A Stage Model for Cloud Computing Adoption in E-Government Implementation

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Abstract

As Governments look for ways to improve service provision, the need for restructuring processes and effectively using technology to improve efficiency and effectiveness of their functions becomes critical. Cloud computing is one of the recent technological trends that support these efforts. It is a type of sourcing model in which computing services are provided as a utility over the Internet. The promise of cloud computing has captivated organizations globally. Considering e-Government is one of the sectors that is trying to provide services via the internet, cloud computing is a suitable model for implementing e-Government architecture to improve e-Government efficiency and user satisfaction. Adoption process is the challenge. Organizations have challenges of how to best adopt cloud computing. Existing frameworks of cloud adoption look at different aspects of cloud but fail to view the complete spectrum of cloud adoption issues. This study takes a concept centric approach by creating a stage model for adoption of cloud computing in e-Government. The model is a guide on cloud adoption, especially with the dynamics of technology. The organizations at different stages of cloud adoption exhibit different characteristics and possess distinct competencies, and organizations should not bite more than they can chew, lest their programs fail. In this study, the adoption of cloud computing in implementing e-Government was done through mixed research, where primary and secondary data was utilized to inform the stages of adoption. A stage model was therefore developed. The model is to provide a guideline for Governments in creating cloud-computing strategy by identifying the levels of implementation and stages thereof. Deployment model is mostly utilized by governments to adopt cloud computing. This model is not clear on application and progression nor does it clearly address security issues. This puts at risk the integrity and confidentiality of data owned by the Government or its agencies. The stage model for adoption of cloud computing in e-Government developed in this study is therefore a useful tool for it provides cloud adoption path. It addresses issues of cloud ownership, cloud policy, systems complexity and economic benefits of cloud computing adoption in e-Government implementation. The model evaluation confirms the applicability and the central role it plays on laying a roadmap to cloud computing adoption for governments.

Key words: Cloud computing, E-Government, Stage model, transparency, deployment model, e-Government architecture, concept centric approach

1.0 INTRODUCTION AND RATIONALE

E-Government (Electronic Government) means the operation of providing governmental services to the citizens, businesses or to other governments electronically using Information Communication Technologies (ICTs) especially the Internet (Alvarez, 2012). That means the governmental services are turned into electronic services (E-services). E-government started emerging in the nineties of the last century as a project to provide e-services to the citizens in order to save cost, time and effort. With this progress of technology, the development models of E-government began to appear to put the scientific steps to adopting and development of e-Government from zero point. These development models were developed according to different standards that change from one country to another (Alvarez et al., 2012). They developed to become maturity models to assess the progress of

any e-Government projects. With this change, Cloud Computing began to appear in the horizon as a revolution in the world of information technology. Cloud computing sparked widespread controversy about the future of information technology fields including e-Government (Gens & Frank, 2013).

Cloud computing means providing the computer resources as services via the internet by providers to customers. These computer resources include the power of CPU processor, storage space, bandwidth and the required applications to manage any operations (Brodkin, 2013). Cloud computing services include operation, maintenance and update and manage the applications. That means the computer resources are turned to services and the payment of the services done per use.

Cloud computing is very useful for E-government projects. The cost of infrastructure of E-Government and the inefficiency of human resources and staff have contributed to failure of e-Government projects. Cloud computing presents Cost Saving, professional management and utilization of high-end resources and application (Alvarez et al., 2012).

Even though cloud computing presents many opportunities to e-Government, governments have not fully adopted cloud computing. This has been due to lack of guidance into cloud computing adoption to e-Government implementation. This research seeks to provide that guidance through a stage model for adoption of cloud computing in e-Government implementation (Li, 2016 b).

Despite of the benefits that come with cloud computing, Governments still have not fully adopted cloud computing in service delivery. This could be attributed to lack of adoption criteria. E-Governments cannot clearly identify and define what level of implementation they are in and what it entails.

Questions of control and ownership of data arise with the migration of Government data to the Cloud. In many countries storing Government data outside of country's boundaries is prohibited, thus compliance with legislation is an important challenge related to cloud computing adoption (Gens & Frank 201,3).

From industrial perspective, there are an increasing number of organizations offering Cloud products and services. Amazon is a market leader in Public Cloud and offers Elastic Compute Cloud (EC2) for computing capacity and Simple Storage Service (S3) for storage capacity. Microsoft provides Windows Azure services to allow developers to store their codes and develop new applications for their clients or companies (Li, 2016b).

Salesforce.com is a pioneer in Cloud and presents their Customer Relation Management (CRM) applications for a large number of their users. Oracle consolidates resources with Sun Microsystems, and offers several products and services ranging from hardware to application focus. IBM has Cloud products and applications suites to help their customers. In addition, there are more Small and Medium Enterprises (SME) developing and selling their Cloud services and products, and they offer different types of business models and perspective (Marston, et al., 2010).

Despite of the many players in the cloud business, cloud computing in e-Government has not been addressed adequately. Much of the focus has been on profit making business organizations that adopt short-term cloud service for convenience. This has led to slow adoption of cloud computing by Governments (Li, 2016b).

Different cloud models including service and deployment are in existence, but none addresses the issue of adoption process and the complexities involved. They only address cloud ownership and the services that accompany each deployment. The path to cloud computing adoption in e-Government implementation has not been fully addressed. This leaves e-Governments with no option other than adhoc utilization of cloud services, hence not fully realizing the full benefits.

Cloud frameworks and adoption models available currently have not addressed the issue of e-government adoption of cloud computing instead they focus on general cloud service deployment. Even the cloud service providers have not given a solution on the approach which governments need to take to fully enjoy the benefits of cloud computing, instead Governments use trial and error methods to embrace cloud computing in providing essential services.

Position of the current cloud business market players

Cisco is a founded player in the cloud business. He has identified two broad categories of cloud deployment, virtualization and cloud computing. Out of which several stages of deployment have been identified including data center networking, unified fabric, unified computing, private clouds and inter-cloud as shown in Figure 2.16. A closer look at the model reveals a infrastructural approach of the model, with complete exclusion of service model perspective, which forms the basis of cloud adoption. It is therefore difficult for any e-government to adopt cloud computing using this model because it is oriented towards creating a data center but not the broader perspective of government cloud adoption

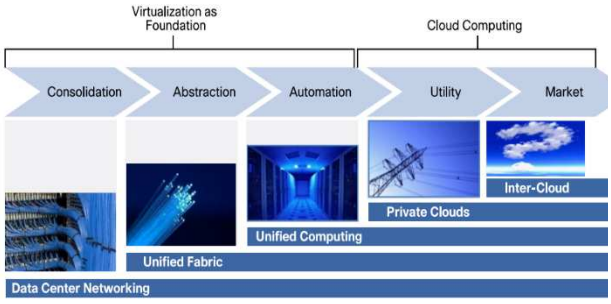

Figure 1: Cisco Cloud data center Evolution Roadmap

Oracle developed a maturity stage model, as shown in figure 2, which has five adoption levels ranging from application level to enterprise level. It identifies hierarchies of adoption ranging from ad-hoc to optimised. It identifies three stages, exploration, expanding and exploitation. This model comes closer to establishing an adoption path but misses to relate the levels with the already existing models for the users who are already in progression. It largely takes a data storage concept and therefore can only be used in cases of deployment of Iaas or Storage as a service adoption, but not e-Government cloud implementation.

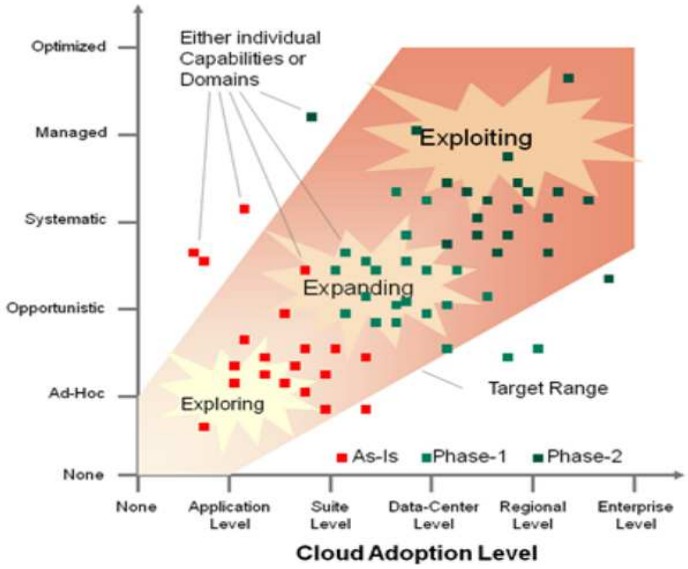

Figure 2.oracle's cloud maturity stage model

Upon review of published literature, it was observed that previous work by Tsaravas and Themistocleus (2011) was limited to analyzing case studies in which cloud computing was used by public organizations. Aamirand and Shahzad (2011) created the cloud service model which related the different services supporting cloud computing namely; Infrastructure as a service (Iaas), Platform as a service (Paas) and software as a service (Saas).

This model only defined the services which support cloud computing but did not define their hierarchy and deployment approach. Aamir and Shahzad (2011) listed Saas as the highest service level citing email service as an example. In reality, it is the lowest because all mail services like Gmail and yahoo are hosted in clouds available to any user at the basic level of deployment, bearing the high level of abstraction and usability in SaaS.

Erwan Granger (2013) came up with the deployment service model which related the service levels to the four types of cloud adoption levels namely private, public, community and hybrid. His study only defined the levels of cloud ownership but did not give a roadmap to adoption of cloud computing. The model presented in this study is for adoption of cloud computing in e-Government implementation. It is intended to map the path for adoption of cloud computing in e-Government by identifying the different levels involved and relating them in hierarchical order.

While most authors examine the potential of cloud computing in e-Government generally, others focus on the e-Government system of a specific country. Tahamtan et al. (2011) studied the potential of cloud computing in Austrian public sector, interviewing eight ministries and the office of chancellor. The research showed that the most important requirements of the Austrian public sector, related to cloud computing adoption, are legal compliance, reliability, availability, compatibility, connectivity and scalability. In addition, Data security and privacy, network security, lack of knowledge of available systems, previous investments and business continuity, were identified as the obstacles for integration of cloud computing in the Austrian public sector

Khan et al. (2011) focused on the future integration of cloud computing in e-Government of developing countries, using as an example the e-Governments system of Pakistan. After reviewing the e-Government challenges and readiness of the country, the authors proposed that cloud computing can be used as a solution to problems such as digital divide and inadequate funding that developing countries usually face in the context of e-Government.

Stefanou and Skouras (2012) conducted a survey to find whether companies in Greece would be positive towards using a Government's payroll information system based on cloud computing. The information payroll system based on cloud computing that authors propose, promises to simplify the bureaucratic procedures related to labor inspection, giving to the state the role of administrator of the businesses database and therefore enabling distant control of labor issues. Through a questionnaire, companies were asked to choose between the Integrated Information System planned by Ministry of labor and aforementioned Payroll Information System provided by public sector via cloud computing. According to the results of the survey, half of the responses were in favor of the first solution and the other half in favor of the cloud based payroll Information system. It therefore seems that companies have some reservations about using the cloud based solution, mainly as regards data security, connection and software issues.

European Commission adopted a more focused approach, indicating key actions for cloud migration in Europe. Although it cannot be considered as a full migration strategy, it clearly helps towards that direction, bringing to the fore the following important actions to be taken. "Cutting through the jungle of standards", "safe and fair contract terms and conditions" and "Establishing a European cloud partnership to drive innovation and growth from the public sector".

Out of related literature, it is clear that there is no existing model on adoption of cloud computing in e-Government implementation.

2.0 Objectives of the study

The main objective of the study was to formulate a stage model for the adoption of cloud computing in E-Government implementation. However, there were other specific objectives;

i. To review the suitability and benefits of cloud computing in e-Government
ii. To review available literature on cloud adoption models
iii. To establish the status of cloud adoption in Kenya, Machakos County Government.

iv. To formulate and discuss the four stages of a stage model for adoption of cloud computing in e-Government services.
v. To evaluate the stage model.

3.0 METHODOLOGY

Research Design

This study has used a mixed approach deriving its insights from combination of primary data and system modelling. To identify the level of e-Government implementation initiatives and their influence on public service delivery in Kenya, a survey design was adopted where the relevant public office holders in the county government on adoption of cloud computing in e-Government and public services dissemination was carried out to ensure an informed discussion, evaluation and conclusion.

The steps used in the survey are:-

i. Establish the level of awareness on cloud computing in e-Government service delivery.
ii. Identify the challenges facing e-Government and their impact on electronic public service delivery.
iii. Establish the Government policy on utilization of e-Government services.
iv. Establish whether the Government has any strategy on cloud computing adoption.
v. Establish the cloud adoption criteria in e-Government services.

Findings distilled from the survey and case studies in literature review and accompanying analysis yielded an adoption model. The adoption model was created after identifying distinct characteristics for each of the accompanying stages, mapping characteristics to Adoption. They examined through the lens of the adoption model by ranking them on each of the Adoption and Readiness dimensions.

As final part of the study, the adoption model and other insights were evaluated through focus group. Key parameters influencing the move to cloud, were mapped in stock flow diagrams (Infrastructure as a Service (SaaS), Platform as a Service (PaaS) and Software as Service (SaaS)), which contained balancing and reinforcing loops. From the stock flow diagrams, basis of the stage model was developed.

Target Population

Target population refers to the entire group of individuals or objects to which a researcher is interested in generalizing the conclusions (Best and Kahn, 1989). In this study, the target population was the nine (9) departments in the Machakos county government. Each county government has nine ministries, from which two top ICT officers were sampled.

Sample Size and Sampling Procedure

A sample is a finite part of a statistical population whose properties are studied to gain information about the whole (Webster, 1985). The sample size was drawn from the ICT departments from the nine (9) ministries in Machakos county government, established as per Constitution of Kenya (2010). The sampling units were obtained through selective sampling where the two (2) top managers of the ICT departments in each ministry were sampled. The Government of Kenya has two tier Government system, the Central and County Governments. The central government has devolved its functions to the County government in a structured way. All 47 counties just replicate each other but at different geographical regions. Therefore sampling Machakos county is representative of all other counties. Since there are a total of nine ministries in the county government as per the constitution of Kenya (COK, 2010), the study engaged 2 ICT professionals from each department where 18 respondents were picked to fill the questionnaires.

Methods of Data Collection

The survey utilized questionnaires as the main data collection tool. The questions were fully structured with most of the questions being closed (multiple choice and ranking) with only few open-ended question. The questionnaire was pre-tested by administering to five ICT officers in the county government of Machakos before conducting the main survey. This ensured that in the actual survey the response given was specific to the respondent's ministry.

Reliability of Data Collection Instruments

Reliability is the consistency of measurement, or it is the repeatability of your measurement. A measure is considered reliable if a person's score on the same test given twice is similar. It is important to remember that reliability is not measured; it is estimated (Mustonen & Vehkalahti, 1997). Alternative Form Method was used where the questionnaires were purposely administered to a group of seven respondents who were on their internship program in the county government one week after the main data collection exercise. The results were compared with the actual survey and it was found to give almost similar results with the actual results.

Validity of Data Collection Instruments

According to Mugenda and Mugenda (1999), validity is the degree to which a test measures what it purports to measure. Validity was achieved through pilot study where the irrelevant items were removed. Secondly, the results were given to a peer for review and comments and lastly the supervisor for further review and technical input.

Data processing and analysis

Since the survey generates quantitative data, Microsoft excel was used for analysis. Writing was done using Microsoft word and findings presented in graphs.

4.0 RESULTS AND DISCUSSION.

Analysis of primary data from Machakos County.

It was observed that 78% of the respondents had access to the internet. 44% of all staff had corporate email addresses. Of those who had corporate email addresses, 80% of their mail servers were hosted in google cloud. Only 22% of the staff interviewed were aware of restriction to use organization based email domain for official communication. The fact that staff are not restricted on domains to open and use for official use means there is no guidelines on cloud service adoption. The few cloud-based services are just used for personal convenience but not general objective of e-Government service delivery.

From the research, 100% of all respondents had at least one online service they utilize from the central Government. 100% of all application programs from central government were web based. 50% of those who enjoy web based application programs have the servers based on the cloud, 28% are hosted locally while 22% were not sure. 0% of respondents have no official programs which they pay for per usage, 11% have but for personal use only, while 6% were not sure as shown in figure 3. This confirms that Machakos County has not yet embraced cloud computing because the only few persons who use cloud computing is a personal initiative and intended to fulfil a personal obligation but not the e-Government system.

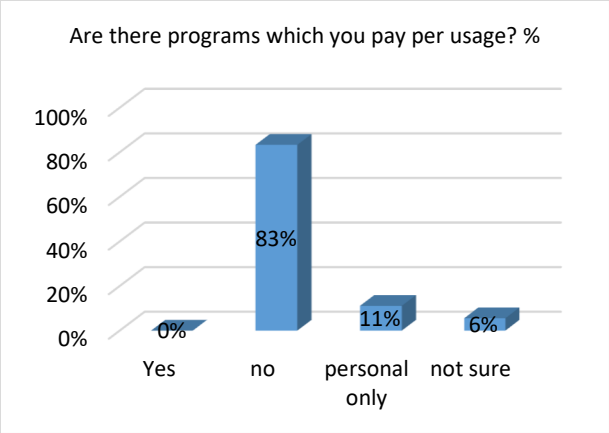

Figure 3: programs paid per usage.

On level of confidence that users have about the government on cloud computing, 61% feel that they are just beginning to familiarise, 28% are relatively familiar, while 11% are very familiar as shown in figure 4. To embrace cloud computing, the Government has to make a deliberate attempt to create awareness and make staff appreciate and embrace cloud computing especially in service delivery.

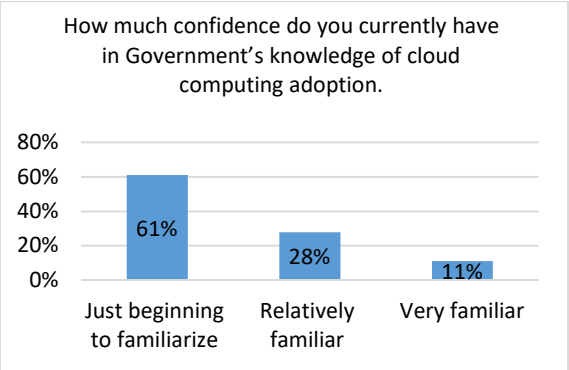

Figure 4: level of confidence in Government's knowledge on cloud computing adoption

On the future of Cloud computing in e-Government computing, 28% of respondents strongly agree, 56% agreed and 17% disagreed while 6% strongly disagreed (figure 5). Considering the global trends, it is clear that cloud computing holds the future of e-Government implementation. The stage model provides this implementation path.

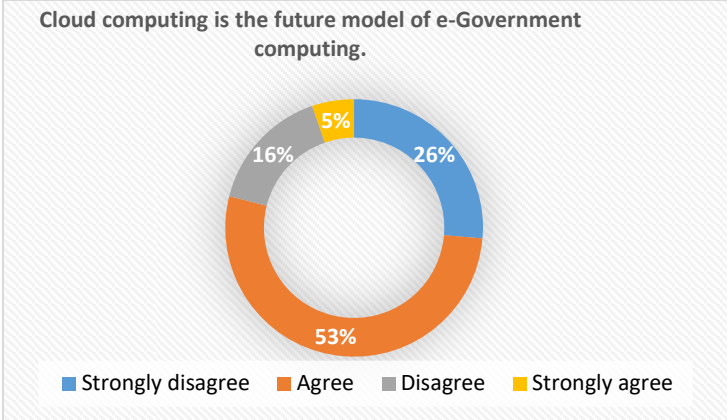

Figure 5: future of cloud computing model of e-Government

About the stage that the government is with regard to cloud computing adoption in offering its services, 17% felt that the government is not involved, 11% thought it was using, 28% thought they were still at the trial stage and 17% were at implementation stage. (figure 6). If the path to the cloud is not known, then it is difficult to fully adopt cloud computing in e-Government service delivery. Therefore, cloud adoption awareness is paramount in the e-Government cloud business.

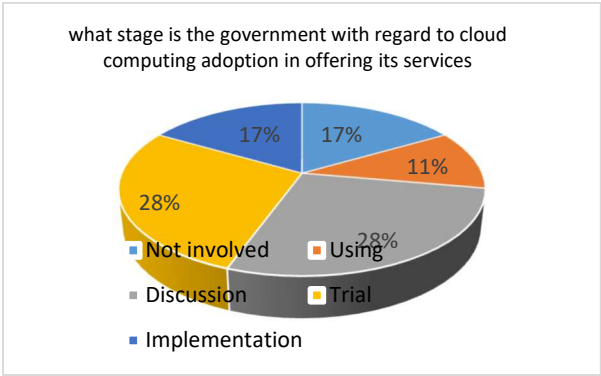

Figure 6: The stage in cloud computing that the Government is in offering its services.

On beneficial characteristics of cloud services in e-Government, the greatest identifiable benefit was buyers' pay per use while the least was rapid acquisition and deployment. Variable pricing based on consumption, lower on going operating costs and little or no capital investment were also identified as benefits (Figure 7). This clearly

shows how financial implication is central to cloud business. The pricing policy is of focus here. E-Government users seem to be more interested in only paying for what they use. At the initial levels, Software as a Service (SaaS) provides the best opportunity for such, because of the level of abstraction and user friendliness. This points out that cloud computing is highly considered for cloud e-Government implementation for the financial gains that it presents, but cutting down on operational cost.

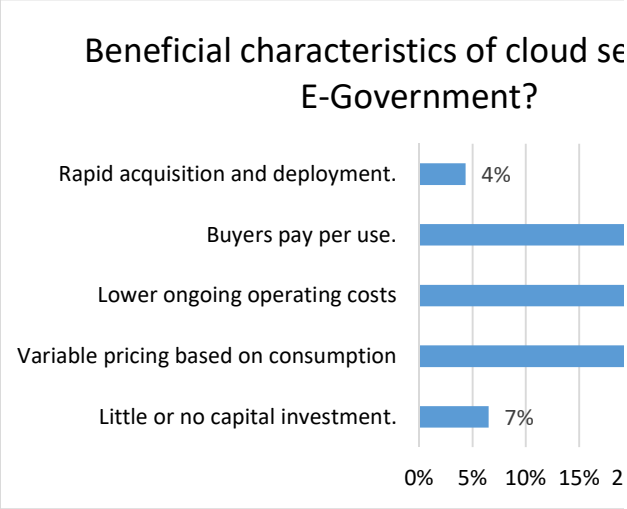

Figure 7: Beneficial characteristics of cloud services in e-Government

The respondents expressed that greatest service provided by e-Government to its citizens is tax returns (31%) while the least is complaint/compliment management (5%). (Figure 8). In the county Government of Machakos, cloud computing is still at the very young stage. There is therefore need to come up with guideline on cloud computing implementation path. There is therefore need for a deliberate effort to achieve this. Some decisions may not be made at the county level but at the national level. This can either be through a roadmap to the cloud, methodology or cloud adoption criteria. Through the stages in cloud adoption presented in this study, this can be achieved.

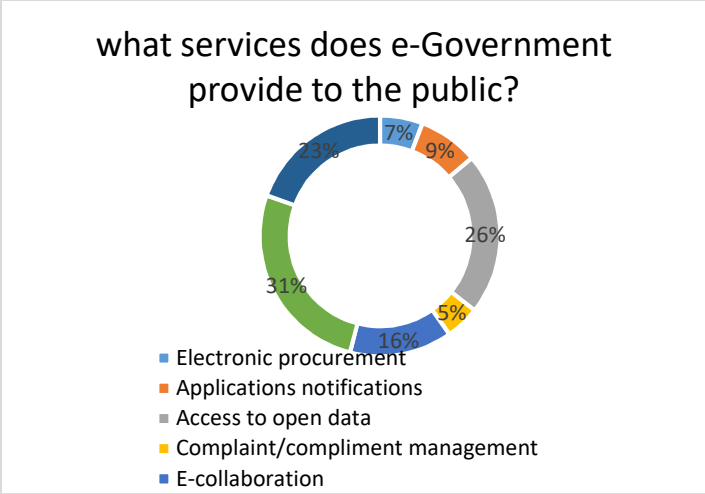

Figure 8: Services provided by Government to its citizens

According to this research, 32% of the respondents expressed that cloud computing for public service means a type of outsourcing of IT and 13% felt it is an interesting business offering (Figure 9), meaning that they have a basic understanding of cloud computing. On this foundation, the concept can be developed further into fully-fledged adoption strategy. Some staff still feel that the cloud hype will subside but this provides a precaution to carefully consider adoption strategy and path to the cloud taking into consideration the unique circumstances for each Government entity.

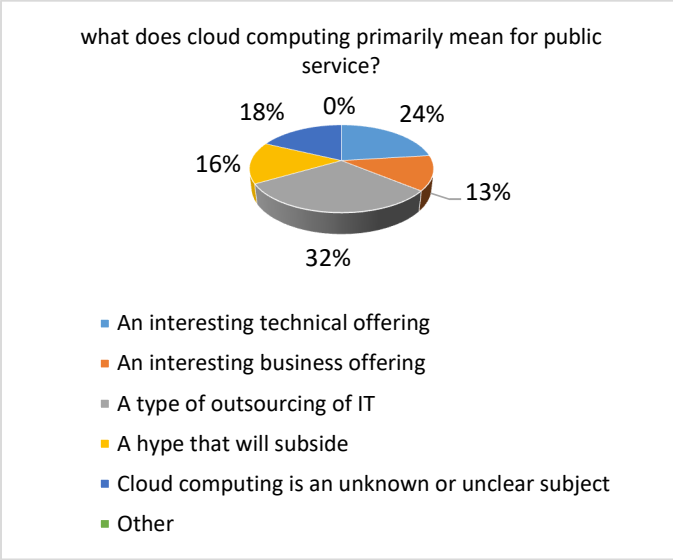

Figure 9: Primary meaning of cloud computing for public service

As clearly presented in this study, 83% of respodents felt that there is no sufficient knowledge in the public to enable them make decisions on cloud computing adoption while 17% felt the contrary (figure 10). This adoption model will therefore provide the knowledge required by the Governmnet to make right cloud adoption decisions.

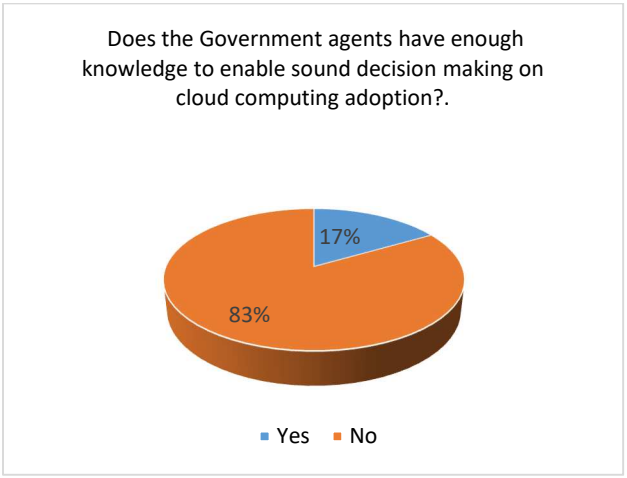

Figure 10: Availability of sufficient knowledge to make decisions on cloud computing adoption

In view of the respondents, hardware cost saving and pricing flexibility are the very important benefits of cloud computing while increased collaboration is the least important. (Figure 11). The financial and economic benefits of the cloud business therefore confirms that cloud adoption into e-Government will save money. This is confirmed by literature review, as cost saving was identified as a key benefit of cloud computing. The technology requires minimal capital investment making it a better alternative to traditional computing, which requires many infrastructural establishments.

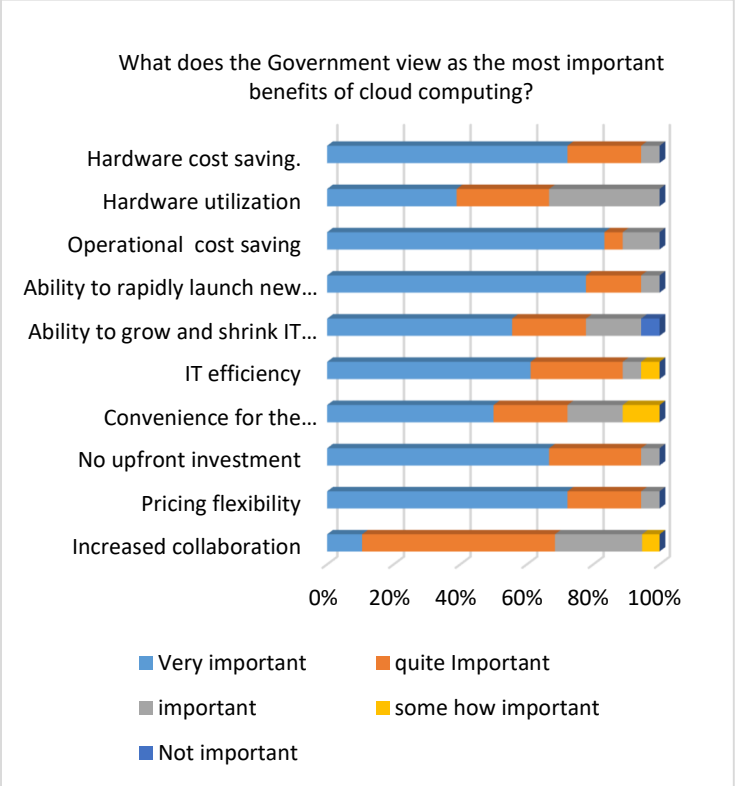

Figure 11: The most important benefits of cloud computing to the Government

Security, Privacy and vendor lock-in were viewed as the main concerns regarding the use of cloud computing in e-Government. Integration, lack of functionality and insufficient financial benefits were the least concerns of the options

provided. (Figure 12). The different levels of cloud adoption stages pose different challenges. When the adoption path is clearly defined, it leaves nothing to doubt. All service model options are made open as well as the underlying deployment designs. Security, privacy and vendor lock-in are factors which slow down cloud adoption. These questions are clearly addressed by the stage model.

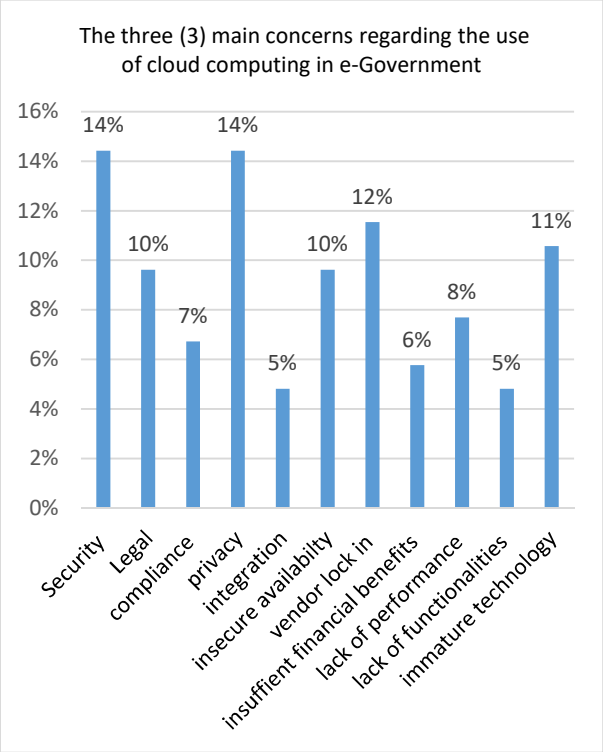

Figure 12: The three main concerns regarding use of cloud computing in e-Government.

Data storage (41%) and email/messaging (21%) were identified as the main online services in the Government currently. Application development (0%), Application hosting (0%) and enterprise service bus (0%) were online services, which the Government is not using at all. (Figure 13). This demonstrates that the time to embrace cloud computing is now. The first thing would be to create awareness on cloud computing models. It is on service and deployment models upon which stage model rides. Further to that, software as a service (SaaS) is already in use while platform as a service (PaaS) and Infrastructure as a Service (IaaS) are not in the picture yet. This confirms what is presented in the stage model that the lowest level of cloud adoption is Software as a Service (SaaS) while PaaS and IaaS traverse second third and fourth stages respectively.

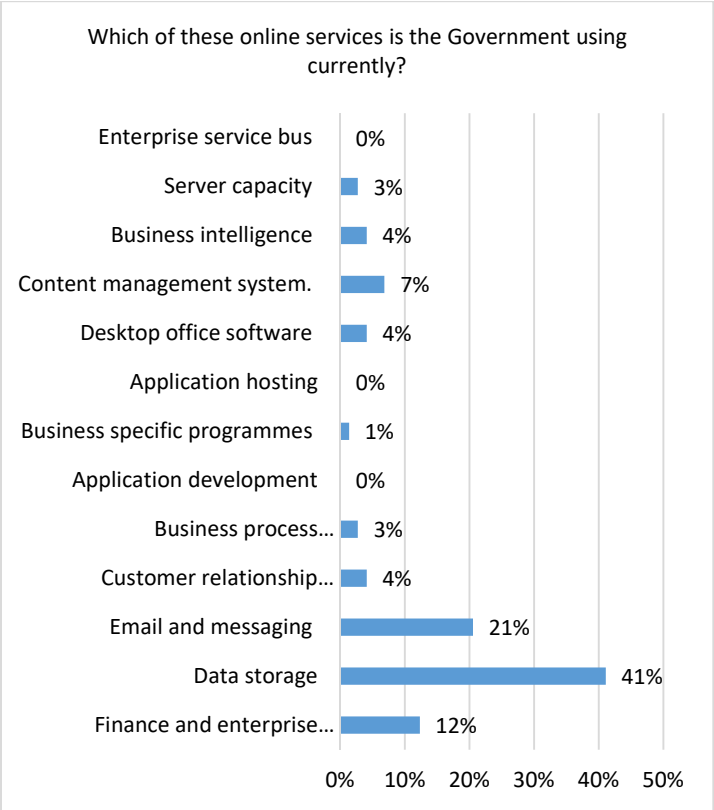

Figure 13: The online services that the Government is using now.

As observed from the study, 100% of all respodents said that cloud computing has not been discussed formally as part of IT strategy in e-Government in their ministries. (Figure 14). For Cloud computing to be fully integrated into e-Government, a policy has to be in put in place to guide the process. This is at the highest level of adoption stages, before which an adoption path has to be discussed and agreed by all process owners and stake holders in the adoption process. The adoption process can only be guided by the available models at any one time. The stage

model therefore provides this guideline to the cloud.

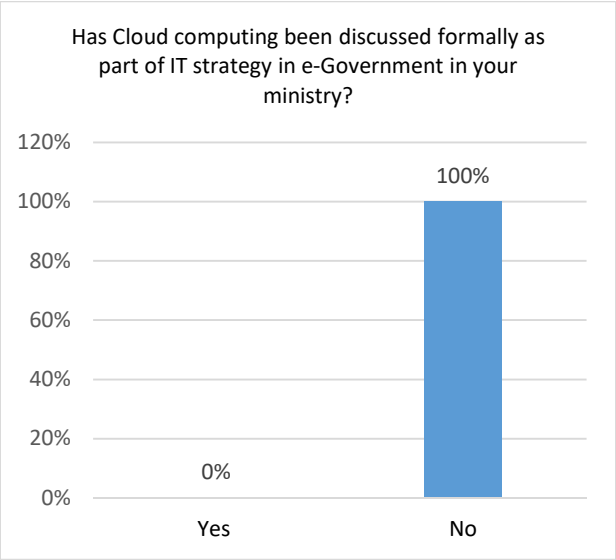

Figure 14: If cloud computing has been formally discussed.

From the research, 100% of all respodents said that the Government has not enlisted the stages in implementation of cloud computing. (Figure 15). This confirms that there does not exist an adoption path to the cloud for e-Government implementation. This research was therefore timely to provide such solution.

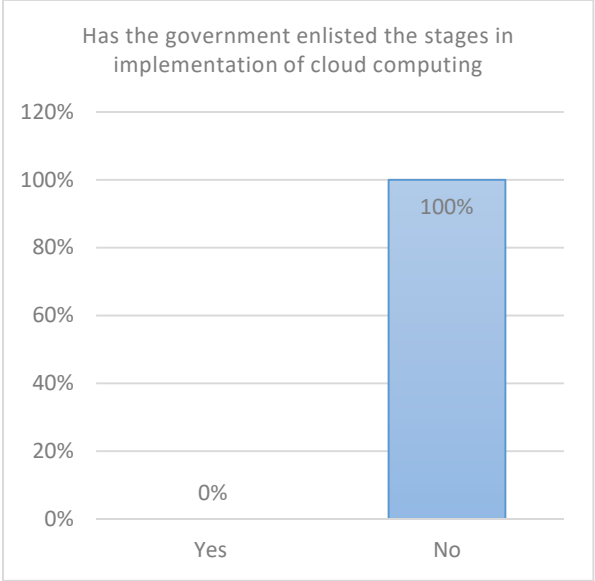

Figure 15: Enlisting of the stages in implementation of cloud computing

It is clear that 83% of the cloud services provided to the Government are owned by private vendors while none is owned by communities or other governments. Only 17% is owned by Government agencies. (Figure 16). This clearly demonstrates how uncordinated cloud computing is in e-Government. The cloud deployment model therefore needs to be maped in the adoption stage model. At the initialization stage, the Governmnet is not expected to own any cloud and if it does, only at agency level. This confirms the explanation of the stage model that stage1 cloud deploymnet is largely private. As we climb up the satages, clouds become more personalised. This is basicallly due to economies of scale and security and confidentiality of the large volumes of government data involved.

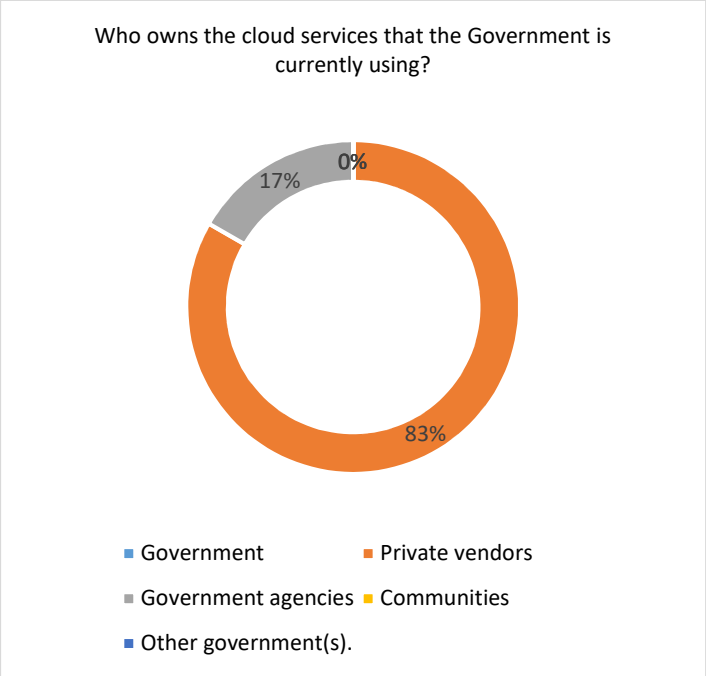

Figure 16: Ownership of the cloud services that the Government is currently using.

Security, cloud computing market and legal expertise were the top most knowledge/expertise which should be sufficient within e-Government regarding cloud computing.(Figure 17). For cloud computing to be fully adopted in e-Governmnet, there are competencies which need to be developed from within the governmnet systems. These findings therefore demonstrate how unprepared the government is for cloud adoption. Stage model provides the areas of competency which need to be developed at each stage of the adoption process.

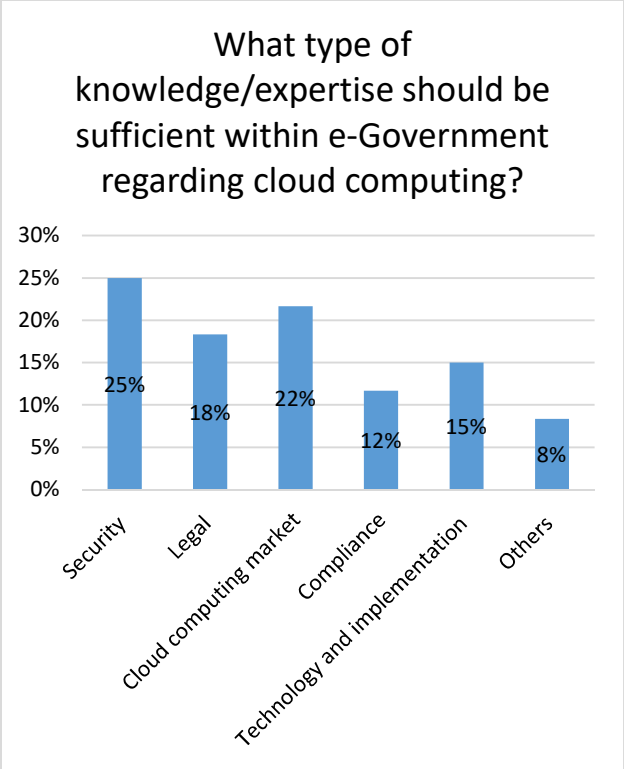

Figure 17: Types of Knowledge/expertise needed within e-Government for cloud computing

Findings from case study

Despite of the fact that the county Government of Machakos has some online services, it is evident from the data collected that the Government does not have a structured way of adopting cloud computing in its e-Government initiatives. Much of the cloud computing is used for personal purpose, meaning it is a personal initiative of the IT staff to deploy the services for their own convenience but not to deliver service to the citizens. This confirms the adhoc nature of cloud deployment as proposed in the stage model.

There is evidently no adequate awareness even among the IT staff on cloud computing and intentions of the Government to deploy and utilize it in service delivery. Despite of the service not being deployed, staff have confidence that cloud computing is the way forward in e-Government deployment. The IT staff, who are to

support the e-Government services, are not able to tell the extent of cloud computing adoption in e-Government services. From the proposed model knowledge base is key to deploying cloud computing. Accordingly, inadequate knowledge is characteristic of the proposed stage1 of the proposed model.

The cost benefits and value for money are factors, which respondents seem to be certain about, as the gains for deploying cloud computing. Currently, e-Government services are utilised by staff through tax compliance and other statutory services, which are mandatory obligations of the citizens to the Government.

It is therefore clear that citizens are ready to consume cloud services once the Government deploys them, going by the rate of consumption of the currently available few Government cloud services. The initiative must be from the Government side. Guiding the Government on how to go about adoption of cloud computing in e-Government implementation will therefore provide a big solution to the current e-Government status.

It is evident that there is no sufficient knowledge in the public to enable them make decisions on cloud computing adoption. Cloud computing is "just a type of outsourcing in IT which offers interesting technical environment". Despite of the inadequate knowledge, the respondents are confident that cloud computing would increase efficiency in e-Government service delivery.

However, respondents are concerned about security, privacy and vendor lock in once the cloud computing is adopted for e-Government implementation. This scenario provides a fertile ground for systematic deployment of cloud computing. The staff have a positive attitude towards the cloud, despite of the few concerns, which are adequately addressed by the cloud computing adoption stage model provided in this study.

Currently, data storage and email/messaging are the major cloud based services enjoyed among the e-Government services. There has never been a formal discussion at the Government level on how and when to adopt cloud computing in offering e-Government services. It is very clear that the Government has never enlisted the stages and cycles involved in implementation of cloud computing in e-Government.

From the stage model presented, SaaS is identified as the service model component at the initial stage of the model. The findings confirm the same because the current cloud based services in use are SaaS based. It is expected that the cloud adoption will take place in progression despite of the current status.

The little cloud services utilised in e-Government are majorly owned by private vendors, only some Government agencies own a small proportion of the cloud services utilised by the Government. For this to happen, respondents were very clear that security, legal and cloud computing market knowledge and expertise were critical. Out of the findings it is evident that there is no structured way of adopting cloud computing in e-Government implementation.

Conclusion

Different audiences know cloud from different perspectives. As organizations across public and private sectors understand cloud computing, they are looking to act and deploy cloud solutions. Some have made significant progress in their journey to cloud and others are just about to start, though mostly under personal initiatives. They offer tenable insights into what makes a successful cloud program and the required competencies.

From the data gathered, there is a clear revelation that cloud computing is the way to go on implementation of e-Government Services. This is due to the positivity expressed by majority of

the respondents. Financial and economic benefits of cloud computing are very clear and immense. The only challenge is the best way to adopt the cloud service. The responses clearly show that the Government sampled has never communicated to its ICT technical staff on cloud policies let alone the adoption methodology. Staff only apply cloud solutions under own initiatives or to close gaps in the short run.

From the respondents it is also clear that cloud solutions in place are not intended to benefit the citizens, businesses or other government agencies but just for in house operation convenience, despite of electronic government being strategic in Government operations.

The respondents have demonstrated positive attitude but are limited in understanding of the cloud deployment. This reveals that the cloud business in Government service is still at infant stage. The status provides a perfect opportunity for the government to guide the implementation process, by avoiding pitfalls or chewing more than enough hence slipping back to the ground. Establishing the status would be the first thing to do, and by the research results presented in this study, much more may be built on it. This study confirms the observations made in literature review that in practical application, e-Governments has a long way to go in fully adopting cloud computing in its service provision initiatives. This confirms the importance of the stage model developed in this study. The model shall provide guidance in implementation of cloud computing in e-Government services.

5.0 A STAGE MODEL FOR CLOUD COMPUTING ADOPTION IN E-GOVERNMENT

This chapter presents the four stages of the stage model for cloud computing adoption in e-Government. The key differences between the stages are also discussed. The model is then evaluated using focus group.

Similarly, for e-Government to adopt cloud computing in its implementation, there has to be a defined approach. This will be achieved by first identifying the stages so involved in relation to existing models. Service model shall be used in this case. At the initial stages of adoption of cloud computing some organizations implement solutions which only address specific needs. As the system grows, a structured way of addressing cloud solutions has to be developed. In the later stages, the cloud adoption process has to be driven by policy, especially when so many players are in place trying to claim space as users as well as clients.

As presented in Figure 18, the proposed model consists of four stages, Ad-hoc e-Government solutions (Stage 1), Cloud based public services (stage 2), e-Government clouds (stage 3) and e-Government cloud policy (stage 4). The horizontal axis represents the degree of cloud computing adoption in e-Government, and the vertical axis represents the organizational and technological complexity of the solutions included in each stage.

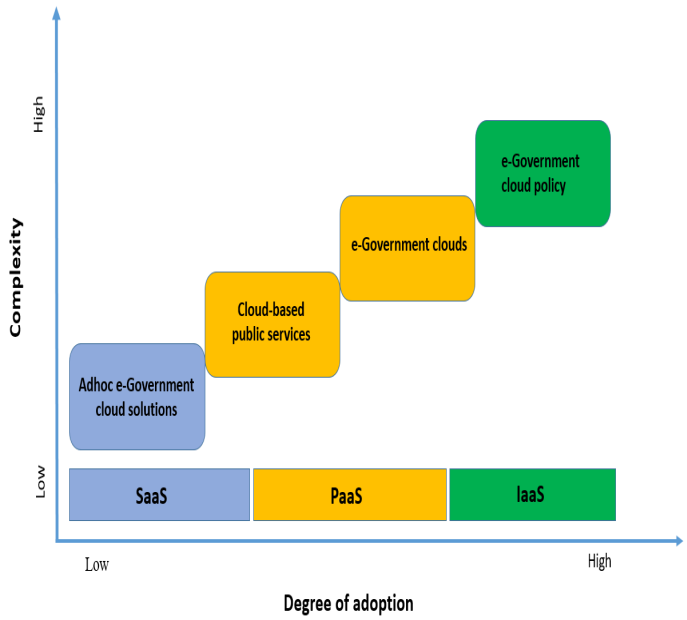

Figure 18: A Stage Model for Cloud Computing Adoption in e-Government

Different agencies or public organizations in a country may use cloud computing in various ways. The stage model provides a guide into how e-Government can systematically adopt cloud computing against the already existing models. From the known service model, a Government entity can evaluate the level of adoption depending on the services they are already utilising (Zhang, 2010). As such, in relation to the cloud adoption model, they are able to establish their level of adoption. Out of which they can systematically adopt cloud computing in e-Government processes as guided by the stage model.

Table 1 highlights the main differences between the stages of the model, which forms the basis of the model as shall be discussed in the subsequent headlines.

Table 1: Main differences among model stages

	STAGES			
VARIABLES	**Stage 1 Adhoc e-Government cloud solutions**	**Stage 2 Cloud-based public services**	**Stage 3 e-Government cloud(s)**	**Stage 4 e-Government cloud policy**
Type of services	Internal agencies	External (citizens and businesses)	Internal and external	Internal and external
Provider	Individual vendors	Individual vendors	Government	Government and individual vendors
Main change in	Procurement of IT services for Government	Provision of public services	Architecture of e-Government systems	Government IT strategy/Policy
Service Model adoption	SaaS	SaaS/PaaS	PaaS/IaaS	IaaS

Stage 1: **Ad-hoc E-Government Cloud Solutions**

At this stage, agencies or public organizations use cloud computing only for covering their needs in IT resources and enhancing collaboration with other agencies, and not for providing digital services to citizens or businesses. Due to absence of Government Cloud(s), the cloud services (SaaS) are entirely provided by individual vendors. In the absence of an official Government policy, each agency decides how and to what extent it will use cloud services on its own. For this reason, adoption of cloud computing in this stage is very erratic. With no central guidance or clear familiarity with cloud computing adoption concept, there are few agencies that use cloud computing. Much of it is on trial and error basis. Thus, the degree of adoption in this stage is very low. The organizational complexity of this stage is low, considering that the change that happens is internal and limited. As for the technological complexity, the organization continues to operate with little technological change. The provision of cloud services is considered as a form of outsourcing. For this reason, the degree of engagement is very low and the agencies can revert to the previous modes quite easily. The low degree of adoption combined with the low technological and organizational complexity places this stage at the bottom of the hierarchy.

An example of this stage would be the implementation of the "Government to Cloud" or "Government to Cloud to Government" business model proposed by Deussen et al. (2011). A more

tangible example that belongs in that stage is the case of "Apps.Gov" portal of US Government. Although in that case there was an involvement of the central Government, the agencies were the ones that decided whether they would use cloud services for their internal operations and which services they would procure. The fact that the portal was closed in December 2012 is consistent with the low engagement, which characterizes this stage. It further shows that this kind of initiatives alone are not enough for the consolidation of cloud computing in e-Government.

Stage 2: Cloud- based Public Services

At this stage, cloud computing is used by agencies and municipalities in order to provide digital public services to citizens and businesses. The public services are based on Software as a service (SaaS) and partly Platform as a Service (PaaS) models provided by individual vendors. The decisions related to cloud computing are made at agency or municipal level. The degree of engagement is still low since the Government holds also in this stage only the role of the customer of cloud services, but the fact that there are more stakeholders (citizens and businesses) in this case makes the return to the previous state more difficult. This is the stage where cloud computing can promote Open Innovation and Open Data Initiatives (Charalabidis et al., 2011). Since cloud solutions that appear at this stage are more sophisticated and are not limited to use of SaaS or storage services, there is an increase in technological complexity. Organizational complexity is also increased due to the use of cloud computing for interaction with citizens.

Furthermore, the decision to deploy PaaS solutions for providing e-Government services implies a higher degree of awareness of cloud computing on the part of Government officials. The cloud-based platforms for e-Government services that have been proposed in literature (Charalabidis et al., 2011) require the active participation of organizations' administrators in the designing process of the services. This involvement of agencies' personnel should result in further familiarization with cloud computing and make agencies more active in using it largely. It should also not be forgotten that the presence of agencies in a Government that deliver public services through PaaS, does not prevent the existence of agencies whose cloud use falls into the first stage. Therefore, the degree of adoption for Governments that have reached the second stage is higher than the first stage.

The increase in both organizational and technological complexity, and degree of adoption that occurs in this stage places it above and to the right of the first stage. The business models "Government to Cloud to Enterprise" and "Government to Cloud to Citizen" suggested by Deussen et al. (2011) describe possible examples that fall into this stage. Moreover, as was discussed in the Case Studies section, the City of Edmonton in Canada has already used cloud computing platform in order to offer census data and other public information online. This confirms that Platform as a Service (PaaS) model is suitable for the second stage of cloud service adoption in e-Government service delivery. It therefore provides a perfect synergy for integrating the second stage of the model under discussion.

Stage 3: E-Government Cloud(s)

The main change in this stage is the development of one or more Government clouds. The private clouds can belong either to the central Government or more often, to agencies or Government organizations. They are used in order to replace the former e-Government information systems that the organization probably had and can support the provision of both internal and public services. The fact that a private cloud offers more security and control than the other deployment models may encourage the organization to use cloud computing more

broadly. There are also some cases where the agency handles sensitive Government data and the development of its own private cloud is the only way to adopt cloud computing. The turn of the Government from customer of cloud services to owner of a Cloud, increases the organizational complexity along with the degree of engagement. Although it is not impossible in theory to quit the use of cloud computing in the future, it is highly unlikely that the organization will leave its own cloud to turn again to traditional computing.

While a third party can operate a private cloud, in practice the public organizations choose to build an on-premises cloud. This can be attributed either to their distinctive security requirements, or to the fact that Government organizations usually have their own data center and want to utilize its resources. A lot of technological changes take place in this stage, with the virtualization of the data center being the most significant. The organization is also responsible for the security of the virtualized data center, so technological changes will probably occur in this field too. These changes, which are not found in the previous stages, increase the technological complexity of this stage.

A typical example of a Government cloud is the Open-Gov Private Cloud of Greece Government that accommodates various applications of e-Government. At the agency level, the cases of US, DoD and NASA illustrate how cloud computing can be incorporated in public organizations with special needs in terms of security and control (Zhang, 2010).

As the above examples indicate, private clouds are usually developed either by large public organizations that their considerable needs in IT resources justify such a decision or by Governments that intend to use cloud computing for hosting their central information systems but they want to have the control of the IT resources they use. (Frost & Sullivan, 2011) In either case, the Government or organization will have to follow an organized approach or strategy in order to move its information systems to a cloud environment. The US DoD's Cloud Computing Strategy presented in literature review is such an example (US DoD, 2012). The degree of adoption in this stage is higher than the previous due to the organized effort and the number of agencies that Government may have.

Stage 4: eGov Cloud Policy

At this final stage cloud computing adoption is fully supported by the central Government of a country. While in the other stages the use of cloud computing is usually a result of individual initiatives of agencies and municipalities, here the central Government promotes cloud adoption in e-Government through policies and roadmaps.

The coordinated effort for integrating cloud computing in e-Government at this stage results to high degree of engagement. A strategy is developed to facilitate cloud deployment by all departments/Agencies. In addition, the Government encourages smaller agencies and public organizations that have not developed private clouds to procure cloud services from individual vendors, by establishing a cloud marketplace for public sector. In that way, the quality of cloud services is ensured and the procedure of IT procurement is easier for agencies. Successful initiatives in this stage lead to the highest degree of adoption for a Government.

The diffusion of cloud computing in the whole e-Government system of a country raises also complexity since the organizational changes that happen are significant. At this point, the change of mindset from assets to services occurs (Kundra, 2011). In contrast to the previous stages, the change here refers to the IT culture of the Government. The Government should also take steps in order to resolve the legal issues that according to several scholars (Clemons & Chen, 2011; Hada et al., 2012; Macias &Thomas,

2011b; Zissis & Lekkas, 2011) hinder the adoption of cloud computing in e-Government.

Another important issue that should be resolved in this stage is the absence of standards. According to the recommendations of NIST (2011b), cloud computing standards should be developed and used widely from Government agencies to support Government's requirements for interoperability, portability and security. In the previous stages, cloud computing is adopted for covering the needs of individual public organizations or central Governments and the related decisions do not affect other organizations or agencies outside of organization's/Government's direct authority.

In this stage, for the diffusion of cloud computing in the whole Government, standards are necessary to ensure the interoperability of the different information systems. The development of technological standards characterizes the technological complexity of this stage.

6.0 CONCLUSIONS

As the research related to the use of cloud computing in e-Government started quite recently, the number of studies published in this topic is relatively limited. This research presented an extended literature review in order to promote further research in the topic, by mapping the areas in which scholars have already published studies and identifying the areas that are still unexplored. The conceptual model that is presented in indicates the main areas of current research, which are: the examination of suitability of cloud computing for supporting e-Government, strategies for adopting cloud computing successfully and implementation of cloud solutions in e-Government. While some sub-areas have drawn the attention of many researchers, such as the identification of benefits and risks of cloud adoption in e-Government and the development of cloud architectures for e-Government, other sub-areas clearly need further research. The frameworks and models that have been proposed so far obviously do not cover all needs of Governments. The discussion about open data has been intensified lately, so further examination of how cloud computing can promote open data initiatives would be welcomed. The development of secured cloud architectures for e-Government is also important, since security is one of the main challenges in cloud adoption by Governments. About the question of whether cloud computing should be used in e-Government, the unique characteristics of each case should be taken into consideration. The research drew attention to the following issues:

i. Governments should take steps towards standardizing and ensuring quality of services.
ii. Although the general migration strategies that have been presented can be applied almost in any situation, it is advisable that each agency develops a strategy that covers its own requirements.
iii. Cloud computing will bring about changes in the way some services are delivered. The stakeholders should be properly informed in order to accept these changes.

The case studies examined in answered the question about the ways that Governments around the world deploy cloud computing for supporting e-Government. The analysis of the cases showed that the complexity of the cloud solutions and the extent to which these are applied in e-Government system, differ from country to country. This finding, in conjunction with the different aspects from which the topic has been viewed in literature, led to the proposal of a stage model that classifies the different levels of adoption.

The stage model, which was the main objective of this study, was developed from the basis of literature review, relying on what players in the market are offering and improving on the same.

Again, the model concept is drawn from other frameworks and models already in application. After analysing them the gaps identified which what informed this model.

From the primary data from Machakos county government, the ideas from literature were confirmed out of the responses from the ICT county officers. From the same, it was established that the levels of adoption are related to perceived benefits, risks and knowledge available to guide decision making. The stage model on adoption of cloud computing in e-Government implementation therefore comes in handy to inform governments on several aspects about cloud adoption and stages involved

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