

IMPACT OF CLOUD COMPUTING ON HEALTHCARE SERVICES IN EAST AFRICA

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CONTENTS

INTRODUCTION	3
PROBLEM STATEMENT	3
AIM	4
RESEARCH OBJECTIVES	4
REVIEW OF RELATED LITERATURE	5
CLOUD COMPUTING: DEFINITIONS AND CHARACTERISTICS	5
METHODOLOGY	9
RESEARCH DESIGN.....	9
DATA COLLECTION.....	9
ANALYSIS & FINDINGS	13
ENVIRONMENT	13
ORGANIZATION.....	17
CLOUD ADOPTION	20
NET EFFECT.....	24
CONCLUSION	29
RECOMMENDATIONS	30
REFERENCES.....	31
APPENDIX 1: FROM THE FRAMEWORK TO QUESTIONNAIRES	32
APPENDIX 2: STUDY PARTICIPANTS.....	37
ABOUT THE AUTHORS.....	38
ACKNOWLEDGEMENT	40

INTRODUCTION

The establishment and growth of network infrastructure in Africa, driven largely by a growing mobile operator's coverage, has made cloud based systems increasingly viable. A number of countries have deployed cloud based healthcare solutions to enhance the quality of services provided to healthcare seekers. Not only are some solutions at national level, many are at clinic, hospital or program level. Cloud computing for healthcare consumers provokes key issues like security, privacy, reliability among others. Adopters must understand the unique benefits as well as risks associated with the technologies, so as to set realistic expectations with their cloud provider.

Various organizations that have deployed have had various decision paths, experiences various challenges and have success stories they can talk about. East Africa region, just like other African countries has been making progress in cloud technology adoption but are experiencing various challenges including access, policy, skills and infrastructural issues like portability, integration.

This study aims to provide guidance to help practitioners, decision makers and policy makers in East Africa not only evaluate cloud computing offerings taking into account different requirements of the actors such as medical practices, hospitals, research facilities, insurance companies and governments but also consider the socio-economic impact of these decisions. By compiling and analysis real data available in the East African countries, the researchers aim to communicate real prospects and challenges in the region. Further, this research will provide policy recommendation that would help accelerate cloud computing focused on healthcare in the region.

Problem Statement

A number of initiatives have been reported in East Africa of healthcare services going to the cloud. Despite the challenges that range from technological capabilities, legal and regulatory framework incoherence among others, some initiatives have flourished. There is however no coherent documentation of these initiatives, particularly the challenges of conceptualizing, implementing and evaluating them, their estimated impact on individuals and organizations, and presentation of the policy implications of these deployments.

Aim

The aim of this study was to systematically articulate the experiences, challenges and impact of Cloud Computing on healthcare services in East Africa.

Research Objectives

This research project has three objectives:

- a) Identify various cloud based healthcare deployments in East Africa;
- b) Analyze the systematic journey of implementing them, with particular focus on the implementation challenges and the socio-economic impact;
- c) Highlight the various policy implications emerging from these deployments.

REVIEW OF RELATED LITERATURE

Cloud computing: Definitions and Characteristics

Definitions

The following definition of cloud computing is a simplified extract from the definition produced by the National Institute of Standards and Technology (NIST) (United States) and the ITU Focus Group.

“Cloud computing is a model for enabling network users’ on-demand access to a shared pool of configurable computing resources that can be rapidly provisioned and released to the client without direct service provider interaction.” [4] [5]

Characteristics of Cloud Computing

Cloud computing services have characteristics which distinguish them from other technologies:

- As a rule, cloud computing users do not own the IT resources they use, the servers they exploit being hosted in external data centers.
- Services are provided via the pay-per-use model or subscription model.
- The resources and services provided to the client are often virtual and shared among several users.
- The services are provided via the Internet.

With these characteristics, cloud computing technology is a new solution giving users the option to access software and IT resources with the desired flexibility and modularity and at very competitive prices.

Description of the main Cloud Computing Services

Following are the service models of cloud computing:

Software-as-service (SaaS): SaaS provides various software applications which clients can use without having to install them on their machines. These services like e-mail, facebook, and Google docs are accessible from any device having a web browser.

Platform-as-a-service (PaaS): It comprises a set of software development and deployment technologies e.g. operating systems, application development environment, databases, and web servers. People can use these services either to host or to develop and test their applications. Microsoft Azure, Google AppEngine and Amazon SimpleDB/S3 are some examples of PaaS.

Infrastructure as a service (IaaS): This model offers an organization with services like processing, storage and network bandwidth. Businesses and institutions can purchase these compute and I/O services to meet their application demands. Examples include GoGrid, FlexiScale, AmazonEC2 etc.

Deployment Models

Four deployment models of cloud computing are as follows:

Public cloud: Public cloud as its name suggests 'Public' is available to general public. It is economical cloud that is stand-alone, proprietary based and off-premises. In house and small businesses use public cloud mostly to meet their requirements [3].

Private cloud: Big organizations use private cloud to serve their business needs internally. Private cloud is more secure, well configured and expensive as it is not shared. Private cloud is usually on-premises [3].

Community cloud: Organizations that have similar requirements and business targets they use community cloud. It is just like public cloud but only for the participating groups with enhanced security and privacy control. It can be located on-premises or off-premises [3].

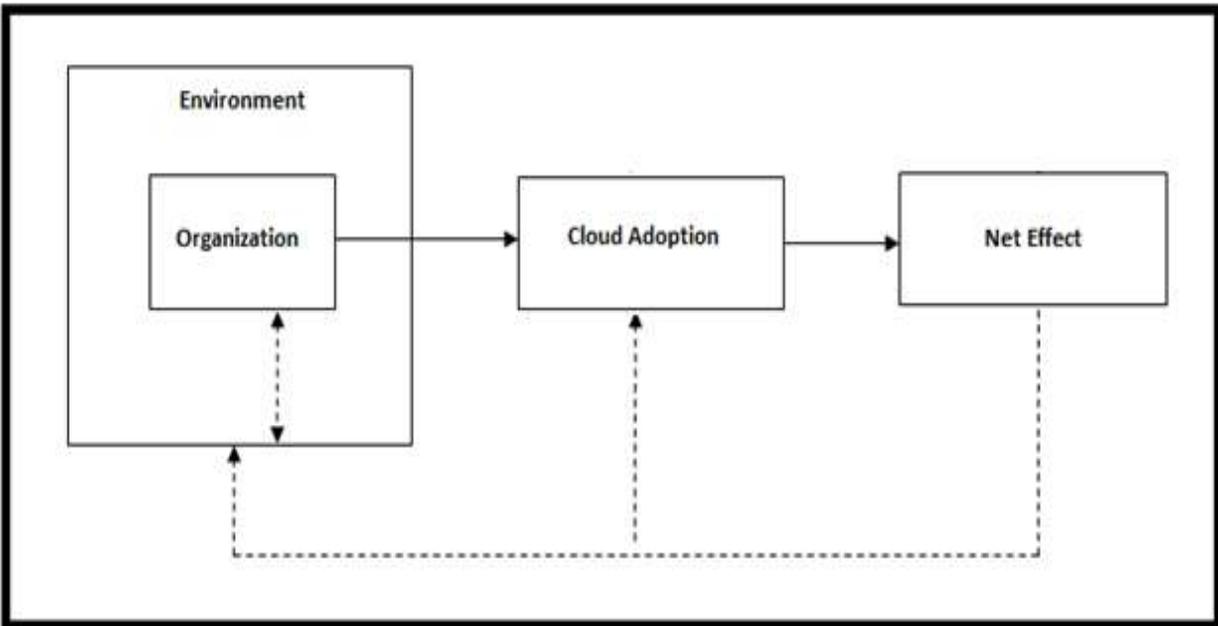
Hybrid cloud: Hybrid Cloud is a combination of two or more clouds (private, community or public). Hybrid cloud is a single cloud that provides blend of shared services. The major issue of hybrid cloud is its security and control. Hybrid cloud can be on user or on provider's premises [3].

HEALTHCARE DELIVERY SYSTEM PERSPECTIVE IN EAST AFRICA

Based on Porter and Guth's [8] observation in relation to the healthcare system reform in countries around the world, it could well be argued that the healthcare challenges are universal across the globe. Mahundi, Kaasbøll and Twaakyondo [7] point out that the health information systems in developing countries are characterized by fragmentation due to a number of subsystems operating separately, and in most cases vertically.

Correspondingly, health information systems in East Africa have been characterized by fragmentation and lack of interoperability between disparate systems.

Figure 1: Framework for Evaluating Organizational Cloud Adoption and resulting Effect



The elements of the concepts in Figure 1 are elaborated in Table 1

Table 1: Concept Details of the Conceptual Framework

Element	Sub-Element	Indicator
Environment	Regulatory Environment	Licensing, Conflict Resolution, Supervision etc
	Policy Environment	Standards, Guidelines etc
	Legal Environment	Procurement law, consumer protection
	Government Support	Incentives, Endorsement/encouragement
Organization	Organization characteristics	Organizational Mandate, Organizational Culture, Identified Data Challenges etc
	Organization capabilities	Supportive leadership, Technology Infrastructure, Existing Skill sets
Cloud Adoption	Needs & readiness assessment	Organizational assets identification and classification, Threats identification,
	Strategy	Cloud Adoption Strategy, Training and capacity building, Funding, Change Management,
	Procurement and Deployment	Partner identification, Partner engagement, Solution deployment.

	Use and Maintenance	Risk Control, Cost Benefit Analysis Monitoring of risks Measuring of effectiveness Endorsement/encouragement
Net effect	Positive net effect	Improved Operational efficiency, New products/services, Enhanced market reach, Enhanced security, Information sharing & collaboration, Scalability, Cost saving.
	Negative net effect	Compromised data security, Compromised privacy, Poor service reliability, Low availability levels, Integration and interoperability challenges

The components of the three concepts in the last column were used to generate questions for the study. In addition to the above framework, some additional questions were included to capture the demographics and challenges across the value chain, among others aspects.

METHODOLOGY

This chapter outlines the research methodology that was adopted for this study. The chapter describes the research design, the data collection methods, sampling, qualitative data analysis and ethical considerations.

Research Design

The study adopted a qualitative approach to collect primary data. The qualitative approach has been used in this study because of its ability to investigate in detail human subject motivation and actions within a research study, thus providing in-depth understanding of the phenomena under study. A data collection tool, Google Forms, was used in this study. The tool was used because the provider has wider access to the population; in this case, IT Managers, Research Officers, Technical Directors, Directors of Medical services, Health Record and Information Management officers, doctors and nurses among in healthcare service providers in East Africa. Participants for this study were purposively selected from the population of Healthcare service providers in East Africa which had deployed cloud related services in their respective hospitals. Respondents were selected considering their technical and managerial expertise to evaluate the company's existing IT system as well as cloud computing services.

The sample size for the actual study was calculated using the Krejcie and Morgan formula.

The survey instrument was administered once to randomly selected participants from the respective hospitals during the actual study. The first page of the survey required participants to complete the Informed Consent form in which non-agreement with the consent form terminates participation. Collected data was partially cleaned to remove monolithic responses before the raw dataset was exported to SPSS format, downloaded, and stored encrypted on local computer for further analysis.

Data Collection

The sampling criteria consisted of 39 respondents. Educational qualification, healthcare ICT experience, and designation were the main criteria to choose 39 respondents. Out of 16 experts, four had a history of computer science education, whereas twelve had the background of medical science. They worked in different roles, such as of IT Managers, Research Officers, Technical Directors, Directors of Medical services, Health Record and Information Management Officers, software developers, doctors and nurses. These individuals were chosen because they were most likely familiar with the IT challenges

facing the organizations, were likely to be involved in the formulation and implementation of ICT strategies and were likely to have a bird's view of the effectiveness and efficiencies related to ICT investments. Of the 45 healthcare service providers targeted, a total of 39 healthcare service providers participated and filled in the questionnaires. The other six were either unwilling to participate or were not available during the study period.

We used both traditional paper questionnaires and online questionnaires to collect the data. The questionnaires centered on finding the participants' expectations or concern pertaining to the deployment of cloud computing in at their respective hospitals in East Africa. The researcher created the web-based survey using Google Forms to collect the data, and thus, there was no interaction between the researcher and the participants. The data type for this study is interval data. The Likert-type variables are linear combinations of responses to the corresponding Likert questions; i.e. the average response to the Likert -type questions for any given observation or survey response associated with that Likert variable is computed.

To translate the framework into questionnaires, a mapping was done to the various categories so as to guide the design. The questionnaires were piloted and timed and improved after the results of the piloting.

Challenges

There were challenges with implications for the process of data collection although they did not compromise the quality of the findings of this study. It is possible that companies which were significantly impacted or were not impacted on by cloud computing technology did not participate in the study. The effect of this was reduced by focusing on both large and small healthcare service providers in East Africa. In addition, some respondents were less conversant with the area of study. In such cases, they were faced with challenges in answering questions or gave contradicting statements. We addressed this problem by asking respondents to recommend technical and business-oriented personnel before or after the interviews. This request was granted in most cases. Further, we faced a challenge in contacting healthcare service providers—a challenge we addressed by obtaining letters of introduction from key informants in the respective sectors and we were allowed to conduct our study.

Stakeholder Engagement

The promotion of cloud computing is an important matter for policymakers and regulators worldwide, since the cloud computing holds out distinct benefits for governments, companies, service providers, industry and research. To enable full enjoyment of these benefits, a coherent regulatory framework guaranteeing transparency, data protection and respect for data integrity has to be established.

Given the significance of stakeholder engagement, a seminar was held in April (19 and 20 April 2016), where all the stakeholders in were invited to discuss the impact of cloud computing. The seminar in April presented preliminary findings of the study. The focus group meetings were characterized by lively discussions on the impact of cloud computing in the region. The seminar served as an opportunity for participants to raise questions concerning the cloud computing and its socioeconomic impact. Those questions related mainly to:

- i. Data security.
- ii. Cost effectiveness for the following reasons:
 - No need for an expensive computer or protected storage system.
 - No IT maintenance costs.
 - No expensive software.

However, other key prerequisites for cloud computing were identified:

- a) Good Internet connectivity.
- b) A sound software and hardware market.
- c) Trust in the security of the systems used.
- d) Access, privacy, reliability and compliance in cloud computing.
- e) Liability and regulation in regard to cloud computing.
- f) Data location.

To this end, the seminar recommended the launch of a reflection process on the opportunities at hand with a view to elaborating a coordinated and coherent approach to the adoption of cloud computing in the region while minimizing the risks. In that regard, countries must adopt guidelines on:

- a) the strategy for the transition to cloud computing;
- b) capacity-building programs;
- c) the harmonization of legislative and regulatory reference frames;
- d) the adoption of data-centre selection criteria;

- e) Attracting investment and seizing business opportunities.

Ethical Considerations

A number of ethical considerations were taken into account throughout the study. A letter of consent was sent by email to participants in the research. Once permission was granted, respondents received an overview on the nature and purpose of the research under study. The participants were assured of confidentiality to make them more comfortable in sharing and explaining their personal views [6]. The participants had a right and the freedom to decline at any time, to participate in the research.

The anonymity of participants was protected as individuals were not identified at any point during the study. The filled questionnaires were assigned codes which were then used when presenting quotations in the report of the findings. In our case, healthcare service providers were presented with identifiers namely Case1, Case 2, Case 3 etc... Companies and respondents that take part in this study are briefly described in Appendix 2.

Study Limitations

As occurs with practically all research studies, there were several potential limitations to this study. The first potential limitation was the necessity to use non-probability sampling in selecting the survey respondents. Purposive sampling was used as it was the only feasible option for accessing an adequate and representative sample across the healthcare service providers considered in this study. Care was however taken to ensure that these respondents had knowledge of the study area.

Another potential limitation is that fact the study relied on the perception of the study respondents and an assumption of their truthfulness in self reporting on their cloud computing use and adoption. Though there is no evidence to suggest that they under or over exaggerated their system use characteristics,

These limitations notwithstanding, the study provided useful findings which contribute considerably to expanding knowledge and understanding of the impact of cloud computing on healthcare services in East Africa. This can serve as a foundation to guide further research in this subject area.

ANALYSIS & FINDINGS

This section discusses the findings with respect to the research objectives. The results provide in-depth insights to the challenges, solution and possible opportunities within the health sector in East Africa. A comparison of the findings of current study with the previous work on cloud computing adoption shows that some factors found in the current study match with the findings of previous work.

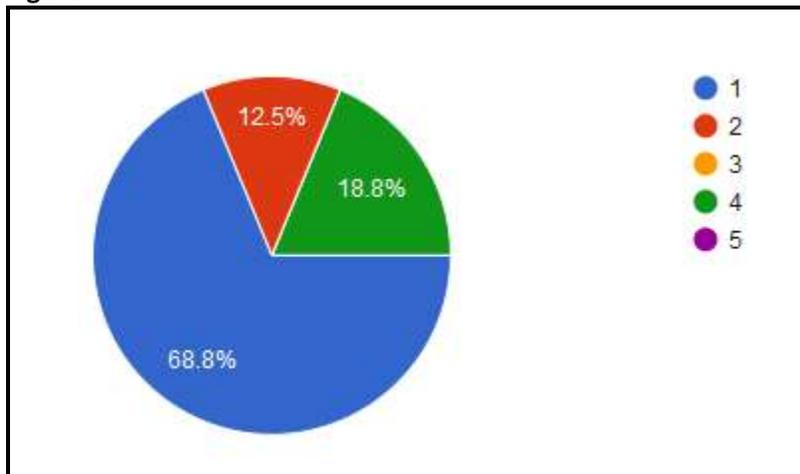
It is worth noting that cloud computing technology is being used at different levels according to the healthcare service providers concerned. Below is a summary of the responses regarding the cloud computing technologies being deployed at various healthcare service providers.

Environment

The government has listed approved cloud computing providers (with 1 being the least rated and 5 the highest rated)

All the respondents were asked if they knew of any approved cloud computing provider approved by the government and majority (68.8%) indicated that they did not know of any.

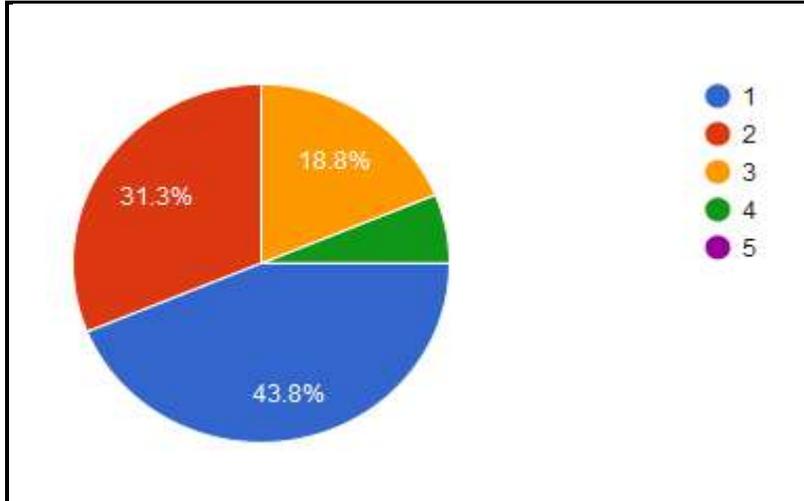
Figure 2:



The Government provides Supervision of Cloud Computing Service Providers (with 1 being the least rated and 5 the highest rated)

Similarly when asked, 43.8% indicated they were not aware of any supervision of the Cloud Computing providers by government.

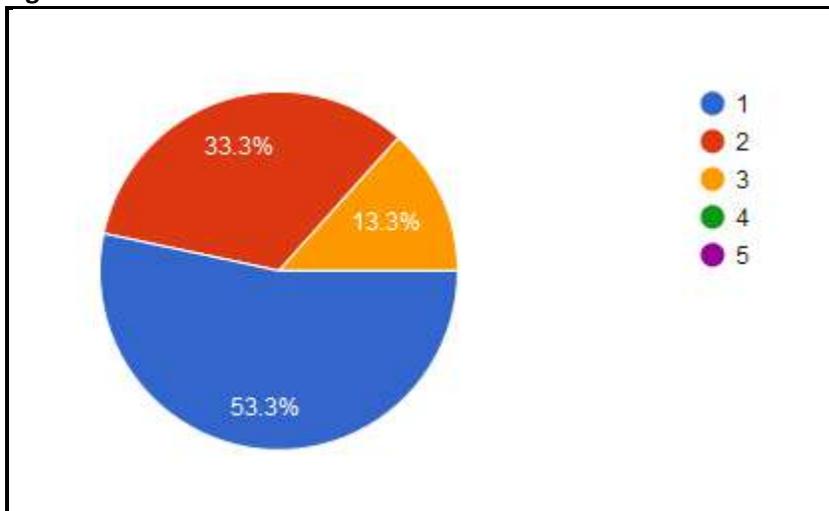
Figure 3:



There exist clear Government standards relating to Cloud Computing Services (with 1 being the least rated and 5 the highest rated)

All respondents were asked if they were familiar with any standards that would apply to cloud computing. Majority of the respondents (53.3%) indicated they were not aware of any.

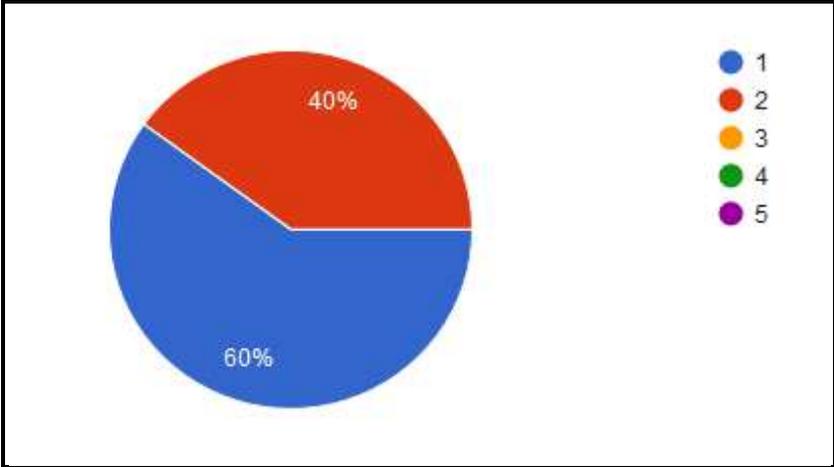
Figure 4:



There exist necessary Government guidelines relating to Cloud Computing Services (with 1 being the least rated and 5 the highest rated)

60% of the respondents indicated that there exist no clear government guidelines relating to cloud computing services for healthcare service providers in the region.

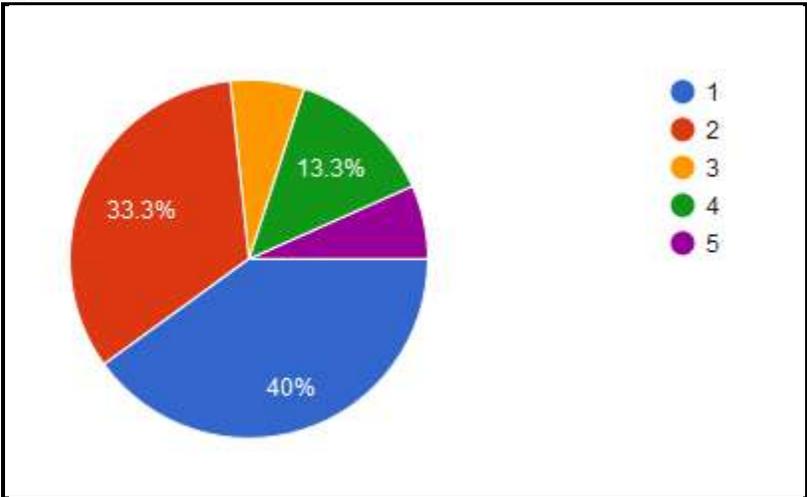
Figure 5:



The Procurement Law supports acquiring Cloud Computing Services (with 1 being the least rated and 5 the highest rated)

40% of the respondents indicated that the existing procurement laws did not shape their journey of cloud computing use and adoption.

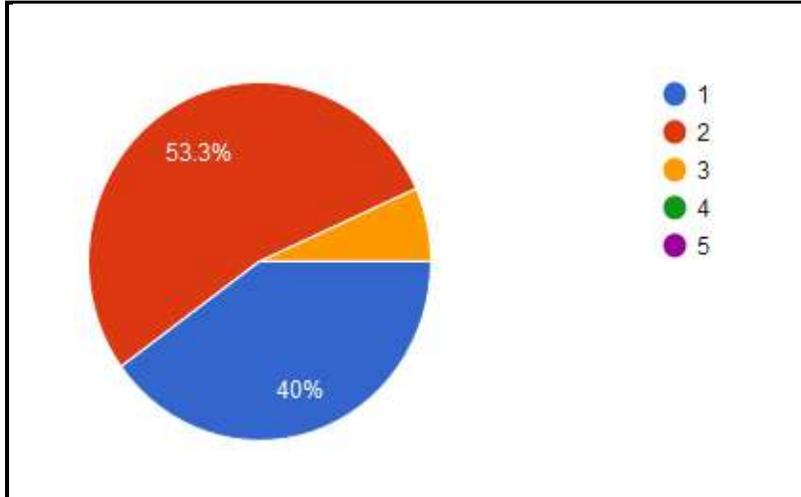
Figure 6:



There exist necessary Consumer Protection Laws for Cloud Computing Services in Healthcare (with 1 being the least rated and 5 the highest rated)

Of interest was the fact that most of the respondents (53.3%) who indicated they knew of some kind of a consumer protection laws for cloud computing services.

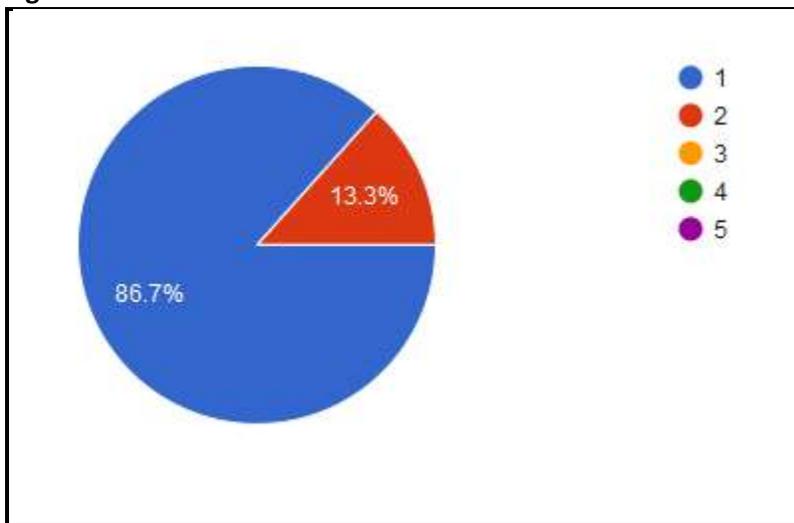
Figure 7:



The Government provides incentives for adopting Cloud Computing Services in healthcare (with 1 being the least rated and 5 the highest rated)

All the respondents were asked if they knew of any government incentives for cloud computing adoption and use and majority (80%) indicated that they did not know of any.

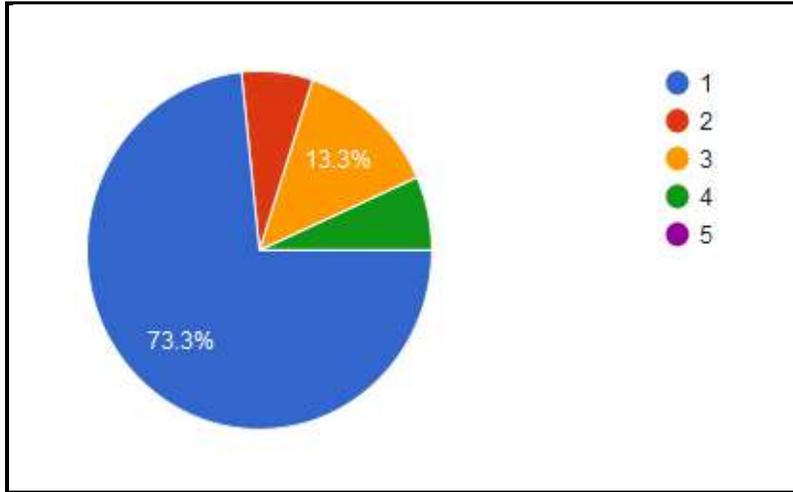
Figure 8:



The Government promotes Cloud Computing Services in healthcare (with 1 being the least rated and 5 the highest rated)

Majority of the respondents (80%) indicated that they did not know of any government promotion of Cloud computing services in the healthcare sector. The responses to this question suggest that consumers were not very familiar with government initiatives.

Figure 9:

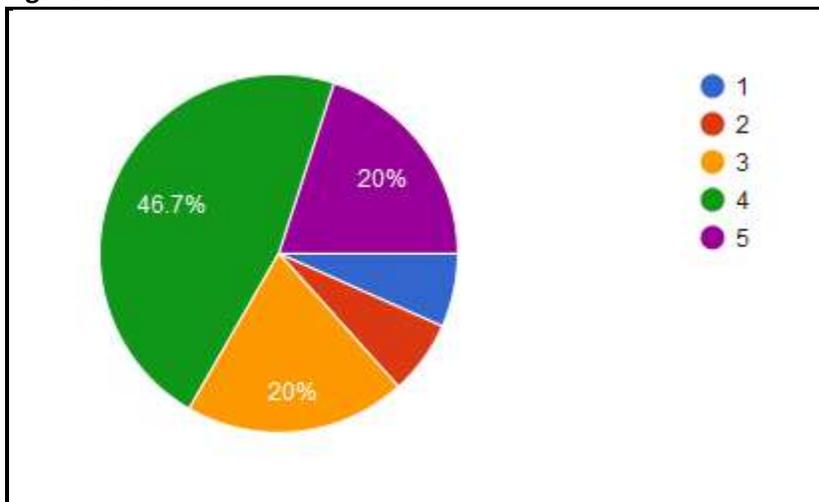


Organization

Our organization processes significant amount of data (with 1 being the least rated and 5 the highest rated)

Majority (66.7%) of the respondents indicated that their organizations generate a lot of data.

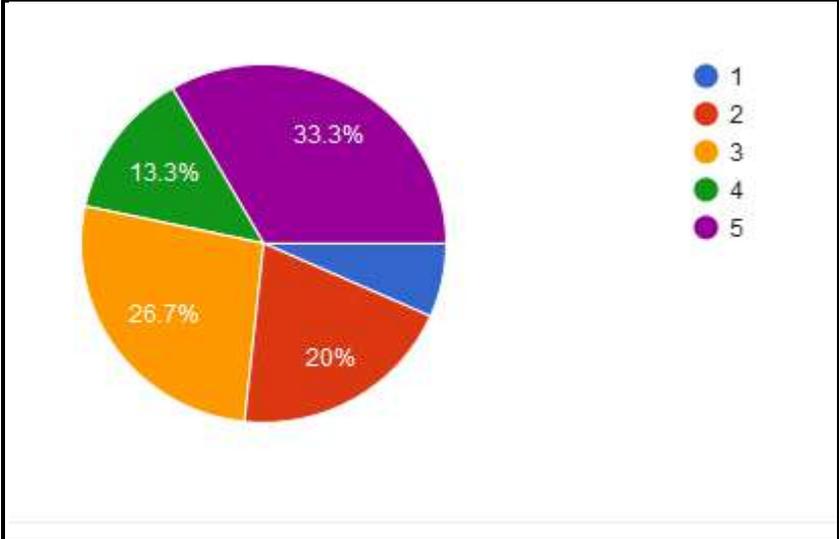
Figure 10:



Our organization has adopted new and innovative ways of conducting business (with 1 being the least rated and 5 the highest rated)

Responses from participants reveal a great deal of innovativeness in conducting business in respective healthcare service providers.

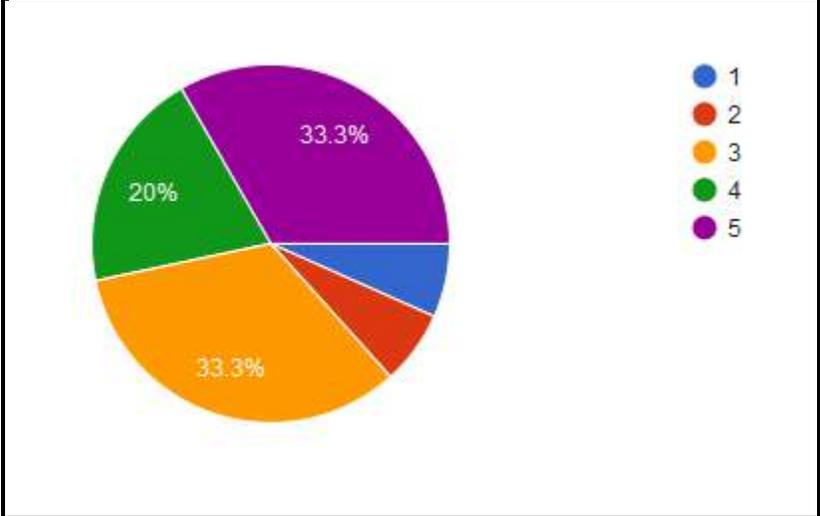
Figure 11:



We have challenges managing data using conventional methods (with 1 being the least rated and 5 the highest rated)

Majority (53.3%) of the respondents indicated that they had challenges in managing data using conventional methods.

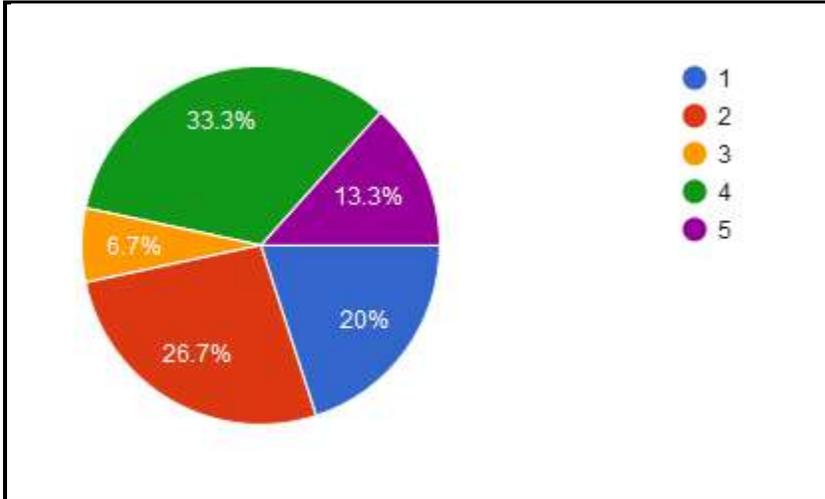
Figure 12:



We have a very supportive leadership (with 1 being the least rated and 5 the highest rated)

Respondents were asked to indicate the kind of support they are receiving from their respective organizations. 46.6% of the respondents gave a particular support from their organizations leadership.

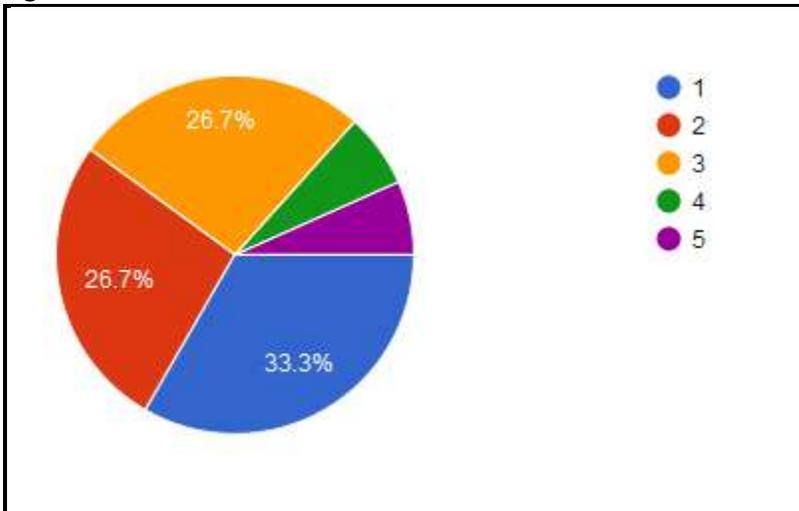
Figure 13:



Internally we have available technology infrastructure (with 1 being the least rated and 5 the highest rated)

Majority of the respondents (33.3%) indicated that their organizations did not have available technology infrastructure to support cloud computing adoption and use in their respective organizations.

Figure 14:

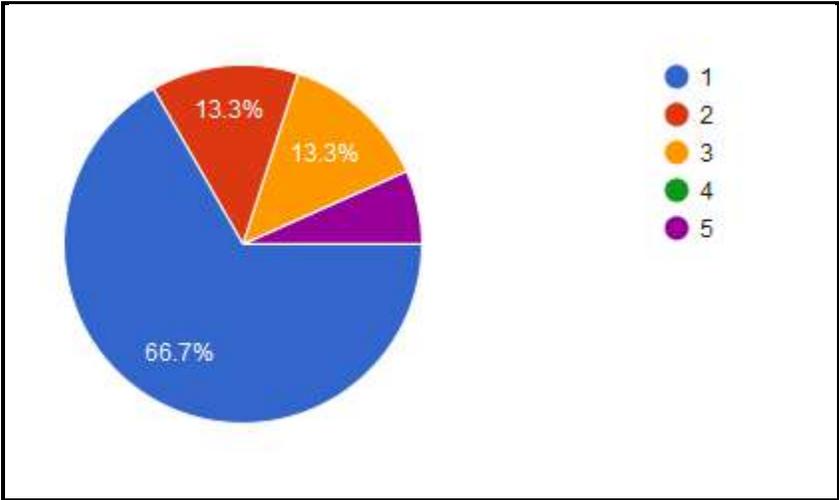


Cloud Adoption

Your organization has a clear Cloud Adoption Strategy (with 1 being the least rated and 5 the highest rated)

Several of the respondents (66.7%) indicated that their organization did not have a clear cloud adoption strategy.

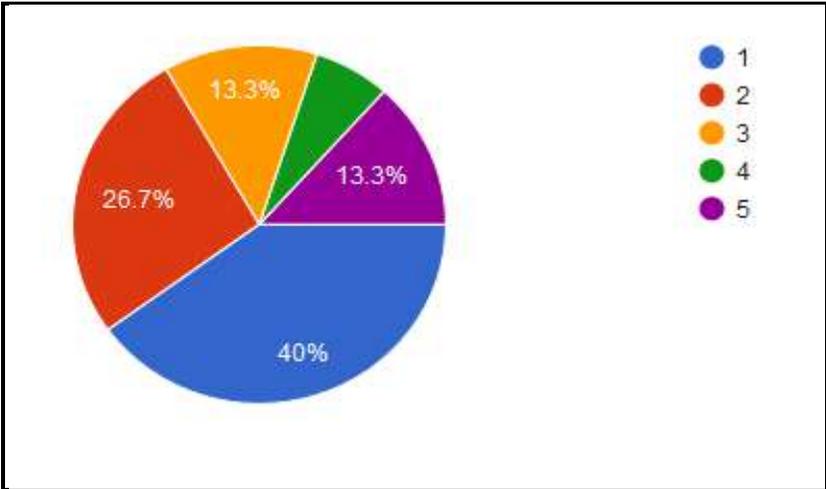
Figure 15:



Your organization has a clear Change Management Plan (with 1 being the least rated and 5 the highest rated)

When asked about the organization change management plan, 40% said their respective organizations did not have clear a change management plan.

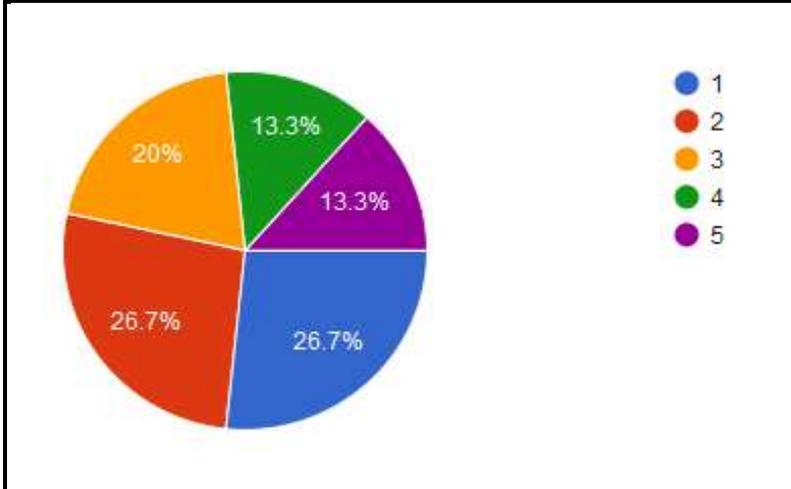
Figure 16:



Your organization has a clear Training and Capacity building Plan (with 1 being the least rated and 5 the highest rated)

26.7% indicated that their organizations did not have clear training and capacity building plan.

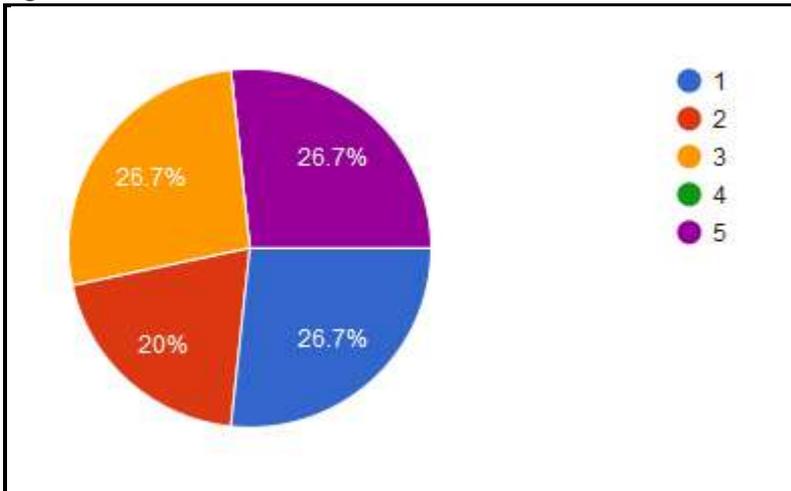
Figure 17:



Your organization has a threat identification mechanism (with 1 being the least rated and 5 the highest rated)

Of interest was the fact that most of the respondents (46.7%) who indicated their organizations did not have a threat identification mechanism.

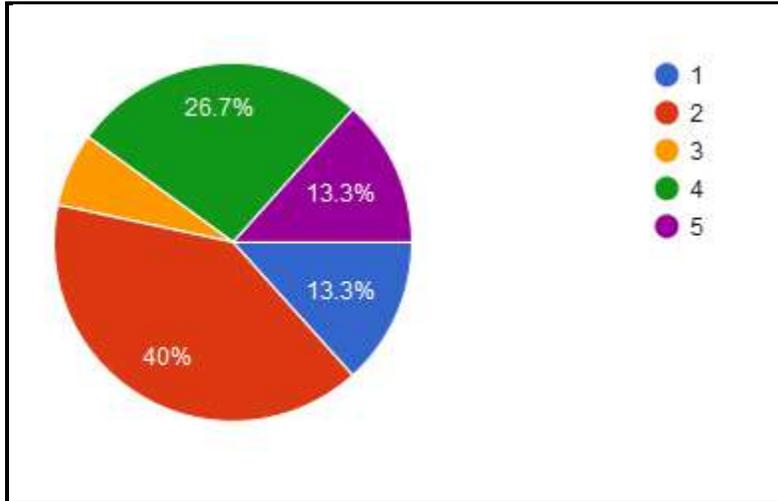
Figure 18:



During the process of Procurement and Deployment, there was an effort to identify Implementation Partners (with 1 being the least rated and 5 the highest rated)

Of interest was the fact that most of the respondents who indicated they were aware of the process of identifying implementation partners for the various cloud solutions deployed at their various organizations.

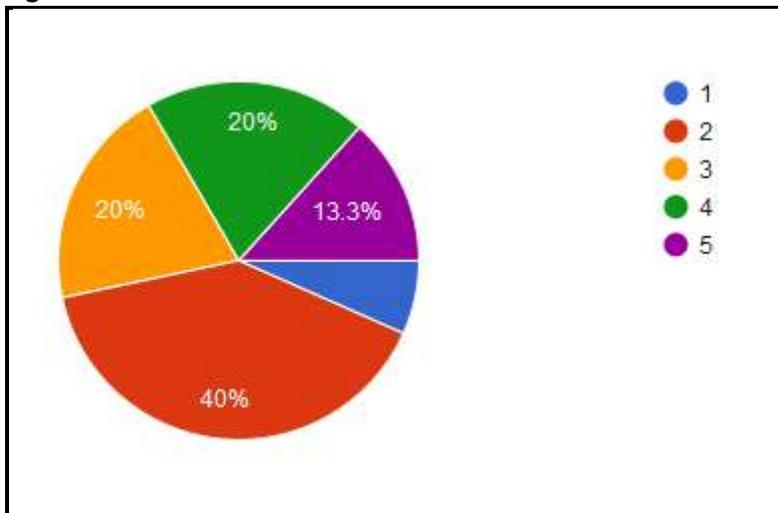
Figure 19:



During the process of Procurement and Deployment there was a systematic process for Partner Engagement? (With 1 being the least rated and 5 the highest rated)

Figure xx shows that most of the respondents indicated they were aware of the process of partner engagement for the various cloud solutions deployed at their various organizations.

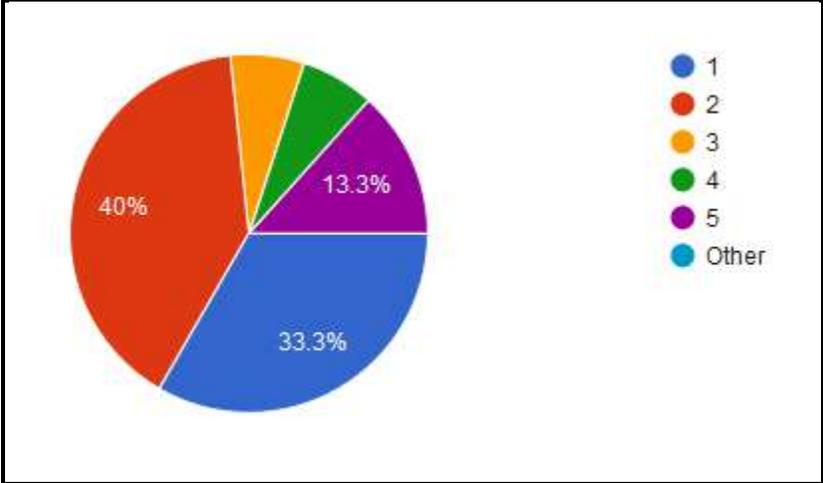
Figure 20:



There is a clear mechanism to monitor Risk to the Cloud Computing Solution deployed (with 1 being the least rated and 5 the highest rated)

Most of the respondents (33.3%) who indicated they were not aware of mechanisms at their respective organizations to monitor risk.

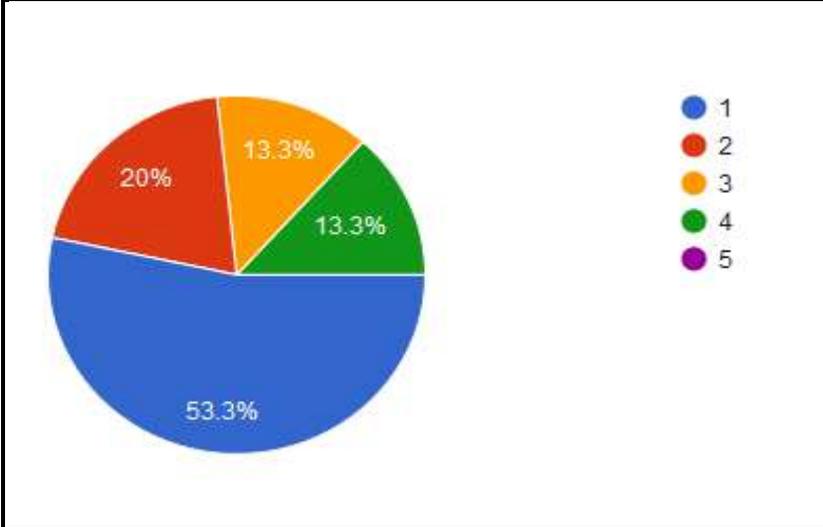
Figure 21:



There is clear Risk Control Mechanism for the Cloud Computing Solution deployed (with 1 being the least rated and 5 the highest rated)

Most of the respondents (53.3%) who indicated they were not aware of any risk control mechanisms at their respective organizations.

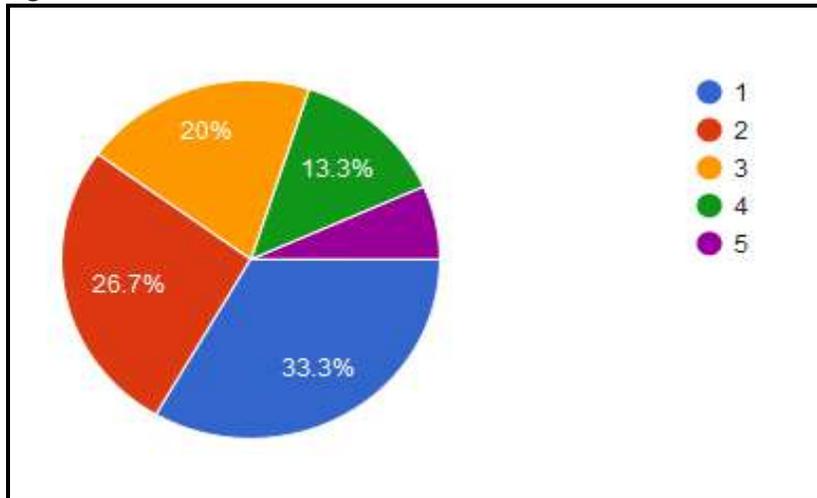
Figure 22:



There is a clear Cost Benefit Analysis done for the Cloud Computing solution deployed (with 1 being the least rated and 5 the highest rated)

Most of the respondents (33.3%) indicated they were not aware of any cost benefit analysis done for the cloud solutions deployed at their respective organizations.

Figure 23:



Net Effect

Positive Net Effect of Cloud Computing adoption and use

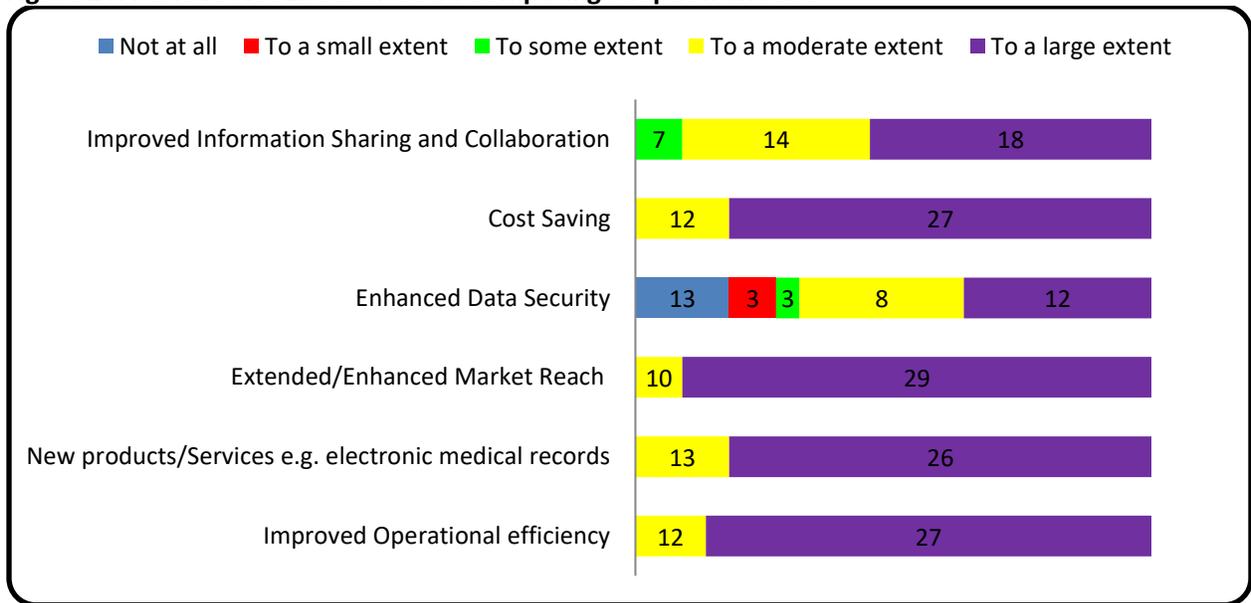
Overall, results from a review of the responses shows that the dominant expectations of the impact of cloud computing were enhanced market reach, improved operational efficiency and cost savings as shown in figure 3.1.

Question: To what extent did cloud adoption and use contribute to:

- Improved information sharing and collaboration
- Cost saving
- Enhanced data security
- Extended/Enhanced Market reach
- New products/services
- Improved operational efficiency

The replies were as follows:

Figure 24: Positive Net Effect of Cloud Computing adoption and use



Most of the respondents agreed that by adopting these cloud techniques in the healthcare sector medical organizations experience cost savings to a great extent. Since there is no need for these healthcare institutions to invest huge amounts in hardware infrastructure and their maintenance as these problems are already handled and taken care of by the cloud computing providers.

Security is still a major issue; conflicting views identified emerging from the respondents. Taking into account the explanations of respondents, it can be concluded that private cloud is perceived as a more secure deployment model compare to public cloud. Regarding security issues, healthcare service providers in this research either prefer to use private cloud computing services or public clouds for non-critical business processes and applications.

Sample Responses

Table 2: Positive Net Effect of Cloud Computing adoption and use

Theme	Response
Improved operational efficiency	<p>Respondent 31 - “Storing, archiving, sharing and accessing images in the cloud allows us to manage data more efficiently”</p> <p>Respondent 23 – “ It has improved access to data from multiple locations and reduced cost of purchasing storage hardware”</p> <p>Respondent 35 – “Ease of turnaround time between data collection and analysis”</p> <p>Respondent 15 – “Improved turnaround time from data collection to reporting; quick visual infographics and easy dissemination”</p>
New products/services	<p>Respondent 5 -“dental imaging to share and facilitate discussions with partner doctors and hospitals”</p> <p>Respondent 18 –“ Able to reach new areas of operation/ new communities”</p>
Extended/enhanced market reach	<p>Respondent 18 -“records are available anywhere and anytime allowing healthcare providers to have a comprehensive view of the patient”</p> <p>Respondent 26 –“ Wider reach of new communities”</p> <p>Respondent 2 –“ Extended communication beyond districts of operation”</p>
Cost saving	<p>Respondent 8 -“with cloud services there is no need of someone to monitor the services regularly this is left for the cloud service provider thus reducing costs”</p> <p>Respondent 11 -“No need for equipment procurement- financially unable hospitals can perform the medical test without owning equipment”</p> <p>Respondent 22 – “There were great savings: servers, system admin, etc”</p> <p>Respondent 37 – “Cost of cloud computing less than cost of storage hardware or data recovery”</p> <p>Respondent 4- “Cost for data collection reduced”</p>

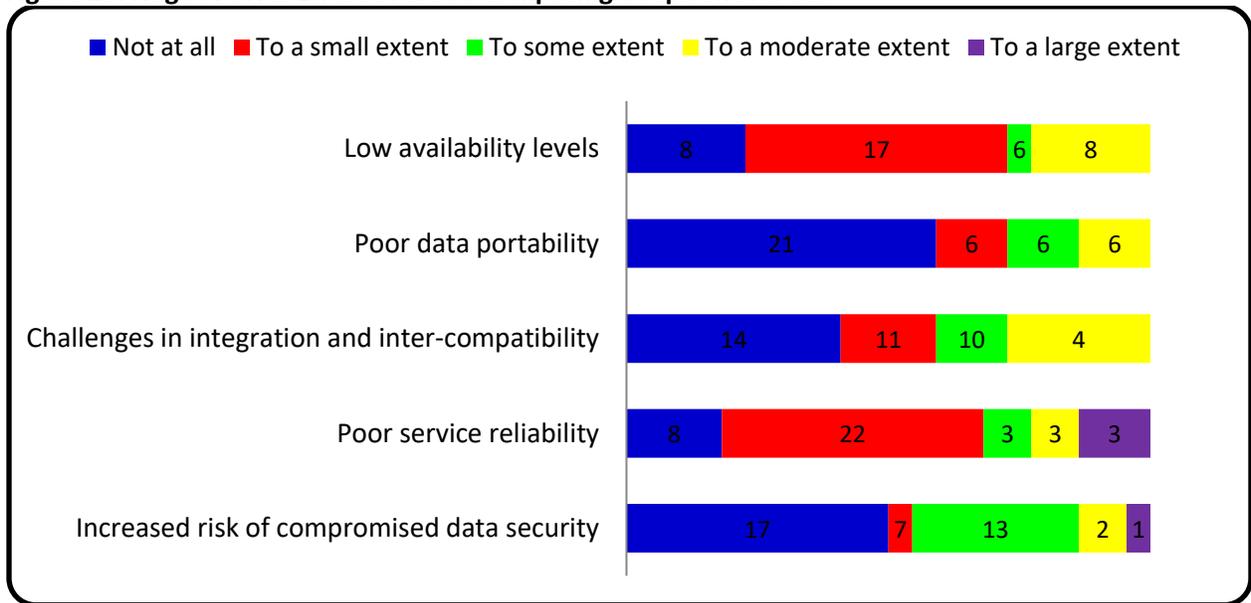
Negative Net Effect of Cloud Computing Adoption and Use

Overall, results from a review of the responses show that the dominant perceptions of the impact of cloud computing were low availability levels and poor service reliability as shown in Figure 25.

Question: To what extent did cloud adoption and use contribute to:

- Low availability levels.
- Poor data portability.
- Challenges in integration and inter compatibility.
- Low availability levels.
- Increased risk of compromised data security.

Figure 25: Negative Net Effect of Cloud Computing adoption and use



The results show that low availability levels and poor service reliability issues that need to be addressed. Another biggest challenge that some of the healthcare organizations face in adopting the cloud technologies' is the concern regarding the ability to transition to another cloud vendor or back to the healthcare organization without interrupting operations or introducing conflicting claims to the data. The respondents also noted that the data maintained in the cloud may contain personal, private or confidential information regarding a person's health status and his health records which ought to be properly safe-guarded in order to prevent the misuse of this information and their disclosure. Global concerns related to data jurisdiction, privacy of data, security and compliance are having a huge impact in adoption of these cloud technologies by healthcare organizations.

Sample Responses

Table 3: Negative Net Effect of Cloud Computing adoption and use

Theme	Response
Increased risk of compromised data security	<p>Respondent 18 -“if something happened to your data, who is responsible?”</p> <p>Respondent 7 -“we are opening the system to vulnerabilities and attacks by going cloud”</p> <p>Respondent 2 -“data is more compromised in house than when it is on the cloud”</p> <p>Respondent 32 -“ Risk of hacking is high”</p> <p>Respondent 23 -“ Data is in hands of other people who can misuse it”</p>
Challenges in integration and compatibility	<p>Respondent 12 -“there is the need to integrate current healthcare systems and making them interoperable”</p> <p>Respondent 2 -“lack of standards in terms of data integration, different systems in the markets have been developed by different engineers thus using data from other health providers still a challenge”</p> <p>Respondent 24 - “how data is collected and various platforms used may not be a hindrance to cloud computing”</p>
Low Availability	<p>Respondent 11-“Sometimes when we need to access a certain patient records they are inaccessible...”</p> <p>Respondent 34 -“we can’t put the production in the cloud and take the risk of having a loss due to connection failures... It (cloud) can only be an alternative if the availability is 99.99% and the cost is lower than existing solutions”.</p> <p>Respondent 29 -“ When internet is off, you may not access the data”</p>
Poor Service Reliability	<p>Respondent 4 -“the internet fluctuates sometimes and this impacts negatively on service delivery”</p> <p>Respondent 30 -“ Relatively reliable”</p> <p>Respondent 20 -“ There is almost 99% of service availability”</p>

CONCLUSION

The findings suggest that the use of cloud computing in the healthcare sector in East Africa might be a possibility provided superiority of cloud computing is assured, and stakeholders' concerns are satisfactorily answered.

Of further significance in this regard is the connection that existed between the results obtained and literature review analysis.

Although cloud computing is being adopted within the health sector in other countries, it was found that East African healthcare service providers are not yet ready for this emerging technology.

The findings attest to the fact that the ICT infrastructure is not enabled for cloud computing platforms within the health sector. This includes resolving privacy and security concerns throughout the cloud computing ecosystem.

RECOMMENDATIONS

There were conflicting views identified emerging from different stakeholders in the health sector. For example, the healthcare IT service providers pointed towards the ICT infrastructure as one of the major challenges for health information systems in the health sector. Broadband development is a necessary condition for Cloud computing growth.

The availability and affordability of broadband is a critical determining factor for the growth of Cloud computing in healthcare services provision in East Africa. In addition, addressing the policy gaps concerning protection of private information, data and cyber security will go a long way in creating trust among the healthcare service providers.

Another recommendation is that the East African government should first address concerns around collaboration within the broader stakeholders to ensure coordinated healthcare delivery. This will enable the countries to move forward in a coordinated manner as envisioned by the respondents. Chang *et al* [1] attest to the fact that this strategic approach is essential to create evidence value-based healthcare system [2]. This includes interaction between patients, providers, payers, policy makers and regulators.

[1] Conclude that the emergence of cloud computing is observed as driving the need for better collaboration, coordination and interaction in the health sector.

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APPENDIX 1: FROM THE FRAMEWORK TO QUESTIONNAIRES

Impact of Cloud in Healthcare

The study explores the link between organizational readiness and strategy to adopt cloud, the environment in which the organization exists and the impact of the adoption. Respondents should be healthcare organizations that have made some progress in adopting a form of cloud services.

SECTION A: BACKGROUND

Respondent Name	
Current position in organization	
Organization Name	
Country (Kenya/Uganda)	

SECTION B: ENVIRONMENT

1. In a scale of 1-5, (5 being the highest) rate the extent to which the environment shaped your journey of Cloud Computing **adoption and use** in your organization:

a	The Government has listed approved Cloud Computing Providers	1	2	3	4	5
b	The Government provides Supervision of Cloud Computing Service Providers	1	2	3	4	5
c	There exist clear Government standards relating to Cloud Computing Services	1	2	3	4	5
d	There exist necessary Government guidelines relating to Cloud Computing Services	1	2	3	4	5
e	The Procurement Law supports acquiring Cloud Computing Services	1	2	3	4	5
f	There exist necessary Consumer Protection laws for Cloud Computing Services in healthcare	1	2	3	4	5
g	The Government provides incentives for adopting Cloud Computing Services in healthcare	1	2	3	4	5
h	The Government promotes Cloud Computing Services in healthcare	1	2	3	4	5

SECTION C: ORGANIZATION

2. In a scale of 1-5, (5 being the highest) rate the extent to which the following internal factors drive Cloud Computing **adoption and use** in your organization:

a	Processing significant amount of data	1	2	3	4	5
b	adopting new and innovative ways of conducting business	1	2	3	4	5
c	Challenges managing data using conventional methods	1	2	3	4	5
d	very supportive leadership	1	2	3	4	5
e	Internally available technology infrastructure	1	2	3	4	5

SECTION D: CLOUD ADOPTION

3. In a scale of 1-5, (5 being the highest) rate each of the following questions as regards Cloud Computing **adoption and use** in your organization

a	You organization has a clear Cloud Adoption Strategy	1	2	3	4	5
b	You organization has a clear Change Management Plan	1	2	3	4	5
c	You organization has a clear Training and capacity building Plan	1	2	3	4	5
d	You organization has a threat identification mechanism	1	2	3	4	5
e	During the process of Procurement and Deployment, there was an effort to identify Implementation Partners	1	2	3	4	5
F	During the process of Procurement and Deployment there was a systematic process for Partner engagement?	1	2	3	4	5
G	There is a clear mechanism to monitor Risk to the Cloud Computing solution deployed	1	2	3	4	5
H	There is a clear Risk Control mechanism for the Cloud Computing solution deployed	1	2	3	4	5
I	There is a clear Cost Benefit Analysis done for the Cloud Computing solution deployed	1	2	3	4	5

SECTION D: NET EFFECT

Positive net effect

4	In a score of 1-5, to what extent did cloud computing adoption and use contribute to Improved Operational efficiency?	1	2	3	4	5
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Provide a simple explanation for your score: _____

5	In a score of 1-5, to what extent did cloud computing adoption & use result in New products/Services e.g. electronic medical records?	1	2	3	4	5
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Provide a simple explanation for your score: _____

6	In a score of 1-5, to what extent did cloud computing adoption & use result in Extended/Enhanced Market Reach e.g. telemedicine?	1	2	3	4	5
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Provide a simple explanation for your score: _____

7	In a score of 1-5, to what extent did cloud computing adoption and use result in Enhanced Data Security e.g. customer data?	1	2	3	4	5
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Provide a simple explanation for your score: _____

8	In a score of 1-5, to what extent did cloud computing adoption and use result in Cost Saving?	1	2	3	4	5
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Provide a simple explanation for your score: _____

9	In a score of 1-5, to what extent did cloud computing adoption and use result in Cost Saving?	1	2	3	4	5
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Provide a simple explanation for your score: _____

10	In a score of 1-5, to what extent did cloud computing adoption and use result in Improved Information Sharing and Collaboration?	1	2	3	4	5
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Provide a simple explanation for your score: _____

11	Any other positive effect?	1	2	3	4	5
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Provide a simple explanation for your score: _____

Negative net effect

12	In a score of 1-5, to what extent did cloud computing adoption and use result in increased risk of Compromised Data Security?	1	2	3	4	5
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Provide a simple explanation for your score: _____

13	In a score of 1-5, to what extent did cloud computing adoption and use result in Poor service reliability?	1	2	3	4	5
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Provide a simple explanation for your score: _____

14	In a score of 1-5, to what extent did cloud computing adoption and use result in challenges in integration and inter-compatibility?	1	2	3	4	5
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Provide a simple explanation for your score: _____

15	In a score of 1-5, to what extent did cloud computing adoption and use result in Poor data portability?	1	2	3	4	5
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Provide a simple explanation for your score: _____

16	In a score of 1-5, to what extent did cloud computing adoption and use result in Low availability levels ?	1	2	3	4	5
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Provide a simple explanation for your score: _____

17	Any other negative effect?	1	2	3	4	5
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Provide a simple explanation for your score: _____

APPENDIX 2: STUDY PARTICIPANTS

Description of Healthcare Service Providers and Respondents that took part in this study

Company	Respondent	Respondent's Position
Case 1	Participant 1	Technical Director
Case 2	Participant 2	IT Manager
Case 3	Participant 3	Technical Director
Case 4	Participant 4	Software developer
Case 5	Participant 5	Software developer
Case 6	Participant 6	IT Manager
Case 7	Participant 7	Director of Medical services
Case 8	Participant 8	Research Officer
Case 9	Participant 9	IT Manager
Case 10	Participant 10	IT Manager
Case 11	Participant 11	Software developer
Case 12	Participant 12	Health Record and Information Management Officer
Case 13	Participant 13	Software developer
Case 14	Participant 14	IT Manager
Case 15	Participant 15	Software developer
Case 16	Participant 16	Research Officer
Case 17	Participant 17	Software developer
Case 18	Participant 18	Research Officer
Case 19	Participant 19	Technical Director
Case 20	Participant 20	Doctor
Case 21	Participant 21	Doctor
Case 22	Participant 22	IT Manager
Case 23	Participant 23	IT Manager
Case 24	Participant 24	Research Officer
Case 25	Participant 25	Technical Director
Case 26	Participant 26	IT Manager
Case 27	Participant 27	Director of Medical services
Case 28	Participant 28	IT Manager
Case 29	Participant 29	Technical Director
Case 30	Participant 30	Technical Director
Case 31	Participant 31	Software developer
Case 32	Participant 32	IT Manager
Case 33	Participant 33	Nurse
Case 34	Participant 34	Research Officer
Case 35	Participant 35	Doctor and Software developer
Case 36	Participant 36	Research Officer
Case 37	Participant 37	Health Record and Information Management Officer
Case 38	Participant 38	Health Record and Information Management Officer
Case 39	Participant 39	Software developer

ABOUT THE AUTHORS

Charles Katua - PI

Charles Katua is the Research Manager at C4DLab of the University of Nairobi in Kenya. He holds a Master of Science Degree in Information Systems from the University of Nairobi and a Bachelor of Science Degree in Management Information Systems from Daystar University. He has worked on issues related to Information and Communication Technologies for Development ICT4D.

His research interests span from information systems methodology, Information and Communication Technologies for Development (ICT4D), Cloud Computing, Big Data Analytics, Financial Inclusion, Mobile Financial Systems and Socio-economic Development.

He was involved in a multi-year project funded by an ESRC-DFID grant to study the effects of broadband use and access in Kenya and Rwanda, asking who benefits (and who doesn't) from improved connectivity. He was part of the team that worked towards the development of the cloud strategy for the public sector in Kenya. He is currently involved project in cooperation with Google Kenya and the multinational consortia Measurement Lab Partnership (M-Lab), KENET (Kenya Education Network) and C4DLab in scaling up the use of the M-Lab Network for measuring the qualitative characteristics of broadband connections in Kenya (e.g. actual access speeds, quality per service/application, etc)

Dr. Lydia Kemunto Atambo

Dr. Lydia Kemunto Atambo is a licensed Medical officer with the Kenya Medical Practitioners and Dentist Board based in Nairobi, Kenya. She holds a Masters Degree in Tropical and Infectious Diseases from the University of Nairobi and a Bachelor of Medicine and Bachelor of surgery from the same University.

Dr. Atambo's areas of expertise include Medical microbiology, Clinical microbiology, Travel medicine, Medical entomology, Parasitology, Virology, Pharmacology, Molecular biology, Social Science, Immunology, Pediatrics and child health, Non Infectious disease, Research methodology, Epidemiology, Biostatistics, Health systems management. For her graduate program, she investigated knowledge, attitude and uptake of antiretroviral therapy for HIV prevention among discordant couples: Pumwani maternity hospital cohort. This was a study funded by the Canadian African AIDS Trial- Network (CAPT-N).

Dr. Atambo has various certifications including GCP for clinical trials with investigational drugs and biologics, MSM Sensitivity, Human Subjects Protection (HSP),

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