Journal of Health, Medicine and Nursing
ISSN 2422-8419 An International Peer-reviewed Journal
Vol.38, 2017
www.iiste.org

The Influence of Infrastructural Investment on Adoption of ICT in Health Information System: A Case of Sub County Referral Hospitals in Nakuru County, Kenya

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Abstract
The use of Information Communication Technology is essential in overcoming the challenges of inadequate health workers and low quality of service delivery. This study was an effort to strengthen the Health Management Information Systems pillar by seeking to assess the adoption of ICT in Health Systems in Nakuru County. The overall objective for this study was to assess the adoption of ICT in health information systems. For the purpose of this paper the researcher has focused on establishing the influence of infrastructural investment on adoption of ICT in HIS. The study employed cross-sectional design with a deductive approach. The target population was 534 made of medical personnel drawn from the sub-county Hospitals within Nakuru County out of which a sample of 98 respondents was used in the study. Data was collected using self-administered questionnaires with questions based on five points Likert Scale which required the respondents to indicate their level of agreement with the statements. The data was analyzed and descriptive statistics used to summarize the responses into frequencies and percentages. The findings were presented in bar graphs with descriptive narratives. The results showed that Lack of adequate ICT infrastructure has hampered ICT adoption in public hospitals in Nakuru County. The study recommends improvement of ICT infrastructure. The County Health Ministry should also support ICT adoption in the public hospitals by allocating adequate funds for this purpose.
Keywords: Adoption of ICT, Health Information Systems, ICT Infrastructure

1. Introduction

While more and more patients seek healthcare services and prioritize quality in their lives through enhanced healthcare treatments and services great demand is created on the health care industry's information-handling abilities and infrastructure (Bodenheim, 1999). It is therefore crucial to ensure there is reliable information and effective communication in public health practices.

According to Lagesen and Vivian (2007), adoption of ICT provide timely information that is proven to save lives, improve the quality and efficiency of the health delivery system and contain the cost of healthcare. Therefore use of appropriate technologies can increase the quality and the reach of both information and communication (Zakaria, Yusof and Zakaria, 2009).

According to Ibegwam (2004), a good ICT infrastructure is a condition for enhancing the well-being of a country. He observed that Internet has become an important component of the electronic services in health institutions and has permeated all aspects of life, breaking down barriers to communication and information access worldwide. The Internet is a particularly valuable resource for information relating to health care. However, in spite of the potential contributions of ICTs to the activities of health workers, some constraints exist that prevent their widespread utilization.

With the potential of Health care benefiting from Information and Communications Technology, it is taking so long to move towards the adoption while research has shown that ICT adoption in healthcare can save billions of dollars (RAND, 2013). This study explains the relevance of establishing factors that influence adoption of ICT in HIS which is paramount for quality and timely service delivery by health service providers.

The study concentrated on Nakuru County one of the 47 counties in Kenya located in the former Rift valley province. The County is one of the most cosmopolitan counties in the country and is home to 1, 603, 325 people (male – 50.2% and female – 49.8%), according to the 2009 National Census. The County has 7 sub-County referral hospitals namely: Annex Hospital Nakuru, Naivasha Sub-County Hospital, Gilgil Sub-County Hospital, Olenguruone Sub-County Hospital, Molo Sub-County Hospital, ElburgonNjoro Sub-County Hospital and Bahati Sub-County Hospital.

1.1 Statement of the problem

Health care is clearly an information intensive sector which could benefit from Information and Communications Technology, and the potential has also been noted. The question is; why is it taking so long to move towards the adaption of more comprehensive health ICT? Despite the potential of ICT in solving challenges of inadequate health workers and low quality of service delivery, the technology has not been fully utilized in Kenya which is evidenced by the observed masses of data still being collected at the operational level by the already overburdened health workers. This paper documents status of ICT infrastructure in healthcare and how it affects

adoption of ICT.

1.2 Objective of the study

The objective of the study was to establish the influence of infrastructural investment on adoption of ICT in HIS.

2. Methodology

Cross-Sectional study design was used to collect data. The data was collected using self-administered questionnaires with questions organized in a five points Likert scale. The information gathered represents the situation of ICT adoption at that point in time. The target population comprised of medical personnel making a total of 534 respondents as shown in Table 2.1

Personnel	**Number in each facility**							**Total**	**Percentage**
	Annex	Gilgil	Olenguruone	Molo	Elburgon	Bahati	Naivasha		
Doctors	3	3	3	6	2	5	19	41	7.6%
Pharmacists	2	2	2	3	2	4	8	23	4.2%
Nurses	42	75	14	53	13	32	112	341	63.5%
Clinical.Officers	3	10	8	8	6	12	13	60	11.2%
HIS Officers	1	1	1	1	2	1	2	9	1.7%
Administrators	1	1	1	1	1	1	1	7	1.3%
Lab Technologists	2	5	3	7	3	5	12	37	6.9%
Accountants	1	0	0	1	1	0	0	3	0.6%
Nutritionists	1	1	1	1	1	1	1	7	1.3%
Radiographers	1	0	0	2	0	0	3	6	1.1%
Total	**57**	**98**	**33**	**83**	**31**	**61**	**171**	**534**	

Table 2.1 Target population

This table shows the health workers in the sub county hospitals of Nakuru County according to their cadres. The Data was obtained from the health ministry office of Nakuru County as it was in October 2016.

Stratified Random Sampling was used to generate the study sample. The population was put in strata as shown above which helped to minimize the error of estimation. The statistical formula suggested by Saunders, Lewis and Thornhill (2009), and Mugenda & Mugenda (2003) was used to calculate the sample size.

$$n = [\frac{z^2 pq}{e^2}]$$

Where:

n = the desired sample size; z = the standard normal deviate (1.96 for 95% confidence interval); p = 50% estimate of the proportion under study since studies on the characteristics is unknown; q = proportion not having the characteristic (1-p) and e = the level of statistical significance set, which is the margin of error (set at 8.9% in this study)

$$n = [\frac{1.96^2 0.5(1-0.5)}{0.089^2}]$$

$$= 120$$

Since the population size is less than 10,000, the sample size (called adjusted sample size) was calculated using the formula:

$$n^1 = [\frac{n}{1+\frac{n}{N}}]$$

Where n^1 is the adjusted minimum sample size; n is the sample size and N is the total population

$$n^1 = \left[\frac{120}{1+\frac{120}{534}}\right]$$

After applying the formula above a multiplying factor of 0.18 was generated. The cadres that had only one personnel in a facility, the one was included in the sample hence ignoring the multiplying factor.

The sample size that was therefore used is as summarized in table 2.2:

Table 2.2 Sample Size: The number of health workers who were used as respondents and therefore were given questionnaire in each of the participating facilities.

Personnel	Number in each facility							Total
	Annex	Gilgil	Olenguruone	Molo	Elburgon	Bahati	Naivasha	
Doctors	1	1	0	1	0	1	1	5
Pharmacists	1	1	1	1	1	2	2	9
Nurses	2	9	1	4	1	2	19	38
Clinical.Officers	1	2	1	2	1	1	3	11
HIS Officers	1	1	1	1	1	1	1	7
Administrators	1	1	1	1	1	1	1	7
Lab Technologists	1	2	1	2	1	2	2	11
Accountants	1	0	0	1	0	0	0	2
Nutritionists	1	1	0	1	0	1	1	5
Radiographers	1	0	0	1	0	0	1	3
Total	**11**	**18**	**6**	**15**	**6**	**11**	**31**	**98**

3. Results and Discussion

Influence of infrastructure was considered under availability and adequacy of computers in the facilities, maintenance of the available computers, connection to local area network as well as internet connectivity. The researcher also considered availability of reliable electricity including back-up generator.

3.1 Relationship between availability of computers and adoption of ICT

Findings from the study showed that regression was significant at 0.42 as shown in table 3.1 which is a significant relationship between availability of computers in the department and adoption rate. This means that availability of computers in the department is paramount for adoption of ICT in HIS in the hospital. The study findings are in line with Eysenbach and Wyatt (2002), that ICT infrastructure is a major issue that stands as an impediment to access of information, most people are not able to access digital information due to lack of the necessary infrastructure. The study further revealed that Lack of adequate ICT infrastructure has hampered provision of efficient and affordable ICT services in public hospitals in Nakuru County.

Table 3.1 Availability of computers vs. Adoption

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.727	1	2.727	4.272	.042[a]
	Residual	56.811	89	.638		
	Total	**59.538**	**90**			
a. Predictors: (Constant), Do you have computer(s) in your department						
b. Dependent Variable: How do you rate adoption of ICT in this Facility?						

ANOVA analysis results on the effect of availability of computers on adoption of ICT in health information system

Results from regression analysis indicated a significant relationship of 0.000 as shown in table 3.2 and figure 3.1 which is a strong relationship. This is an indication that availability of adequate number of computers allows ease in data entry and hence influence adoption rate of ICT in HIS.

Table 3.2 Adequate computers vs. Adoption if ICT

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.873	1	13.873	27.253	.000[a]
	Residual	45.812	90	.509		
	Total	**59.685**	**91**			
a. Predictors: (Constant), Hospital has adequate computers to allow data entry						
b. Dependent Variable: How do you rate adoption of ICT in this Facility?						

ANOVA analysis results on how availability of adequate number of computers in hospital affects adoption of ICT in Health Information Systems

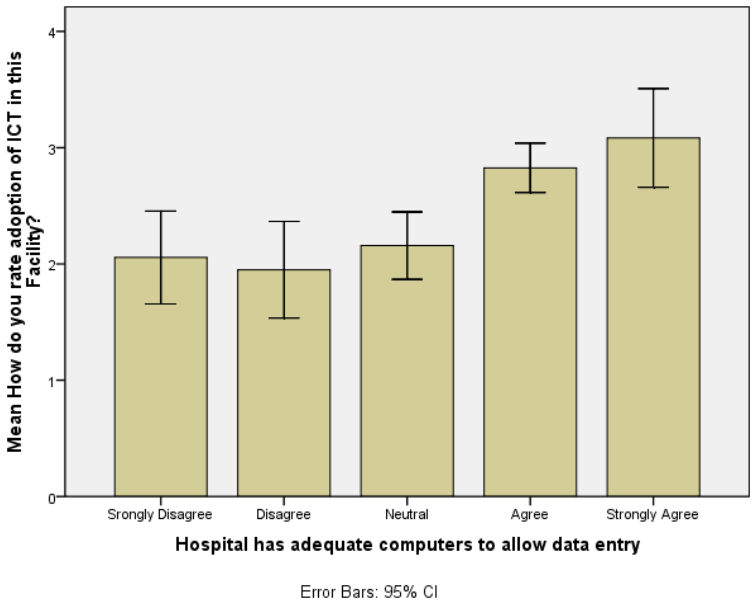

Figure 3.1: Adoption of ICT vs. Adequate computers

The figure shows the relationship between availability adequate number of computers and adoption ICT as per the responses by the six hospital managers who participated in the study.

On adequacy of the computers in the facilities, the question posed to the hospitals management staff produced results as shown in table 3.3 and figure 3.2.Four out of six (66.7%) of the respondents who were hospital administrators disagreed that the number of computers in their facilities were adequate while 33.3% (two respondents) agreed that the number of computers in their facilities were adequate as shown in Table 3.3 and Figure 3.2. This shows that inadequate number of computers in the facilities has hindered adoption of ICT because the relationship shown by ANOVA in table 3.2 is a strong one.

Table 3.3 Do you have adequate computers in your facility

do you have adequate computers in the facility					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	28.6	33.3	33.3
	No	4	57.1	66.7	100.0
	Total	6	85.7	100.0	
Missing	System	1	14.3		
Total		**7**	**100.0**		

This table shows response by hospital managers on whether they have adequate number of computers in their facilities.

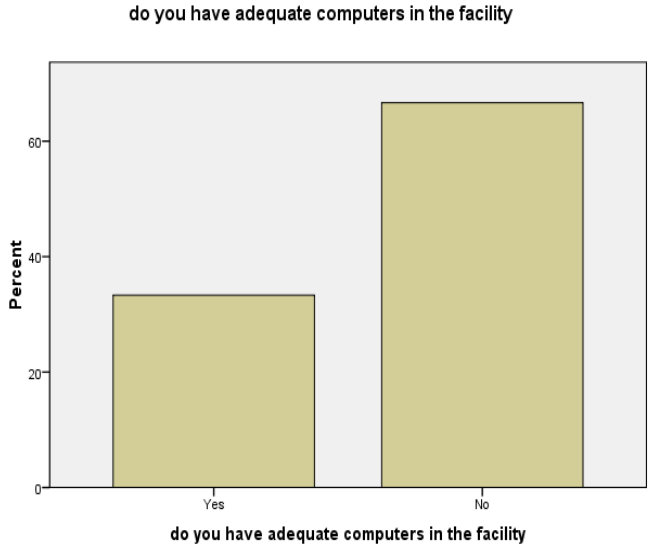

Figure 3.2: Are there adequate computers?

The figure shows availability of adequate number of computers in the sub-county hospitals on Nakuru County.

3.2 Regular maintenance of computers in the hospital enables continued use ofICT

From the study fifty respondents (54.4%) either agreed or strongly agreed that maintenance of computers in the hospital enabled continued use of ICT in the hospital, twenty two respondents (23.9%) either disagreed or strongly disagreed that maintenance of computers in the hospital enabled continued use of ICT while twenty respondents (21.7%) were uncertain as shown in table 3.4 and figure 3.3. these results illustrate the importance of maintaining computers to enable workers adopt ICT easily.

Table 3.4 Maintenance of computers

Regular maintenance of computers in the hospital has enabled continued use of ICT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	9	9.2	9.8	9.8
	Disagree	13	13.3	14.1	23.9
	Neutral	20	20.4	21.7	45.7
	Agree	31	31.6	33.7	79.3
	Strongly Agree	19	19.4	20.7	100.0
	Total	92	93.9	100.0	
Missing	System	6	6.1		
Total		**98**	**100.0**		

Table 3.4 shows the response by health workers on whether the computers are regularly maintained to enable continued use of ICT

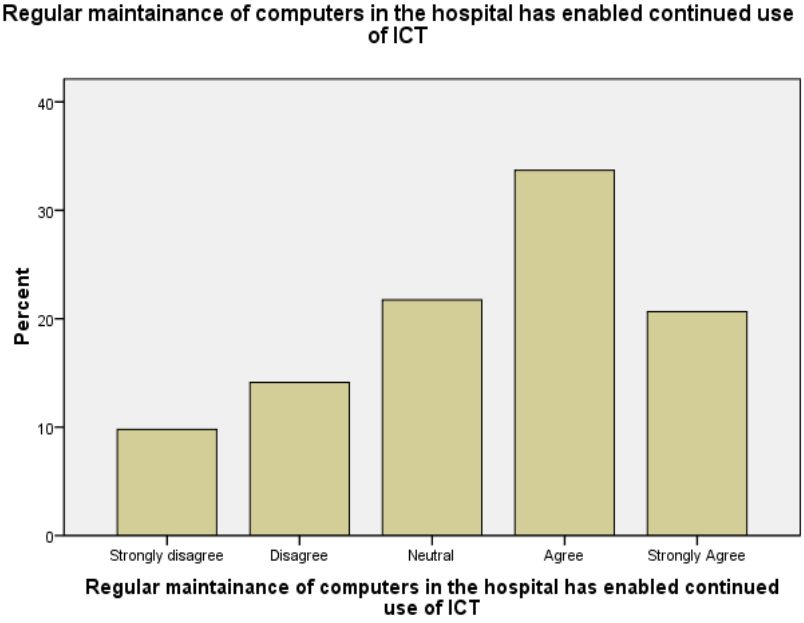

Figure 3.3: Maintenance of computers

The figure shows the percentages of the level of agreement that maintenance of computers in the hospital enables continued use of ICT

3.3 Connection of computers in a local network allows easy communication among hospital departments

From the study findings Fifty eight making 62% of the respondents agreed or strongly agreed that connection of computers in a local network has allowed easy communication among hospital departments, twenty one respondents (22.8%) disagreed or strongly disagreed that connection of computers in a local network has allowed easy communication among hospital departments while thirteen respondents (14.2%) were uncertain as indicated in table 3.5 and figure 3.4.

Table 3.5 Connection to LAN

Connection of computers in a local network has allowed easy communication among the hospital departments					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	14	14.3	15.2	15.2
	Disagree	7	7.1	7.6	22.8
	Neutral	13	13.3	14.1	37.0
	Agree	23	23.5	25.0	62.0
	Strongly agree	35	35.7	38.0	100.0
	Total	92	93.9	100.0	
Missing	System	6	6.1		
Total		**98**	**100.0**		

The table 3.5 shows response by health workers on whether connection of computers in a local network allows easy communication among hospital departments

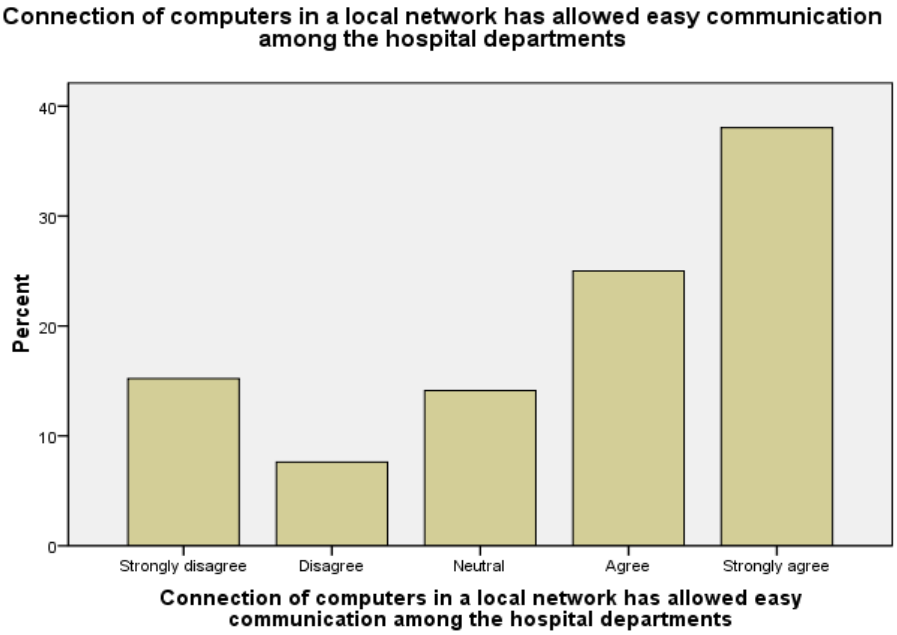

Figure 3.4: Connection to LAN

The figure shows level of agreement by respondents on how connection of computers in local area network has enabled easy communication among hospital departments

3.4Availability of reliable electricity enables use of ICT

Results from correlation study on computers installation of computers with uninterrupted power supply (UPS) and adoption level indicated that correlation was significant at 0.001 level as shown in Table 3.6 and Figure 3.5.

Table 3.6 Uninterrupted Power Supply

Correlations			
		Computers are installed with uninterrupted power supply(UPS)	How do you rate adoption of ICT in this Facility?
Computers are installed with uninterrupted power supply(UPS)	Pearson Correlation	1	.269**
	Sig. (2-tailed)		.010
	N	92	92
How do you rate adoption of ICT in this Facility?	Pearson Correlation	.269**	1
	Sig. (2-tailed)	.010	
	N	92	92
**. Correlation is significant at the 0.01 level (2-tailed).			

The Pearson correlation on installation of computers with uninterrupted power supply (UPS) with adoption of ICT in hospitals

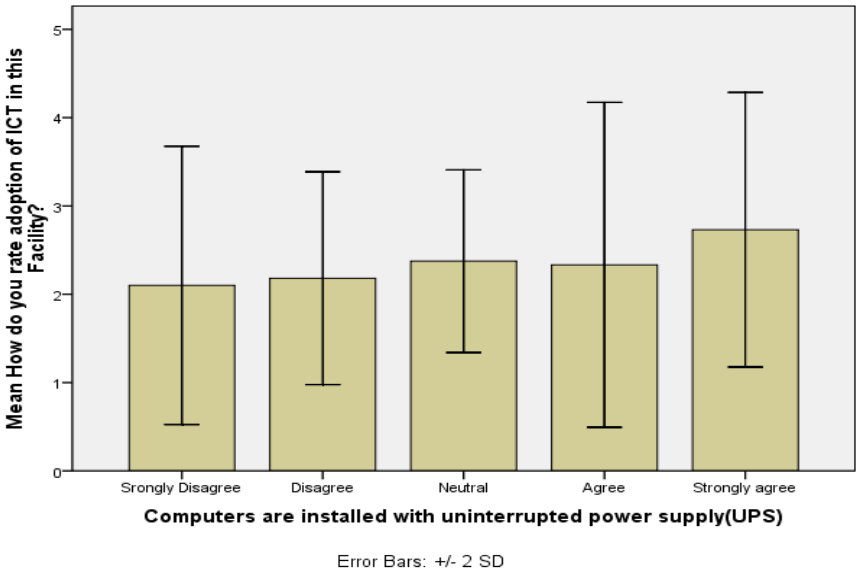

Figure 3.5: Uninterrupted Power Supply

The figure shows ANOVA test of how installation of computers with uninterrupted power supply affects adoption of ICT

Sixty seven respondents (72.9%) either agreed or strongly agreed that reliable electricity in the hospital has enabled use of ICT, twenty respondents (21.7%) disagreed or strongly disagreed while five of them (5.4%) were uncertain as shown in Table 3.7 and Figure 3.6.

Table 3.7 Reliable electricity

Hospital has reliable electricity which has enabled use of ICT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	12	12.2	13.0	13.0
	Disagree	8	8.2	8.7	21.7
	Neutral	5	5.1	5.4	27.2
	Agree	18	18.4	19.6	46.7
	Strongly Agree	49	50.0	53.3	100.0
	Total	92	93.9	100.0	
Missing	System	6	6.1		
Total		**98**	**100.0**		

The table 3.7 showing response of ninety two respondents on availability of reliable electricity which enables use of ICT in the sub-county hospitals of Nakuru County, Kenya

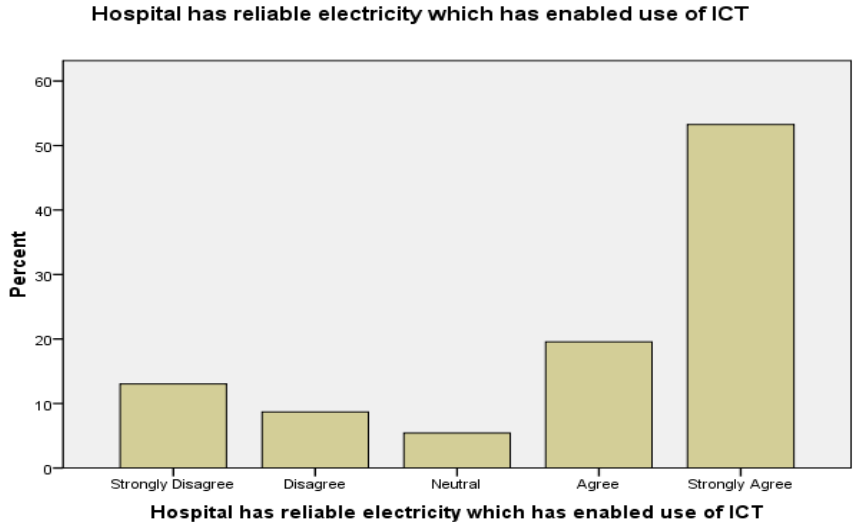

Figure 3.6: Reliable electricity

The figure shows level of agreement that availability of reliable electricity which enables continued use of ICT in hospital

This is in agreement with findings by Alabi (2016) on adoption of Information and Communication technologies (ICTs) by Agricultural Science and Extension Teachers in Abuja, Nigeria where Participants indicated lack of infrastructure such as electricity as a major issue impending adoption of ICT.

Out of ninety two, sixty two respondents (67.4%) agreed or strongly agreed that backup generator in the hospital for use in case of power blackout facilitated use of ICT, twenty nine respondents (31.5%) disagreed or strongly disagreed that backup generator in the hospital for use in case of power blackout facilitated use of ICT while only one respondent (1.1 %) was uncertain as shown in Table 3.8 and Figure 3.7.

Table 3.8 Back-up generator

Hospital has back-up generator for use in-case of power blackout which facilitate use of ICT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	21	21.4	22.8	22.8
	Disagree	8	8.2	8.7	31.5
	Neutral	1	1.0	1.1	32.6
	Agree	8	8.2	8.7	41.3
	Strongly agree	54	55.1	58.7	100.0
	Total	92	93.9	100.0	
Missing	System	6	6.1		
Total		**98**	**100.0**		

The table 3.8 shows that most of the hospitals in Nakuru County have back-up generators for use in case of electricity power failure according to the responses given by the 92 respondents who participated in the study

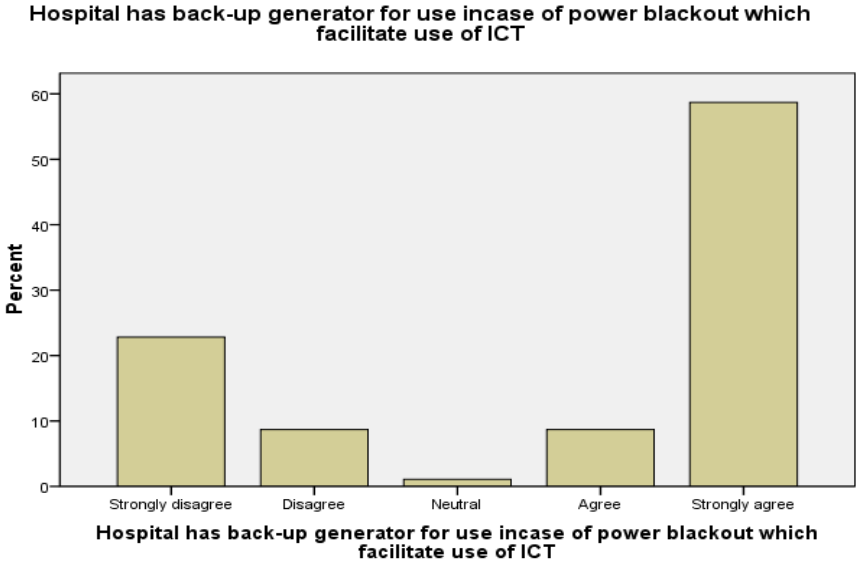

Figure 3.7: Back-up generator

The figure shows level of agreement that the hospitals have generator for power back up in the event of electricity failure within the facility to enable continued use of ICT.

This is in agreement with findings by Nyaggah (2015) in her research on factors influencing adoption of information and communications technology in public hospitals in Nairobi County, where she found out that installation of ICT infrastructure is a major drawback to the adoption of ICT in public hospitals in Nairobi County. Installation of power back-up generator in the County referral hospitals in Nakuru was also found to have a positive influence on adoption of ICT.

3.5 Availability of reliable internet connectivity

Findings from study on whether their hospitals have reliable internet connectivity indicated that forty nine respondents (53.9%) either agreed or strongly agreed that their hospital has reliable internet connectivity , thirty four respondents (37.64 %) disagreed or strongly disagreed while eight (8.8%) were indifferent as shown in table 3.9 and Figure 3.8.

Table 3.9 Internet connectivity

Hospital has reliable internet connectivity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	22	22.4	24.2	24.2
	disagree	12	12.2	13.2	37.4
	Neutral	8	8.2	8.8	46.2
	Agree	15	15.3	16.5	62.6
	Strongly Agree	34	34.7	37.4	100.0
	Total	91	92.9	100.0	
Missing	System	7	7.1		
Total		**98**	**100.0**		

Table 3.9 shows responses by respondents on the availability of reliable internet connectivity in the hospitals to allow easy access of information online.

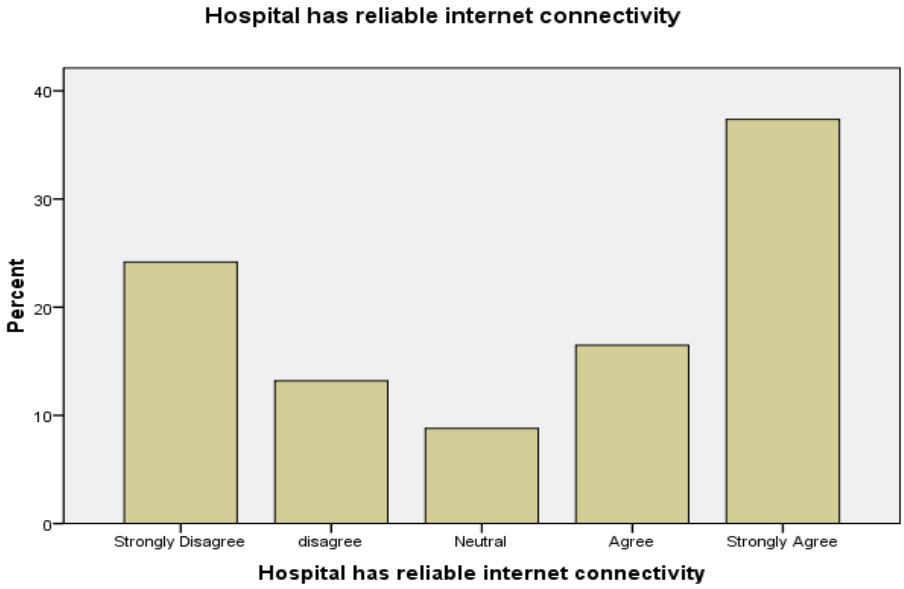

Figure 3.8: Internet connectivity

The figure shows level of agreement that the hospital has internet connectivity which enables ICT adoption

Correlation analysis on relationship of internet connectivity and the adoption rate of ICT indicated that correlation was significant at 0.01 which means that availability of reliable internet connectivity influenced adoption rate of ICT in the referral hospitals as shown in Table 3.10.

Table 3.10 Adoption vs. Internet connectivity

Correlations			
		Hospital has reliable internet connectivity	How do you rate adoption of ICT in this Facility?
Hospital has reliable internet connectivity	Pearson Correlation	1	.332**
	Sig. (2-tailed)		.001
	N	91	91
How do you rate adoption of ICT in this Facility?	Pearson Correlation	.332**	1
	Sig. (2-tailed)	.001	
	N	91	92
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 3.10 shows the correlation test analysis on the relationship between availability of reliable internet connection and adoption of ICT in health facilities.

This study therefore revealed that lack of adequate ICT infrastructure has hampered provision of efficient and affordable ICT services in public hospitals. There is therefore need to put more emphasis on provision of support infrastructure, such as internet connectivity. The study findings are in line with Eysenbach and Wyatt (2002), that technological infrastructure is a major issue that stands as an impediment to access of information. Hospital staffs are not able to access digital information online due to lack of internet connectivity

which is a necessary infrastructure. This has left a bigger part of the population unable to access the digital information hence discouraging the adoption of ICT in the referral hospitals in Nakuru County.

3.6 Has continued use of computers led to minimal paper work in hospital?

Findings from the study showed that fifty eight respondents (63.1 %) either agreed or strongly agreed that continued use of computers has led to minimal paper work in their hospital, 30.4 % (twenty eight respondents) disagreed or strongly disagreed that Continued use of computers has led to minimal paper work in their hospital while six respondents (6.5%) were indifferent as indicated in Table 3.11 and figure 3.9.

Table 3.11 Computers vs. paperwork

There is minimal paper work in the hospital due to continued use of computers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	15	15.3	16.3	16.3
	Disagree	13	13.3	14.1	30.4
	Neutral	6	6.1	6.5	37.0
	Agree	19	19.4	20.7	57.6
	Strongly Agree	39	39.8	42.4	100.0
	Total	92	93.9	100.0	
Missing	System	6	6.1		
Total		**98**	**100.0**		

Table 3.11 shows the effect of using computers in hospitals on minimizing paper work

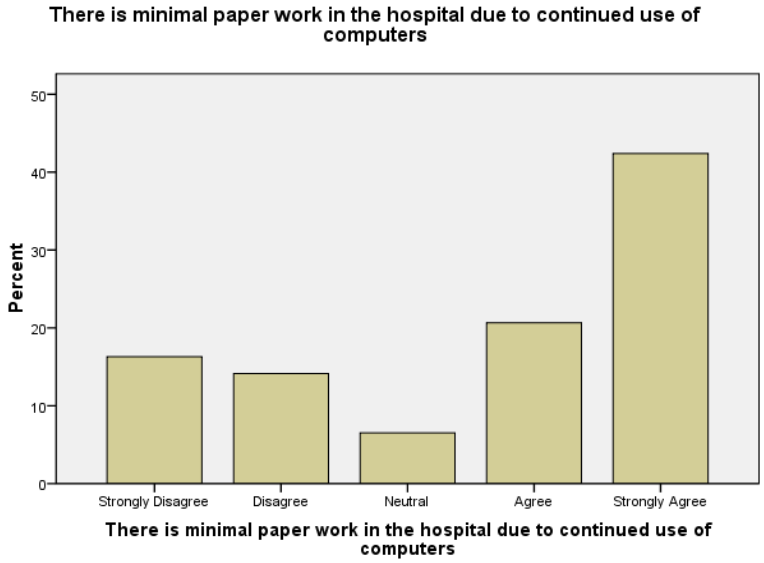

Figure 3.9: Computers vs. Paperwork

The figure shows the level of agreement that the hospitals have reduced paper work as a result of ICT adoption.

This is in agreement with conclusion of findings by Nyaggah (2015) that adoption of electronic medical records in public hospitals in Nairobi can support medical professionals in their decision-making and also improve operating efficiency, thus improving medical care quality. Rogers (2003) states in general that successful adoption of a particular innovation should score higher in terms of its relative advantage over existing practices, compatibility to users‟ needs, trial ability and observability, and lower in its complexity to use. Therefore this support why use of ICT in HIS is advantageous in reducing paperwork compared to the manual data entry.

3.7 Conclusion

Lack of adequate ICT infrastructure has hampered provision of efficient and affordable ICT services in public hospitals in Nakuru County. The findings indicated that most of the facilities do not have adequate support infrastructure, such as computers, local and internet connectivity, supporting software development and assembly of ICT equipment and accessories.

Regular maintenance of computers in the hospitals is very important for continued use of ICT in health facilities.

Most of the facilities have reliable electricity including generator for power back up in case of power failure. This has highly influenced adoption of ICT as seen in the results above

3.8 Recommendations

Facility managers should critically address and put more resources to ensuring that there is adequate number of computers in their facilities.

The computers should be installed with uninterrupted power supply (UPS), be properly maintained and served with reliable electricity and internet connectivity.

3.9 Suggestions for further research

More research should be done to establish the most effective and efficient platform that could be used by all medical facilities in Kenya for uniform sharing of information

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