Cloud Computing calls for new IT leadership role in Higher Education

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ABSTRACT *: This paper discusses the new roles of IT leaders (CIOs) which came into being as a result of the new dimension assumed in cloud computing. The focus has shifted from simple internal IT infrastructure solutions to developing cloud strategies that deliver increased flexibility and functionality using a mixture of public and private cloud-based application and platform services to institutions. This shift has given birth to a new role for the CIOs in the universities since they are saddled with the responsibility of ensuring an effective alignment of IT investment strategy with that of the overall organizational objectives in order to create value to the organization. With the advent of cloud computing, the roles of CIOs have become more challenging, which force the CIOs to rapidly adapt to the changes surrounding their roles. Traditionally, the roles of the CIOs in high education focus more on technical support to the IT infrastructures of the institutions such as ensuring internet security and availability, employing IT resources and personnel but now the focus include project management, vendor relationships, security and compliance management, process analysis, group facilitation, data analysis, business intelligence and data management. Therefore, this paper examines the evolving roles and responsibilities of CIOs through literature review in which two questions were answered. The question are: 1. Why the roles of CIOs in Higher education become challenging in third computing model? 2. What competencies do the Institutions expect from CIOs to have?*

Keywords: *Cloud computing, higher education, CIO, roles, IT*

I.   INTRODUCTION

The world is witnessing the emergence of a third computing model that presents significant impact on business as well as education. The third shift in information technology (IT) over the past five decades from centralized computing (i.e. Mainframe computers and client-server computing) to Cloud Computing has changed the game for Chief Information Officers (CIOs). The CIOs are the IT leaders that occupy the highest position in institutions to oversee IT infrastructures.

In the past, the role of CIOs in high education focuses more on technical support to the IT infrastructures of the institutions such as ensuring internet security and availability, employing IT resources and personnel, and so on. Nowadays, the role of CIOs is not the technical support of network services and maintenance of administrative activities related to IT resources but also it is about on-demand business innovation that can support the enterprise overall objectives. The on- demand business innovation comprises of new skills required for proper contracts management as well as facilitating a cordial relationships with vendors, know how to create an optimum level of value in the current IT investments, ensuring an efficient alignment between in-house and outsourced services, acquire expertise on various models for budgeting IT resources, keep abreast of new developments in security, and compliance and risk-management issues [1]. In higher education, there is high demand of IT resources due to the current requirements of electronic learning, online collaborative research, online application and admission, research and development, online students' and staff portals. Besides, the new phenomena called Bring Your Own Device (BYOD) where students and staff can have more than one device (i.e. personal mobile devices) configured to actively participate in the institutions' network has also added to the situation. This high demand of IT resources has consumed much of higher education's budget. In view of that, many institutions across the globe have started looking for alternative ways to cut down these IT costs while at the same time meeting the institutions' requirements.

Thanks to cloud computing! The cloud computing has allowed the institutions to cut down costs on Information Technology (IT) infrastructural ownership through reducing the requirements of software licensing and updating, upgrading hardware and Software to meet the current situation, and data centers maintenance, etc., while improving IT resources for the institutions. Nevertheless, the cloud computing is composed of different services and infrastructures that require critical analysis and selections to be made before adoption. At a moment, the cloud computing is associated with some concerns such as data security, reliability, performance, interoperability, and control despite the established evidence of its benefits to those who have adopted it. This

makes the work of CIOs in higher institutions to become very complex, because they need to consider the business demand as well as the technology to be utilized in order to achieve the goals of the institution. In addition, CIOs need to assess both the benefits and shortcomings of the cloud computing services and infrastructures to be used.

Therefore, this paper focuses on the role of IT executives (CIOs) of higher education in the third computing model that requires not only technical expertise but also decision making skills by the CIOs. The aim of this paper is to examine the evolving roles and responsibilities of CIOs through literature review. Accordingly, two questions were raised to provide a direction to what this paper tends to achieve. The questions are:

1. Why the roles of CIOs in Higher education become challenging in third computing model?
2. What competencies do the Institutions expect from CIOs to have?

II.   LITERATURE REVIEW

1.   Defining Cloud Computing

There are several definitions of cloud computing although definition from the National Institute of Standards and Technology (NIST) is widely being used to defines cloud computing. The NIST defines cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [2]. Accordingly, this cloud model support ease of use and is hovering of five essential characteristics, three service models, and four deployment models [2]. In spite of several definitions of the term "cloud computing", the characteristics, service models and deployment models described by NIST were consistence and consensus in the literature on the general [3]. Because the characteristics and the models are very important in understanding the context of cloud computing within higher education, the followings three sections have discussed them in brief.

1.1 The Essential Characteristics of Cloud Computing

The following five characteristics of cloud computing services were defined by NIST [2]:

a. *On-Demand Self-Service*: Customers can automatically provision computing capabilities and resources (e.g. server time and network storage) without requiring human interaction with each service's provider.

b. *Broad Network Access:* the network provides access and capabilities to the service via standard devices, such as cell phones, laptops, PDAs, etc.

c. *Resource Pooling*: computing resources from providers (e.g. memory, virtual machines, processing power, storage capacity, and network bandwidth) are pooled together to serve multiple customers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned based on customers' need and demands. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter).

d. *Rapid Elasticity:* Resources and capabilities can be quickly and automatically deployed and scaled at any quantity and at any time. The consumer can purchase in any quantity at any time of these Resources because the capabilities available for provisioning often appear to be unlimited.

e. *Measured Service:* the resources and services usages by the customer are automatically monitored, controlled and reported offering a high level of transparency for the customer and vendor.

1.2 Service Models

There are three types of cloud computing services include Software as a Service (SaaS), Infrastructure as a service (IaaS) and Platform as a Service (PaaS) [2]. However, the three service models are not mutually exclusive in that organizations can employ different service models on varying scales within the organization based on specific needs [3].

i   *Cloud software as a service (SaaS):* Software deployment model whereby a provider licenses an application for use as a service on demand to the customers. The vendor provides, manages and controls the underlying cloud infrastructure, including individual applications, network, storage, servers, operating systems, etc. The customer is allows to fully access the vendor's applications in the cloud via a variety of devices (e.g. cell phone, laptop, PDA). SaaS examples include MyErp.com, Salesforce.com and Workday.com. Google Docs, Twitter and Facebook also fall into this category.

ii   *Cloud platform as a service (PaaS)*: the vendor provides, manages and controls the cloud infrastructure, only for applications that the customer has control. The vendor provides tools and resources allowing the customers to create and/or acquire applications to meet their specific needs.

iii *Cloud infrastructure as a service (IaaS)*: The vendor provides, manages and controls the general cloud infrastructure but provides the customer control over operating systems, storage, processing, and networks on demand. IaaS vendor examples include Flexiant's Flexscale, Rackspace and Amazon's Elastic Cloud Compute (EC2) and their Simple Storage Service (S3) [3].

1.3 Cloud Deployment Models

These deployment models can be hosted and employed in different approach. The use or deployment type of cloud computing includes the followings

A. *Private cloud*: This cloud infrastructure is managed by the respective enterprise and / or leased.
B. *Community cloud*: This cloud infrastructure is jointly owned by more than one organization and support a specific community that has common considerations (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.
C. *Public cloud*: This cloud infrastructure is available to the general public or enterprise and is owned by a vendor selling cloud services.
D. *Hybrid cloud*: The composition of two or more independent clouds (internal, community, or public) that are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds) [2].

In summary, the five characteristics, the service models, and the deployment models of cloud computing are interrelated and connected to each other [3]. Accordingly, Jerry Bishop, the Chief Information Officer at Chippewa Valley Technical College in Wisconsin, visualized the 3 elements (see Fig 1) of the NIST Cloud Definition (i.e. five characteristics, the service models, and the deployment models) to show how the interrelate and work together in a coherent model of what is cloud computing [4]. This visual explains different configurations available for institutions in cloud-based strategy. Usually, institutions begin with one service model, such as SaaS and a Public Cloud deployment model as a pilot, and then slowly scale if the pilot proves successful. In addition, sometime it is possibly to use several deployment models to support one or more service models (as indicated by the various red, green, and grey arrows) depending again on the institutional needs and costs [3].
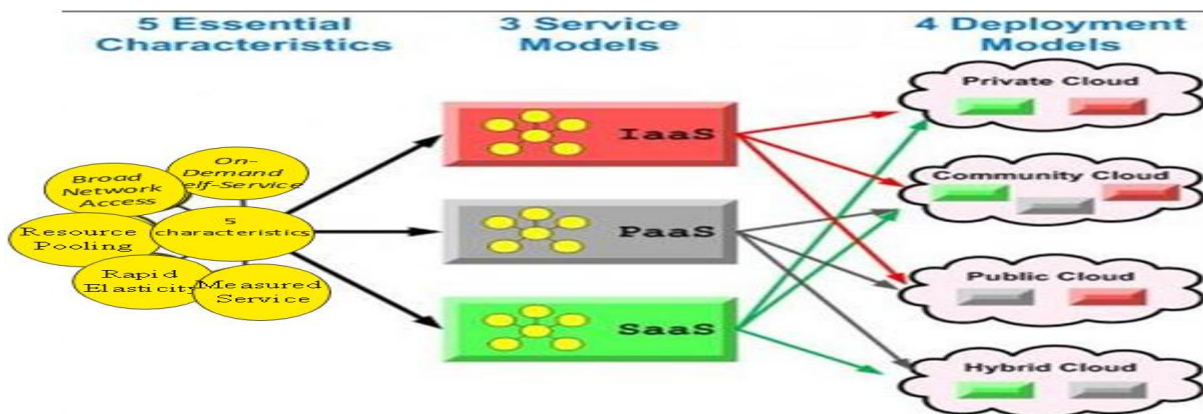

Figure 1: The interrelationships with the characteristics, Service and Deployment Models

2. The roles of Chief Information Officers (CIOs) in era of cloud computing

The main driving force of cloud computing adoption in higher education is connected with the inherent benefits, which include ease of implementation, flexibility, scalability, Access to top-end IT capabilities, focusing on core competencies, sustainability, freeing up internal IT resources, cutting costs, adaptability, and efficiency [5] [6]. The current development and growth of cloud computing alongside its immense benefits in institutions have rapidly changed the environment of CIOs. With regard to cloud, the roles of CIOs have become challenging that make them to embrace change more rapidly than ever before. The CIOs are facing an "*imperative to create a new vision for their organization one that includes both human and technology assets*" [7] .

As the cloud computing becomes a stronghold of businesses, it is very real possible to see the role of CIOs changing. The research conducted by network solutions company Brocade in which more than 100 CIOs from Europe, the Middle East and Africa (EMEA) participated in the survey found that many participants predict the role of CIO to evolve significantly in the future as businesses adapt to some of the challenges

associated with cloud computing. In the survey, participants were asked to provide feedback on the 'survival' of five common types of CIOs: the Enforcer, the Mediator, the Evangelist, the Dinosaur and the Strategic Consultant. The 'strategic consultant' was on the top of the list that received a rating of 'excellent'. The type of CIOs that was describes as having a vast knowledge on cloud computing and IT. Furthermore, the CIOs of this kind *"understand the organization's long-term strategy and sees technology as a tool to realizing that strategy"*, and are More likely to be found in the *"boardroom than the server room ... Has a door always open is"*. However, the 'Dinosaur' was given a survival rating of 'low', and the CIO of the habit finds it hard to adapt to new technologies and who "remembers a time before email" [8].

In two ways, it shows how a CIO's position radically emanating into new roles. Firstly, operational requirements: this ensures that systems, data centers, and applications are well managed. In addition, it involves managing security and disaster recovery as well as ensuring system optimization (i.e. quick responses to queries). Secondly, change management: finding new methods for empowering strategic opportunities within the business arena [9].

A survey from ECAR's IT leadership and workforce showed that among respondents, majority reported to have relatively positive assessments of their influence. The findings indicated that 74.1 percent were engaged often in discussing the IT implications of institutional decisions, 62.6 percent participated often in decisions related to the administrative directions of the institution, and 69.2 percent participated at least sometimes in decisions pertaining to the academic direction of the institution, including 36.2 percent who participated often [10].

Accordingly, Institutions are facing high IT demand, as they are moving into digital capabilities. For example, a university exhausted up to 20 TB on desktop screencasts in a year to allow its staff and students to use screencasting software to capture desktop demonstrations. This is one of the big challenges the Institutions are faced with, which require consideration by the CIOs to arrive at the concept of "do more with less" [11]. Therefore, the cloud computing has changed the expectations for what institutions require from IT leadership (the CIOs).

The cloud computing comprises of different services and platforms that allow institutions to make choices to outsource IT services, as such some institutions are probable to end up with a mixture of sources for their services including internally provided, externally provided, and collaboratively provided models. For instance, many of the outsourcing services (e-mail, storage, data centers, application software) by the institutions might be the combination of different cloud models. Therefore, CIOs are responsible for the budgets and staffing that deliver these services [10]. More and more, the roles of the CIOs will be to identify the sourcing options for a variety of IT services and to be the role model of the institutions to weigh the options. With the increasing numbers of services provided by the cloud, however, the leadership style of CIOs would have to be broaden to include the providers of these outside services, whether they are corporations, associations, or multi-institutional collaborations.

In sum, the evolving roles of CIOs in higher education are not restricted to importance areas such as a Services Architect, Data Evangelist, Innovation Incubator, Process Architect, Orchestrator, Information Policy Manager, and Proactive Strategist. Furthermore, as cloud computing services have started become common to institutions, the IT areas that the CIOs are required to focus on include   project management, vendor relationships, security and compliance management, process analysis, group facilitation, data analysis, business intelligence and data management [10].

III.   CHIEF INFORMATION OFFICERS AND HYPE CYCLE MODEL

The roles of IT executives (CIOs) of higher education in the new computing models require not only technical expertise but also decision-making skills. Therefore, the Hype Cycle model will contribute in CIOs' decision-making process because it allows CIOs to careful evaluate concerning whether, where, how, and when to adopt new technology. The hype cycle has been designed to provide a visual representation of the technologies and applications evolving over time. The hype cycle shows graphical representation of the maturity, adoption and common application of specific technologies. The term "Hype cycle" was defined by Gartner, Inc [12]. The hype cycle has five stages, and it is generally plotted in two axes (i.e. the vertical axis and the horizontal axis). The vertical axis signifies the expectations (visibility) while the horizontal axis shows the time (maturity) for a technology (see fig 2). The major contribution of hype cycle is in decision making in which the hype cycle put in the picture of where a technology is now (i.e. what phase a technology is in) [12]. According to Christian Arturo Meza Alvarez, *"The hype cycle is also the unique model of its kind that has switched from an abstract concept and has been employed extensively as a useful tool for management decision-making, keeping track of several innovations over more than ten years. The hype cycle has proven to be not only a descriptive but also a predictive tool. The hype cycle is beneficial to anyone interested in the adoption of any innovation, especially to those who must take critical decisions about whether and when to select a new idea,*

practice, process, technology, or product. It helps to show in a highly visual and simple manner the cycle of over enthusiasm, dashed expectations, and eventual maturity" [13].
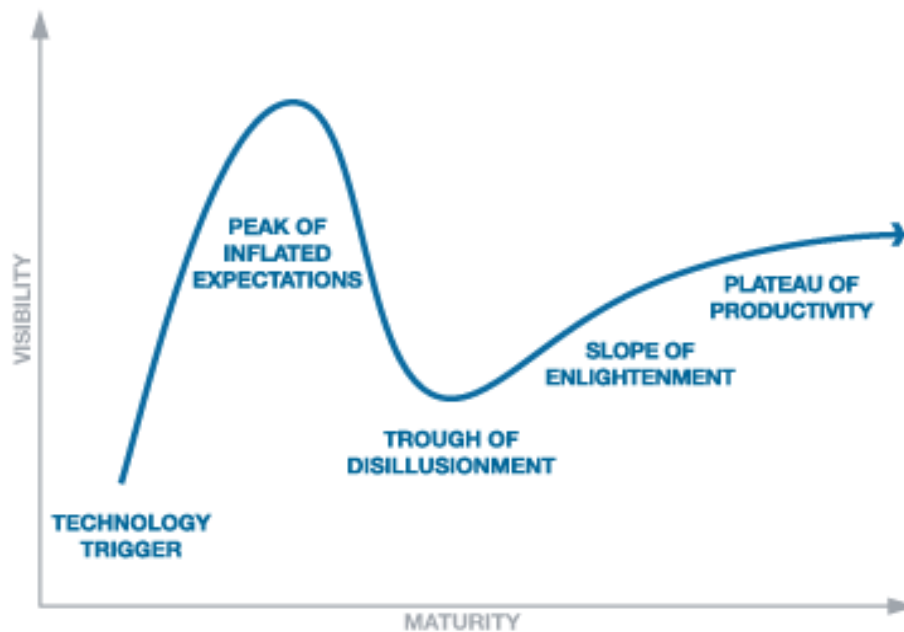

Figure 2: The five stages of hype cycle of a technology's life cycle (source: [12]

3.1 The five critical phases or stages are defined as under:
i   Technology Trigger: This first stage is when an event for a potential technology (yet to be adopted) is held or a product is launched, triggering the interest of the media who in turn creates heavy publicity about it.
ii   Peak of Inflated Expectations: At this stage is where a technology or product is overhyped, causing elevated expectations more than it can really deliver.
iii   Trough of Disillusionment: In this major phase is where people realize that the technology lacks the capability to entirely serve their demands or it looks quite different from what marketing declared. In consequence, the press no longer pushes the subject. During this phase, several organizations begin to use the technology while many others still wait to see a feasible advantage.
iv   Slope of Enlightenment: Finally, while the hype is no longer present, more and more successful examples on the use of the technology continue to emerge.
v   Plateau of Productivity: Here, the market has broaden and matured.

3.2 Gartner's 2012 Emerging Technologies Hype Cycle
        Recently, the Gartner published the hype cycle showing the position of various emerging technologies including the cloud computing (see figure 3). The cloud computing has many services (SaaS, PaaS, IaaS) and many platforms that participate in different phases of the hype cycle. The Cloud computing is slopping gradually to the trough of Disillusionment, and private cloud computing is still at the peak of Inflated Expectations while Hybrid cloud computing is at the rising position**.** This indicates that cloud computing is in the hype phase (i.e. some organizations begin to use the technology while many others still wait to see a viable benefit). In essence, the idea behind of using the hype cycle is that adoption of cloud computing follows a standard technology maturity model that requires critical analysis and strategy by the CIOs of the enterprise to perform.
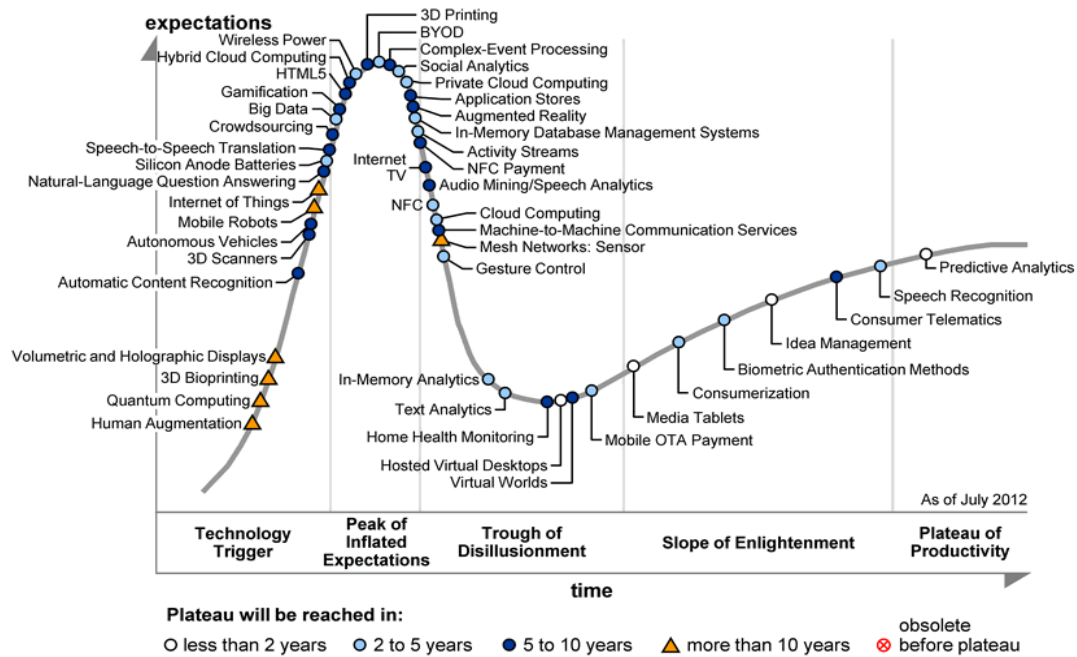
Figure 3: Gartner's 2012 Emerging Technologies Hype Cycle [14]

IV.   DISCUSSIONS

The new evolving premium model of cloud computing allows institutions to cut down costs on Information Technology (IT) infrastructural ownership through reducing the necessities of software licensing and updating, upgrading hardware and Software to meet the current situation, and data centers maintenance while improving IT resources for researches and students. In view of that, a growing number of higher education institutions across the globe have started adopting cloud computing. For instance, North Carolina State University has shifted to cloud offerings, which enable the University to significantly lower expenditures on software licenses and simultaneously, reduce the campus' IT staff from 15 to 3 full-time employees. [15]. For the meantime, the presents of cloud computing in higher education has changed IT practices. These changes call for CIOs and IT staff in institutions to come up with new ideas and skills to meet the new roles and responsibilities of emerging and evolving types of IT positions in order for them to stay relevant to this era of cloud computing [3]. Therefore, this situation leads us to the questions raised in this paper.

Question one: Why are the roles of CIOs in Higher education become challenging in the third computing model?

According to previous researches in the field of CIOs' roles, the major reasons of why the third computing model is challenging can be summarized as:

1. **The CIOs are required to have business skills and talent to harness them to the overall objectives of the Institutions.** the role of CIOs have changed as a result of new technology in higher education because the CIOs must be engage in more strategic business planning and decision making in order to maximize the strategic benefits of IT for their institutions [1]. Accordingly, as organizations are moving into cloud outsourcing, "CIOs are required to possess business skills and the ability to relate to the organization as a whole, as opposed to being a technological expert with limited functional business expertise. The CIO position is as much about anticipating trends in the market place with regards to technology as it is about ensuring that the business navigates these trends through expert guidance and proper strategic IT planning that is aligned to the corporate strategy of the organization" [16].
2. **The Cloud computing supports the whole institution's IT infrastructures in a cost effective way, which has broaden scope of the CIOs' responsibilities.** The cloud computing comprises of different services and platforms that allow institutions to make choices to outsource IT services as such the CIO has the responsibility for the budgets and staffing that deliver these services. In addition, the CIO is saddled with the responsibility to identify the sourcing options for a variety of IT services and to be the role model of the institutions to weigh the options [10].
3. **The concern about Security, compliance, control, and risk-management issues related to cloud computing have increasingly dominated the CIOs' responsibilities.** Even though, the cloud computing provides increased reliability and flexibility of IT infrastructure and services with lower or more transparent costs to the Institutions, the security concern is complicating the situations. The reason of the security concern is due to the loss of control over the cloud computing by the CIOs. Yet, Information is

the livelihood of higher education, and decisions on how to manage that information can have important political, social, and economic considerations because higher education is subject to regulations concerning the protection of student records. Therefore, the CIOs have the responsibility to strategize on the measures to be put in place to secure those IT resources before embracing the cloud computing [17].

4. **The CIOs are required to have vendor management skills.** The cloud computing has allowed the higher education to outsource some of its internal functions (i.e. IT resources and services). As a result, CIOs are required to have the vendor management skills for them to establish contracts, Negotiate, and work with the suppliers [1].

Question two: What competencies do the Institutions expect from CIOs to have?

The focus on internal IT resource solutions have started moving into cloud strategies that deliver increased flexibility and functionality using a mixture of public and private cloud-based application and platform services to institutions. For that reason, CIOs are expected to make important IT strategies that can lead to the achievement of the institutions' mission. However, for the CIOs to accomplish these requirements, they need to have a broad range of skills and capabilities [1], including the following:

1. The knowledge and skills to develop and maintain a strategic perspective that grounds IT in the institutional mission and strategic objectives as well as the ability to interact with other senior leaders effectively on the broader strategic issues of the institution and the mission the institution needs to achieve. The IT strategies at this stage involve in indentifying high level institutional l benefits, IT project objective and scope, Approach and methodology of the engagement in IT project, relationship to overall business strategy, and IT resource planning (i.e. staffing and budgets).

2. Communication skills and outreach capabilities that enable the CIO to frame IT issues clearly, concisely, and in terms relevant to the institution as a whole. The competences required at this stage include assessment of internal capabilities in term of current projects being managed by the information technology department and their status (i.e. IT Project Portfolio Management), existing applications supported and the level of resources required to support them, architectural directions and methods for implementation of IT solutions and current IT departmental strengths and weaknesses. Meanwhile, after the assessment senior leaders need to be informed for them to understand the complexity of IT solutions issues.

3. The ability to collaborate effectively to pull shared needs and resources within and beyond the institution, and thus maximize the value of IT in advancing higher education.

4. Operational management skills that comprises of large to small scales project management, vendor relations skills, technology skills, contract management skills and ERP issues as well as the practical skills needed to be successful in the current environment.

5. Broad knowledge of IT policy and regulatory, compliance, and legal issues relating to overall IT infrastructures because IT Policy expertise is among the top requirement for CIOs to possess.

Accordingly, the CIOs need to have the four Leadership behaviors – thinking, influencing, achieving, and self-managing (see fig 4) to handle strategically the organizational need and IT. The four key leadership behaviors allow the CIOs to effectively deliver the IT strategy that drives the organization to its goals. Therefore, a model has been designed to show the interrelationship among the four attributes of CIOs. In the model, CIO leads the exploitation of the IT Profession's body of knowledge and the capability to deliver the organization's goals (see fig 5) [18].

THINKING	Customer Understanding
	Strategic Thinking
	Innovation
	Forward Thinking
INFLUENCING	Strategic Influencing
	Relationship Building
	Interpersonal Awareness
	Developing Others
ACHIEVING	Results Focus
	Concern for Excellence
	Critical Information Seeking
	Initiative
SELF MANAGING	Independence
	Tenacity
	Flexibility
	Self Development

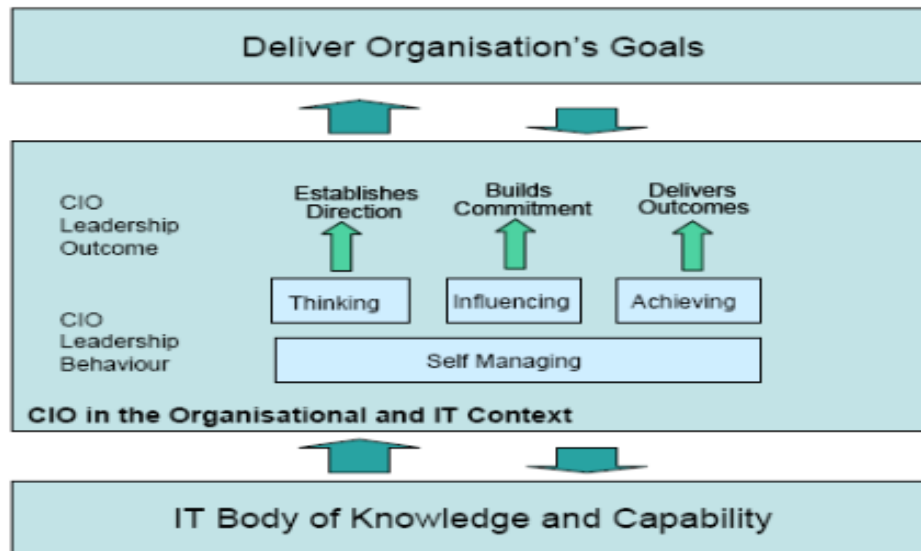**Figure 4: four key areas of CIOs Leader Behaviour Source:** [18]

Figure 5: The model representing the CIO in the context of the organization and IT [18]

V.   CONCLUSION

Nowadays, IT leaders require not only strong technical skills, but also excellent communication and political skills to influence the IT strategy across the overall objectives of institution. Seeing that the cloud computing realizes its full potential, this will place a premium on IT leaders (particularly CIOs) who have cleared understanding of the broader institution's mission, are skilled at developing and managing internal and external relationships, and are skilled at communicating as well as knowledgeable on what technology can be used to meet the most strategic needs of the higher education [1].

Despite the evolving challenges faced by CIOs, they will remain relevant to institutions but also have to shoulder new roles and responsibilities as the institutions are moving into cloud computing. The CIOs need to possess the skills and capabilities to support the institutions' objectives through business on demand initiatives and up to date technology. What's more, they need to establish a cordial relationship with IT infrastructure and service partners to determine the best and appropriate options available to support the overall objectives of the institutions.

Finally, the cloud space is rapidly adopting a superfluity of new concepts that offers diverse aspects of IT infrastructures and services, which has altered on the job requirement of IT staff in general. For example, literature has shown that the North Carolina State University has shifted to cloud offerings, which leads to reduction of the campus' IT staff from 15 to 3 full-time employees [15]. Therefore, this paper suggests that there is need for research work to examine what roles do IT staff required to play in order to stay relevant in the new computing model in higher education. On the other hand, this paper focuses only on the evolving roles of CIOs, which serve as the limitation of the study.

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