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Data Quality in Health Management Information Systems at Kenyatta National Hospital in Nairobi City County, Kenya: Influence of Technological Factors

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Abstract:
Background*: Efficient and effective Health Management Information System (HMIS) is critical to both the healthcare system and to people's health, by providing the system and data that is central for target setting, policy planning and implementation. There is tremendous increase in available and accessible information; however, growth in the quantity of information has not necessarily been accompanied by improvements in quality of data. There has also been evolution and potential of information technologies in enhancing the relevance of the quality health information management. Thus, various technological aspects such as system design, knowledge, training and skills that support HMIS within these environments are key in ensuring data quality. Kenyatta National Hospital operates several stand alone information systems, making it a challenge to provide quality data that can be utilized in the management process. The study therefore, set out to examine the technological factors influencing data quality in HMIS at Kenyatta National Hospital in Nairobi City County, Kenya.*
Materials and Methods*: We used a cross sectional descriptive design, applying both quantitative and qualitative techniques. Census was done to collect data from all the 195 employees of the department of health information using questionnaires and Key Informant Interviews after obtaining their informed consent. We excluded those who were absent and who declined consent. Pretesting was conducted at Moi Teaching and Referral Hospital (MTRH) where the validity and reliability of the research instruments were verified. All necessary ethical approvals and permits were obtained prior to commencing the study. Analysis was done using SPPS version 25.0. Mean, frequencies and percentages were used for descriptive statistics while Chi-square and linear regression were applied for inferential statistics.*
Results*: The response rate was 98.97% (n=193). 90.2% (n=174) respondents stated that Network issues were a concern, 64.2% (n=124) stated HMIS in the hospital was user friendly, while 62.7% (n=121) stated that the hospital was keeping up with technological and innovative trends applicable to the health sector. The association between the dependent (data quality) and independent (technological factors) variables was statistically significant(X^2=63.341, P-Value= 0.001). Regression analysis generated a model with predictors of data quality being age, gender, highest level of education, subsection, and technological factors,*
Conclusion: *Technological factors are key determinants of data quality in HMIS at Kenyatta National Hospital in Nairobi City County*

Key Words*: **HMIS; Data; quality; Technological Factors, KNH***

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I. Introduction

Health Management Information Systems (HMIS) encompass all technologies that are used in the health data specifically designed to support planning, management, and decision making in health facilities and organizations as well as refers to systems for health information management at various levels. The WHO states that HMIS is a key component of a health system. Therefore, a proper design and implementation of HMIS is core to an effective and efficient system (1–3). In the present-day competitive world, human resources and technology influence the way that health management works. The increasing demand for health services is also critical to the operations within the modern health service industry. As such, it is of vital importance for different players in the industry to keep up with various tools and technologies that improve and increase the chances of success (4). There is unprecedented speed at which data creation is evolving in the economies today. Thus, the potential for IT has skyrocketed enhancing the relevance of the quality health information

management. With these new evolutions, there are various aspects such as system design, knowledge, training and skills that support HMIS within these environments in a bid to ensure data quality(5,6). Production of quality information through proper design and alignment of technical abilities within a system is facilitated by quality data (7). Considering the emerging competitive environment that health managers are operating in and an increased need from the public regarding fast service delivery, health managers require high-quality information to inform their daily decision making. Therefore, to succeed, it is important to match the current trends and innovative services offered by competitors(4). Kenyatta National Hospital (KNH) operates a number of standalone information systems. These include the Funsoft System, Quick books and IQ Care system. These systems are not integrated and therefore do not speak to each other making sharing of information between these systems a difficult process. This has made it a challenge to provide quality data that can be utilized in the management process. The full benefits of deploying a HMIS are not fully exploited in order to improve efficiency and effectiveness in healthcare. Therefore, this study aimed to establish the technological factors that influence data quality in HMIS at Kenyatta National Hospital.

II. Material and Methods

Study Design: We employed a cross sectional descriptive study design

Study Location: We conducted the study at the department of health information, KNH. It is the largest national referral, teaching and research hospital in Kenya, and participates in national health planning and policy. KNH is at the apex of the referral system in health sector and plays a critical role in terms of Health information system. It is located in the Nairobi City County along Hospital Road, upper hill, about 5km west of the Central Business District. It has a bed capacity of over 2000, attends to 80,000 inpatients and over 500,000 outpatients annually

Study Duration: Data was collected between April and August 2020.

Sample size: The study included 195 participants.

Sample size calculation: In this study, we used a census survey that eliminated the need for selecting a sample from the study population. The sample size therefore, included all HID staff.

Subjects & selection method: In order to apply the census technique in this study, we established and maintained a list of primary sampling units (all HID staff) who were then classified by area of deployment. Upon the establishment and maintenance of this list, we ensured that all the employees in the department were included. The participants were recruited by visiting all areas of deployment to provide study information and obtain an informed consent.

Inclusion criteria:

We included all staff working in the health information department, Kenyatta National Hospital who were present during the study and gave their consent to participate in the study.

Exclusion criteria:

We excluded all the staff who qualified based on the inclusion criteria yet were either absent during the study period or who did not consent to take part in the study

Procedure methodology

After written informed consent was obtained, semi structured questionnaires were given to the participants to complete and return. The questionnaires were divided into three parts based on the objectives or independent variables and had 19 elements. A key informant guide which was also designed in line with the objectives was used to guide the face to face interviews and had 7 items. This acted as a confirmatory tool for the questionnaire findings.

Quantitative and qualitative data collection techniques were used to collect data from the respondents and key informant interviews. The quantitative technique produced quantifiable data while qualitative technique produced data in form of words. Both techniques were complimentary. Qualitative techniques provided extensive explanations while quantitative techniques produced the numeric data needed to test hypotheses and meet the required objectives

Statistical analysis

We checked data for errors before data entry. We assigned numeric values to the responses in the questionnaire according to data type. Validation was done to ensure that wrong fields were not entered. Cleaning of the data was done to ensure that what was entered is what was required. Analysis was done using SPSS version 25.0. Descriptive and inferential statistics were applied. Mean, frequencies and percentages were used for descriptive statistics. Chi-square and linear regression were applied for inferential statistics. The level of confidence was set at 95% and the hypothesis testing was done. The results were presented in frequency tables and figures.

III. Results

Out of the 195 questionnaires distributed, 193 (98.97%) were completed, accurately filled and returned. A total of seven (7) face to face semi-structured interviews were conducted. The thematic analysis was undertaken, and recurring themes incorporated in the findings.

The respondents' background/demographic characteristics are given in table 1 below.

Table 1: Participants' background information

Variable	Frequency (n)	Percent (%)
Age in years		
Less than 30	32	16.6
30 to 40	24	12.4
41 to 50	101	52.3
Over 50	36	18.7
Gender		
Male	75	38.9
Female	118	61.1
Marital status		
Married	149	77.2
Single	37	19.2
Divorced	3	1.6
Widowed	4	2.1
Highest Level of education		
Secondary	18	9.3
College	117	60.6
Undergraduate	41	21.2
Postgraduate	17	8.8
Sub-section		
Labs, X-Ray and Farewell Home	37	19.2
Outpatient Clinics	64	33.2
Coding & Indexing, MRS and Statistics	15	7.8
Wards	42	21.8
Central records	35	18.1

Respondents' Mean age was *42.92* (*SD*=9.72) with a range from 20 to 59 years and a median (IQR) of 45(38.5-49.5) years. Participants aged 41 to 50 years old were the majority (52.3%). The second largest age group were those over 50 years (18.7%, n=36). 16.6% (n=32) were aged less than 30 years, and 12.4% (n=24) were aged between 30 to 40 years. Over half of the respondents were females (61.1%, n=118) and 38.9% (n=75) were males. On marital status, 77.2% (n=149) were married, 19.2% (n=37) were single, 2.1% (n=4) widowed and 1.6% (n=3) divorced. Sixty-point six percent of the participants had gone to college for certificate or diploma training, followed by 21.2% (n=41) with undergraduate training. 9.3% (n=18) had secondary education and only 8.8% (n=17) had postgraduate training. A third of the participants (33.2%, n=64) worked in the

outpatient clinics, 21.8% (n=42) in the wards, 19.2% (n=37) in labs, X-Ray and Farewell Home, while (7.8%, n=15) worked in Coding & Indexing, medical records secretariat and Statistics.

Technological factors

The technological factors were categorized into user friendliness, stake holder involvement, network connectivity, data cleaning/editing and innovativeness. The findings from these 5 areas are summarized in table 3 below:

Table 2: Technological factors influencing data quality

Statement	True	False
HMIS is in this hospital is user friendly	124(64.2%)	69(35.8%)
Users of the HMISs are usually consulted throughout the process of designing the systems	75(38.9%)	118(61.1%)
Network issues are a concern at this subsection	174(90.2%)	19(9.8%)
This subsection conducts its own data cleaning/editing before forwarding to Statistics subsection for further analysis	108(56%)	85(44%)
KNH is keeping up with technological and innovative trends applicable to the health sector	121(62.7%)	72(37.3%)

Out of the 193 respondents, 90.2% (n=174) stated that network issues are a concern at their subsection, 64.2% (n=124) stated that HMIS in this hospital was user friendly, while 62.7% (n=121) stated that KNH was keeping up with technological and innovative trends applicable to the health sector at that time. 56% (n=108) of respondents stated that the subsection they worked in conducts its own data cleaning/editing before forwarding to Statistics subsection for further analysis. 38.9% (n=75) users of the HMISs stated that they are usually consulted throughout the process of designing the systems.

The face to face interviews showed that the respondents had witnessed major benefits of the HMISs which included; effective management of points of information, provision of reliable latest useful information and ease of retrieval. The major demerits identified include: system intra-operability, inconsistence and manipulation.

A sample of the interviews:

"data quality issues often occurred when a new dataset is introduced or an existing dataset is modified. For effective transition, test plans should be built with two aims: firstly, confirming the transition meets the requirement; secondly ensuring the transition does not have an unintentional impact on the data in the pipelines. For mission critical datasets, when a change happens, regular regression testing should be implemented for every deliverable and comparisons should be done for every field and every row of a dataset. With the rapid progress of technologies in big data, system migration constantly happens in a few years. Automated regression test with thorough data comparisons is a must to make sure good data quality is maintained consistently"

Association between dependent variables (Data quality) and independent variables

Table 3: Relationship between data quality and other study variables

Variable	Data Quality		Chi-Square (P-Value)
	Low n (%)	**High n (%)**	
Age in years			4.717 (0.194)
Less than 30	14 (43.8%)	18 (56.3%)	
30 to 40	4 (21.1%)	15 (78.9%)	
41 to 50	28 (26.9%)	76 (73.1%)	
Over 50	14 (36.8%)	24 (63.2%)	
Gender			0.14(0.514)
Male	24 (31.6%)	52 (68.4%)	
Female	36 (30.8%)	81 (69.2%)	
Marital status			4.479 (0.214)
Married	41(27.7%)	107 (72.3%)	
Single	15()	23(60.5%)	

Divorced	2(66.7%)	1(33.3%)	
Widowed	2(50%)	2 (50%)	
Highest Level of education			4.532(0.021)
Secondary	8(44.4%)	10 (55.6%)	
College	37(31.9%)	79(68.1%)	
Undergraduate	12(30%)	28 (70%)	
Postgraduate	2(11.8%)	15(88.2%)	
Sub-section			2.436(0.016)
Labs, X-Ray and Farewell Home	8 (21.6%)	29 (78.4%)	
Outpatient Clinics	19 (29.7%)	45 (70.3%)	
Coding & Indexing, MRS and Statistics	6 (40%)	9 (60%)	
Wards	13 (31.7%)	28 (68.3%)	
Central records	12 (35.3%)	22 (64.3%)	
Technological factors	52 (26.9%)	141 (73.1%)	63.341(0.001)

Females compared to males were more likely to ensure high quality of data (χ^2 =0.14, p=0.514). Participants aged between 30 to 40 years were also more likely to ensure data quality than either less than 30 years, 41 to 50 and over 50 years but this was not statistically significant (χ^2 = 4.717, p=0.194). A higher proportion of respondents working in Labs, X-Ray and Farewell Home were reported to ensure high quality of data which is statistically significant (χ^2 = 2.436, P<0.016). A higher proportion of respondents stated that all aspects of the technological factors identified contributed to data quality which was reported as statistically significant (χ^2 =63.341, p=0.001). Participant highest level of education, sub section, and all technological factors are factors associated with data quality and were statistically significant.

Linear regression

Table 5: Determinants of data quality

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Bound	
1		**B**	**Std. Error**	**Beta**			**Lower**	**Upper**
	(Constant)	-.090	.170		-.531	.596	-.425	.244
	Level of education	-.010	.030	-.017	-.345	.731	-.070	.049
	subsection	.012	.016	.038	.775	.440	-.019	.043
	Technological factors	.159	.019	.418	8.296	.000	.121	.197

Predictors: (Constant), Age, Gender, Marital status, Highest Level of education, subsection, Technological factors,

Dependent variable: Data quality

Regression analysis was undertaken to measure the relationship between the statistically significant variables (highest level of education, sub section, and technological factors) with p-values less than 0.05. According to the regression analysis findings, Technological factors depicted a positive coefficient.

IV. Discussion

While each of the six building blocks of health systems are essential, health information systems are identified as critical for decision-making within each of the other five building blocks, hence forming the foundation of health systems (8). Since hospitals are the main health providers in developing countries, there is a general need to improve efficiency and effectiveness(9). Thus, it is critical to have an efficient and effective HMIS. HMIS is one of the major priority areas needed in order to strengthen the health care delivery system (10). There is a myriad of factors- including technological that influence the effective functioning of HMISs. We therefore, set out to explore the technological factors that influence data quality in HMIS at the national referral hospital. We further explored five sub categories of technological factors; user friendliness, stake holder involvement, network connectivity, data cleaning/editing and innovativeness.

In terms of user friendliness and stakeholder involvement, a large proportion of respondents (64.2%) stated that the HMIS at KNH was user friendly. However, just over one third (38.9%) of participants stated that users of the HMISs are usually consulted throughout the process of designing the systems. The study findings

further established that stakeholder involvement in the IT implementation is inexorable. This concurs with Cebul et.al, (11) who stated that involvement of health information users was critical. Similarly, the MOH health information systems policy also intimated that existing HISs are designed and implemented with no or limited participation of those who are to ultimately operate them. Neither is there adequate involvement of those who are to use the information generated by these systems(5). Thus, there is emphasis on involving users in the design to prevent hindrance in addressing data quality. It is worth noting that most systems are developed without engaging the information users which prevents efficient and effective data quality processes from being addressed adequately. Further, in the instances where information users are engaged, many at times they produce data not in tandem with challenges encountered to generate information anticipated (5).It is already known that technological performance largely relies on its feasibility and practicality in the pre-implementation phase(12). Therefore, it is important to consider a proper design and implementation of HMIS which is core to an effective and efficient system (5). Since the use of HMIS is prioritized as revealed in the study, the IT teams should put more effort to live up to the expectations of the users with periodical trainings on health IT for patient safety in the hospital.

In terms of network connectivity, most of the respondents (90.2%) reported that there were concerns regarding network connectivity in the subsections they worked in. HMISs use relationships between various databases that if not properly linked, may lead to system crashes. System connectivity and integration within those systems hugely affect the functionality of the data management process, especially when technologies are involved(5).

Slightly more than half (56%) of respondents stated that they conduct their own data cleaning/editing before forwarding to Statistics subsection for further analysis. Improving data quality requires continuous monitoring and cleansing of data, validation and analysis of the data for its reusability. Therefore, decision makers can have faith and depend on data for making decisions which in turn affects the level of data quality. In terms of keeping up with innovation, majority of the respondents (62.7%) concurred that the hospital was keeping up with current trends. This further revealing that innovation and innovative ways of making the system better, aimed at ensuring it is at par with current trends, clear and concise data cleaning tools before consolidation and rigorous consultation with relevant stakeholders are always needed. This concurs with Thompson et.al(4), Senkubuge (13) and WHO (14) that reported the importance of keeping up with and advancements in technology. According to Baryamureeba (7), the rudimentary approaches to health management ought to be changed following the evolution of health systems across the world. In the present-day competitive world, human resources and technology influence the way that health management works. The increasing demand for health services is also critical to the operations within the modern health service industry. As such, it is of vital importance for different players in the industry to keep up with various tools and technologies that improve and increase the chances of success. Therefore, to succeed, it is important to match the current trends and innovative services offered by competitors (4).

IV Conclusions

We concluded that all aspects of technological factors studied (user friendliness, stake holder involvement, network connectivity, data cleaning/editing and innovativeness) are essential in enhancing data quality. Regression analysis also showed an association between technological factors and data quality which was statistically significant. Thus, the predictors of data quality were age, gender, marital status, highest level of education, subsection, and technological factors.

We recommend further similar studies in other referral facilities in Kenya or consideration in both public and private hospitals with an aim of comparative analysis in Kenya. Similarly, the study can be done in other hospitals to establish the dynamics involved in data quality practices and their influence not only in health care management but also high-level decision making and policy development.

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