Health Information Systems and Management of Health Products and Technologies: A Multi-County Study on Access to Quality Affordable Health Products and Technologies

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Abstract

Health Products and Technologies (HPTs) are critical pillars of the health system and essential to achieving Kenya's Universal Health Coverage (UHC). UHC prioritizes access to high-quality medical care with minimal financial hardship. Despite efforts to enhance HPTs management, counties like Kisumu, Machakos, Nyeri, Kiambu, and Isiolo in Kenya face inefficiencies in the management of HPTs, leading to the unavailability of HPTs in public health facilities. This study aimed to examine the influence of health information systems on the management of Health Products and Technologies in selected Counties, Kenya. The utilization management theory guided the research, and the pragmatism paradigm supported a mixed-methods design. Quantitative data utilized a descriptive research design, while qualitative data employed an exploratory design. A census sampling method was used in the study, where 141 staff engaged in managing HPTs at level 4 and 5 public health facilities. Key informant interviews were conducted with members of the County health management team. Data collection involved pre-tested questionnaires and key informant interview guides to ensure validity and reliability. Quantitative data was analyzed using descriptive and inferential statistics, while qualitative data was thematically analyzed. The study found that the model explained 53.5 % (R Square value of 0.535) of the variance in the management of HPTs. The study revealed that health management information systems had a positive, strong, and statistically significant association with the management of HPTs (r=544**, n=106, P=0.000). The study concluded that the health management information system has a statistically significant influence on the management of HPTs in public hospitals in Kenya. The study recommends deployment and widespread adoption of HMIS across all public hospitals and the establishment of a framework that tracks the impact of HMIS on the management of HPTs.

Keywords: *Health Information Systems; management; Health Products and Technologies; Affordability; Availability and Quality*

IJPP 13(2); 67-79

1.0 Introduction

Health products are defined as medications, vaccines, and devices used in disease prevention, diagnosis, treatment, and rehabilitation, as well as surgical and medical procedures (Wang et al., 2020). For the public to receive high-quality healthcare services, efficient health products and technology management ensure that the HPTs are consistently available at the Service Delivery Points (SDP) in the appropriate quality, right quantity, right price, and at the right time (Feyisa et al., 2021). Key indicators for a functional health information system include widespread deployment and utilization in health facilities of a suitable HMIS system supported by adequate ICT infrastructure and data of appropriate quality. A reliable HMIS would lead to efficiency in the management of HPTs; thus, improving access to quality and affordable HPTs. Since devolution, counties have witnessed some improvement in the availability and affordability of health products, mainly driven by health commodity management reforms and strategic partnerships. However, inadequate or underutilization of health information management systems to track and monitor usage of HPTs often results in a lack of essential medicines and diagnostics continue to persist and need to be addressed to achieve UHC and improve service delivery.

Statement of the Problem

Access to essential health products and technologies remains a persistent challenge in Kenya, particularly under the devolved system of governance. Variations in county-level capacities have led to inconsistencies in the availability, affordability, and quality of HPTs, undermining the overall effectiveness of healthcare delivery. Despite national policies and investments, many counties face systemic inefficiencies such as poor Health Information Management Infrastructure, lack of investment in HMIS, failure to adopt HMIS in public health facilities, and underutilized health information systems. These information systems have a direct impact on how HPTs are managed, yet limited research has been conducted to comparatively assess dynamics across counties. This study seeks to fill the gap by looking at the influence of health information systems on the management of health products and technologies in selected counties in Kenya. The findings will help inform targeted interventions and policy decisions aimed at improving access to essential health technologies nationwide.

Literature Review

Health information systems include a range of technologies integrated into healthcare settings. Effective management of health products and technologies, especially for advancing Universal Health Coverage (UHC), depends on these technological systems to improve patient safety and reduce mortality and morbidity (Awadh, 2021). Health Information Management Systems (HIMS) are computerized tools used to organize and manage health-related data. Their implementation improves the administration of high-priority medicines by optimizing inventory, monitoring use, and ensuring timely distribution

Deployment of Health Management Information

The adoption of computerized health information management systems (HIMS)

has significantly improved the management of crucial medications, including high-priority targets (HPTs), across various African countries. In Ghana, computerized inventory systems enhanced medication management (Rahi, 2017), while in Uganda, electronic health records (EHR) improved hypertension management by better monitoring medication usage and reducing stockouts (Okungu, 2019).

"The study concluded that the health management information system has a statistically significant influence on the management of HPTs in public hospitals in Kenya.

Ethiopia's use of computerized prescription systems increased accuracy in medication prescribing and dispensing, while Tanzania has invested in health information technology despite challenges like community illiteracy (Kulaba, 2019). In Zimbabwe's Mashonaland region, HIMS contributed to lowering mortality and morbidity rates (Kanyepe, 2022). Malaysian hospitals utilize technologies such as computerized physician orders, smart pumps, electronic medical records, and automated dispensing cabinets to improve care (Bakry, 2018). Globally, HIMS is essential in enhancing healthcare quality by addressing human errors through technology and system improvements (Kelly, 2018). Health care workers in Kenya are recommended to undergo mandatory training on health-related software to stay updated with medical advancements, improve patient benefits, and increase worker satisfaction. Using information systems, such as a web-based drug usage monitoring platform, has proven effective in identifying service gaps and improving management of health promotion technologies (Rahman & Zailani, 2017). HMIS is vital for efficiently managing health products and technologies, which support the goal of Universal Health Coverage (UHC) by ensuring equitable access to essential healthcare without financial hardship. Tools like electronic health records, inventory, and supply chain management systems enhance monitoring, resource allocation, and accessibility to critical health products. Research, especially in Ethiopia, highlights the positive impact of HIMS and ICT on healthcare management to promote UHC (Schleipman, 2017).

Application of HMIS

A systematic review by Haskew et al. (2020) found that ICT, including mobile health applications, improved supply chain management, medicine accessibility, and patient outcomes in low and middle-income countries. Similarly, a study in Uganda showed that implementing an integrated HIMS significantly improved inventory control by reducing stockouts and expired items, boosting supply chain efficiency, and enabling better monitoring of equipment use and maintenance (Scala & Lindsay, 2021). Mwangi (2018) reviewed healthcare facilities in Machakos County, Kenya, and established that most hospitals were equipped with computer systems, and the healthcare workers were familiar with using Health Management Information Systems (HMIS) to manage high-priority targets (HPTs). Similarly, in the coastal region, healthcare workers effectively used computerized physician order entry systems via computers and smartphones, improving time efficiency in recording and retrieving patient information for timely therapeutic interventions (Shangala, 2020). However, a meta-analysis by Orang and Kwamboka (2020) highlighted challenges in marginalized areas of Kenya, including a

lack of internet, hardware, software, trained personnel, and high community illiteracy, hindering effective HMIS use. Langat (2019) urged government intervention to equip both marginalized and urban healthcare facilities with proper HMIS technologies to support decision-making and reduce human errors. Overall, HMIS is critical for accurate data management, forecasting, issuing, and tracking of HPTs, which reduces pilferage and expiries, improves availability, and saves healthcare costs.

Data Quality

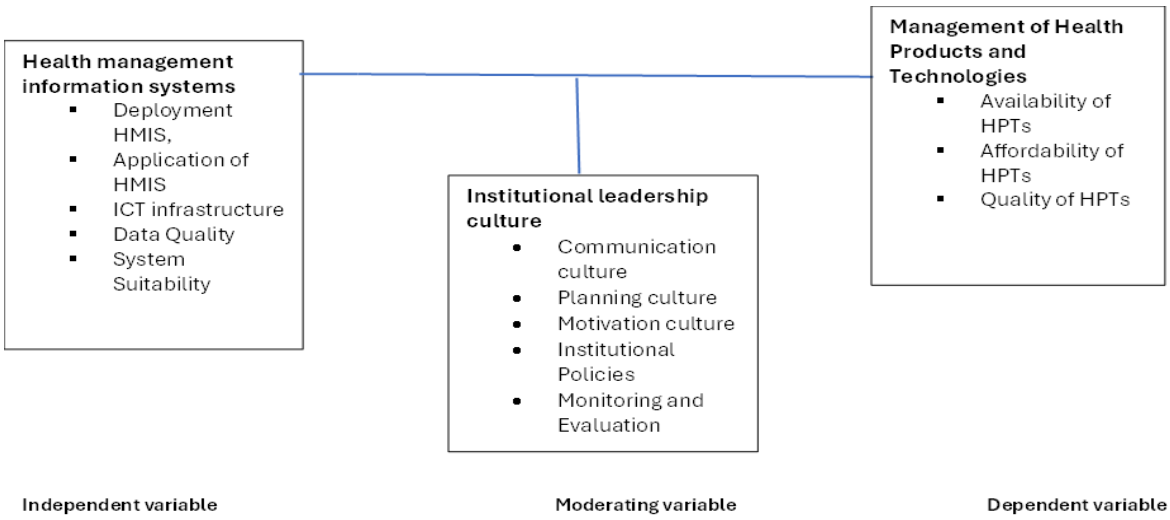
Efficient Health Management Information Systems (HMIS) are essential for advancing Universal Health Coverage (UHC) and managing high-priority health products and technologies (HPTs). Two critical factors in HMIS effectiveness are data quality and data storage, which impact accurate decision-making and the integrity of health product records. Studies show that poor data quality hampers inventory management and supply chain efficiency, potentially slowing progress toward UHC (Yarkoni, 2020). In resource-limited settings, robust data storage and secure information systems are vital for continuous access to health product data (Wu & Luo, 2019). Reviews emphasize the need for data quality assurance through regular audits, validation processes, and staff training to ensure reliable health information (Westman, 2021). Cloud-based storage solutions, as demonstrated in Tanzania, improve the ability to manage large health data volumes securely, enhancing inventory control and decision-making for UHC (Tama et al., 2018). Studies across diverse contexts highlight that precise and well-managed data boosts supply chain decisions, facilitates uninterrupted data access, and improves healthcare delivery. Indeed, accurate data plays a critical role in the efficient management of HPTs through accurate forecasting.

Suitability of the HMIS system

The design and functionality of HMIS influences healthcare efficiency and UHC outcomes. In South Korea, system interoperability, real-time data capture, and supply chain integration were key to effective health product management (Wang et al., 2020). In Bangladesh, user-friendly systems that ensure data security promote greater adoption and improved management of health technologies (Verger et al., 2021). A review in Kenya underscored scalability, flexibility, and adaptability as crucial system traits to meet evolving healthcare needs and integrate new technologies (Shangala, 2020). Mobile-based HMIS in remote India helped overcome geographic barriers by enabling data collection, remote monitoring, and supply chain management, thereby enhancing access to essential health products and supporting UHC efforts (Sharma et al., 2020). Adoption of a suitable HMIS system that is interoperable across various units would greatly improve management of HPTs.

Figure 1

Conceptual Framework



Theoretical Framework

Utilization management theory was used in the study. The theory has for decades been used across healthcare settings to improve the quality of healthcare services through the provision of health products and technologies across medical facilities. The theory emphasizes the essence of efficiency, medical necessity, and appropriateness during the application and management of health products and technologies in the delivery of medical services.

2.0 Materials and Methods

The study took place in Kisumu, Kiambu, Machakos, Nyeri, and Isiolo counties to determine the influence of financing on the management of health products and technologies in selected Counties in Kenya. The research was anchored on the Pragmatism paradigm because it is basically based on the existing body of knowledge that is fixed, observable, and objective, much as it is multiple and socially constructed by individuals. A cross-sectional research design and interviews were used in the study. Staff dealing with the management of health products and technologies at the service delivery level 4 and 5 public health facilities in select counties were the study's target group. The study also targeted the county health management team as key informants. Interview schedule and Key informant interview guide were used to collect data. The questionnaire was shared with participants using Google Forms, while the interview guide was filled out by the respondent in the presence of the researcher. The researcher sought and got approvals to conduct research from each of the five counties.

Pretesting of the data collection tools was conducted at Kajiado County. The instrument was appropriately modified before the actual data collection activity based on the evaluation. A census sampling method was used in the study, where 141 staff managing HPTs at level 4 and 5 public health facilities were targeted. Key informants were purposively selected for the study. A statistical program for social sciences (SPSS) version 25 was used to construct a data file from the numerical information gathered from the field via interview schedules. The researcher then checked the data for flaws, cleaned it up, and performed a preliminary analysis to see if the statistical techniques' underlying assumptions were met. Qualitative data was analyzed thematically. The study adhered to research ethics throughout the investigation, where informed consent was sought from the respondents. The study was

approved by the Institutional Scientific Ethical Review Committee of Kenya Methodist University (KeMU/ISERC/HSM/26/2023), and NACOSTI offered a research permit referenced NACOSTI/P/23/31

3.0 Results and Discussion

Health management information systems factors

Table 1 below shows the health information factors with major contributions to the management of health products and technologies.

Table 1

Health management information systems factors

County	Deployment of HMIS	Application of HMIS	ICT Infrastructure	Data quality		Chi-Square (χ^2)	P value
Kiambu	4(30.8%	3(23.1%	3(23.1%	3(23.1%	13		
Isiolo	4(28.6%	3(21.4%	1(7.1%	6(42.9%	14		
Machakos	6(16.2%	14(37.8%	7(18.9%	10(27.0%	37		
Kisumu	3(13.0%	7(30.4%	6(26.1%	7(30.4%	23		
Nyeri	4(21.1%	6(31.6%	3(15.8%	6(31.6%	19		
	21(19.8%	33(31.1%	20(18.9%	32(30.2%	106	6.322	0.899

The findings indicate that application of HMIS (33, 31.1%) and Data Quality (32, 30.2%) were the most frequently cited factors, indicating that these were considered by respondents as having a relatively greater impact on the management of HPT. While deployment of HMIS (21, 19.8%) and ICT Infrastructure (20, 18.9%) were cited less frequently, but still had a notable influence. There was no statistically significant difference in the perceived effect of these HMIS factors on the management of HPT across the counties, implying that none of the factors stood out as having a significantly greater effect compared to the others (Chi-Square Test (χ^2) = 6.322; P-value = 0.899). While no single HMIS factor was significantly more important than the others, the application of HMIS and data quality were slightly emphasized by respondents, guiding where efforts and resources could be concentrated.

These findings were consistent with the research conducted by Mokaya (2021), who found that HMIS application and data quality were key factors influencing the management of Health Products and Technologies (HPT) in health facilities in Nakuru County (Mokaya, 2021). Additionally, Lesiyampe (2021) observed similar patterns in their national study, where HMIS application and data quality were frequently cited as crucial for effective HPT management. However, contrary to these findings (Lesiyampe, 2021), Mwanakarama et al. (2022), in their study in Mombasa County, reported that ICT infrastructure was perceived as the most critical factor, suggesting that regional differences might influence the prioritization of HMIS factors (Mwanakarama et al., 2022).

Kruskal-Wallis H Health management information systems variables

Table 2 below shows the Kruskal-Wallis H test on health management information systems variables

Table 2

Health management information systems variables

Description	County	N	Mean Rank	Kruskal-Wallis H	df	P Value
How well are users trained on the functionalities of the deployed HMIS?	Kiambu	13	39.35	5.329	4	0.25
	Isiolo	14	53.25			
	Machakos	37	60.05			
	Kisumu	23	53.96			
	Nyeri	19	50.05			
	Total	106				
Rate the frequency of use of HMIS for managing HPT.	Kiambu	13	58.69	2.678	4	0.61
	Isiolo	14	49.07			
	Machakos	37	54.51			
	Kisumu	23	46.78			
	Nyeri	19	59.37			
	Total	106				
There is adequate and reliable ICT infrastructure to support HMIS in the facility.	Kiambu	13	30.42	11.920	4	0.017
	Isiolo	14	63.04			
	Machakos	37	60.62			
	Kisumu	23	51.39			
	Nyeri	19	50.95			
	Total	106				
Rate the accuracy and completeness of data recorded and processed by HMIS in this facility.	Kiambu	13	41.19	7.705	4	0.102
	Isiolo	14	59.64			
	Machakos	37	61.72			
	Kisumu	23	49.37			
	Nyeri	19	46.39			
	Total	106				
Overall, how Satisfied are you with the contribution of HMIS to HPT management in this facility?	Kiambu	13	49.38	12.594	4	0.013
	Isiolo	14	57.71			
	Machakos	37	65.42			
	Kisumu	23	41.59			
	Nyeri	19	44.42			
	Total	106				

While training HMIS effectiveness varied slightly, with Machakos (60.05) having the highest mean rank, the variation was not significant enough to conclude that one county's training was definitively better or worse than the others (Kruskal-Wallis H =5.329, p = 0.25; p-value = 0.25). The use of HMIS was frequently used in Nyeri County (mean=59.78) while Isiolo County (49.07) showed low use of HMIS. However, the frequency of HMIS use for managing HPT appeared to be relatively consistent, with slight variations which were not statistically significant (Kruskal-Wallis H =2.678, p = 0.61). Further, the study found that Isiolo County (mean=63.04) had adequately deployed reliable ICT infrastructures, followed by Machakos County (mean=60.62). Kiambu County (mean=30.42) had the lowest mean rank, suggesting that respondents in Kiambu perceived the ICT infrastructure as less adequate and reliable compared to other counties. The results showed statistically significant differences in the adequacy and reliability of ICT infrastructure across the counties. The p-value of 0.017 was less than the

conventional 0.05 at 95% confidence levels. The p-value of 0.102 suggests no statistically significant differences in the accuracy and completeness of data recorded and processed by HMIS across the counties. Machakos County had perceived higher data quality (mean rank=61.72), while Kiambu had low data quality (mean rank=41.19). Nevertheless, the differences were not significant enough to suggest a definitive variation among counties (Kruskal-Wallis H = 7.705, p = 0.102). Respondents in Machakos (mean rank=65.42) reported the highest satisfaction, while Kisumu (41.59) and Nyeri county (mean rank=44.42) reported the lowest. The findings suggested that some counties benefited from improvements in how HMIS contributes to HPT management to enhance overall satisfaction. The results indicated statistically significant differences in overall satisfaction with HMIS's contribution to HPT management (Kruskal-Wallis H = 12.594, p-value of 0.013).

Agreeing with the findings, Malakoane et al. (2020) observed similar patterns of training effectiveness across different Counties, highlighting that slight variations in training quality were not statistically significant. Similarly, Koech (2020) reported the use of HMIS across regions, noting that while the frequency of use varied, the differences did not significantly impact overall performance. However, Kiarie and Mbugua (2022) argued that the adequacy of ICT infrastructure should have shown more pronounced regional differences, suggesting that the reported lack of significant variation might overlook underlying issues affecting infrastructure reliability.

Health management information system

The respondents were asked to rate their opinion on health management information systems in public hospitals. The findings indicated that there was a clear recognition of HMIS's role in improving data accuracy, facilitating better stock management, reducing pilferage, and promoting the availability of quality HPTs. The respondents strongly agreed that the health information management system (HMIS) significantly enhances data accuracy, aiding in better forecasting and quantification of required HPTs (Mean = 4.13, Std. Deviation = 1.043) and that the deployment of ICT technologies improves the accuracy of issuing HPTs from stores to wards (Mean = 4.12, Std. Deviation = 1.002). Further, the subjects felt that the health information management system facilitates dispensing pharmacies within the health facility (Mean = 4.15, Std. Deviation = 1.040) and enhances the availability of HPTs by minimizing pilferage and reducing losses due to expiries (Mean = 4.06, Std. Deviation = .964). Additionally, respondents strongly agreed that the application of HMIS improved the management of HPTs (Mean = 4.04, Std. Deviation = 1.004) and ICT literacy was crucial for effective HPT management (Mean = 4.06, Std. Deviation = 1.050). However, moderate agreement on some aspects (Mean 3.0 - 3.99), such as staff knowledge and full adoption of HMIS, suggested that there might still be areas for improvement. Ensuring comprehensive staff training and full integration of HMIS could further enhance HPT management efficiency and effectiveness.

Correlation analysis

Bivariate Pearson product-moment correlation analysis was used to

measure the strength and direction of the relationship between the independent variables and the dependent variable. Further, the analysis assessed whether the associations reached statistical significance or not. The results of the analysis are captured in Table 3 below.

Table 3

Correlations

		Y	X2	X2	X3	X4	X5
Y	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	106					
X5	Pearson Correlation	.544**	.241*	.436**	.364**	.609**	1
	Sig. (2-tailed)	.000	.013	.000	.000	.000	
	N	106	106	106	106	106	106

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Y=HPTs management X5=Health management information system

The study assessed whether the association between the health management information systems and the management of HPTs existed. Effective information systems can streamline processes, and improve data accuracy for forecasting and quantification to enhance decision-making, potentially leading to better management outcomes for HPTs. The study revealed that health management information systems had a positive, strong, and statistically significant association with the management of HPTs (r=544**, n=106, P=0.000). The study identified a strong positive correlation (r = 0.544), which implied that effective HMIS is strongly associated with better management of HPTs. The association is statistically significant (p = 0.000), providing strong evidence that the relationship is real and not due to random chance. The results underscored the importance of investing in and optimizing HMIS to improve the management of HPTs in hospitals.

The findings are in line with the feedback given by one key informant who indicated that lack of a health information management system is a hindrance to efficient management of Health Products and technologies.

".....Lack of an electronic system to assist in quantification, selection, and inventory management is one of the major challenges. ..." **(***KII, Male, 003, 24th June 2024***)**

Additionally, another key informant respondent recorded that: *"...by automating services through the use of HMIS, investing in staff, and securing proper storage facilities, HPT management can significantly improve access to essential HPTs by creating a ripple effect of positive outcomes such as motivated Staff, enhanced monitoring, fair appraisals, increased staffing and capacity building..." (KII, Female 007, 24th June, 2024).*

Model Summary

The study found that model 1, Financing, supply chain practices, human resources factors, inventory optimization, health management information system, explained 53.5 per cent of the variance on the management of HPTs (R Square = 0.535) as shown in Table 4 below.

Table 4

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2	Sig. F Change
1	.732[a]	.535	.512	4.886	.535	23.029	5	100	.000
2	.732[b]	.536	.507	4.908	.000	.092	1	99	.762

a. Predictors: (Constant), health management information system

b. Predictors: (Constant), Financing, health management information system

c. Dependent Variable: Management of HPTs

The R Square value of 0.535 indicated 53.5% of the variance in the management of HPTs. The study estimated an Adjusted R Square value of 0.512 which accounts for the number of predictors in the model, and adjusts for an Adjusted R Square of 0.512, indicating that 51.2% of the variance in the management of HPTs is explained by the model, slightly less than the R Square, but still a strong effect. However, adjusted R Square is reported with relatively small sample sizes (n<30).

Analysis of Variance

Analysis of Variance (ANOVA) was constructed to test the overall significance of a regression model, and the results are captured in Table 5 below.

Table 5

Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2748.818	5	549.764	23.029	.000[b]
	Residual	2387.267	100	23.873		
	Total	5136.085	105			
2	Regression	2751.031	6	458.505	19.032	.000[c]
	Residual	2385.054	99	24.091		
	Total	5136.085	105			

a. Dependent Variable: HPT Management

b. Predictors: (Constant), health management information system

c. Predictors: (Constant), health management information system

The results presented in Table 5 represents an ANOVA test for two regression models predicting the management of HPTs. The F-statistic is lower for Model 2 (19.032) compared to Model 1 (23.029).

4.0 Conclusion

The study concluded that the health management information system has a statistically significant influence on the management of HPTs in public hospitals in Kenya. The study rejected the null hypothesis (H05) and failed to reject the alternative hypothesis (Ha5). The results underscored the importance of investing in and optimizing HMIS to improve the management of HPTs in hospitals. The study revealed that health management information systems had a positive, strong, and statistically significant association with the management of HPTs (r=544**, n=106, P=0.000). Additionally, the health management information system made the most substantial unique contribution to explaining the variance in the management of HPTs and stood out as the most impactful predictor of the management of HPTs (Beta=0.209; t=2.342; P=0.021).

5.0 Recommendations

County governments should have a strategic focus on the deployment and widespread adoption of HMIS across all public hospitals. In addition, healthcare facilities must prioritize the rollout of HMIS, especially in regions where the system is not yet fully implemented. Further, the application of HMIS should be maximized by providing comprehensive training programs for healthcare workers. These programs should be designed to improve the proficiency of hospital staff in using HMIS tools effectively. The suitability of the HMIS should be regularly evaluated to ensure it meets the specific needs of each hospital. Policymakers should also integrate HMIS development into national healthcare strategies to ensure that the necessary resources, including funding and technical expertise, are allocated to support the continuous improvement of HMIS in public hospitals. This strategic alignment will help standardize HMIS practices across the country, fostering a more cohesive and efficient healthcare system. The study further recommends establishment of a monitoring and evaluation framework that tracks the impact of HMIS on the management of HPTs.

Implications for practice

Strengthening the ICT infrastructure is critical for the successful operation of HMIS. Public hospitals should invest in upgrading their technological resources, including hardware, software, and internet connectivity, to support efficient functioning of HMIS and enhance data quality. Accurate and timely data is crucial for making informed decisions regarding the management of HPTs. Hospitals should implement rigorous data validation and verification processes to ensure that the information entered into the system is reliable.

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