50). Unlike private hospitals, most public hospitals in Dar es Salaam had less than five years of experience in implementing and using ePIS (15). Consequently, many public hospitals may still be in the learning phase, especially regarding technology and staffing.

Study Limitations

In this study, we were unable to include laboratory and radiology technicians as part of the participants. We recognize the important role of radiology and laboratory services in the rational use of medications. However, our focus was on providers using ePIS to perform medication-related processes (prescribing, transcribing, dispensing, and administering medication to patients). Our initial assessment revealed that very few hospitals had ePIS in these departments, which led to the exclusion of this group from the participants.

Conclusion and recommendations

The adoption and, consequently, the use of available ePIS features was low, with a primary focus on administrative functions such as revenue collection and report generation, while clinical decision support functionalities were largely overlooked. The study emphasized that adequate ICT staffing and regular supportive supervision are essential for improving ePIS in hospitals.

We recommend strengthening ePIS by aligning it with national and international standards that support clinical decision-making and error detection. Hospitals should adopt safety features such as drug label printing, barcode verification, and automated dispensing cabinets, complemented by regular expert-led supervision. Further studies are needed to examine factors influencing ePIS adoption and use

Abbreviations

BCMA	Barcode-assisted medication administration
CPOE	Computerized Provider Order Entry
ePIS	Electronic Pharmacy Information Systems
ICT	Information and Communications Technology

Declarations

Funding

No fund was received for this study.

Authors' contributions

ESK Conceptualization, writing the first draft, methodology, data curation, formal analysis, review and editing the manuscript. JTM Formal analysis, Validation. DIM writing, review and editing. ESE writing, review and editing. FKS validation, writing, review editing and supervision

References

1. Radley DC, Wasserman Olsho LE, Olsho Le - Shoemaker SJ, Shoemaker Sj - Spranca MD, Spranca Md - Bradshaw B, Bradshaw B. Reduction in medication errors in hospitals due to adoption of computerized provider order entry systems. JAMIA. 2013;Volume 20(3):Pages 470–6.
2. Wolper LF. Health care administration: managing organized delivery systems. 5th Ed ed: Jones & Bartlett Publishers; 2010.
3. Pharmacists ASoH-S. ASHP guidelines: minimum standard for pharmacies in hospitals. American Journal of Health-System Pharmacy. 2013;70(18):1619-30.
4. Krähenbühl-Melcher A, Schlienger R, Lampert M, Haschke M, Drewe J, Krähenbühl S. Drug-related problems in hospitals. Drug safety. 2007;30(5):379-407.
5. Masotti P, McColl MA, Green M. Adverse events experienced by homecare patients: a scoping review of the literature. International Journal for Quality in Health Care. 2010;22(2):115-25.

6. Alexopoulou A, Dourakis SP, Mantzoukis D, Pitsariotis T, Kandyli A, Deutsch M, et al. Adverse drug reactions as a cause of hospital admissions: a 6-month experience in a single center in Greece. European journal of internal medicine. 2008;19(7):505-10.
7. Tariq RA SY. Medication Errors [Internet]. Treasure Island StatPearls Publishing; 2019 [Available from: https://www.ncbi.nlm.nih.gov/books/NBK519065/.
8. Elliott RA CE, Campbell F, Jankovic D, Martyn-St James M, Kaltenthaler E et al. Prevalence and Economic Burden of Medication Errors in The NHS in England: Rapid evidence synthesis and economic analysis of the prevalence and burden of medication error in the UK. Policy Research Unit in Economic Evaluation of Health and Care Interventions (EEPRU). 2018;174
9. Ferner RE, Aronson JK. Clarification of terminology in medication errors. Drug safety. 2006;29(11):1011-22.
10. Fathi A, Hajizadeh M, Moradi K, Zandian H, Dezhkameh M, Kazemzadeh S, et al. Medication errors among nurses in teaching hospitals in the west of Iran: what we need to know about prevalence, types, and barriers to reporting. Epidemiol Health. 2017;39:e2017022.
11. Patel I, Balkrishnan R. Medication Error Management around the Globe: An Overview. Indian J Pharm Sci. 2010;72(5):539-45.
12. Durham ML, Suhayda R, Normand P, Jankiewicz A, Fogg L. Reducing Medication Administration Errors in Acute and Critical Care: Multifaceted Pilot Program Targeting RN Awareness and Behaviors. J Nurs Adm. 2016;46(2):75-81.
13. Holloway K, Van Dijk L. The world medicines situation 2011. Rational use of medicines. Geneva: WHO. 2011.
14. James KL, Barlow D, McArtney R, Hiom S, Roberts D, Whittlesea C. Incidence, type and causes of dispensing errors: a review of the literature. International journal of pharmacy practice. 2009;17(1):9-30.
15. Ministry of Health, Community Development,Gender, Elderly and Children (MoHCDGEC) and President Office-Regional Admnistration and Local Government (PO-RALG). Guidelines and Standards for Integrated Health Facility Electronic Management Systems. January, 2016. [20th March 2019]. Available from: http://api-hidl.afya.go.tz/uploads/library-documents/1573687506-altbEYCL.pdf
16. MoHCDGEC. National Health Facility Registry (HFR) 2019 [20th March 2019]. Available from: http://www.moh.go.tz/en/health_facility_registry.
17. Hamad WB. Current Position and Challenges of E-health in Tanzania: A review of literature. GSJ. 2019;7(9).

18. Kajirunga A, Kalegele K. Analysis of activities and operations in the current E-Health landscape in Tanzania: focus on interoperability and collaboration. arXiv preprint arXiv:150700176. 2015.
19. Israel GD. Determining sample size 1. University of Florida. 2013:1-5.
20. Mlay CI. Assessment of the Use of Electronic Medicines Inventory Management Systems in Public and Private Hospitals in Dar es Salaam Region, Tanzania [Dissertation]. Dar es Salaam: Muhimbili University of Health and Allied Sciences; 2018.
21. El Mahalli A, El-Khafif SH, Yamani W. Assessment of Pharmacy Information System Performance in Three Hospitals in Eastern Province, Saudi Arabia. Perspect Health Inf Manag. 2016;13(1559-4122 (Electronic)):1b.
22. Mahalli AE, Sahar H, Yamani W. Assessment of pharmacy information system performance in three hospitals in Eastern Province, Saudi Arabia. Perspectives in health information management. 2016;13(Winter).
23. Farzandipur M. Factors affecting successful implementation of hospital information systems. Acta Informatica Medica. 2016;24(1):51.
24. Ministry of Health, Community Development, Gender, Elderly and Children,. Guideline for Internal Supportive Supervision (ISS) and External Hospital Performance Assessment (EHPA) for Regional Referral Hospitals. In: Assurance Q, editor. 2018. p. 6. [20th March 2019]. Available from: https://policyvault.africa/wp-content/uploads/policy/TZA163.pdf
25. Bayati S, Mohammad Ebrahimi S, Ahmadzade F, Nematolahi M. Assessment of pharmacy information system's (PIS) performance in Shiraz hospitals. Journal of Health and Biomedical Informatics. 2015;2(2):84-93.
26. Rouse M. computerized physician order entry (CPOE) 2019 [Available from: https://searchhealthit.techtarget.com/definition/computerized-physician-order-entry-CPOE.
27. Njozi M, Amuri M, Selemani M, Masanja I, Kigahe B, Khatib R, et al. Predictors of antibiotics co-prescription with antimalarials for patients presenting with fever in rural Tanzania. BMC Public Health. 2013;13(1):1-7.
28. Ali AM. Knowledge, attitudes and practices of health care workers in the implementation of integrated management of childhood illness for underfives: A case study of Wete district government owned health facilities [Dissertation]: Mzumbe University; 2015.
29. Francis MK. Assessment of availability, affordability and prescribing patterns of essential medicines in public health facilities in Tanga region, Tanzania [Dissertation]: Muhimbili University of Health and Allied Sciences; 2011.

30. Teshale C, Hussein J, Mussa S. Assessment of the quality of pharmaceutical service in Jimma Zone, Oromia regional state, South West Ethiopia. International Journal of Pharmacy Teaching & Practices. 2014;5(2):1-6.
31. Bayati S, Bastani P, Sagheb ZM, Jamalabadi S, Samadbeik M. The performance implications of pharmacy information system at the university teaching hospitals of Shiraz, Iran: Cluster approach. Journal of advanced pharmaceutical technology & research. 2017;8(4):125.
32. Truitt E, Thompson R, Blazey-Martin D, Nisai D, Salem D. Effect of the implementation of barcode technology and an electronic medication administration record on adverse drug events. Hospital pharmacy. 2016;51(6):474-83.
33. M. Boyd A, W. Chaffee B. Critical Evaluation of Pharmacy Automation and Robotic Systems: A Call to Action. SAGE Publications Sage CA: Los Angeles, CA; 2019.
34. Schneider PJ. The impact of technology on safe medicines use and pharmacy practice in the US. Frontiers in pharmacology. 2018;9:1361.
35. Ash JS, Sittig DF, Campbell E, Guappone K, Dykstra R, editors. An unintended consequence of CPOE implementation: shifts in power, control, and autonomy. AMIA Annual Symposium Proceedings; 2006: American Medical Informatics Association.
36. Khajouei R, Wierenga P, Hasman A, Jaspers MW. Clinicians satisfaction with CPOE ease of use and effect on clinicians' workflow, efficiency and medication safety. International journal of medical informatics. 2011;80(5):297-309.
37. Nkanata MG. Use of hospital management information systems among healthcare workers at Kenyatta national and Mater hospitals [Dissertation]: University of Nairobi; 2015.
38. Nanji KC, Gandhi TK, Poon EG, Churchill W, Cina J, Patel N. Overcoming Barriers to the Implementation of a Pharmacy Bar Code Scanning System for Medication Dispensing: A Case Study. Journal of the American Medical Informatics Association. 2009;16(5):645-50.
39. Alquraini H, Alhashem AM, Shah MA, Chowdhury RI. Factors influencing nurses' attitudes towards the use of computerized health information systems in Kuwaiti hospitals. Journal of Advanced Nursing. 2007;57(4):375-81.
40. Mohd Ghazali Ismail, Maryati Mohd Yusof2, Mokhtar UA. Evaluation of User Satisfaction on Pharmacy Information Systems in Government Hospital. International Journal of Science and Applied Technology. 2017;Vol. 2,(No. 1,).
41. Ministry of Health and Social Welfare-United Republic of Tanzania. National Supportive Supervison Guideline for Quality Healthcare Services. Dar es Salaam2010.

42. Kiplagat A, Musto R, Mwizamholya D, Morona D. Factors influencing the implementation of integrated management of childhood illness (IMCI) by healthcare workers at public health centers & dispensaries in Mwanza, Tanzania. BMC public health. 2014;14(1):277.
43. Manzi F, Schellenberg JA, Hutton G, Wyss K, Mbuya C, Shirima K, et al. Human resources for health care delivery in Tanzania: a multifaceted problem. Human resources for health. 2012;10(1):3.
44. Ministry of Health Social Welfare. The Tanzania Quality Improvement Framework in Health Care 2011-2016. Ministry of Health and Social Welfare Dar es Salaam; 2011. [20th March 2019]. Available from: https://hssrc.tamisemi.go.tz/storage/app/uploads/public/5cf/a3b/e31/5cfa3be318859093558408.pdf
45. Glenton C, Colvin CJ, Carlsen B, Swartz A, Lewin S, Noyes J, et al. Barriers and facilitators to the implementation of lay health worker programmes to improve access to maternal and child health: a qualitative evidence synthesis. Cochrane Database of Systematic Reviews. 2013(10).
46. Mwendwa P, McAuliffe E, Uduma O, Masanja H, Mollel H. The impact of supportive supervision on the implementation of HRM processes; A mixed-methods study in Tanzania. Health Systems and Policy Research. 2017;4(1).
47. Manongi RN, Marchant TC. Improving motivation among primary health care workers in Tanzania: a health worker perspective. Human resources for health. 2006;4(1):6.
48. Jha AK, Bates DW, Jenter C, Orav EJ, Zheng J, Cleary P, et al. Electronic health records: use, barriers and satisfaction among physicians who care for black and Hispanic patients. Journal of evaluation in clinical practice. 2009;15(1):158-63.
49. Ornstein, C. Hospital Heeds Doctors, Suspends Use of Software; Cedars–Sinai physicians entered prescriptions and other orders in it, but called it unsafe. The Los Angeles Times. 2003 Jan 22, 2003;Sect. Sect B:1.
50. Saghaeiannejad-Isfahani S, Sharifi-Rad J, Raeisi A, Ehteshami A, Mirzaeian R. An evaluation of adherence to society of pharmacists' standards care in pharmacy information systems in Iran. Indian journal of pharmacology. 2015;47(2):190.

Appendix 1: List of hospitals that participated in the study

	Name of the Hospital	Level	Ownership
1	Sino Hospital	District	Private
2	Kitonka Hospital	Region	Private
3	Mikumi Hospital	District	Private
4	Lugalo Zonal Referral Hospital	Zonal	Public
5	Bochi Hospital	Region	Private
6	Mount Ukombozi Hospital	District	Private
7	St. Benedict Hospital	District	Private
8	Hindu Mandal Hospital	Region	Public
9	Kairuki Hospital	Region	Private
10	Mwabepande Hospital	District	Public
11	Msasani Penisular Hospital	District	Private
12	Tabata General Hospital	District	Private
13	Burhani Charitable Hospital	Region	Private
14	Cardinal Rugambwa Hospital	Region	Private
15	Kilwa Road Police Hospital	District	Public
16	Temeke Regional Referral Hospital	Region	Public
17	Mwananyamala Regional Referral Hospital	Region	Public
18	Muhimbili National Hospital- Upanga	National	Public
19	Aga Khan Hospital	Zonal	Private
20	JPM Hospital	District	Private
21	Amana Regional Referral Hospital	Region	Public
22	Regency Hospital	Zonal	Private
23	Kinondoni Hospital	District	Private
24	Salaman Hospital	District	Private
25	Marie Stopes Hospital	District	Private
26	Lugalo RCH Hospital	District	Public
27	Kibangu Hospital	District	Private
28	TOHS Hospital	Region	Private
29	Muhimbili Orthopaedic Institute - MOI	National	Public
30	Ocean Road Cancer Institute - ORCI	National	Public
31	Sali International Hospital	Region	Private
32	IMTU Hospital	District	Private

33	Rabininsia Memorial Hospital	Zonal	Private
34	Mbweni Hospital	District	Private
35	CCBRT Hospital	Zonal	Private
36	Care Plus Hospital	District	Private
37	Masana Hospital	Region	Private
38	Ekenywa Hospital	District	Private
39	TMJ Hospital	Zonal	Private
40	Muhimbili National Hospital - Mloganzila	National	Public
41	Moyosafi Hospital	District	Private
42	MD MULT Hospital	District	Private
43	Jakaya Kikwete Cardiac Institute	National	Public
44	Mnazi Mmoja Hospital	District	Public