Cloud Computing Adoption by Public Hospitals in Kenya: A Technological, Organisational and Behavioural Perspective

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Abstract- Cloud computing has emerged as a technological paradigm to reduce Information Technology costs, foster collaboration while increasing productivity, availability, reliability, flexibility and minimizing response times. Despite cloud computing offering numerous benefits to the health sector, there are only few successful implementations. Adoption is slower in healthcare sector compared to other industries. Furthermore, there is little concerning the adoption and benefits of cloud computing in Kenyan healthcare sector. This study integrated the Technological Acceptance Model, Technology-Organization-Environment model and the Theory of Planned Behaviour to provide a richer theoretical lens for assessing factors affecting cloud adoption. This study sought to determine the influence of technological, organisational and behavioural contexts in cloud computing adoption. The target population for this study were 114 healthcare personnel (facility in-charges and health records and information officers) in Public hospitals. The study employed a cross sectional survey in one-time data collection using questionnaires from sampled personnel. Logistic regression was used to establish the correlation between the projected factors and adoption of cloud computing, and to show the strength of this relationship. The cloud computing adoption prevalence was at 58% among public hospitals. In terms of cloud computing service models among adopters, Software-as-a-Service was at 100%, followed by Platform-as-a-Service at 5% while none had implemented Infrastructure–as-a-Service. The study found out that technological readiness, service quality, expert scarcity, top management support, firm size, perceived usefulness, perceived ease of use and social influence have a significant effect on cloud computing adoption. The findings from this study will help healthcare organisations to better understand what affects cloud computing adoption and to guide them in the adoption process. Cloud computing providers can also use the findings of this work to address areas of concern thereby offering products and services that have the confidence of healthcare institutions in Kenya.

Index Terms- Adoption, Cloud computing, Hospitals, Kenya, Technology-Organization-Environment

1. INTRODUCTION

Organizations are under increasing pressure to cut on costs, increase profitability and improve productivity in order to remain relevant in a dynamic business environment [1].The Healthcare industry is also evolving towards a consumer driven approach to care and the need for greater collaboration [2] [3]. Cloud computing has emerged as a major technological innovation to reduce information technology(IT)costs, foster collaboration while increasing productivity, availability, reliability, flexibility and minimizing response times [4] [5].Cloud computing is therefore an effective platform for healthcare organizations to leverage so as to remain germane.

Cloud computing is the on-demand delivery of network access to a shared pool of configurable computing resources-data storage ,networks, servers, applications and services-with minimal management effort or provider interaction [6] .The healthcare sector can greatly benefit from cloud computing. Healthcare organizations can use cloud computing to achieve cost saving and scalability. Cloud computing provides for pay-for-use computing resources that supports the shift from capital-intensive technology investments to operational costs. When a cloud infrastructure is introduced in an enterprise, majority of the IT tasks is shifted to providers, according to IBM IT labor costs is reduced by 50%.Energy costs for small business is also reduced by 90 % [7]. Cloud computing can also be leveraged to support data driven healthcare delivery, enhance collaboration between different stakeholders and support patient and family-centered care models. Collaboration is vital to the healthcare industry; by allowing professionals to store and access data remotely; healthcare professionals around the world can gain access to patient data immediately and offer care immediately. In addition ,cloud computing allows remote conferencing, up-to-the-second updates on healthcare developments and patient conditions; which enhance collaboration and care quality [8].Data analytics has a great potential to support clinical decision-making, enhance patient safety and enable continuous learning process in the care delivery process. However, traditional IT network platforms may not easily fulfil the computational capabilities and flexibility it demands. Healthcare providers can turn to cloud computing for

scalable storage capacity, greater processing power and timely access [9].

Cloud computing can therefore be an effective platform for healthcare organizations to leverage, in light of the evolution of healthcare industry towards a consumer driven approach to care and the need for greater collaboration. It has however not yet placed a significant footprint in the healthcare sector in Kenya and the decision to adopt a cloud-computing model is often complicated by challenges and uncertainties about the expected business value related to the new technology [10].

The global healthcare cloud computing market is expected to reach $9.48 billion by 2020 up from $3.73 Billion in 2015 [11].This market is expected to be dominated by North America, followed by Europe, Asia, and the Rest of the World. Cloud computing and storage infrastructure is growing at an annual rate of 33% worldwide [12]. Review of publications on cloud computing at the global scene has revealed that research on the Adoption aspect was only at 10% compared to the Technology aspect that stood at 85%; this was explained that cloud computing being a new paradigm is facing many technological challenges [13].However more research efforts are needed to address this worrying gap. Health Information Management Systems survey [14] found out that 83% of IT healthcare organizations in the USA are using cloud services with SaaS being the most popular service model at 67%, however an earlier survey found Healthcare sector to be ranked 7th out of Eight industries in cloud adoption , just ahead of State and local government.

Cloud computing, in Europe, has evolved substantially; becoming more robust, secure, open and interoperable. However, the uptake in the European Healthcare sector has been slow; mainly due to a fragmented regulatory framework and security concerns. The fragmented regulatory framework has led to significant differences among European Union (EU) countries concerning cloud computing adoption. Denmark, Sweden, Finland, Austria and Estonia have been much more open to remote storage and archiving of patient data than the Leading EU economies; France, Britain and Germany. Nordic countries lead in terms of cloud computing market maturity in the healthcare sector; the Netherlands, Estonia and Austria are in maturation phase while Belgium, France, Germany, Italy, Spain, Switzerland and Britain are emerging markets; each progressing at a different speed [9].The EU healthcare sector has a higher adoption in primary care and outpatient settings than in acute care. This is mainly due to the need to host basic IT functions like scheduling, administration and billing and patient records.

Researchers have indicated that actual adoption depends on sector and enterprise size because of the different features and security levels they need and that cloud adoption studies should be industry specific [15] [16] [17]. Healthcare sector has also been slower to adopt cloud computing compared with other industries as was seen in USA and Europe [9]. The adoption has been slowed by inadequate communication infrastructure, security concerns and a fragmented regulatory framework [9].Despite the growing interest in cloud computing in healthcare only, few successful implementations yet exist [18].

The prevalence of cloud computing in Kenya is at 48% for Medium and Large business [19].A survey by Communications Authority and Kenya National Bureau of Statistics found out that 35.6% of public sector institutions use cloud computing services compared to 22.9% of private ventures [20]. Despite the cloud computing adoption accelerating, majority of public institutions and private businesses are not on the cloud. The survey found out that most businesses and public sector did not have a cogent plan of adopting cloud computing. It further shows that the biggest drawback was lack of knowledge; 53.1% of public institutions not on the cloud and 37.1% of private businesses reported insufficient knowledge about cloud services. Cost, a poor regulatory framework and security concerns were also cited as hurdles.

As the quantity of electronically generated information in healthcare increases, so does the need to be able to store, access and share that data in an increasingly mobile world [21]. Deciding how and where to store healthcare information, while allowing secure, easy and shared access to that data, has been a persistent problem. The acceptance of a person-centered care model within healthcare has necessitated the need for shared access to the information in a person's electronic health record.

Cloud computing adoption processes faces a number of challenges; technological uncertainty, software functionality, demand uncertainty, organizational influence, importance of IT applications and integration [22].Legal hurdles ,the possibility of organizational transition, cost benefit evaluation drawbacks and the choice of cloud vendors are other impediments that have to be solved [23].There is need to understand the determinants, hurdles and challenges involved in the adoption of cloud computing. Cloud computing adoption in Kenya has been looked at in certain sectors; insurance companies in Nairobi [24], Kenyan Universities [25] and Tech industries in Nairobi [26]. However, there is limited research within the Kenyan healthcare sector and because of the sector specific-nature of cloud computing adoption, there exists a gap in the healthcare sector that this study sought to close by addressing the determinants of cloud computing adoption in the healthcare industry within Kisumu County. The aim of this study was to determine the prevalence of cloud computing and the factors (technological, organizational and behavioural) affecting cloud computing adoption among public hospitals in Kisumu county, western Kenya.

2. Literature Review

2.1 cloud computing

Cloud computing is offered using three standard models; Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [27].SaaS entails the consumer using provider applications over a cloud infrastructure through either a program interface or a client interface like a web browser. PaaS involves the consumer deploying consumer created or acquired applications created using programming languages, libraries, tools and services supported by the provider over a cloud infrastructure managed by the provider. IaaS involves the consumer accessing, processing, storage, networks and other computing resources over which they can deploy and run software like operating systems and applications.

Cloud computing can be deployed as a Private cloud, Public cloud or Hybrid cloud. Private cloud refers to a cloud infrastructure run solely for an organization while a public cloud refers to cloud infrastructure rendered over a network that is open to the public and Hybrid cloud refers to a combination of two or more clouds offering the benefits of multiple deployment methods but remain distinct entities [28].

Cloud computing offers healthcare organizations an array of benefits; economic, operational and functional benefits. The economic benefits of cloud computing include cost flexibility and the potential for reduced costs. Heavy capital expenditure can be avoided, since IT; resources are acquired on demand as needed and paid for on a pay-per-use basis. Also, the cost of personnel resources required to deploy and maintain IT resources are included in the cost of cloud computing. Therefore, the need for additional healthcare provider skilled IT staff resources and related costs are reduced when using cloud services for IaaS and PaaS platforms but even more so for SaaS solutions where the cloud provider takes majority of the responsibility [29] [30].

From an operational outlook, cloud computing offers scalability and the ability to adjust to demand rapidly. Cloud computing offers better security and privacy for health data and health systems. Cloud service provider data centers are highly secure and well protected against outsider and insider threats using administrative, physical and technical methods implemented and maintained by expert professional staff. Cloud computing offers sophisticated security controls, including data encryption and fine-grained access controls and access logging. Medical systems built using cloud services can provide web access to data, avoiding the need to store information on client devices. The need for scarce IT security skills within the healthcare organization also is minimized. Cloud service providers typically operate on such a scale that they have all the necessary IT skills, with the costs of those skills spread across many customers [29].

In terms of functional perspective, cloud-based healthcare IT systems offer the potential for broad interoperability and integration. Healthcare cloud services are internet-based and generally use standard protocols, so connecting them to other systems and applications is typically straightforward. The critical capability of cloud computing to share information easily and securely enhances collaboration. Cloud computing offers remote access to applications and data via the Internet to enable access at anytime from anywhere [29].

2.2 Conceptual Framework

This study draws from the integrated Technology-Organization-Environment (TOE), Technological Acceptance Model (TAM) and Theory of Planned Behavior (TPB) frameworks to study the adoption of cloud computing by public hospitals in Kisumu, Western Kenya. Accordingly we looked at the influence of technological, organizational and behavioral contexts on the adoption of cloud computing .The TAM constructs of individual different factors, perceived trust and perceived service quality were integrated into TOE as well as the Behavior control and Social Influence to provide a richer theoretical lens for understanding cloud computing adoption as shown in Figure 1.

2.2.1 Technological context

Technological context refers to internal and external technologies that health organizations can use in their operations [31].External technologies are those that are available in the market but are not used by the organization while internal technologies are those in use by the organization. Technological context has three constructs: technological readiness, service quality and expert scarcity.

Technological readiness refers to availability of infrastructure and human resource which influence adoption of new technology [31] [32].Infrastructure refers to installed network technologies and enterprise systems that provide a platform on which cloud computing can be built on while human resource refers to knowledge and skills needed to implement cloud computing. Service Quality refers to the customer's perception of the overall quality or superiority of a service with respect to its intended purpose. It is a reflection of cloud computing in the eyes of the client's. Expert Scarcity refers to lack of qualified and reputable IT professionals in the cloud service market.

2.2.2 Organisational context

The organizational context refers to the characteristics and resources of the organization .Organisational structure is important in technology adoption and has an impact on the social interaction among the company's employees [33].The constructs in organizational context are top management support, policy, firm size and individual difference factors.

Top management support has a role in initiating, implementing and adopting new technologies [34]. Top managers typically support initiatives and get involved in making decisions of adopting new technologies. Top managers set organizational strategy and establish direction for new technologies like cloud computing. Policy refers to principles, rules, and guidelines formulated to reach certain long-term goals and provide an enabling environment. Cloud computing transcends location, geography and involves cross border data hosting and outsourcing and because of this very nature several grey areas arise concerning privacy, security and intellectual property. Government regulation plays an important role in adoption of technological innovation and as such cloud computing adoption can be encouraged or discouraged by existing regulation [33] [35].

Firm size is a major factor affecting adoption of new technology and it acts as resilience for environmental shocks. [36].Larger enterprises have extra resources that motivate innovation adoption. The uptake of internet and its infrastructures in business is slower in smaller than in larger firms indicating that financial constraints ,lack of professional expertise and short term management perspectives are characteristics of small business, all these are hindrances to adoption of cloud computing. The individual difference factors can be measured by the education, experience, age and gender. The adoption of cloud computing is largely dependent on the individual difference factors of the decision makers. The Idiosyncrasy of an organization is dependent

on the decision maker's cognitive assumptions concerning the future, alternatives and the consequences of these alternatives [37]. The strategic and tactical focus of an organization is shaped by the peculiarity of the decision makers' minds.

2.2.2 Behavioural context

Behavioural context refers to psychological factors like emotional, cognitive, personal and social processes that drive human behavior [38]. It refers to psychological factors that determine the decision to adopt or not to adopt a given technology. Behavioural context can be discussed in terms of Perceived usefulness, Perceived ease of use, trust and social influence.

Perceived usefulness is the user's subjective belief that using a new technology will improve operations .The probability of adopting new technology increases when a firm perceives a relative advantage in that innovation. Perceived Ease of use (PEOU) refers to prospective user's assessment of mental capacity required to use the new technology [39]. Technologies that require less mental effort to use attract more adoption behaviour. Cloud computing offers cost reduction and flexibility but it also affects traditional security, trust and privacy mechanisms. Trust refers to the intention to accept the vulnerabilities based on the positive expectations of the intentions. Trust is broader than security as it includes subjective criteria and experience. Social influences moves from functional to psychological motives of behaviour as they define other peoples' opinions, superior influences and peer group opinions.

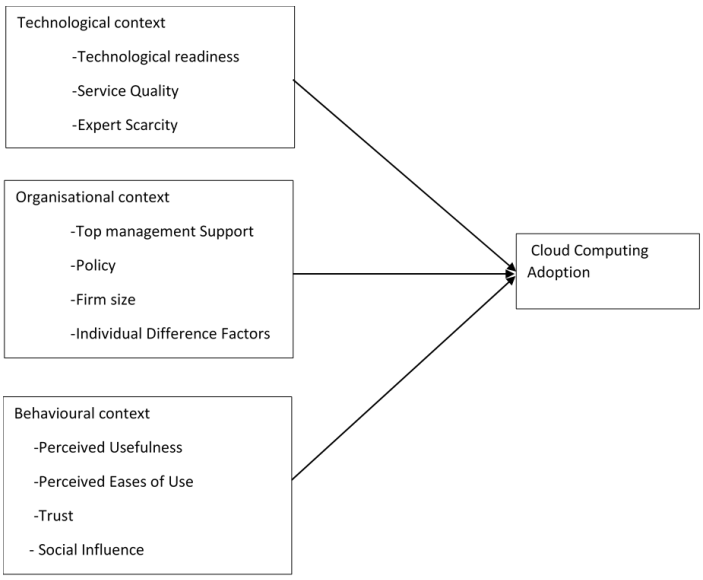

Figure 1. Conceptual Framework for adoption of cloud computing

3. Methods

3.1 Study design and setting

This study used a quantitative approach. The quantitative approach involved a cross sectional survey that entailed a one time collection of data from sampled healthcare personnel in public hospitals using questionnaire. The study site is Kisumu County in western Kenya.

3.2 Target population and sampling

The study target population was facility in-charges and health records and information officers in Tier 3 to Tier 5 public hospitals in Kisumu, Kenya. The target population was 114 personnel (facility in-charge, Health records and information Officers) from 57 public hospitals of interest [40].The samples size was calculated using Yamane formula for sample size: a simplified formula for sample size calculation with the assumption of a 95% confidence level and P=0.05 [41].The sample size for this study was therefore 88 healthcare personnel (facility in-charge and health records and information officers) in public hospitals. The study used stratified random sampling method to draw the sample from the sampling frame.

3.3 Data analysis

Data analysis was done using Stata 14.0 and used both descriptive and inferential statistics. The data was screened for missing data, normality, linearity and multicollinearity. Descriptive statistics like median, Interquartile Range and frequency were used to evaluate demographic information such as age, experience and firm size. Wilcoxon rank sum test was used to test for difference in age and work experience between those who were aware of cloud computing and those who were not. Logistic regression was used to analyze the data to predict the probability of an outcome variable (adoption of cloud computing) from predictor factors.

4. Results

4.1 General Information

The study targeted 88 participants from public hospitals in Kisumu County, this included facility in-charge and health records and information officers. Out of the targeted 88 interviews, 80 interviews were completed successfully giving a response rate of 91% .8 participants were not found in the facility after 3 attempts. Out of the 80 participants interviewed , 69 (86%) were aware of cloud computing while 11(14%) had not heard of cloud computing as shown in figure 2 .Those who had not heard of cloud computing were more likely to be facility in-charges than health records officers(11/47 (23%) vs 0/33 (0%) , p=0.003) and were also likely to have had a longer work experience: median[IQR] 10(9-12) vs 7(4-11), p=0.0438).

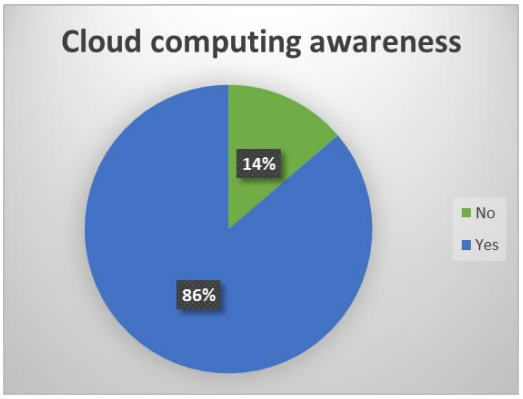

Figure 2. Cloud computing awareness

Further analysis proceeds with the 69 who were aware of cloud computing.

4.1.1 Validity and Reliability

Validity and reliability are two measures that can be used to ascertain the quality and usefulness of the collected data. Cronbach alpha coefficient was used to measure the reliability of the questionnaire. The values of all indicators or dimensional scales below 0.5 are unacceptable [42]. Table I represents the Cronbach alpha coefficients for the independent variables. All the coefficients are well above the unacceptable value of 0.5.

Variable	No. of Items	Cronbach's alpha
Technological factor	9	0.6760
Organisational setting	7	0.5819
Behavioural factor	9	0.6077

Table I. Independent variables Cronbach's alpha

Logistic regression assumes lack of multicollinearity, therefore the independent variables were also tested for multicollinearity. Variance inflating factor (VIF) and tolerance were used to determine multicollinearity; a VIF greater than or equal to 10 and a tolerance less than 0.2 indicate that the variables are multicollinear [43]. Table II shows the results of the VIF's and tolerance for the independent variables. From the results the VIF's range from 1.36 to 1.86 well below the threshold of 10. The tolerance values also range between 0.538 and 0.735 well above 0.2 .These results indicate that there is no evidence of multicollinearity.

Variable	Tolerance	VIF
Technological factor	0.538	1.86
Organisational setting	0.735	1.36
Behavioural factor	0.645	1.55

Table II. VIF and Tolerance for independent variables

4.1.2 Demographic Characteristics

Table III gives the demographic characteristics of the population; designation, gender, age, work experience and education level. In terms of designation, a slightly higher number were facility in-charge 36 (52%) followed by health records officers 33 (48%).This was explained by some tier 3 hospitals not having health records officers deployed to the facilities. The gender distribution was more or less the same; males 33 (48%) compared to females 36 (52%). The overall median age was 33[28-37] years. However, when stratified by designation facility in-charges were older than health records officers (36[33-39] vs 28[26-29], p=<0.0001).The overall median work experience was 7[4-11] years. However, when stratified by designation the facility in-charges had more experience than health records officers (11[9-15] vs 4[3-5], p=<0.0001). The differential in the age and work experience between the facility in-charge and health records officers can be explained by the fact that health records officers is a direct entry position while, to be a facility in-charge one is appointed after having served for some time.

4.1.3 Cloud computing Adoption

The prevalence of cloud computing was at 58% as shown in figure 3 .The cloud computing service models among hospitals that have adopted cloud computing is shown in Figure 4 . Software-as-a Service was the most common cloud computing service model at 100% followed by Platform-as-a-Service at 5% while none of the hospitals had Infrastructure-as-a-Service as a service model. This could be explained by ease of implementation of the services, constraining budgets and the expertise required to implement this service models.

Characteristics	N=69
	n (%)
Designation	
Facility In-charge	36 (52)
Health Records Officer	33 (48)
Gender	
Male	33 (48)
Female	36 (52)
Age	
Median [IQR]	33[28-37]
Experience	
Median [IQR]	7[4-11]
Education	
certificate	1 (1)
Diploma	51 (75)
Bachelors	13 (19)
Masters	3 (5)

Table III. Demographic characteristics among those who were aware of cloud computing

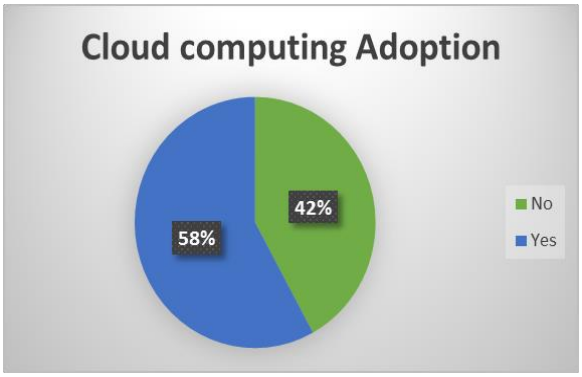

Figure 3. Cloud computing adoption by public hospitals in Kisumu County

4.2 Technological context in cloud computing adoption

There were three indicators under technological context: technological readiness, service quality and expert scarcity. The

results of the logistic regression predicting cloud computing adoption based on technological factor is shown in Table IV.

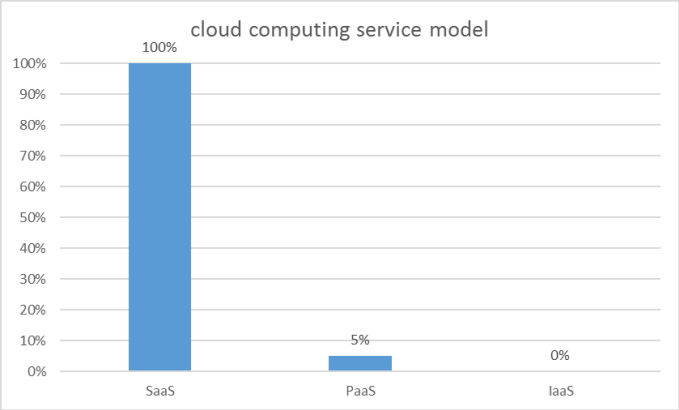

Figure 4. Cloud computing service models among Hospitals adopting cloud computing

Technological readiness was looked at in terms of being skilled in using cloud computing and having technological infrastructure. From the results, both sub-indicators of technological readiness influenced cloud computing adoption and were statistically significant. Those who were skilled in using cloud computing were more likely to adopt cloud computing compared to those who were not skilled (33/40[83%] vs 7/29[24%], odds ratio (OR) =14.82, 95% confidence interval (95%CI) [4.56-48.14], p=<0.0001). Those who had the technological infrastructure were also more likely to adopt cloud computing compared to those that did not have (34/44[77%] vs 6/25[24%], OR=10.77, 95%CI [3.38-34.26], p=<0.0001).

Service quality was looked at in terms of security, privacy of data, timeliness and personalized care .From the results only security and privacy had a statistically significant effect on cloud computing adoption. Those who believed that cloud computing offered secure services were more likely to adopt cloud computing compared to those who did not believe cloud services were secure (33/50[70%] vs 5/19[26%], OR=6.53, 95%CI [1.99-21.41], p=0.0020). Additionally, those who believed cloud computing upheld the privacy of data were more likely to adopt cloud computing compared to those who did not believe that the privacy of data was upheld (37/53[70%] vs 3/16[19%], OR=10.03, 95%CI [2.51-40.06], p=0.0010).

Expert scarcity was looked at in terms of availability of deployment experts, integration experts and security professionals. Out of the three sub-indicators, only two had a statistically significant effect on cloud computing adoption: availability of deployment experts and availability of integration experts. Those who agreed that IT professionals who guide deployment into the cloud were readily available were more likely to adopt cloud computing compared to those who did not believe such experts were available (21/27[78%] vs 19/42[45%], OR=4.24, 95%CI [1.42-12.63], p=0.0100). Additionally those who believed that IT professionals who manage integration with on-site systems were there in sufficient numbers were more likely to adopt cloud computing compared to those who did not believe such experts were available(18/22[82%] vs 22/47[47%], OR=5.11, 95%CI [1.50-17.42], 0.0090).

Characteristics	Cloud Computing Adopted	Cloud computing not Adopted	Odds Ratio[95%CI]	p-Value
	n/N (%)	n/N (%)		
Technological Readiness				
Skilled in using Cloud computing				
No	7/29 (24)	22/29 (76)	**Ref**	
Yes	33/40 (83)	7/40 (17)	**14.82(4.56-48.14)**	**<0.0001**
Technological Infrastructure				
No	6/25 (24)	19/25 (76)	**Ref**	
Yes	34/44 (77)	10/44 (23)	**10.77(3.38-34.26)**	**<0.0001**
Service Quality				
Secure services				
No	5/19 (26)	14/19 (74)	**Ref**	
Yes	35/50 (70)	15/15 (30)	**6.53(1.99-21.41)**	**0.0020**
Privacy of Data				
No	3/16 (19)	13/16 (81)	**Ref**	
Yes	37/53 (70)	16/53 (30)	**10.03(2.51-40.06)**	**0.0010**
Timeliness				
No	1/1 (50)	1/1 (50)	Ref	
Yes	39/67 (58)	28/67 (42)	1.39(0.84-23.23)	0.8170
Personalized Care				
No	8/14 (57)	6/14 (43)	Ref	
Yes	32/55 (58)	23/55 (42)	1.04(0.32-3.42)	0.9440
Expert Scarcity				
Deployment Experts available				
No	19/42 (45)	23/42 (55)	**Ref**	
Yes	21/27 (78)	6/27 (22)	**4.24(1.42-12.63)**	**0.0100**
Integration Experts available				
No	22/47 (47)	25/47 (53)	**Ref**	
Yes	18/22 (82)	4/22 (18)	**5.11(1.50-17.42)**	**0.0090**
Security Experts available				
No	22/44 (50)	22/44 (50)	Ref	
Yes	18/25 (72)	7/25 (28)	2.57(0.90-7.38)	0.0790

Table IV. Logistic regression assessing cloud computing adoption based on Technological context

4.3 Organisational setting in cloud computing adoption

There were four indicators under organisational setting: Top management support, Policy, Firm size and individual difference factors. The results of the logistic regression predicting cloud computing adoption based on organisational setting is shown in Table V.

The researcher looked at top management support in terms of adequate budgetary allocation and providing an enabling environment. The results illustrates that only adequate budgetary

allocation had a statistically significant effect on cloud computing adoption. Those who had adequate budgetary allocation were more likely to adopt cloud computing compared to those who did not have adequate allocation (13/15[87%] vs 27/54 [50%], OR=6.50, 95%CI [1.34-31.60], p=0.0200).
Although those who were aware of policy/legislation regarding cloud computing were more likely to adopt cloud computing compared to those who were not aware, the difference was not statistically significant (12/15[80%] vs 28/54[52%], OR=3.71, 95%CI [0.94-14.66], p=0.061).Furthermore only 15/69 (22%) were aware of existing policy/legislation regarding cloud computing.

The researcher looked at firm size in terms of the hospital bed capacity. Firm size had a statistically significant effect on cloud computing adoption. Hospitals that had a bed capacity greater than or equal to 15 beds were more likely to adopt cloud computing compared to hospitals with a bed capacity of 0-15 beds (21/23[91%] vs 2/23[41%], OR=14.92, 95%CI [3.12-71.34], p=0.0010).

Individual different factors had three sub-indicators: age of respondent, work experience of the respondent and level of education. All the three sub-indicators under individual different factors did not have a statistically significant effect on cloud computing adoption

4.4 Behavioural factor in cloud computing adoption

Behavioural factor was looked at in terms of Perceived usefulness, Perceived ease of use, Trust and Social influence. The results of the logistic regression predicting cloud computing adoption based on behavioural factor is shown in Table VI.

Perceived usefulness was addressed by two sub-indicators: belief that cloud computing cloud computing will help the hospital staff accomplish tasks more quickly and belief that cloud computing would improve efficiency in delivery of service. Only belief that cloud computing would improve efficiency in delivery of service had a statistically significant effect on cloud computing adoption. Those who believed that cloud computing would improve efficiency in delivery of service in the hospital were more likely to adopt cloud computing compared to those who did not believe it would improve efficiency (34/44[77%] vs 6/25[24%], OR=10.77, 95%CI [3.38-34.26], p=<0.0001).

The researcher looked at Perceived ease of use in terms of easy to learn and easy to use in accomplishing tasks. Both of the sub-indicators had a statistically significant effect on cloud computing adoption. Those who believed it is easy to learn how to use cloud computing were more likely to adopt cloud computing compared to those who thought otherwise (31/40[78%] vs 9/29[31%], OR=7.65, 95%CI [2.60-22.57], p=<0.0001). Those who believed it is easy to use cloud computing in accomplishing tasks were more likely to adopt cloud computing compared to those who had a contrary opinion(35/49[71%] vs 5/20[25%], OR=7.50, 95%CI [2.29-24.57], p=0.0010).

Trust was addressed by three sub-indicators: ability of cloud computing to operate reliably without failure, the ability of cloud computing to demonstrate the functionality to execute required tasks and lastly belief that cloud computing providers offered help when needed. All the three sub-indicators of trust did not have statistically significant effect on cloud computing adoption.

Characteristics	Cloud Computing Adopted	Cloud computing not Adopted	Odds Ratio[95%CI]	p-Value
	n/N (%)	n/N (%)		
Top Management Support				
Adequate budgetary allocation				
No	27/54 (50)	27/54 (50)	**Ref**	
Yes	13/15 (87)	2/15 (13)	**6.50(1.34-31.60)**	**0.0200**
Enabling environment				
No	3/7 (43)	4/7 (57)	Ref	
Yes	37/62 (60)	25/62 (40)	1.97(0.41-9.59)	0.3990
Policy				
Aware of Policy				
No	28/54 (52)	26/54 (48)	Ref	
Yes	12/15 (80)	3/15 (20)	3.71(0.94-14.66)	0.0610
Firm Size				
0-15 beds	19/46 (41)	27/46 (59)	**Ref**	
>= 15 beds	21/3 (91)	2/23 (9)	**14.92(3.12-71.34)**	**0.0010**
Individual Difference Factors				
Age Category				
>30 years	19/29 (66)	10/29 (34)	Ref	
24-30 years	21/40 (53)	19/40 (47)	0.58(0.22-1.56)	0.2810
Work experience				
>10 years	29/50 (58)	21/50 (42)	Ref	
1-10 years	11/19 (58)	8/19 (42)	1.00(0.34-2.90)	0.9940
Education				
Diploma	25/51 (49)	26/51 (51)	Ref	
Certificate	1/1 (100)	0/1 (0)	-	-
Bachelors	10/13 (77)	3/13 (23)	3.47(0.85-14.09)	0.0820
Masters	3/3 (100)	0/3 (0)	-	-

Table V. Logistic regression predicting cloud computing adoption based on Organisational setting

Characteristics	Cloud Computing Adopted	Cloud computing not Adopted	Odds Ratio[95%CI]	p-Value
	n/N (%)	**n/N (%)**		
Perceived Usefulness				
Accomplish tasks quickly				
No	4/7 (57)	3/7 (43)	Ref	
Yes	36/62 (58)	26/62 (42)	1.04(0.21-5.04)	0.9630
Improved efficiency				
No	6/25 (24)	19/25 (76)	**Ref**	
Yes	34/44 (77)	10/44 (23)	**10.77(3.38-34.26)**	**<0.0001**
Perceived Ease of Use				
Easy to Learn				
No	9/29 (31)	20/29 (69)	**Ref**	
Yes	31/40 (78)	9/40 (22)	**7.65(2.60-22.57)**	**<0.0001**
Easy to use in accomplishing tasks				
No	5/20 (25)	15.20 (75)	**Ref**	
Yes	35/49 (71)	14/49 (29)	**7.50(2.29-24.57)**	**0.0010**
Trust				
Operates reliably without failing				
No	33/56 (59)	23/56 (41)	Ref	
Yes	7/13 (54)	6/13 (46)	0.81(0.24-2.74)	0.7380
Functionality to execute required tasks				
No	10/19 (53)	9/19 (47)	Ref	
Yes	30/50 (60)	20/50 (40)	1.35(0.47-3.91)	0.5800
Providers offer help when needed				
No	2/6 (33)	4/6 (67)	Ref	
Yes	38/63 (60)	25/63 (40)	3.04(0.52-17.86)	0.2180
Social influence				
Other hospitals are adopting				
No	8/23 (35)	15/23 (65)	**Ref**	
Yes	32/46 (70)	14/46 (30)	**4.29(1.48-12.41)**	**0.0070**
Hospitals that adopt are benefitting				
No	4/11 (36)	7/11 (64)	Ref	
Yes	36/58 (62)	22/58 (38)	2.86(0.75-10.92)	0.1230

Table VI. Logistic regression predicting cloud computing adoption based on Behavioural factor

5. Discussion

The purpose of the study was to establish the determinants of cloud computing adoption by public hospitals in Kisumu County, Western Kenya. The study found out that there were eight drivers for cloud computing adoption in the healthcare sector: technological readiness (skilled in using cloud computing and technological infrastructure), service quality (security and privacy), expert scarcity (availability of deployment experts and availability of integration experts), top management support (adequate budgetary allocation), firm size, perceived usefulness (improved efficiency), perceived ease of use (easy to learn and easy to use to accomplish tasks) and social influence (other hospitals currently adopting cloud computing).

5.1 Cloud computing adoption

The study found out that the prevalence of cloud computing in public hospitals was 58%. This is an improvement compared to 35.6% among public sector institutions reported by CA and KNBS [20]. This increase can be attributed to a high ratio of internet users connecting with mobile devices compared to traditional fixed point connections [12].In terms of cloud services models, most public hospitals implemented SaaS while very few adopted PaaS and none had IaaS. This is consistent with the findings from Medium and high tech industries in Nairobi, Kenya [26]. This differential in implementation of cloud service models could be attributed to high cost implications and the level of skills required to implement and maintain services associated with PaaS and IaaS [31] [44].

5.2 Technological context

The study found all the three indicators of technological context to be drivers of cloud computing adoption: technological readiness (skilled in using cloud computing and technological infrastructure), service quality (security and privacy) and expert scarcity (availability of deployment experts and availability of integration experts).

Technological readiness through its sub-indicators, skilled in using cloud computing and technological infrastructure, were found to positively affect adoption. This is consistent with previous studies [45] [46]. This finding can be explained by the fact that hospitals with existing technological infrastructure (installed network technologies and enterprise systems) would incur less financial costs compared to those who do not have an existing infrastructure. Additionally, hospitals having staff with the technical competence to handle cloud computing would readily adopt compared to those who are technically incompetent as there will be minimal resistance.

Service quality was also found to be a predictor of cloud computing adoption through its sub-indicators of security and privacy. This is in concurrence with the findings from other studies [47] [48] [49]. Data security and privacy is more complicated in cloud computing than in traditional information systems as cloud computing transcends into the realm of architecture and data models. Therefore providing a trustworthy environment in terms of security and privacy is a prerequisite that wins confidence of users to adopt cloud computing.

Lastly, expert scarcity was found to influence adoption through the sub-indicators availability of deployment experts and availability of integration experts. This was in agreement with previous studies [50] [51]. Organizations need IT professionals to help them articulate their cloud computing plans, determine what and how to move into the cloud and guide them on how to manage integration with on-site systems. This finding could be explained

by the fact that adequate technical support guarantees smooth and seamless transition to the cloud and institutions who believed this experts are readily available would be predisposed to adopt cloud computing. The study found out that only 39% and 31% of the respondents believed deployment and integration experts were available respectively. This is in concurrence with existing literature that have reported scarcity of IT professionals in the area of cloud computing [50] [52] [53] and this shortfall is projected to hit 5 million globally within the next decade, if nothing is done to mitigate it .

5.3 Organisational setting

The study found only top management support (adequate budgetary allocation) and firm size constructs of organizational setting to be predictors of cloud computing adoption. Top management support under the sub-indicator of adequate budgetary allocation was found to influence adoption. This is concurrent with existing literature on cloud computing adoption [54] [55] [56]. This can be explained by the fact that cloud computing comes with additional costs as it is a pay-per-use platform and it also heavily relies on the internet, institutions with adequate budgetary allocation for IT would therefore be more inclined to adopt cloud computing compared to those with inadequate allocations. However, overall only 22% of respondents indicated they had adequate budgetary allocation for IT. This small proportion compared to 89% who indicated that top management was supportive of cloud computing illustrates that not lack of interest in cloud computing but rather budget constrains from allocations by county governments as the possible reason for inadequate budgetary allocations for IT .This brings to the front the need for implementation of the Abuja declaration on health budget[57] which would in turn translate to improved allocations to the counties and consequently the hospitals and IT department.

Firm size was also found to be a predictor of cloud computing adoption. This is consistent with findings from previous studies [31] [55]. Hospitals with a higher bed capacity are more likely to have a bigger budget than those with lower bed capacity and in turn be more likely to adopt cloud computing than their counter parts from hospitals with a smaller bed capacity. Additionally, the uptake of internet and its infrastructures in hospitals is slower among smaller hospitals than in large ones.

Policy was not a predictor of cloud computing adoption from the findings of the study. This is consistent with results from previous adoption studies [35][55].This could possibly be explained by the fact that despite deliberate government policy to promote new computing technologies, their advancement is largely due to corporate focus on technology [58] and this is justified by the 89% of top management that provided an enabling environment.

5.4 Behavioural factor

The study found three indicators under behavioural factor to be predictors of cloud computing adoption: perceived usefulness (improved efficiency), perceived ease of use (easy to learn and easy to use to accomplish tasks) and social influence (other hospitals currently adopting cloud computing).

Perceived usefulness in terms of improved efficiency in delivery of services was found to influence cloud computing. This is consistent with existing literature [31] [34] [59]. This could be explained by the fact that adoption of new technology increases when a firm perceives a relative advantage in that innovation. Additionally, the study reported operational benefits of cloud computing at 69% indicating confidence of respondents that cloud computing provided a relative advantage.

Both sub-indicators of perceived ease of use were found to be predictors of cloud computing adoption: easy to learn and easy to use to accomplish tasks. This finding is in agreement with results from previous studies [60] [61] [62].This can be explained by the proliferation of cloud computing services that can be accessed by mobile devices. Services like email and storage(google drive and drop box) have reduced complexities in user interface and learning curve thereby bolstering the belief of users that cloud computing requires less mental effort to learn and use.

The study did not find trust to be a significant factor in adoption cloud computing. This is contrary to results from previous studies that found trust to be a predictor of adoption [63] [64].

Lastly, social influence in terms of other hospitals currently adopting cloud computing was found to be a predictor of cloud computing. This is in concurrence with existing literature [65] [66] [67].This can be explained by the need for non-adopter hospitals to conform to the current trend in the sector. Sociologists believe that often group member's exhibit cohesiveness even against their own feelings in order to show commitment to group norms [68].

6. Conclusion

This study was motivated by the desire to see the healthcare sector compete favorably with other industries in adoption of cloud computing and consequently realize the associated operational, financial and functional benefits thereby remaining relevant in a dynamic business environment.

The study results showed that the following factors significantly affect adoption: technological readiness (skilled in using cloud computing and technological infrastructure), service quality (security and privacy), expert scarcity (availability of deployment experts and availability of integration experts), top management support (adequate budgetary allocation), firm size, perceived usefulness (improved efficiency), perceived ease of use (easy to learn and easy to use to accomplish tasks) and social influence (other hospitals currently adopting cloud computing) were all significant constructs of cloud computing adoption. Policy, individual difference factors and trust were found to be insignificant predictors of cloud computing adoption.

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