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ABSTRACT

This study examined the influence of ICT infrastructure on implementation of a centralized offsite datacenter for backup within the national government specifically, the state departments and their respective agencies and parastatals. Findings from various sources indicated that most administrative units within the national government were slowly embracing the need for a data backup system that is secure, efficient and reliable. However, due to the failures of well-formulated strategies at various phases of the implementation process, the establishment of these datacenters remained a difficulty. The study was guided by the resource dependency. It adopted a descriptive survey design and targeted the population of 142 datacenter staff in the 24 selected government ministries, agencies and parastatals. Proportionate stratified random sampling method was used to select a sample of 85 datacenter staff from the 24 selected datacenter projects in the national government. Data was collected from the sample using structured questionnaires and analyzed using percentages, frequencies, means, standard deviation, and the multiple linear regression techniques. The findings revealed that ICT infrastructure had a statistically significant and favorable impact on COD implementation in the national government. The study recommended that to improve implementation of COD, there is a need to improve infrastructure.

Key Words: *ICT, Data Centres, Data Security, Data Management, Scalability*

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INTRODUCTION

The ICT sector is proving to be a growth driver for the economy. In reality, data centers are forming the backbone of a wide variety of ICT services offered. Some of these services include, web hosting, ecommerce, social networking, and a variety of more general services such as software as a service (SAAS), platform as a service (PAAS), and grid/cloud computing (Kant, 2009). Organizations are increasingly reliant on computer-based information systems for their transaction processing, management reporting and decision making. As a result of increased computerization, most organizations data and information are held in electronic form in computer hard disks, tape drives, compact disks and other forms of storage. No matter how well computer based information systems are designed, they often experience problems such as hardware failures, software errors or users' mistakes (Cashman et al, 2008).

Big data applications have become increasingly popular in most countries especially with the rise of cloud computing (Rong, Zhang, Xiao, Li, & Chunhua, 2016). This has necessitated most government institutions and internet service providers (ISPs) to build datacenters for data storage and processing. Such projects have a wide range of complications in the implementation process, necessitating a high level of technical expertise to fully comprehend and embrace the key factors that lead to successful implementation (Kituku & Lelei, 2012).. In Kenya, the national government has encouraged centralization of all its datacenters to eliminate operational expenses relating to innovation and maintenance (Mukabi & Omulo, 2013). The Government through the ministry of ICT and its parastatal Communications Authority (CA) Kenya have been on the forefront in providing and facilitating a thriving environment by encouraging centralization of datacenters to free up capital and operational expenses on innovation and investments (Korir, 2018).

In addition, the Ministry of Information Communication and Technology has invested in the National Optic Fiber Backbone (NOFBI) and shared it out to all service providers (Malungu & Moturi, 2015). Despite all this progress, the government has experienced a sluggish adoption of fiber optic cable for fast and secure data transmission, averaging 17.1 percent per year compared to the global pace of 67.6 percent per year (Mwangi & Ogollah, 2017). Due to significant upheavals in project delivery, there is little acceptance of this technology among users. There is a paucity of literature examining factors that influence the implementation of datacenter projects in government institutions in Kenya. Most scholars have studied the adoption of ICT focusing mostly in the private sector. The current study sought to address this gap in knowledge by examining the influence of ICT infrastructure on implementation of a centralized offsite datacenter for backup within the national government.

LITERATURE REVIEW

Theoretical Review

The study was founded on resource dependency theory, which was proposed by Pfeiffer & Salancik (1978). The theory proposes that organizations rely on resources derived from their surroundings, and that their capacity to acquire and utilize these resources is critical to their existence (Dorfman, Hanges, & House. 2012). As a result, corporations must devise strategies to use these resources, which are also sought by rival organizations in the same environment (Abok, 2013). Hatch (2013) goes on to say that such organizations couldn't survive unless they can count on a steady supply of key resources.

As a result, the implementation of an offsite datacenter is not a self-contained entity, as it is heavily reliant on the environment in which it operates and services. This idea is bolstered by the institutional organizational theory, which states that an organization can have all of the resources it needs from the environment in the form of raw materials, labor, and capital, but it will fail if it is not recognized by the same society. In this study's

perspective, the availability of ICT infrastructure and its resilience may depend on its external social influence which would dictate the delivery of the datacenter. Reliable and adequate infrastructure may be difficult to find hence the need to mobilize effectively for the necessary resources required.

Conceptual Framework

As indicated in Figure 1, the conceptual framework for this study was based on one independent variables and one dependent variable. According to the study, Implementation of a COD was achieved through as proper consideration of the ICT infrastructure

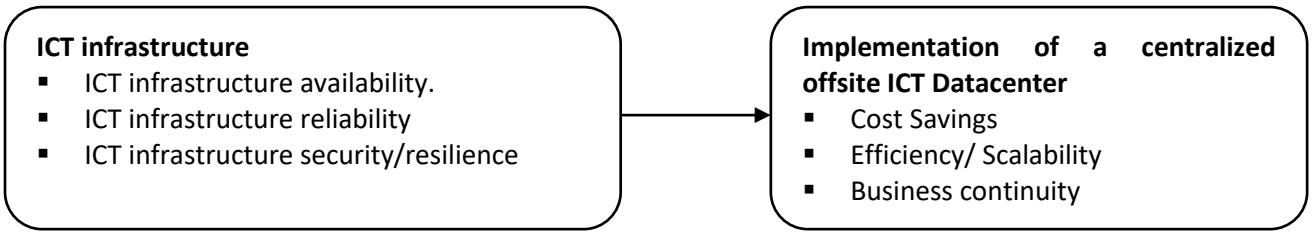

Figure 1: Conceptual Framework

ICT Infrastructure

For the government and all its administrative units, setting up a network convergence is a key consideration to ensuring effective delivery of its services. Network convergence refers to the efficient coexistence of telephone, video and data communication within a single network (Rouse, 2008). To do so, convenient ICT infrastructure is required. This infrastructure must be adequate to handle the transmitted bandwidth as well as have enough support mechanism to provide redundancy. This therefore necessitates the need for proper architecture and technical design to support all the emerging trends within the ICT field.

Montgomery (2019) asserts that having a datacenter architecture that enables more control over the blend of resources required and allows independent scaling to achieve optimized levels of processing, storage and network bandwidth is the way to go. The end objective must be a flexible and compassable infrastructure that goes beyond converging IT resources into a single integrated unit but optimizes them to improve business agility. This has necessitated the need to have compassable disaggregated infrastructures (CDI) that treat their physical compute, storage and network fabric resources as services. The establishment of CDI has led to development of virtual application programming interface environment that provides whatever resources required in real-time to achieve the optimum and secure performance required to meet workload demands. Therefore, this study sought to examine the ICT infrastructure issues relating to datacenters implementation with respect to the infrastructure availability, reliability scalability, resilience and security needed to deliver an effective facility.

Implementation of a Centralized Offsite ICT Datacenter

In ICT projects, the project team implements the project design and architecture by controlling its outputs to meet its objectives within the budget, under the set timelines and specifications desired. Once these are achieved the project is declared having been implemented effectively. However, these are easier said than done. Several factors influence the effective implementation, and these include; ICT infrastructure in terms of availability, reliability, scalability, resilience and security; associated ICT costs i.e. development, operations and maintenance costs; ICT legal framework i.e. the regulatory and policy frameworks and ICT awareness i.e. team sensitization, competency levels and knowledge transfer on issues to do with

implementation and change management of the ICT network. The team leads must therefore have the relevant skills and competencies required to implement these projects. These include technical, interpersonal, administrative, problem solving and people handling skills which are key to ensure effective implementation (Gillwald & Moyo, 2013).

Therefore, this study sought to examine all these factors and activities that are carried out by the project teams in terms of the key elements of ICT infrastructure, costs, legal framework and awareness. Analysis of each independent variable with reference to the key elements will be made to measure their impact on Implementation of the COD.

Empirical Review

The need for faster and safer dissemination of information is increasing and this requires a stable and scalable ICT infrastructure to handle the demand. To compete effectively, organizations need IT infrastructure that can scale quickly to meet dynamic business demands and maximize utilization of their IT investments (Indimuli, 2013). As Kant (2009) reports in his paper on datacenters evolution, for an effective datacenter the ICT infrastructure has to conform to the three key elements i.e. adequate storage and networking infarstructure, reliable electrical and cooling infrastructure and a resilient management infrastructure. According to CISCO, data traffic on smartphones, tablets, and other mobile devices increased 69% in 2014 compared to the previous years. These statistics led organizations to adopting a datacenter infrastructure management (DCIM) module to sustain the demand.

Further, Morrow (2016) in her study on gaining awareness into data center energy issues concludes that proper management of power issues within the datacenter lead to an efficient and effective implementation of the datacenter. According to ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) 2014 release, the temperature recommendations for maximizing energy efficiencies in data centers is between temperatures of 59- and 89.6-degrees Fahrenheit (15 and 32 degrees Celsius) and a relative humidity in the 20% to 80% range for class A1 (highest standards) data center. The combination of a higher temperature and a lower relative humidity in the acceptable ranges maximizes the energy efficiency of the data center and minimizes energy needs at both the cooling coil as well as the humidifier. In another paper by Uddin & Rahman (2010) they assert that reliable infrastructure in terms of energy security and availability is becoming an issue for datacenter as the combined pressures of fuel availability, generation and distribution infrastructure capacity and environmental energy policy make prediction of energy availability and cost difficult. These studies go to show that the availability of ICT infrastructure is key to setting up an effective datacenter that would meet all the user demands.

According to Wysocki (2011) effective implementation refers to the enhancement of project management with the purpose of enhancing delivery on time, on budget, and meeting all customer requirements budget and satisfying all customer requirements. He describes the different tools, tips and recommendations to better manage projects. Further in a study done by Sundqvist, Backlund, & Chroneer, (2014), the key concepts of time, cost and scope during implementation were not expressly linked to effectiveness but instead meeting the planned goals on customers' satisfaction was the link to effectiveness. However the study alluded that to most organizations cost element was a dominating variable due to its ease of measurement. Time was mostly equaled to money and delays were clasified as costly to a particulary organization. In conclusion, effectiveness was found out to be short-term and doing things right the first time.

Sangori (2010), in his study on factors that influence effective implementation of CDF projects found out that there was a strong correlation between project funding and effectiveness with the funding variables being the project budget, funding allocation, and

funding disbursements. It therefore recommended that for effective project implementation, there should be adequate budget allocations, prompt disbursements and clear selection and allocation criteria through involvement of all key stakeholders in the project cycle. In another study done by Maina (2016) on Implementation of health projects in Kenya, the use of strategy was found out to be vital in ensuring seemless execution. The study further found out that the key determinatnts in formulating the strategy was establishing an organization structure that fully supports the project implementation and ensuring all key stakeholders are involved throughout the project phases.

METHODOLOGY

This study adopted a descriptive survey design. The target population was the 142 datacenter staff in the 24 selected government ministries, agencies and parastatals. The sample size for the study was determined using the Krejcie and Morgan table. The table showed that assuming a population proportion of 0.5 and a confidence level of 95%, the appropriate sample size for a population of 142 individuals is 85 individuals. Therefore, the appropriate sample size for the study was 85 datacenter staff from the 24 selected datacenter projects in the national government. The proportionate stratified random sampling was used to select the 85 participants.

The study used structured questionnaires as the collection instrument to be distributed to the targeted respondents. The drop-off and pick-up strategy was used to distribute questionnaires to the sampled individuals. This strategy entailed hand delivering the questionnaires to potential respondents and picking them at a later date. A register of all questionnaires was kept for analysis.

A pilot test was conducted to check on the instrument's reliability and validity, the completeness of responses, and analyze the various measures within the instrument. Nine datacenter employees from two national government entities (National Social Security Fund and Kenya Pipeline Company) were invited to participate in filling the questionnaires distributed for pre-testing. The two national government entities were left out during the selection of the sample for the main study. Reliability of the instrument was examined by analyzing the pilot study data using the Cronbach alpha test. Table 1 presented the results:

Table 1: Cronbach Alpha Test Results

Variable	N. of Item	Respondents	Cronbach alpha	Comment
ICT Infrastructure	9	9	0.812	Reliable
Implementation of COD	9	9	0.814	Reliable

According to Bonett and Wright (2014), the Cronbach alpha test examines whether items in a given Likert scale are measuring the same construct. The second column in Table 1 indicated the number of items that made-up the Likert scale for each study variable while the third column details the number of participants in the pilot test. The fourth column presented the Cronbach alpha for the Likert scales for the five variables of the study while the final column presents the verdicts that were derived from the alpha values. Bonett and Wright (2014) opine that an alpha that is greater than 0.7 connotes that the items in scale provide a consistent measure of the variable that the scale is supposed to measure. The results in Table 1 thus indicated that the items in the each of the two Likert scales provided a consistent measure of the study variables.

To determine the validity of the instrument, the researcher examined the relevance and suitability of the data collected during the pilot-test in addressing the research issue. The pilot data confirmed that the instrument was capable of generating the date needed to examine determinants of implementation of COBDC. Validity was also enhanced by seeking the input of university research supervisors regarding the

relevance and clarity of the content of the data collection instrument. In addition, the instrument was sub-divided into sections that correspond to the variables of the study with the view of making certain that all variables are comprehensively covered.

Before being analyzed, the data was processed through the following steps: data editing, coding, and analysis entry. To assist all computations and output for interpretation in the study, the statistical program for social sciences (SPSS) software version 22 was used. Descriptive analysis of the study was performed and expressed using frequency tables, percentages, graphs, and charts. The link between the dependent variable and the independent variables was investigated using the simple regression method. The following regression model guided the analysis:

$Y = \alpha + \beta_1 X_1 + \varepsilon$,

Where;

Y= Implementation of a centralized offsite datacenter

X_1 = ICT Infrastructure

έ = is the error term

FINDINGS AND DISCUSSION

Seventy-two out of the 85 questionnaires issued out were returned to the researcher having been completed appropriately. This number represents a response rate of 84.7%, which is close to the 81.9% that was recorded in the study by Wanjohi et al. (2019) that also targeted government entities in Kenya. The non-responses were mainly due to unavailability of some personnel during questionnaire pick-up period. There is no evidence indicating that those who failed to respond differ significantly from those who responded in terms of characteristics that are important to the study.

Table 2: Demographic Characteristics of the Respondents

Demographic Trait	Categories	Frequency	Percentage
Gender	Male	53	73.6
	Female	19	26.4
Highest Education Level	Diploma	9	12.5
	Degree	36	50.0
	Masters	22	30.6
	PhD	5	6.9
Job Designation	Manager	24	33.3
	Technical staff	48	66.7
Work Years	Less than 3 years	6	8.3
	3-5 years	26	36.1
	Over 5 years	40	55.6
Institution Size (No of departmental employees)	Less than 10	4	5.6
	10-50 employees	49	68.1
	Over 50 employees	19	26.4
Employee aware of datacentre existence	Yes	85	100.0
	No	0	0.0

The sample was dominated by males at 73.6% while females accounted for 26.4%. This finding is congruent with the survey by the USAID (2020), which found that women hold 23% of the jobs at the national government level. It connotes that the sample was representative of the population of national government workshop with respect to gender composition. Results also showed that half of the respondents (50.0%) had bachelors level of education while 30.6% had the masters' level. Similar distribution was observed in the study by Wanjohi et al. (2019) where 51.7% of the same had a bachelors' degree and 38.1% had masters' degree. The findings suggest that the sample for the current

study was a close representation of the population of national government employees in terms of education level.

In terms of job designation, findings revealed that the largest proportion of the respondents (66.7%) were technical staff while 33.3% were managerial staff. This was consistent with the survey by USAID (2020), which also found that there are few managerial positions in the Kenyan public sector. Results further showed that most of the participants (55.6%) had worked in their respective department or agency for more than five years. This indicated that many of the respondents had in-depth understanding of their organizations and thus were in a position to provide authoritative data regarding determinants of COD implementation. Finally, results denoted that the most of the respondents (68.1%) were in departments with 10-50 employees, 26.4% were in departments with more than 50 employees while only 5.6% were in departments with less than 10 employees.

Descriptive Analyses

Descriptive analyses were conducted to examine the existing situation within the government entities in regard to ICT infrastructure and implementation of COD for backup. This section detailed the results of this analysis.

ICT Infrastructure

To access ICT infrastructure in the government departments, the study included a Likert scale containing nine items in the questionnaire. Respondents were asked to specify their agreement with each of these items on five point scale (1 =strongly disagree to 5 = strongly agree). Table 3 presented the results.

Table 3: Respondents views on ICT Infrastructure in National Government Entities

SN	Statement	N	Mean	S.D.
1	The institution has the infrastructure needed to ensure reliable supply of power	72	4.26	.839
2	The institution ICT infrastructure has a cooling system	72	4.21	.871
3	The Cooling system operates efficiently with minimal downtime	72	3.97	.903
4	The institution's ICT setup comprises of an effective fire suppression system	72	3.72	1.141
5	The institution has access to internet services	72	4.67	.557
6	The internet services available at the institution are reliable	72	4.32	.747
7	The institution ICT infrastructure is scalable depending on the data dynamics and scenarios.	72	3.93	.699
8	The institution ICT infrastructure is reliable and resilient to handle the data demands.	72	3.61	.815
9	The institution ICT infrastructure is secure to ensure data privacy and protection.	72	3.64	1.039
	ICT infrastructure aggregate score	**72**	**4.04**	**.656**

As Table 3 exemplifies, all the nine items had mean scores of above, which when rounded off to the nearest whole number was 4 representing agree in the Likert scale used. This implied that respondents either agreed or strongly agreed with all the nine items. It indicated that on average, the national government entities had an efficient ICT infrastructure. Item 5 had the highest mean score of 4.67 suggesting that most of national government entities have access to internet services and thus this component of the ICT infrastructure is well established. Item 8 had the lowest mean score of 3.61, indicated that although respondent agreed that the institution ICT infrastructure is reliable and resilient to handle the data demand there may be some deficiency in this aspect.

Seven out of the nine items had standard deviation values that are less than 1 indicating that there was little dispersion of respondents rating of the items around the average position. This means that there

was a high level of consensus among the respondents on the seven issues. On the other hand, items 4 and Items 9 had standard deviation values that are greater than 1 suggesting that there were major variations in respondents' views regarding the two issues. This means that there may be be major differences across the national government entities with regard to the presence of an effective fire suppression system and security of the ICT infrastructure to ensure data privacy and protection.

However, the aggregate ICT infrastructure mean score was 4.04 out of a possible maximum score of 5. This suggests that most of the surveyed government entities have an adequate ICT infrastructure that exemplifies most of the nine components that were assessed in the scale. These findings are in line with the study by Mungai (2017), who observed that the Kenyan government had embarked in improving ICT infrastructure across the country in the five years before his study. Government efforts were mainly driven by the need to digitize government services to improve service quality and reduce inefficiencies.

Implementation of COD for Backup

The dependent variable of the study was the implementation of centralized offsite datacenter for backup. This was assessed by asking respondents to rate the effectiveness of their institutions in realization different aspects of project implementation success such as timely completion and budget adherence. The rating was done on five-point scale: (1=very poor, 2= below average, 3= average, 4= above average, and 5= excellent). Results are as displayed in Table 4.

Table 4: Implementation of COD for Backup

SN	Statement	N	Mean	S.D
1	Completing the datacenter project within the stipulated timeline	72	3.58	.852
2	Completing the project within the planned budget	72	3.67	.904
3	Solving the data problem of your institutions	72	3.89	.928
4	Reducing information security risk	72	3.67	.628
5	Satisfying key stakeholders in the project	72	3.74	.839
6	Improving delivery of services to the public	72	3.86	.844
7	Enhancing availability of the organization crucial data	72	3.92	1.017
8	Saving cost involved in storing, processing, and retrieving data	72	4.17	.822
9	Enhancing the institution's disaster recovery capability	72	3.71	1.093
	COD Implementation aggregate score	**72**	**3.80**	**.658**

Table 4 showed that all the nine items measuring implementation of COD for backup had mean scores that fell between 3.58 and 4.17. These score became 4 when rounded-off to the nearest whole number, which stood for above average in the Likert scale used. These findings suggested that from the respondents' perspective, the government institutions performed above average in the implementation of COD for backup project. Item 8 had the highest mean score of 4.17, indicating that most institutions excelled in terms of saving cost involved in storing, processing, and retrieving data. On the other hand, item 1 had the lowest mean score of 3.58 suggesting that the institutions may have struggled to complete the datacenter projects in time. Items 7 and 9 had standard deviations that are above than 1 suggesting that there were major variations in the respondents views on whether the COD project had enhanced availability of their organization's crucial data as well as whether the project have enhanced their institution's disaster recovery capability.

Nonetheless, the aggregate COD implementation score was 3.80 which rounds-off to 4 representing above average. This leads to the conclusion that the implementation of the COD for backup projects by national government institutions was above

average. These findings challenges the general assumption that ICT projects implemented by developing countries tend to be completed beyond planned timelines and rarely deliver the intended benefits (Kimani, 2017). Current findings indicate that the datacenter projects were successful implemented in terms of being completed on time and within budget as well as in terms of delivering intended benefits such as reducing the cost of storing, processing, and retrieving data.

Regression Analysis

Regression analysis was conducted to examine the relationship between ICT infrastructure and implementation of COD for backup. Table 5 presented a summary of predictive power of the model.

Table 5: Simple Regression Results

Multiple R	.346
R Square	.120
Adjusted R Square	.107
Std. Error of the Estimate	.622

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	22.580	4	5.645	46.398	.000[b]
	Residual	8.152	67	.122		
	Total	30.732	71			

		Unstandardized Beta	Coefficients Std. Error	Standardized Beta	t	sig
1	Constant	2.399	.460		5.220	.000
	ICT Infra	.347	.112	.346	3.085	.003

Table 5 indicated that the model had a coefficient of determination (r^2) of 0.120. This coefficient indicated that ICT infrastructure explains 12% of the variances in the implementation of COD for back-up. The ANOVA test gave a p-value that is less than 0.01. This implied that there is a statistically significant relationship between ICT infrastructure and the implementation of COD for back-up within the national government. Consequently, the model is a statistically significant predictor of implementation of COD.

Results further showed that ICT infrastructure had a beta coefficient of 0.347. Since the coefficient is positive, it implies that there is a reinforcing relationship between ICT infrastructure and the implementation of COD. Specifically, the coefficient denotes that if the ICT infrastructure is improved by 1 unit, the implementation of COD would improve by 0.347. The t-test gave a p-value of that is less than 0.05 (p=.003). This implies that the improvement that was observed on implementation of COD as a result of change in ICT infrastructure is statistically significant. These findings lead to the conclusion that ICT infrastructure has a significant and positive influence on the implementation of COD for backup within the national government.

These findings were congruent with Kant (2009), who opined that to create an effective datacenter, the ICT infrastructure has to conform to the three key elements. These elements include adequate storage and networking infrastructure, reliable electrical and cooling infrastructure and a resilient management infrastructure. The study is also congruent with Morrow (2016), who observed that effective implementation of datacenter was dependent on proper management of power issues. This includes installation of infrastructure for providing reliable power as well as back-up power that comes when the main power supply is out.

CONCLUSION AND RECOMMENDATIONS

This study purposed the influence of ICT infrastructure on the implementation of centralized offsite datacenter (COD) for backup. Descriptive findings revealed that most of the national government institutions have adequate ICT infrastructure comprising of reliable supply of power, cooling system, fire suppression system, and reliable internet connection. However, the institutions' ICT infrastructure' reliability and resilience in handling increased data demands received the lowest score. The regression analysis showed that ICT infrastructure has a positive and statistically significant influence on the implementation of a COD for backup.

The study concluded that ICT infrastructure has a significant and positive influence on the implementation of COD. Government institutions that have adequate infrastructure that encompasses a reliable power supply, cooling system, fire suppression system, and internet connection are more likely to be success in implementing a COD for backup. The study recommended that government institution should work on improving their ICT infrastructure, reliability and resilience in handling increased data demands received the lowest score. Findings indicated that there may be deficiencies in this area.

Government institutions should also establish better strategy for securing their ICT infrastructure in order to improve implementation of a COD. They should focus on provide both technological and physical security solutions to their infrastructure.

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