Health Management Information System and Health Products and Technologies Management in Level Four and Five Hospitals in Nyeri County, Kenya

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Abstract

INTRODUCTION

An effective health system is based on well-managed health products and technologies. However, the efficient administration of medical supplies and equipment in Kenya's public hospitals faces several challenges. This research focused on Level Four and Five hospitals in Nyeri County, in Kenya, aiming to identify the factors influencing health product and technology (HPT) management in relation to health management practices.

METHODOLOGY

This study employed a cross-sectional research design with a mixed-methods approach. Six key informants were identified through purposive sampling, while 51 health professionals were selected using a census technique. Data were gathered using structured questionnaires, which were piloted in Laikipia County to ensure accuracy. Quantitative data were analyzed using SPSS version 25, employing hierarchical regression methods, descriptive statistics, and correlation analysis. Qualitative data were analyzed thematically and presented verbatim.

RESULTS

The Health Management Information Systems (HMIS) accounted for 43.3% of the variation in HPT management. The explanatory power slightly improved to 43.9% with the addition of the leadership style as the mediating variable, indicating its contribution to the model. The regression analysis revealed a positive and significant relationship between HMIS and HPT management (β = 0.331), suggesting that improvements in HMIS are associated with better management of HPTs.

CONCLUSION

Level Four and Five hospitals in Nyeri County rely heavily on the Health Management Information System (HMIS) for HPT management. Further research should explore additional factors—such as the regulatory environment, patient needs and preferences, healthcare provider adoption, healthcare infrastructure, and global health challenges—that account for the remaining 56.7% of the variation in HPT management, both in Nyeri County and beyond.

Keywords: *Health Management Information System, Health Products, Health Technologies, Hospitals, Nyeri County*

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Introduction

Leadership, control, organization, and strategy are the main areas of concentration in health product and technology management. Achieving health-related SDGs, such as UHC, the right to health, and the larger Sustainable Development Goals (SDGs), requires effective management of health products and technology (HPTs). To achieve these objectives, it is essential to have well-managed HPTs, says the World Health Organization (WHO) [1].

Investments in HPTs seek to ensure the availability and wise usage of efficient, safe, and economical HPTs in industrialized countries including Ireland, New York, New Mexico, and Texas [2]. Furthermore, for the management of HPTs, a successful Health Management Information System (HMIS) must be able to gather, store, and evaluate hospital data, since drugs, vaccines, and technologies are crucial components of patient care [3].

Despite this, health product and technology management has not yielded notable improvements in the African countries of Egypt, Tunisia, Nigeria, Ghana, and Morocco. Neither primary care clinics nor hospitals have the medications that patients need [4]. Additionally, compared to other countries, South Africa's administration and general acceptability of HPT are still below par [5]. Critical medication information management system is inaccessible to patients in Zimbabwe [6]. The government of Namibia has not made data-driven choices a top priority to bolster HPT management [7]. Essential pharmaceuticals are inaccessible to almost 30% of Africa's population

In Kenya, there is low adoption of effective HMIS contributing to poor HPT management [8]. Notwithstanding, Hassan [9] submitted that HMIS has a negative strong statistical association with health technology management in Kenyan hospitals [10]. Public hospitals in Kenya are now better able to administer HPTs according to new national guidelines published by the Ministry of Health. These recommendations provide a foundation for the effective administration of health HPT and the establishment of regulatory standards. In Embu County, hospitals reported stocking only about half of the commonly required pharmaceuticals, while lower-level healthcare facilities faced shortages, with 60% of essential medicines consistently out of stock, as noted by a pharmaceutical agency [11]. To address these issues, the Nyeri County government implemented measures to improve HPT management. This included creating dedicated units for HPTs and enacting Supplement No. 16 (Acts No. 5), which formalizes guidelines for procuring and managing medical supplies [12]. This framework governs practices for both county-level and hospital operations. Additionally, the Nyeri County Government invested significant resources in constructing or renovating nine rural health facilities and two health centres to enhance healthcare accessibility and quality.

Methodology

Study design

This study employed a cross-sectional design with a mixed-methods approach, integrating both qualitative and quantitative research methodologies [13].

Study site and population

The study was conducted in Nyeri County, Kenya, focusing on Level Four and Five hospitals responsible for managing health products and technologies using HMIS. The target population all 51 healthcare professionals in Nyeri County who were responsible for managing HPTs in public hospitals. These included five nurse managers, five nutritionists, six store personnel, five laboratory technologists, five physiotherapists, five occupational therapists, five pharmacists, and five medical officers in charge. To fully grasp the phenomenon being studied, the research set out to interview important county officials in Nyeri County, such as the director of health, the county pharmacists, the county supply chain officer, the director of finance, and members of the health management team.

Sampling strategy and sample size determination

To collect qualitative data, six key informants were selected through purposive sampling, ensuring that only individuals with direct expertise in HMIS and HPTs management

participated. On the other hand, a census technique was used to select 51 health professionals, all of whom met the inclusion criteria for inclusion; ensuring comprehensive quantitative data collection from all eligible participants within the target hospitals

Inclusion criteria

Participants included were health professionals and key informants involved in health products and technologies (HPT) management, with at least one year of experience using HMIS in Level Four and Five hospitals. Individuals with no direct experience in HMIS or HPT management and those unwilling to provide informed consent were excluded from participation in the study.

Data collection tools

Quantitative data was collected using a structured questionnaire while qualitative data was collected using structured interview guides with key informants to gain in-depth perspectives.

Pilot testing

A pilot study was conducted in Laikipia County due to its similar healthcare infrastructure and prevalence of non-communicable diseases (NCDs), ensuring reliability before full-scale data collection. The research used Cronbach's alpha to assess the internal consistency of the questionnaire components with decision rule, while also employing construct validity and content validity to evaluate the instrument's usefulness: $r > 0.6$ - Doubtful, $r > 0.7$ - Acceptable, $r > 0.8$ - Good, and $r > 0.9$ – Excellent [14].

Reliability test

The internal consistency of the structures used to evaluate health management information systems and HPT management was examined using Cronbach's Alpha coefficient.

Twenty constructs yielded a Cronbach's alpha grade of 0.891, indicating good internal consistency and reliability [15]. Further, the items making up the scale According to the research, 15 items had a high degree of reliability with a Cronbach's Alpha value of 0.800. A number higher than 0.7 is deemed acceptable [16].

Data management and analysis

Quantitative analysis. Data were analysed using SPSS version 25, employing descriptive statistics (means, frequencies, percentages) to summarize data and inferential statistics; correlation analysis to examine relationships between HMIS implementation and HPTs management and regression methods to assess the influence of HMIS factors on HPTs management outcomes. Data triangulation was applied to enhance the credibility and consistency of findings.

Qualitative analysis. Interview data were transcribed verbatim and analysed using thematic analysis. Themes were identified through open coding, categorizing responses based on emerging patterns.

Ethical considerations

License to conduct research was obtained from the National Commission for Science, Technology, and Innovation (NACOSTI/P/23/27207). Ethical approval was granted by the Kenya Methodist University Institutional Scientific Ethical Review Committee (KeMU/ISERC/HSM/12/12023). Participants provided informed consent, and strict confidentiality measures were upheld throughout the study.

Table 1:
Reliability results

Variable	Cronbach's coefficient Alpha	Number of items	Comment
Health Management Information System	0.891	20	Reliable
Management of HPT	0.800	15	Reliable

The descriptive analysis of respondents' opinions on the Health Management Information System (HMIS) and the management of HPTs in public hospitals in Nyeri County revealed varying levels of agreement regarding its implementation and effectiveness. A mean value of 3.0 indicated moderate agreement, suggesting that certain HMIS practices were present but not consistently applied.

Table 2:
Respondents' Opinions on Health Management Information System

Statements	SD	D	M	A	SA	M	Std. Dev
HMIS managers ALWAYS undertake regular quality assessments of data collected on HPT.	3(6.0%)	3(6.0%)	14(28.0%)	24(48.0%)	6(12.0%)	3.54	.994
The Facility OFTENLY uses ICT for data collection on HPT.	0(0.0%)	6(12.0%)	17(34.0%)	19(38.0%)	8(16.0%)	3.58	.906
The facility RARELY uses sophisticated and powerful data management applications	3(6.0%)	3(6.0%)	17(34.0%)	20(40.0%)	7(14.0%)	3.50	1.015
We ALWAYS conduct periodic in-depth data reviews timed to feed into HPT panning	3(6.0%)	13(26.0%)	14(28.0%)	16(32.0%)	4(8.0%)	3.10	1.074
Data collected on HPT is ALWAYS trustable	2(4.0%)	4(8.0%)	17(34.0%)	24(48.0%)	3(6.0%)	3.44	.884
We HARDLY make mistakes during data entry and computation.	2(4.0%)	8(16.0%)	18(36.0%)	18(36.0%)	4(8.0%)	3.28	.970
We RARELY have issues with incomplete HMIS data used in managing HPT	3(6.0%)	9(18.0%)	18(36.0%)	16(32.0%)	4(8.0%)	3.18	1.024
We ALWAYS ensure the internal validity of the HMIS data	0(0.0%)	5(10.0%)	18(36.0%)	22(44.0%)	5(10.0%)	3.54	.813
We ALWAYS have on-premises (local storage systems) for HPT data storage	0(0.0%)	2(4.0%)	21(42.0%)	22(44.0%)	5(10.0%)	3.60	.728
We RARELY leverage the remote servers for HPT data storage in our facility	2(4.0%)	2(4.0%)	26(52.0%)	14(28.0%)	6(12.0%)	3.40	.904
Data stored is ALWAYS accessible without delays	1(2.0%)	7(14.0%)	19(38.0%)	15(30.0%)	8(16.0%)	3.44	.993
Our facility HARDLY deploys hybrid storage systems (both on-premises and remote servers) to store HPT data	3(6.0%)	6(12.0%)	26(52.0%)	9(18.0%)	6(12.0%)	3.18	1.004
We ALWAYS shave data privacy and security measures (robust encryption, authorization and role-based access policies)	2(4.0%)	3(6.0%)	21(42.0%)	13(26.0%)	11(22.0%)	3.56	1.033
We ALWAYS store data in separate locations (data backup) to avoid data loss	2(4.0%)	4(8.0%)	22(44.0%)	13(26.0%)	9(18.0%)	3.46	1.014
The facility ALWAYS complies with data storage laws to safeguard the HPT data	2(4.0%)	3(6.0%)	21(42.0%)	15(30.0%)	9(18.0%)	3.52	.995
We ALWAYS develop a plan for the immigration of stored HPT data from the old system to the new system	2(4.0%)	3(6.0%)	23(46.0%)	19(38.0%)	3(6.0%)	3.36	.851
The facility ALWAYS employs qualified data analysts like biostatisticians and data scientists.	5(10.0%)	10(20.0%)	18(36.0%)	12(24.0%)	5(10.0%)	3.04	1.124
We ALWAYS compare the figures from different health facilities before making conclusions	6(12.0%)	8(16.0%)	20(40.0%)	13(26.0%)	3(6.0%)	2.98	1.078
There are ALWAYS cases of inadequate analysis in the facility	5(10.0%)	9(18.0%)	16(32.0%)	14(28.0%)	6(12.0%)	3.14	1.161
The analytical results are ALWAYS visualized through tables, graphs, statistics	3(6.0%)	7(14.0%)	15(30.0%)	20(40.0%)	5(10.0%)	3.34	1.042

A mean score greater than 3.0 indicated high agreement, implying that the corresponding HMIS function is effectively practised and it influences the management of and health product and technologies (HPTs). A mean score below 3.0 reflected disagreement or poor implementation of an HMIS function, signalling inefficiencies and gaps in the system.

Health management information system

According to the findings, HMIS affects HPT management. Interval data was used to assess how much people agreed with the HMIS assertions overall. Table 2. Respondents agreed that the health management information system was not doing well in public hospitals in Nyeri County. HMIS managers undertook regular quality assessments of the data collected on HPT (Mean=3.54; S. D=.994), and there was use of information and communication technology for data collection on HPT (mean=3.58; S.D =.906). Additionally, the study found that health facilities stored data in separate locations (data backup) to avoid data loss (mean=3.46; S. D =1.014). Similarly, there were data privacy and security measures (robust encryption, authorization and role-based access policies (mean=3.56; S. D=1.033). Hence, the public hospitals in Nyeri County the facility complied with data storage laws to safeguard the HPT data (mean=3.52; S. DW=.995). When asked about HMIS use in data analysis, respondents moderately agreed that health facilities employed qualified analysts such as biostatisticians and data scientists (mean=3.04, SD=1.124).

Table 3:

Respondents' Opinions on Management of Health Products and Technologies

Statements	SD	D	M	A	SA	M	Std. Dev
We always establish objectives and provide steps to manage HPT.	0(0.0%)	3(6.0%)	11(22.0%)	29(58.0%)	7(14.0%)	3.80	.756
We always have ways of solving problems related to the management of HPT	0(0.0%)	2(4.0%)	11(22.0%)	31(62.0%)	6(12.0%)	3.82	.691
The facility always sets long-term goals.	2(4.0%)	0(0.0%)	10(20.0%)	25(50.0%)	13(26.0%)	3.94	.913
Our short-term goals are always planned daily	2(4.0%)	6(12.0%)	14(28.0%)	27(54.0%)	1(2.0%)	3.38	.878
We always take great efforts to identify the tasks necessary to manage HPT.	0(0.0%)	4(8.0%)	15(30.0%)	27(54.0%)	4(8.0%)	3.62	.753
Management of HPT is always performed within the framework of plans laid out.	1(2.0%)	2(4.0%)	12(24.0%)	27(54.0%)	8(16.0%)	3.78	.840
The facility always identified activities needed in the management of HPT.	0(0.0%)	1(2.0%)	11(22.0%)	29(58.0%)	9(18.0%)	3.92	.695
All staff are always assigned duties.	0(0.0%)	5(10.0%)	6(12.0%)	32(64.0%)	7(14.0%)	3.82	.800
There is always a delegation of authority responsibility.	1(2.0%)	3(6.0%)	11(22.0%)	27(54.0%)	8(16.0%)	3.76	.870
The facility's managers hardly appraise the effectiveness of plans put forth.	6(12.0%)	15(30.0%)	10(20.0%)	15(30.0%)	4(8.0%)	2.92	1.192
There is always clarity on the role positions of every staff in the management of HPT	3(6.0%)	4(8.0%)	11(22.0%)	24(48.0%)	8(16.0%)	3.60	1.050
Managers always impact staff member's work in the right direction	1(2.0%)	6(12.0%)	8(16.0%)	25(50.0%)	10(20.0%)	3.74	.986
The facility administrators rarely oversee the work of subordinates	5(10.0%)	17(34.0%)	7(14.0%)	14(28.0%)	7(14.0%)	3.02	1.270
There are always clear guidelines on how to manage HPT in our facility	0(0.0%)	9(18.0%)	7(14.0%)	26(52.0%)	8(16.0%)	3.66	.961
There is always efficient utilization of resources in our facility	5(10.0%)	4(8.0%)	5(10.0%)	28(56.0%)	8(16.0%)	3.60	1.161
Overall mean						3.63	.481

Notwithstanding, the facility rarely used sophisticated and powerful data management applications as well hardly leveraged the remote servers for HPT data storage in our facility (mean=3.50; S. D =1.015) and (mean=3.40; S. D =0.904). Additionally, the study respondents opined that public hospitals hardly deployed hybrid storage systems (both on-premises and remote servers) to store HPT data (mean=3.18; S. D = 1.004). The respondents opined that public hospitals rarely compared the figures from different health facilities before making conclusions, hence there were cases of inadequate analysis in the facility (mean=2.98; S. D =1.078)

The quantitative findings were consistent with the qualitative study. Therefore, the qualitative findings were triangulated with the quantitative findings by identifying themes that supported or provided context to the statistical results. This approach allowed for a deeper understanding of the patterns observed in the quantitative data, enriching the overall analysis. The interviews confirmed that although collecting is good, the hospitals are not able to quantify what is used in the facilities through the system.

"There is disorganization with the HMIS which always is not updated which risks loss of data and patients get delayed due to network problems. The hospitals lack qualified personnel to work with the systems like technologists. Sometimes, we require biostatisticians who can help us to analyse the data but the hospitals have not hired one…" (KII, 005).

Management of Health Products and Technologies

The purpose of this study was to determine whether these healthcare facilities consider HPT management to be a critical component in improving operational efficiency.

Public hospitals in Nyeri County have inefficient HPT management, according to all respondents. Healthcare organizations usually set long-term objectives, with an average rating of 3.94 (S.D. = 0.913), and daily short-term goals, with a mean score of 3.38 (S.D. = 0.878), according to the participants. Also, with a mean score of 3.92 (S.D. = 0.695), hospitals often acknowledged the importance of HPT management initiatives. With an average score of 3.82 (S.D. = 0.691), they also said that options for dealing with HPT management concerns are constantly accessible.

Table 4:
Correlations: HMIS and Management of Health Products and Technologies

Variable		Management of HPT	Health management information systems
Management of HPT	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	50	
	N	50	
Health management information systems	Pearson Correlation	.581**	1
	Sig. (2-tailed)	.000	
	N	50	50

Table 5:
Model Summary for the Influence of Predictors on the Management of HPTs

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.658[a]	.433	.383	5.687	.433	8.608	4	45	.000	

a. Dependent Variable: Management of HPTs

The distribution of authority and responsibility is ongoing, and all employees reliably get assignments (mean=3.82; S.D.=.800). In addition, public hospitals routinely provide HPT following predetermined plans (mean = 3.78; S.D. = 0.840), and a lot of work goes into outlining the necessary steps for HPT management (mean = 3.62; S.D. = 0.753).

Correlations: HMIS and management of health products and technologies

Using the Pearson product-moment correlation coefficient, the research investigated the connection between health management information systems (the independent variable) and the management of health goods and technology (the dependent variable). Due to the dependent variable's normal distribution of scores, this parametric technique was preferred over the standard Spearman correlation.

Health management information systems showed a significant positive association with health product and technology management (r = 0.581**, p = 0.000, N = 50).

Multiple Regression analysis

The model's ability to capture differences in HPT management was tested using multiple linear regression analysis. The statistical significance of the model might also be evaluated by this technique. Finding possible breaches of assumptions such as normality, autocorrelation, multicollinearity, and homoscedasticity was the primary focus of preliminary research.

With $R^2 = 0.433$, the results shown in Table 6 revealed that the Health Management Information System explained 43.3% of the variation in HPT management. The study reported norma R-square instead of adjusted R-square since the research involved a relatively bigger sample of 51 respondents (greater than 30). A large sample tends not to be an optimistic overestimation of the true value of the population. Later, the variance provided by the HMIS was controlled for by leadership skills and model 2 as a whole explained 43.9 per cent (.439 × 100). Model 2 had a F Change of 0.401 (df1 = 1, df2 = 44), a significance level of 0.530, and a R Squared change of.005. This indicates that the mediating variable explains 0.5 percent of the total variation. Health Management Information System accounted for 43.3% of the variance in HPT management in Nyeri County's public hospitals after accounting for leadership qualities. The models' validity and statistical significance were assessed using an Analysis of Variance (ANOVA).

Regression values indicate how much of the observed variation can be attributed to the model's independent variable, whereas residuals quantify the amount of variation that remains unexplained. Researchers looked at the likelihood value to see whether the HMIS had any predictive power. The models were considered significant when their p-values were less than 0.05 (model1; P=0.000 & model2 P=.000). Model 2 (HMIS and adjusted for) and model 1 (simply the predictor variable) were, therefore, well-fitting in predicting the variation on HPT management. Table 6.

Table 6:
Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1113.578	4	278.395	8.608	.000
	Residual	1455.402	45	32.342		
	Total	2568.980	49			
2	Regression	1126.721	5	225.344	6.875	.000
	Residual	1442.259	44	32.779		
	Total	2568.980	49			

b. Dependent Variable: Management of HPTs

Qualitative analysis

The study conducted an in-depth investigation into the how management of HPTs is influenced by health management information systems. The interview with key informants confirmed that although collecting is good, the hospitals are not able to quantify what is used in the facilities through the system:

"There is disorganization with the HMIS which always is not updated which risk loss of data and patients get delayed due to network problems. The hospitals lack qualified personnel to work with the systems like technologists. Sometimes, we require biostatisticians who can help us to analyze the data but the hospitals have not hired one" (KII 005).

Discussion

This proportion implies that the outcomes reflect the intended audience quite fairly. Results show that level four and five Nyeri County hospitals make good use of health management information systems (HMIS) to enhance HPT management. With a mean score of 3.36—above 3.0—and a low standard deviation of 0.563, the study reveals a solid agreement among respondents with the least variance in their responses. The study findings agreed with those of Mboera et al. that HMIS enhances routine health facility-based data management in hospitals, highlighting the positive impact of HMIS on data quality and the use of ICT in HPT data management [17]. Conversely, the findings disagreed with those of Ndungu and Kimani in Kisumu County, who found that public hospitals frequently use sophisticated data management applications and leverage on remote servers for HPT data storage, contrasting with the moderate use of such technologies indicated by the mean scores of 3.50 and 3.58 in other regions [18]. These varying results underscore the differences in the adoption and implementation of data management systems across different counties.

The administration of HPTs was positively and significantly correlated with health management information systems (r=0.581**, P=0.000, N=50). Researchers in Nyeri County concluded that public hospitals' use of health products and technology management is significantly impacted by health management information systems. Logistics management was shown to have a favourable connection with the management of health commodities in maternity and child health facilities, contrary to the results of Mbatia from Meru County, Kenya [12]. in maternity and child health facilities were positively associated. In contrast to the weaker correlation shown in Nyeri County, Mudogo et al. documented a consistent improvement in inventory management procedures in Vihiga County [1]. Further, the result agreed with those of Bunyali, Muthoni, and Kimemia [19] who found a strong correlation ($r = 0.737$, $p = 0.000$) between health information systems and the accessibility of medicinal commodities. Contrarily, the results by Lugada et al. [20] in Uganda corroborated the substantial link found by showing a robust positive correlation between health information systems and the availability of medicinal goods [20].

The key informants submitted that the public hospitals in Nyeri County can quantify what is used in the facilities through the HMIS. These findings contradict those of Mudogo et al., who observed that public health institutions in Vihiga County experienced an improvement in average storage scores, increasing from 68.72% to 86.13%. On the other hand, Muiruri et al. [21] found a significant rise in storage scores from 70.15% to 88.45% over two years. They attributed this improvement to enhanced staff training, the implementation of effective inventory management systems, increased government infrastructure support, and active community involvement [21].

Limitations of the study

The study was based on mixed mixed-method design. Even though it provided comprehensive insights within a single study, it provided complexity in integrating the findings of both pieces of research. The study was resource intensive in terms of costs, time-consuming and needed expertise. Methodical challenges such as conflicting findings from the different designs could be a limitation.

Conclusion

Level Four and Five hospitals in Nyeri County rely heavily on the Health Management Information System (HMIS) for HPT management. Further research should explore additional factors—such as the regulatory environment, patient needs and preferences, healthcare provider adoption, healthcare infrastructure, and global health challenges—that account for the remaining 56.7% of the variation in HPT management, both in Nyeri County and beyond.

Recommendations

1. The study recommends further study to interrogate the probable factors such as regulatory environment, patient needs and preferences, healthcare provider adoption, healthcare infrastructure, and global health challenges across the board.
2. A similar study is suggested to he conducted in other counties to support policy formulation.

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