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Cloud Computing: Transforming Medium and High Tech Industries in Kenya

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Abstract: Cloud Computing provides novel perspectives in internetworking technologies and has the potential to dramatically change business models. This study aimed at establishing Cloud Computing adoption in Medium and High Tech Industries in Kenya, with an ultimate intention of recommending an appropriate model for its adoption. Using questionnaires, data was collected from 126 Medium and High Tech Industries within Nairobi and interviews were conducted with 25 Cloud Computing providers. Data analysis was done using SPSS and qualitative content analysis. Approximately 70% of cloud users and providers had recognized Cloud Computing as a force that is reshaping ICT and powering innovation. The major factors influencing the adoption of Cloud Computing were identified as cost, performance and reliability of The Cloud application. After analysis of four existing models for technology adoption, the Unified Theory of Acceptance and Use of Technology (UTAUT) model is recommended for adoption of Cloud Computing.

Keywords: Cloud Computing Adoption, Medium and High Tech Industries, UTAUT.

1. Introduction

Information and Communications Technology (ICT) has become a strategic asset for companies around the world, increasing competitiveness and shaping business operations from finance and logistics to customer relations and human resources [1]. Cloud Computing is a technology model in which any and all resources, application software, processing power, data storage, backup facilities, development tools are delivered as a set of services via the Internet [2, 19].

Cloud Computing is rapidly transforming business processes both domestically and in the international emerging markets. ICT is estimated to be based in more than 50 percent in The Cloud in the current decade, and it may be an ideal environment for many developing markets. This shift allows emerging markets to move past costly technology barriers and drastically increase productivity and growth [3]. Although the use of cloud services is still in its formative years in many emerging markets, the adoption of The Cloud is becoming more prevalent [4]. This steadily increasing switch to The Cloud by an assorted range of organizations has fueled the need for providers to invest in new data centers and cloud infrastructures as well as related offerings such as security and management services, more so in rapidly developing markets like Singapore [5].

Cloud utilization has steadily become the standard in more established markets like the US and the UK, and is also gaining a foothold in emerging markets with a focus on Singapore and South Africa [41]. Other emerging markets like Kenya are finding that Cloud Computing has the potential to help them achieve many of their developmental goals

while stimulating change and economic growth. This provides access to important opportunities for the development of new services and products in these countries [6, 7].

Worldwide spending on The Cloud is anticipated to increase rapidly as emerging markets may have a simpler task when it comes to switching to The Cloud. Singapore, for example, had a swifter move to Cloud Computing [8]. The awareness and acceptance of the necessity for changes in the technological world by the providers and users has made Singapore the third most ready country for Cloud Computing in the Asia Pacific region which has enhanced trade with other emerging markets [9, 10].

In Africa, Cloud Computing has been embraced to a certain extent. The Cloud can support efforts to enhance the ability to provide services in an economical and effective manner to citizens [11]. As the number of emerging markets adopting Cloud Computing increases, opportunities in the global market will begin to level out [12]. All industries and nations need to adopt the technology in order to enhance their organizational operations [42].

A viable way of avoiding unnecessary ICT infrastructure expenses [13], especially in the Medium and High Tech Industries, is adopting Cloud Computing [14]. This research sought to identify the most appropriate model of technology adoption that can be used to adopt Cloud Computing in Medium and High Tech Industries to address the low level of prevalence ([15, 17, 18]). This will close the existing gap in the adoption of Cloud Computing in Medium and High Tech Industries in Kenya.

2. Research Objectives

1. To establish the prevalence of Cloud Computing adoption in Medium and High Tech Industries in Kenya
2. To determine the factors influencing the adoption of Cloud Computing in Medium and High Tech Industries in Kenya
3. To identify and validate an appropriate technology adoption model for Cloud Computing in Medium and High Tech Industries in Kenya.

3. Methodology used for the Cloud Computing Survey

3.1 Review of ICT Adoption Models

The study reviewed the following four ICT adoption models with a view of identifying the most suitable model to use.

3.1.1 Technology-Organization-Environment Framework (TOE) Theory

Technology-Organization Environment theory (TOE) was proposed by [29] to analyze adoption of technological innovations by firms and organizations. The TOE framework posits that adoption of IT technology by firms and organizations is influenced by three different context groups: technological, organizational, and environmental contexts [30]. The technological context refers to the characteristics of innovation such as availability, complexity, and compatibility which significantly affect adoption of innovation [31]. The organizational context refers to the characteristics of an organization such as size, the degree of complexity in managerial structure, degree of formalization, human resources, amount of slack resources, and linkages among employee. The environmental context includes structure of the industry, competitors, and government's regulations and policies. In fact, within this context, the relationship between organizations and trading partners, competitors, government, pressure from trading partners, and industry community may affect adoption decisions [32].

3.1.2 Technology Acceptance Model (TAM -2)

TAM-2 enables an organization to grasp the effects of external variables concerning the causal relationship between Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Behavioral Intention (BI); it thereby helps the organization with implementation and application of technology systems. With regard to the original version of TAM, [33] argues that (1) user's motivation can be explained by three factors: PU, PEOU, and Attitude Toward Using (ATU); (2) the ATU is a major determinant of whether the user will actually use the system; (3) the ATU is affected by two major beliefs: PU and PEOU; (4) PEOU has a direct influence on PU; and (5) these beliefs are both directly influenced by ''System Design Characteristics [34].

TAM has been modified into more advanced forms: the first modified version the final modified version, TAM2 [35], the Unified Theory of Acceptance and Use of Technology (UTAUT) model and TAM3. Four kinds of modifications contributed to the evolution of TAM: (1) altering external antecedents; (2) amending predictive variables; (3) manipulating moderator variables; and (4) varying consequence measures. Apart from the main stream of TAM modifications, there have been further attempts at modifying TAM. The TAM-diffusion theory model (TAM-DTM). Eight constructs are contained within the TAM-DTM, including: Media Influence, Social Influence, Perceived Flexibility Benefits, Perceived Status Benefits, Attitude toward Mobile Innovations, PU, PEOU, and BI. TAM assigns considerable weight to two key determinants perceived usefulness and perceived ease of use [36].

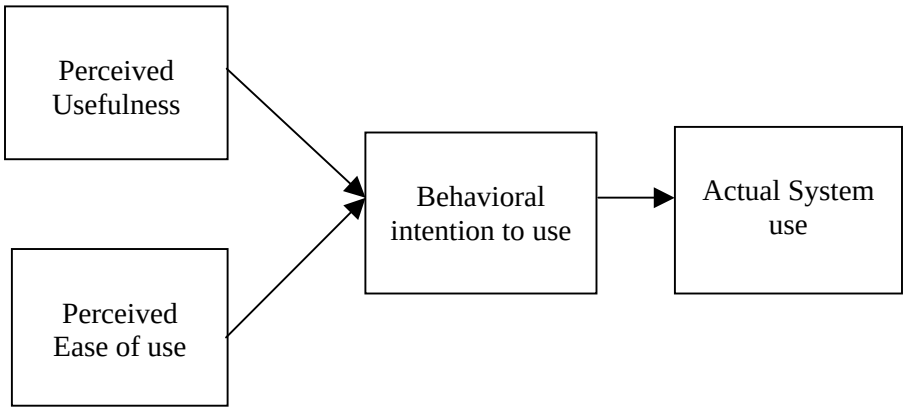

Figure 1: Technology Adoption Model (Source: [36])

3.1.3 The Diffusion Model of Innovation

Diffusion of Innovation model argues that media and interpersonal contacts provide information that influences a person's opinion and judgment [37]. The theory comprises four elements: invention, diffusion through the social networks, time and consequences. Information filters through the networks and depending on the nature of the networks and the roles of its opinion leaders, new innovations are either adopted or rejected. The most striking feature of diffusion theory is that, for most members of a social system, the innovation-decision depends heavily on the innovation-decisions of the other members of the system. The model proposes five stages of innovation process as in Figure 2 below:

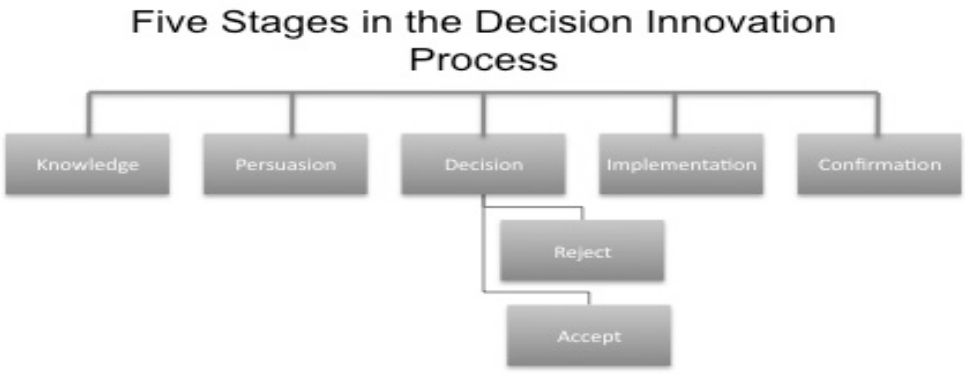

Figure 2: Five stages of decision adoption innovation process (Source: [37]

3.1.4 Unified Model of Acceptance and Use of Technology (UTAUT)

UTAUT is a technology acceptance model formulated by Venkatesh and Davis [34] that aims to explain user intentions to use an information system and subsequent usage behavior. The theory holds that four key constructs: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions; the first three being direct determinants of usage intention and behavior, and the fourth a direct determinant of use behavior. Gender, age, experience, and voluntariness of use are posited to moderate the impact of the four key constructs on usage intention and behavior.

The theory was developed through a review and consolidation of the constructs of eight models that earlier research had employed to explain information systems usage behaviour (theory of reasoned action, technology acceptance model, motivational model, theory of planned behavior, a combined theory of planned behavior/technology acceptance model, model of personal computer use, diffusion of innovations theory, and social cognitive theory). Subsequent validation by Venkatesh and Davis of UTAUT in a longitudinal study found it to account for 70% of the variance in behavioral intention and about 50% in actual use.

[38] found that the explanatory power of this UTAUT model is up to 70% with regard to technology using behavior, it is more effective than any of the models that are known before; and the use of UTAUT model has become more extensive in recent years, it is no longer confined to the discussion of the use of information system, such as mobile commerce, online learning and wireless network; and this study this model into special consideration.

3.2 Selected Model

In selecting a model we considered the following criteria: **Performance expectancy** - the degree to which an individual believes that using a particular system would improve job performance; **Effort expectancy** - the degree of simplicity associated with the use of a particular system; **Attitude toward using technology** - the degree to which an individual believes he or she should use a particular system; **Social influence** - the degree to which an individual perceives that others believe he or she should use a particular system; **Facilitating conditions** - the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of a particular system; **Self-efficacy** - the degree to which an individual judges his or her ability to use a particular system to accomplish a particular job or task; and **Anxiety** - the degree of anxious or emotional reactions associated with the use of a particular system.

Empirical evidence [36] showed that the Unified Model of Acceptance and Use of Technology (UTAUT) was useful in industrial platforms for adoption of technology and could be used for adoption of Cloud Computing. UTAUT was thus deemed as the best model for use in The Cloud Computing processes in Medium and High Tech Industries.

3.3 Data Collection and Analysis

The study used both quantitative and qualitative approaches. The quantitative dimension utilized descriptive survey research design, which involved the collection of data using a semi-structured questionnaires, based on UTAUT Model, were used and specifically targeted MHTI that have some form of ICT infrastructure. The relationships amongst the six TAM factors were tested. Data was collected from sampled participants from 126 Medium and High Tech Industries within Nairobi. This quantitative approach used SPSS for data analysis. The qualitative aspect used an interview guide for 25 Cloud Computing providers in order to explain The Cloud Computing adoption phenomena.

4. Technological Framework

4.1 Cloud Computing

The essential characteristics for the Cloud include [24]:

a) On-demand self-service: A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
b) Broad network access: Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants.
c) Resource pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.
d) Rapid elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
e) Measured Service: Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service e.g., storage, processing, bandwidth, and active user accounts. Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Cloud Computing has different types of developments via four important services or developments [25]:

a) **Software as a Service (SaaS):** This model allows users to pay for the software per one use
b) **Hardware as a Service (HaaS):** This means that computing processing capacity is purchased on the web. For example, Amazon allows their customers to purchase data storage online from a service called elastic compute cloud.
c) **Infrastructure as a Service (IaaS):** This allows Cloud Computing users to pay for the technology on a pay per use basis. The technology includes firewalls and antivirus software and is found to be efficient in terms of organizational service delivery.
d) **Platform as a service (PaaS):** Cloud providers deliver a computing platform, typically including operating system, programming language execution environment, database, and web server. Application developers can develop and run their software solutions on

a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers [26].

Cloud Computing represents a convergence of two major trends ([27] [28]) i.e. ICT efficiency (using computing resources more efficiently through highly scalable hardware and software resources) and business agility (ability of a business to use computational tools rapidly, to adapt quickly and cost efficiency in response to changes in the business environment).

5. Results and Discussion

A response rate of 86% was achieved. The results of this study could be used to make generalizations regarding the adoption of Cloud Computing in medium and high tech industries in Kenya.

Concerning Cloud Computing adoption**,** 70% of the medium and high tech organizations were found to have adopted Cloud Computing as a technology that boosts their operations and increases their competitveness. This showed a high prevalenc of computerization in the industries. This implies that; the industries rely heavily on computerized services, and that they must be informed of the best model for cloud adoption.

Table 1 indicates that 88% of the respondents agreed that Cloud Computing is a force that is reshaping ICT and powering innovation. 84 % of the participants agreed that at macro level, Cloud Computing has been beneficial for the economy and environment, while 72% agreed that at micro level, the diffusion of cloud has been advantageous for Medium and High Tech Industries, and 66% stated that The Cloud Computing services have helped Medium and High Tech Industries improve, protect and grow business as users carry out their duties with minimum capital.

Table 1: Cloud Computing Adoption

Statement	**Agree**	**Moderately agree**	**Disagree**
Cloud Computing is a force that is reshaping IT and powering innovation	88	7	5
At macro level, Cloud Computing has been beneficial for the economy and environment	84	9	7
At micro level, the diffusion of cloud has been advantageous for Medium and High Tech Industries	72	22	6
The Cloud Computing services have helped Medium and High Tech Industries improve, protect and grow business as users carry out their duties with minimum capital	66	31	3

On prevalence of Cloud Computing, results indicated that the computerization level of most organizations was at 51%-75% as accounted for by 50%. This confirms studies that organization/ industries in Kenya are still and non-aggressive towards adopting trending technologies and thus the need to create awareness on importance of technology adoption in industries.

Table 2: Computerization Level

Level of computerization	**Frequency**	**Percentage %**
0-25%	2	2
26 – 50%	21	19
51-75%	54	50
76-100%	31	29
Total	**108**	**100**

Results in Table 3 indicate that only 35 industries (32.40%) had computerized their services to a level 41-60%. This indicated that the level of cloud based technologies / services in MHTI industries is low, which calls for the need to create more awareness on computerization of processes in the industries as well as government intervention to encourage adoption of Cloud Computing.

Table 3: Percentage of Cloud Services

% of services	Frequency	Percentage %
21– 40%	24	22.22
41-60%	35	32.40
61-80%	27	25.00
76-100%	9	8.33
Total	**108**	**100**

Statistics on allocation of IT budget to adoption of Cloud Computing showed that IT managers in MHTI have an IT budget, meaning that there is a consideration in MHTI to adopt Cloud Computing technologies. Only 4.63% (5 industries) indicated that none of their annual budget has been budgeted for cloud. Presumably, these organizations that had no IT budget or were still in their early stages of Cloud Computing adoption and they had not set aside the budget.

Table 4: Cloud Budget

% of services	Frequency	Percentage %
21– 30%	32	29.63
11-20%	27	25.00
More than 30%	24	22.22
Less than 10%	20	18.52
None	5	4.63
Total	**108**	**100**

Results showed that cost, performance, reliability, scalability, security, compliance and integration with other services as important factors for consideration when adopting cloud services.

Table 5: Factors Influencing Cloud Computing Adoption

Factor	Very great extent %	Great extent %	Moderate extent %	Little extent %	Very little extent %
Cost	13	67	15	5	2
Performance	15	61	14	7	3
Reliability	21	54	16	6	3
Scalability	16	44	25	10	5
Security	26	38	25	9	2
Compliance	35	36	24	3	2
Integration with other services	37	31	22	5	5

Further, analysis of three selected constructs measuring statements for the validation of UTAUT; Effort expectancy, performance expectancy and facilitating conditions was done, and a summary of the responses for the measure statements for each construct was computed.

On performance expectancy, 97.70% participants agreed that Cloud Computing technologies were useful in their day to day tasks, 93.10% agreed that Cloud Computing services enabled the users to accomplish their tasks more quickly while 94.1% agreed Cloud Computing services increased their productivity. This implies that the adoption of The Cloud will improve operations in these industries.

Table 6: Analysis for Performance Expectancy Constructs

Item	Disagree	Neutral	Agree	Total
Cloud Computing service(s) useful in my tasks	0.50%	1.80%	97.70%	100%
Using Cloud Computing service(s) enables organizations to accomplish tasks more quickly	2.30%	4.60%	93.10%	100%
Using Cloud Computing service(s) increases productivity	1.80%	4.10%	94.10%	100%
Cloud Computing service(s) is convenient	2.30%	2.30%	95.40%	100%

On effort expectancy, 74.1% and 74.2% participants agreed that their interaction with Cloud Computing Technologies/ services is clear and easy respectively while 72.80% and 75.90% agreed that acquiring skills in Cloud and learning how to use Cloud Computing Technologies is easy. This response statistics suggest that a high number of the respondents have good knowledge of the usage of Cloud Computing services and they do not find the process of improving skills on how to use Cloud Computing services a hindrance. This could be due to the fact that the respondents are ICT Managers and hence have prior training and interest in the area. More work should be done focusing respondents that have little or no training in ICT in MHTI.

Table 7: Analysis for Effort Expectancy Constructs

Item	Disagree	Neutral	Agree	Total
My interaction with Cloud Computing service(s) is clear and understandable	19.4%	6.5%	74.1%	100%
It is easy for me to become skillful at using Cloud Computing service(s)	18.4%	8.8%	72.8%	100%
I find Cloud Computing service(s) easy to use	17.5%	8.3%	74.2%	100%
Learning to operate Cloud Computing service(s) is easy for me	18.1%	6.0%	75.9%	100%

On facilitating conditions, 90.30% participants had the knowledge necessary to use and deploy Cloud Computing technologies and services. 77.40% respondents agreed that their organization has the finances and the equipment necessary for Cloud Computing. 64.5% confirmed that their current core system is not compatible with Cloud Computing technologies/ services. This is an indication that most o the operations in MHTI are still manual and that the systems run on old technologies hence the incompatibility. To move fully to The Cloud, the industries would need to computerize their operations as well as upgrade their systems to the latest technologies hence an implication on the cost. With 38.80% confirming that manpower to provide assistance to users is readily available, this is an indication that the ICT department in MHTI is not well staffed hence affecting negatively adoption of new technologies like Cloud Computing.

Table 8: Analysis for Facilitation Condition Measure

Item	Disagree	Neutral	Agree	Total
Our organization has the resources (financial and/or equipment) necessary to use Cloud Computing service(s)	8.30%	14.30%	77.40%	100%
I have the knowledge necessary to use Cloud Computing service(s)	2.80%	6.90%	90.30%	100%
Cloud Computing service(s) is not compatible with the university systems I use	16.10%	19.40%	64.50%	100%
There are people available for assistance with Cloud Computing service(s) difficulties	35.90%	25.30%	38.89%	100%

6. Business Benefits

From the study, it is evident that Cloud Computing as a technology has started receiving great emphasis in the medium and high tech industries in Kenya similar to other African countries [43]. It enables organizations to utilize computing resources and the internet in their operations so as to deliver high tech services to their clients. The benefits of The Cloud in the medium and high tech industries cannot be underestimated. Due to inadequacy of financial resources to employ a huge number of manual operators and infrastructure maintenance, the industries can still accomplish their goals due to cloud data management and sharing. Additionally, The Cloud enables data manipulation, storage, processing, sharing as well as delivery of services in a scalable, efficient and secure manner in an organization.

There is a high prevalence and continued adoption activities of Cloud Computing in Medium and High Tech Industries. These industries are making effort to move to The Cloud and reap the benefits. This has been made possible by measures taken by the management that include: allocation of a reasonable budget to ICT operations, employing competent employees in the ICT field etc. Cost, performance and reliability are major factors that influence the adoption of Cloud Computing in most organizations because the adoption adds to the organizational budget. This mainly affects The Cloud Service models that the industries adopt. Hence; most industries have implemented PaaS and SaaS since they have low cost implications compared to HaaS and IaaS [39].

Other accrued benefits are that; The Cloud enables the staff to be resourceful because they are able to focus on their core competencies. The Cloud also saves on time, and tasks can be completed in the shortest time possible. All organizational functions can as well be performed in a faster and efficient manner via the utilization of modern IT based software and infrastructural components. Most importantly, The Cloud is beneficial because it is user friendly, and that one gets a variety of options to select from. However, for The Cloud to bring the expected impact, competent staff must be available to work with and maintain The Cloud system, and the management of the organizations must be willing to adopt and maintain The Cloud systems.

7. Conclusion

The study looked into adoption and prevalence of Cloud Computing, and analyzed four models for cloud adoption i.e. Technology-Organization Environment theory (TOE), Technology Adoption Model (TAM), The Diffusion model of innovation and Unified Theory of Acceptance and Use of Technology (UTAUT). Prior empirical tests that ascertain the viability of the model have been presented by various researchers in order to justify the usefulness of the proposed model. The study looked into the distinct elements of the recommended model and concluded that facilitating conditions is an element that is used in the validation of the UTAUT model in regard to its applicability in the adoption of Cloud Computing as well as other elements that include performance, attitude, social influence, anxiety and self-efficacy.

This study recommends the UTAUT model as the most appropriate to use. Empirical evidence further shows that the model is useful in industrial platforms, thus; the reason why it is deemed as the best model for use in The Cloud Computing processes. Continued use of this model will see the prevalence of Cloud Computing rise rapidly in the coming decades. The developing world, Kenya in particular must take advantage of the opportunities offered by the Cloud and, at the same time, minimize the associated risks and threats so that advanced IT infrastructure, data centers and applications can be accessed and sensitive information can be protected. Some barriers to realizing The Cloud's full potential could be avoided through better planning and efforts to address human resources.

This study makes the following recommendations:

1. The Government of Kenya, specifically the Ministry of Education Science and Technology, Ministry of ICT and the ICT Authority needs to take measures to develop and improve cloud related skills. Regulatory measures should be taken to encourage adoption of Cloud Computing. Various bodies that regulate how MHTI operate should also be involved ensuring adoption of Cloud Computing is achieved. Some of these organizations are: Ministry of Industrialization and Enterprise Development, Kenya Association of Manufacturers and Kenya Private Sector Alliance.
2. There should be provision of tax breaks to the necessary ICT equipment in order to reduce the cost of moving to The Cloud for MHTI.
3. MHTI need to increase the HR skills with specific focus on ICT in their organizations to ensure ease of adoption of new innovations like Cloud Computing.
4. There should be more effective mechanisms to curb cybercrime in Kenya in order to increase trust in Cloud Computing among MHTI.

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