"Toward Cloud Computing Applications in Academic Institutions Sector"

Dr. Mohamed Ali Elhayes
Assistant professor and head of the Information Systems Department
Faculty Of Business, Economics & Information Systems
Misr University for Science& Technology
mohamed.elhayes@must.edu.eg

Farah Yasser ElSayed

PhD Degree Researcher in Business Information Systems Department, Faculty of Commerce and Business Administration,Helwan University, Egypt.
farah.yasser21@commerce.helwan.edu.eg

Abdelaziz Fathy Abdelaziz

PhD Degree Researcher in Business Information Systems Department, Faculty of Commerce and Business Administration, Helwan University, Egypt.

abdulaziz.fathy.pbis2020@commerce.helwan.edu.eg

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Abstract:

This study aims to identify the reality of the use of cloud computing applications in the universities in Egypt and identify the quality of cloud computing services provided, identify the advantages of using computing applications cloud for academic institutions, and to identify the obstacles and difficulties facing the application cloud computing in academic institutions in Egypt. Study adopted descriptive and analytical approach to identify the studied community and its properties, through a questionnaire sent to a specialist information to know the reality the use of cloud computing applications. after analyzing data into a number of outcomes including: the importance of adopting and employing cloud computing techniques in the academic institutions, most of the participants in the study stated that reduced hardware infrastructure, software, IT support cost of the reasons that push them to implement cloud computing in data centers form, the leading cloud computing services provided in universities , Microsoft Office 365, Google Apps and Windows Azure, the most important benefits of using cloud computing in the information services by the participants in the study is the easy access to the data and, Disaster recovery capabilities and Business continuity and Scalability on demand / flexibility of IT resources, the most prominent obstacles to the use of cloud computing in universities, data concerned problems, security issues, speed issues, Dissatisfaction with vendor offerings/pricing and Performance issues.

Keywords:(Cloud Computing, Academic Institutions, Cloud Computing Services, Cloud Computing Applications).

"نحو تطبيقات الحوسبة السحابية في قطاع المؤسسات الأكاديمية"

مستخلص:

تهدف هذه الدراسة إلى التعرف على واقع استخدام تطبيقات الحوسبة السحابية في جامعات مصر والتعرف على جودة خدمات الحوسبة السحابية المقدمة، والتعرف على مميزات استخدام تطبيقات الحوسبة السحابية للمؤسسات الأكاديمية، وأيضاً التعرف على المعوقات والصعوبات التي تواجه تطبيقات الحوسبة السحابية في المؤسسات الأكاديمية في مصر. اعتمدت الدراسة المنهج الوصفي التحليلي للتعرف على مجتمع الدراسة وخصائصه، وذلك من خلال استبيان أرسل إلى متخصصي المعلومات لمعرفة واقع استخدام تطبيقات الحوسبة السحابية. وبعد تحليل البيانات تم الوصول إلى عدد من النتائج أهمها: أهمية تبني وتوظيف تقنيات الحوسبة السحابية في المؤسسات الأكاديمية، يعتقد معظم المشاركين في الدراسة أن انخفاض تكلفة البنية التحتية للأجهزة والبرمجيات ودعم تكنولوجيا المعلومات من الأسباب التي تدفعهم إلى تطبيق الحوسبة السحابية في مراكز البيانات، خدمات الحوسبة السحابية الرائدة المقدمة في الجامعات، Microsoft Office 365، Google Appsو Windows Azure، أهم فوائد استخدام الحوسبة السحابية في خدمات المعلومات من قبل المشاركين في الدراسة هو سهولة الوصول إلى البيانات، وقدرات التعافي من الكوارث واستمرارية الأعمال وقابلية التوسع عند الطلب / مرونة موارد تكنولوجيا المعلومات، وأبرز العقبات التي تحول دون استخدام الحوسبة السحابية في الجامعات هي المشاكل المتعلقة بالبيانات، وقضايا الأمن، وقضايا السرعة، وعدم الرضا عن عروض البائعين / التسعير و قضايا الأداء.

الكلمات المفتاحية:(الحوسبة السحابية، المؤسسات الأكاديمية، خدمات الحوسبة السحابية، خدمات الحوسبة السحابية).

1. Introduction

Resulted exponential data and information growth in increase limitations on companies or the inability to manage this data, especially if high storage costs continued under these circumstances companies face once more with difficulties recovering their database along with backup copy preparations supported by systems' models which require further investments that fiercely upgrades take place within few days of running efficiently affecting company's productivity. At the present time the academic institutions are facing to keep up with the rapid advancements in information and communication technologies, which necessitate the production of previously used material for training and education, as well as expensive new hardware and software. Because colleges are in different places inside universities, there is a need to use information technologies, such as cloud computing technology, this offers a fresh approach for resolving these issues. Students can access applications at any time, from any location and on any internet-connected device. They can also access systems and software, create their own applications, and store university infrastructure, as well as access databases, social network, and e-learning tools via a range of computers and mobile devices.

Recent years have also seen the rise of "Cloud Computing (CC)" as a practiced and promising approach to address reduced IT budgets in parallel with increasing IT demand. A shared pool of reconfigurable computing resources, including as networks, servers, storage apps, and services, can be quickly accessed and released with little administration work or service provider contact when using the CC model, which offers reliable, practical on-demand network access. Permit users to access these from any computer with a high-speed internet connection, without requiring a connection to any hardware except from the item holding the application (Sunyaev, Ali, 2020).

All forms of education are adapting mobility within the learning and working environment or communities, even in companies. Just as technology is evolving, so must the way we approach pedagogy given that remote learning has moved from a need to a necessity not just for our students but also in delivering education itself.

The technology known as cloud computing allows users to access computer programs without having to purchase, set up, or maintain their own servers or software. Teaching establishments have started benefiting from the meritorious 'cloud' hosted applications. Free services are provided by cloud based platforms today to education institutions such as messaging, email, contacts, calendars, and office applications (which save and generate documents) and platform apps (which

let you make websites or learn about learning management systems) (Qasem, Abdullah, Jusoh, Atan, & Asadi, 2019) .

2. Problem of Research:

Cloud computing is an important topic that has been the subject of debate in intellectual production. The importance of this topic is highlighted by the applications provided by cloud computing in academic institutions. From this perspective, the study's identification of the actual use of university libraries for cloud computing applications is possible. The question that follows highlights the issue:

- What is the current state of using cloud computing applications in Egyptian universities?
- What are the characteristics of cloud computing applications' surroundings in academic institutions?

3. Research Questions:

The study attempts to answer the following questions:

- What is the current state of using cloud computing applications in Egyptian universities?
- What are the characteristics of cloud computing applications' surroundings in academic institutions?
- Which kinds of cloud computing services are offered by Egyptian universities' academic institutions?
- What are the benefits of using cloud computing solutions in Egyptian university?
- What are the obstacles and limitations identified while using cloud computing technologies in Egyptian universities?

4. Research limits:

Spatial boundaries: The statistical application was conducted across several academic institutions, including the German University, the Arab Academy for Science, the British University, the German University, and El-Shorouk Academy. The purpose of this study was to analyze the utilization of cloud computing within these institutions and to identify the environmental features that influence its adoption. This analysis aims to determine the significance and impact of these environmental features on their information technology infrastructure.

5. Literature Review

One of the most important pillars for social development is higher education. Here is a great partnership of the academic system and industry. Researchers can export their knowledge and scientific advancements to the industry, thereby promoting a more dynamic economy with stronger companies that drive healthier

societies. For this reason, governments should aim to build well established universities as resources for more effective learning tools such as good IT infrastructure where academic software can be run or quickly shared between computers in the classroom. Higher education colleges and universities derive great benefits from the application of cloud computing, mainly in academic purposes. First, it is inexpensive for them because they are potentially running on a shoestring budget. Secondly it also influences the learning of those who practice academicians. Also, cloud computing only helps with productivity of IT staff (Ghani, Hendradi, Mohamad, Aissaoui, & Yudatama, 2023). Universities use cloud-based applications to enable their staff and students in completing the academic work access (Al-Dujaili, ALRikabi, Abdul-Hussein, Kanber, & ALRubeei, 2024), With appropriate IT support and services offered by cloud computing, variety of advantages comes to the academic institutions which in turns saves operational costs as well keep personal and virtual exploitation rates along with centralized storage for monitoring data access. In (Mircea & Andreescu, 2011), was centered around moving away from IT, it lead universities to become more agile and seek savings. The methodology adopted for this research is a thorough review of the leading present evidence on Cloud Computing in place of IT provisioning, management and security. The authors also considered specific sets of best practices for Cloud Computing use at universities, and they applied their IT implementation experience in the academic community. The study starts with how Cloud Computing is being adopted in universities, mentioning the most significant results that have been reached at this point. It concludes by suggesting an adoption strategy as a starting point for universities to implement Cloud Computing. This strategy is composed of five steps, where we highlight the rating system data and processes/functions/applications from some top universities in light a few criteria relevant to this procedure associating them with models/services/apps that are de facto on the Cloud market. We got encouraging results and that endorse the importance of implementing Cloud solutions in universities via increasing awareness about this technology, as well as delivering a practical guideline that adopts an adaptive methodology to fit best with university environment. For the proposed model to be implemented in real life, it must also take into account the architecture of the university and its guiding principles, such as mission, availability or significance of applications and data, and methods of provision like sensitive confidential integrity or disciplinary with regard to existing information systems. This is part of the study (Gital & Zambuk, 2011) that relate to Cloud Computing in Nigerian higher education, challenges faced with ICT/Cloud technologies in Nigeria and also attempt a definition of some benefits all anticipated shortcomings

inherent within this rudiment version of open innovation concept. One of the main observations that we can derive from this study is that Cloud Computing has significant potential in enhancing ICT application and infrastructure within higher education institutions. However, as this field is still quite young it would be suggested for early University adopters to consider transiting in a long-term maneuver and contact organizations that set industry standards such as NIST frequently to ensure consistent transitions. A second consequence is that it may be appropriate to adopt a hybrid strategy where college ICT operations and administration could well conclude, based on an assessment of the factors listed above), to deploy a mixture such as Cloud Computing for some apps / data but leaving other local. Conclusion: Cloud Computing as a technology relatively less mature in terms of adoption. There will be several changes to best practices and standards in terms of resources, problems, and risks as the bottom line in time to come. Nonetheless, there are some degrees greet advantages it may have for higher ed institutions. Also, this on-demand counterpart can tone well with the existing university tight budgets through some parts of America and possibly more to come. Abstract In (Mehmet Fatih & Serhat Bahadir, 2011) they present the architecture of "Cloud Computing", cloud services, types and layers associated with a particular type, and we propose an experimental prototype campus Distributed University using cloud infrastructure. Surveys results show that Cloud Computing has many benefits in usage on universities such as file storages, e-mails, databases (MySql or SqlServer), web applications and tools research anywhere for university faculty, administrators, staffs & students. The study (Chuleeporn, 2014) sought to examine the determinants of cloud computing adoption and reveal student perceptions on this type of technology. The findings from this study deployed the result that perceived ease of use, perceived usefulness, and security by play important role in influencing acceptance toward cloud computing mandatory curriculum for student while perceive speed of access to data and costs are another factor motivate user intention. They carried out (Hasan & Thamer, 2015) a study to review the characteristics of these academic institutions that can leverage Cloud Computing providers for greater benefits to students and teachers. Public Cloud, Private Cloud, Hydrant-Cloud, Community Cloud Education - so that if you were saying Education educators, academic researchers and students, etc., can apply to use some of the credits provided free-of-charge here. On-demand infrastructure. The funding has allowed the schools to contribute new capabilities for research, such as High-Performance Computing (HPC) and Big Data.

The studies that were previously stated lead to the following conclusions:

- Cloud Computing deployment models and technology models can be used in academic institutions.
- Less expensive overhead costs for organizations, the development of more competent functions.
- There are plenty of services that Cloud Computing technology will bring.
- There have been many cases where Cloud Computing has shown good results for higher education.
- There are some kind of obstacles to the adoption of Cloud Computing that are trust and security (institutions),

– **Cloud Computing Service/ Delivery Models**

Services offered by cloud computing can be divided into: SaaS, or software as a service Infrastructure as a Service, Cloud): Platform-as-a-Service (PaaS), etc. Four more categories have been added by the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO): Network as a Service (NaaS), Computer as a Service (CompaaS), Data Storage as a Service (DSaaS), and Communications as a Service (CaaS) (Norah & Mohamed, 2015). The key characteristics of the recognized cloud computing service models are enumerated in Table (1). In the same table, there are also examples of each service model.

Table 1. Cloud Computing service models

Types of Services	Description	Example
Software as a Service (SaaS)	offers an alternative to purchasing, installing, and using software: renting application functionality from a service provider.	Salesforce.com Gmail, Facebook
Platform as a Service (PaaS)	provide access to a cloud platform where programs can be developed and run.	Microsoft Azure Google AppEngine Amazon SimpleDB/S3
Infrastructure as a Service (IaaS)	On-demand processing power and storage are provided by vendors.	Rackspace GoGrid Flexiscale
Communications as a Service (CaaS)	The cloud service customer is able to collaborate and communicate in real time.	Voice over IP (VoIP)/ Videoconference
Computer as a Service	The provision and utilization of processing resources required for software	Amazon EC2

(CompaaS)	deployment and operation are the capabilities offered to the cloud service customer.	
Data Storage as a Service (DSaaS)	the usage and availability of processing resources required for software deployment and operation are among the capabilities offered to users of cloud services.	Fidelitone/ Urban Mapping/ Signite
Network as a Service (NaaS)	The cloud service client is given transport connectivity and associated network capabilities.	Juniper Networks

– **Cloud Computing deployment models**

Able to classify cloud computing deployment models into Community, Hybrid, Private, and public clouds (Norah & Mohamed, 2015). Table (2) summarizes the cloud computing deployment models.

Table 2. Cloud Computing deployment models

Types	Definition	Example
Public	Publicly accessible cloud services are owned by a company that provides them.	Amazon Google
Private	Only one organization can use cloud services, which are either administered by that organization or by a different one.	Services may exist off site
Hybrid	An integrated cloud services agreement that consists of more than just a cloud model	Data stored in private cloud and agency database manipulated by a program running in the public cloud
Community	Many organizations share cloud services, which cater to a certain community with common issues. These services might be offered off-site and run by a different business.	Government or G-Cloud

Table 3 shows the most important advantages and disadvantages of cloud computing deployment models.

Table 3: Comparison of Cloud Computing deployment models

Types	Advantages	Disadvantages

Public	• Effective utilization of hardware • No acquisition of hardware	• Off-site data storage is utilized.
Private	• High prices • control over data • control over hardware	• Hardware for high-volume usage • Hardware needs to be purchased or rented, which is less efficient.
Hybrid	• Crucial business data might remain on the premises.	• Inefficient compared to a public solution
Community	• Costs are disbursed Improved utilization of hardware	• Purchasing or leasing hardware is necessary, which is less efficient than using a public solution

6. Research Methodology

Study adopted descriptive and analytical approach to identify the studied community and its properties, through a questionnaire sent to specialists of information technology to know the reality the use of cloud computing applications, the themes of the questionnaire were:

Section (1) cloud computing services descriptive and Section (2) cloud computing services evaluation criteria.

The study community is represented by a group of workers in the field of information systems at the academic and professional level, and for this study targeted employees of information systems in Egyptian universities (German University, Arab Academy for Science, British university, German University and EL-Shorouk Academy), and given the small size of the research community, the research sample consisting of (66) individuals was chosen.

7. Questionnaire Design:

Following an extensive review of relevant literature and consultations with subject matter experts, a questionnaire was identified as the most appropriate instrument for this research. The questionnaire was initially developed in English and then translated into Arabic to ensure accessibility and comprehension among the target population. To maximize response rates, each questionnaire was

accompanied by a cover letter detailing the research objectives, the purpose of the study, and assurances of confidentiality.

8. Data Measurement:

In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is an appropriate method that can be applied rather than others. In this research, (Likert scale) are used. Ordinal scale is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the agreement degree (1,2,3,4,5), do not indicate that the interval between scales is equal, nor do they indicate absolute quantities.

9. Research Procedure:

- **Identification of Main Fields and Item Preparation:** The initial step involved identifying the primary fields of the questionnaire and the corresponding items for each field. A preliminary questionnaire was then prepared to facilitate data and information collection.
- **Distribution to Referees:** The preliminary questionnaire was distributed to a panel of referees for review and feedback.
- **Finalization of the Questionnaire:** Based on the feedback and recommendations from the referees, the final version of the questionnaire was prepared.
- **Questionnaire Distribution and Retrieval:** The finalized questionnaire was distributed to the target population, in the first term of the academic year 2023-2024, and completed questionnaires were subsequently retrieved.
- **Data Entry and Analysis:** The data from the retrieved questionnaires were entered into a computer and analyzed using SPSS statistical software to obtain the results.

10. A Proposed Model for Evaluating Cloud Computing

The use of cloud computing services requires knowledge of the reality of using cloud computing applications in academic information institutions in Egyptian universities and the most important applications that they use. Also, identifying the environmental features of cloud computing applications in academic institutions to reach the optimal use of cloud computing services. Figure (1) shows the proposed model.

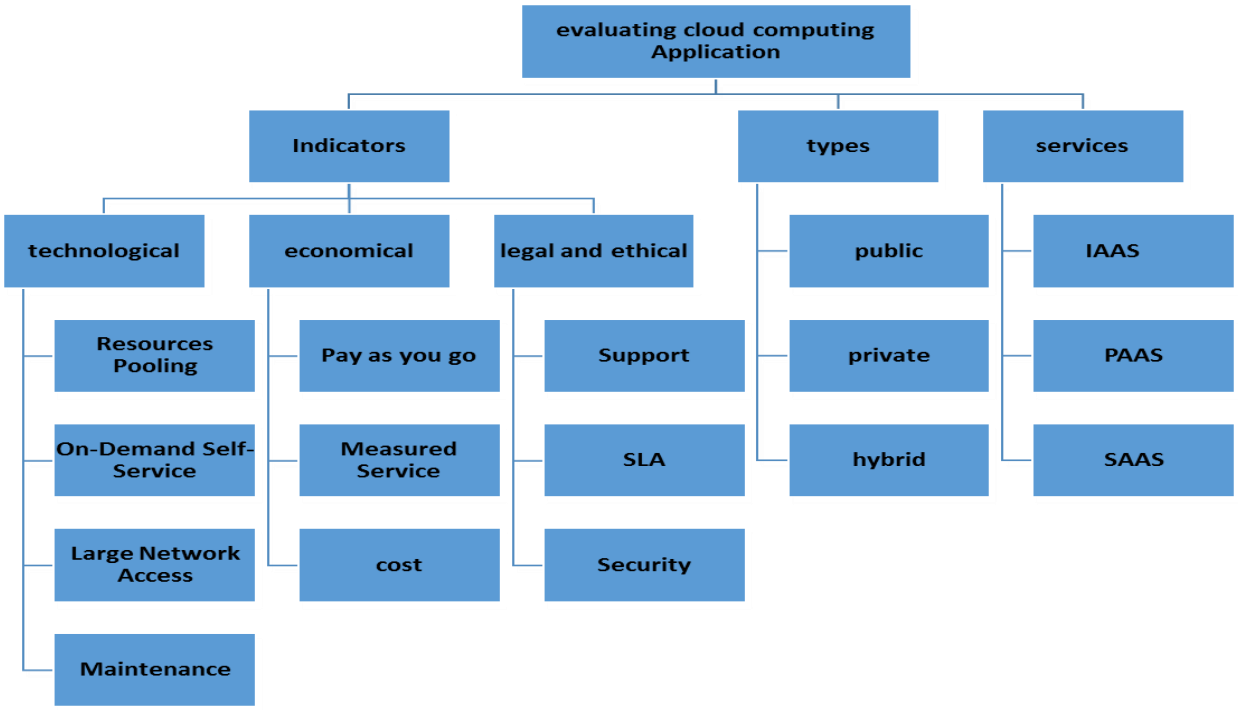

Figure 1: Evaluation model of cloud computing

This model is divided into three sections:

10.1 Cloud Computing types:

Cloud computing is divided into three types: public, private and hybrid. Each of these types is proportional to the type of applications. The process of building trust between the university and the cloud provider comes on the list of priorities of universities where the international and local credibility is the key to trust building, or one of the means that affect their use and assessment. When the trust between the consumer and the cloud provider increases, the universities' trend towards the use of private cloud decreases while its trend towards the use of public cloud increases. On the other hand, when trust between the consumer and the cloud provider decreases, the universities' trend towards the use of private cloud increases while its trend towards the use of public cloud decreases.

10.2 Cloud Computing services:

Three tiers of cloud computing services are available:

SaaS, PaaS and IaaS. The size of the universities may affect the use of a certain type of service. The choosing of the cloud service level involves a compromise between the university needs and financial abilities.

10.3 Indicators for evaluating cloud computing:

In this study we concentrate on the role of the environmental Features forces using the widely used SLEPT framework (Jaime, 2010) (Jamie & María, 2010). The SLEPT factors are:

- Social factors
- Legal and ethical factors
- Economic factors
- Political
- Technological factors

The focus was on only three factors:

- Technological factors
- Economic factors
- Legal and ethical factors

– **Technological factors:**

▪ **Resources Pooling Indicator:** In cloud computing environments, resource pooling refers to a situation in which providers give virtual and scalable services to numerous clients, customers, or "tenants". The services can be adjusted over time to meet the exact demands of a specific client, so that there would never be a need for change on the part of either the client or the end user. Resource pooling is based on scalable systems found in cloud computing and software as a service (SaaS), which enable providers to intentionally generate the appearance or perception of endless or readily available resources by managing genuine resource modifications at the meta level. Consumers can thereby add or remove levels of service at will, free of the limits associated with physical or virtual resources (Rashid & Chaturvedi, 2017).

▪ **On-Demand Self-Service Indicator:** On-demand Self-Service indicator: This is the aggregate self-service ability of cloud vendors that allows end users to provision elastically resources over time, i.e. at runtime On-Demand Self-Service: This whole process is performed by the online control panel where a user access cloud services. Most cloud offerings have at least one feature in common: the on-demand self-service resource sourcing, where a user can scale up to most host operations without interaction. Cloud computing provides customers with the ability to provision computing power, storage and network resources easily as well as software applications. Typically, users start using limited resources and then scale up over the period. Method: On-demand self-service - the capability allows users to request resources as and when they needed. This transformation is done

entirely at once in theory, but On-demand self-service has also been connected, possibly more properly, to utility computing and the pay-as-you-go subscription model with services being charged for on an individual basis or per usage in a similar manner as paying for electricity or water. (Srivastava & Kumar, 2011).

- **Large Network Access Indicator:** Capabilities are provided using a standards-based network protocol accessible through well-defined interfaces that significantly reduce the effort needed to develop and deploy clients running on multiple form factors (e.g., mobile phones, tablets, laptops and workstations). – NIST. Cloud services are consumer facing and accessed by a client/endpoint remotely over the network, usually TCP/IP connected to the Internet or an organization's internal private network. One example is a cloud application, such as an online word processor or spreadsheet that you access and use directly when via the Internet. A wider range of clients can access documents, even if the application itself is not installed on the client. Capabilities in cloud computing are not confined to applications that you access over the network. For the customers, cloud computing permits the availability of nearly any sort of data center capacity mattering from anywhere on Earth and anytime day or night. Cloud solutions also offer access to data, computer systems and storage as well as other facilities like backup/DR. Cloud services are utilized over a system from a wide range of end-point gadgets, for example, personal computers, PCs, tablets and cell phones. They may be based on heterogeneous hardware and software platforms (Changqing, Yu, Wenming, Uchechukwu, & Keqiu, 2012).
- **Maintenance Indicator:** Server maintenance is streamlined with low and even downtime hostile cases, that is why, each time there will be a refinement in cloud computing, and it comes out of the box by updating with every stage. The updates are optimized for the devices and perform better than previous builds as well additional bug fixes (Yi-Kuei & Ping-Chen, 2012).

– **Economic Factors:**

- **Pay as you go indicator:** In cloud computing, User only have to pay for the service, he or they used. There is no cost, charge or hidden fee that one needs to make. The service is inexpensive and Weebly often provides free space (Shadi, Bingsheng, & Hai, 2011).
- **Measured Service indicator:** The infrastructure can be provided or released automatically through a shell that leverages the same metering capability as other cloud services at an abstraction level suitable for the kind of service (e.g., user accounts, storage, computing power, and bandwidth). Materials The supplier and the user of the service can both benefit from transparency brought about by the

measurement, control, and reporting of utilization. — NIST There is a metering system in a cloud infrastructure.

Metering Bill generated for a customer based on resources used in the cloud infrastructure. Metering system monitors resource consumption on an ongoing basis for each consumer and reports the skewed usage of resources. It includes, for instance, the monitoring of software consumption in terms of processor time or network bandwidth and computer resources such as disk space. It can also be used to show current demand on the cloud and support capacity/service planning for a cloud provider. It keeps an eye on resource usage and helps decide how (through dynamic provisioning or de-provisioning: auto-scaling) extra computing resources can be allocated to serve workloads. This makes the cloud property quick elasticity. Metering was way of giving customers an impression more closely aligned with what they were using and a transparency into billing, as we Additionally provided service levels. Service and orchestration layers module that covers resource monitoring & billing (Shawky & Ali, 2012).

- **Cost Indicator:** Cost saving is the Primary and Common Objective for any University. Cost Analysis: It includes (Minimizing the upfront capital expenses, avoiding hefty purchase costs in purchasing new software licenses and Scalability as a Cost factor) (Benedikt & Frank, 2012).

– **Legal and Ethical Factors:**

- **Support Indicator:** It is an activity which would be needed for the successful implementation of a system, product or service. The other department is handling support services. A University needs excellent support services to achieve company success. Aid services provide consumers and clients with instant comfort. They deliver support services, including phone calls as well as email and chat options with web forms; through these social communication channels also include self-service support sites. However, it is used to provide information about how a project can be used. They should avail themselves of different channels so that the stakeholders remotely and in turn be associated with the state of this business. 3/4th of the customers nowadays is into social media where they can talk about their problems on public forums like Facebook, Twitter, Instagram and LinkedIn etc. Therefore, staying omnipresent is a need for business today in the current world. Moreover, what is required today - and indeed always has been if the truth be told- is to listen and then answer every question promptly (Toosi, Calheiros, & Buyya, 2014).
- **SLA Indicator:** As this contract is likely to be governed by the university and so much of the relationship between a college or an out-sourcing cloud computing provider, service level agreements (SLA) should then reflect specific parameters when each service element on minimum level. SLA can be imposed that

specify the remedies to follow in case these SLAs are failed (Inderveer & Sukhpal, 2014).

- **Security Indicator:** While Cloud Computing is a top priority for universities looking to better scale their growth with elevated operational efficiency and reduced total cost, fears over security remain as an impediment of using cloud computing on massive level. Regarding the size of universities as well, they are interested in dealing with Cloud Computing depending on its nature and sensitivity so larger Universities would care more about maintaining their privacy and securing data, hence preferring private clouds over public ones because theoretically speaking larger university minds itself thinking that private clouds offer higher security than cloud computing. Cloud Type (Private/Public) Would cause security-based issues for Universities to move data into these clouds due the nature of Data with two ends, Sensitive in one end and general at another. Therefore, we can say that significantly adding to the improvement of cloud is Encryption where it has become easier for universities in transferring and managing data. If a break in occurs, the data will be impossible to read. Encryption can be performed before data transfer by an encryption password of the file owner, and this encrypted will only decrypt using that password. The cloud service provider also provides control over what users the password can be shared to decode files encrypted so that the authentication for accessing those secret is solid. In addition to tracking the internet network where files transferred from and four cloud, which can be done using SNIFFER (network traffic monitorization), converting then packets input for intrusion detection system that compare and classifies these packet as well get results on whether if it is a secure network or file transfer not (Urooj, Irfan, Sundas , Asim, & Arif, 2017).

11. Data Collection

The data collection process utilized the questionnaire to gather both qualitative and quantitative data, which were subsequently analyzed using the Statistical Package for the Social Sciences (SPSS). The decision to use a questionnaire was validated by literature analysis and expert interviews. To address any potential ambiguities and emphasize the importance of accurate responses, the majority of questionnaires were distributed in person, allowing for direct interaction with respondents.

12. Result and Analysis

12.1 Cloud Computing Services Descriptive

– **Types of Cloud Computing**

Figure 2 shows the Types of cloud computing where comes in the first-round hybrid cloud by 41% and comes in second place private cloud by 32% and then public cloud by 27%.

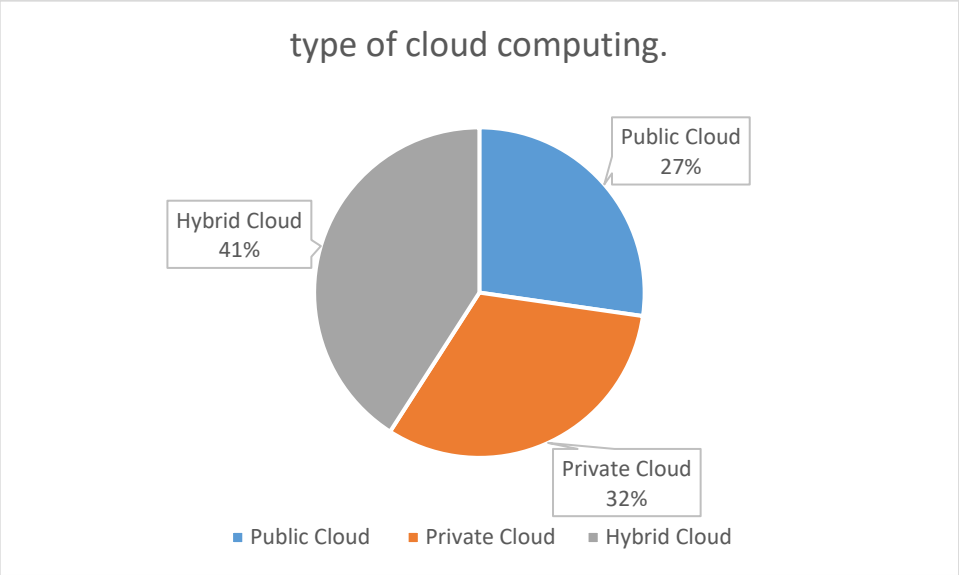

Figure 2: Types of cloud in universities

– **Types of Cloud Service**

Figure 3 shows the Types of cloud computing services where comes in the first Saas cloud by 46% and comes in second place Iaas by 39% and then Paas by 15%.

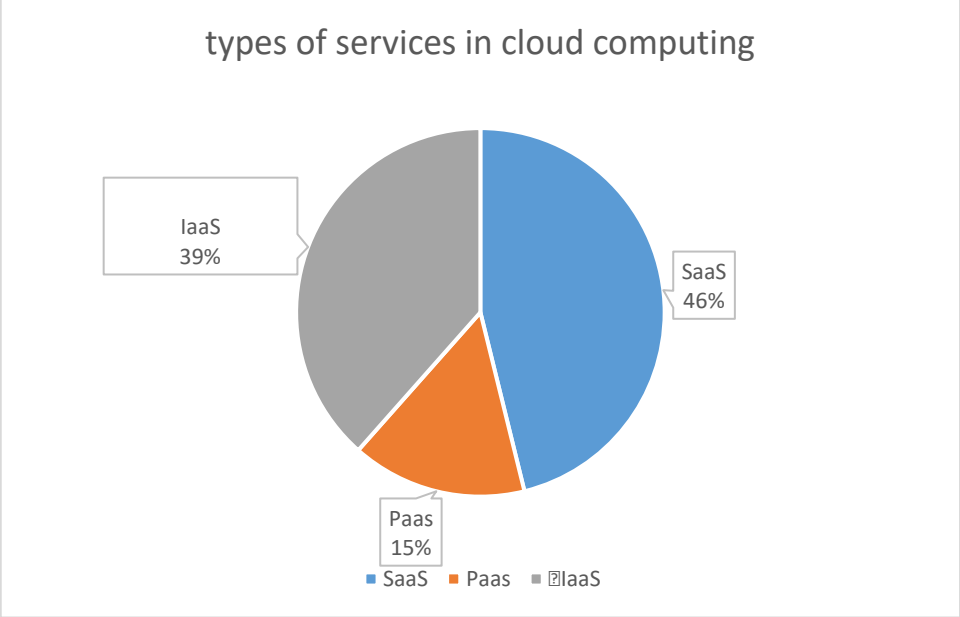

Figure 3: Types of cloud service in universities

– **Cloud Services Providers**

Figure 4 shows the most important companies which provide cloud computing service where comes in the first round Microsoft by 47% and comes in second place Google by 38% and other companies.

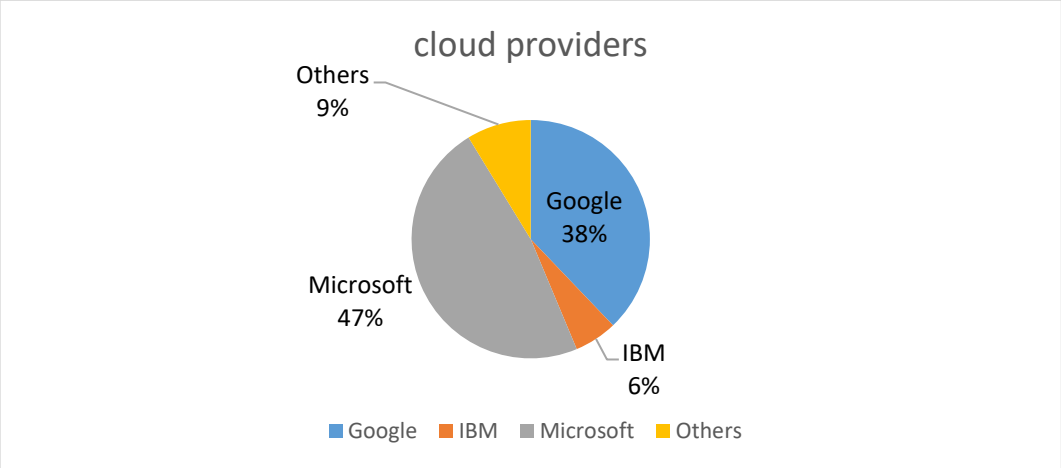

Figure 4: Cloud providers that universities deal with

– **The reasons universities use or plan to use cloud computing offerings.**

Figure 5 shows the most important the main reasons why universities use cloud services Comes first (Reduced hardware infrastructure, software, IT support costs) Then (Disaster recovery capabilities and Business continuity) Then (Scalability on demand / flexibility of IT resources) and then other.

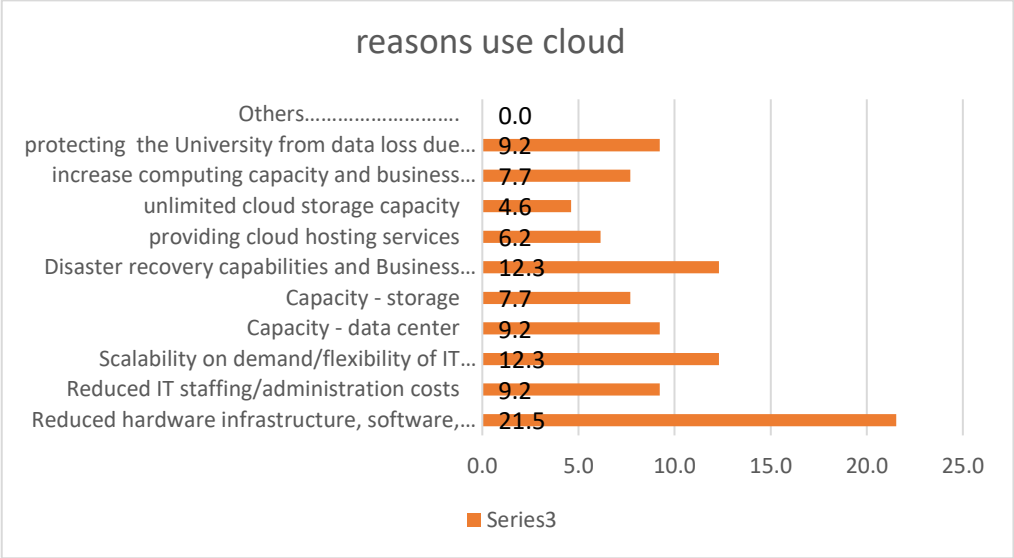

Figure 5: reasons to use cloud computing

– **Cloud Computing Applications**

Figure 6 shows the most important of cloud computing Applications do universities currently use, Microsoft Office 365 comes first, then Google Apps, Windows Azure, VMware, and other applications.

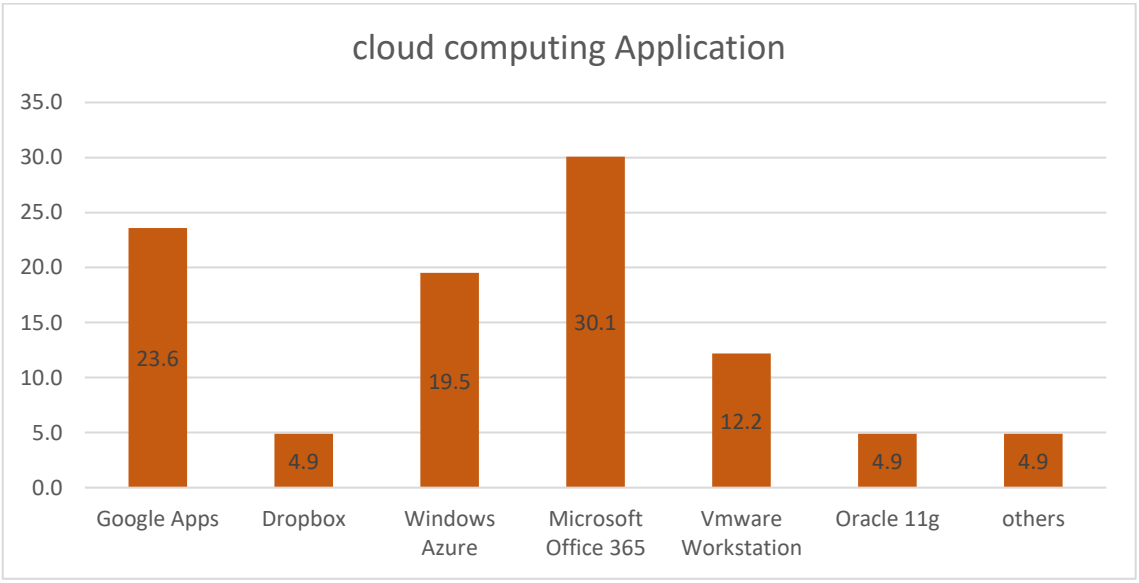

Figure 6: cloud computing Applications do universities currently use

12.2 Cloud Computing Services Evaluation Criteria

– **Measuring Validity For The Indicators:**

The validity value of the indicators ranges between: (0.588) for the tenth item, and (1. 000) for the six items.

Table 4: Measuring validity for the Indicators

no	Indicators	validity	Validity
1	Resources Pooling	0.918	Existing Validity
2	On-Demand Self-Service	0.622	Existing Validity
3	Network Access	0.868	Existing Validity
4	Maintenance	0.905	Existing Validity
5	cost	0.613	Existing Validity
6	Pay as you go	1.000	Existing Validity
7	Measured Service	0.754	Existing Validity
8	Service level agreement (SLA)	0.805	Existing Validity
9	Support	0.683	Existing Validity
10	Security	0.588	Existing Validity

From table 4, all the significances near to 1%, hence they are very significant. Thus, all indicators are characterized with statistical validity.

– **Measuring Reliability For The Indicators:**

Table 5: Cronbach's Alpha Coefficient for Measuring the Consistency of the Study tool between the Contents of the Indicators

no	Indicators	No. of Items	Cronbach's Alpha Coefficient	Reliability
1	Resources Pooling	2	0.958	Existing Reliability
2	On-Demand Self-Service	2	0.789	Existing Reliability
3	Network Access	2	0.932	Existing Reliability
4	Maintenance	2	0.951	Existing Reliability
5	Cost	4	0.783	Existing Reliability
6	Pay as you go	1	1.000	Existing Reliability
7	Measured Service	2	0.868	Existing Reliability
8	Service level agreement (SLA)	6	0.897	Existing Reliability
9	Support	4	0.827	Existing Reliability
10	Security	9	0.767	Existing Reliability

From the results of the previous analysis in Table 5, it is clear that all indicators of measuring cloud computing features are characterized by consistency.

– **Relative Importance and Frequency Distribution**

- **Resources Pooling Indicator**

The following Table 6 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of Resources Pooling.

Table 6: Evaluating of the Sample Items according to the Resources Pooling Indicator

1- The resources are dynamically assigned according to users' needs.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	32	13	21	0	0	4.19	.884	Strongly Agree	84%
Percent	48.5	19.7	31.8	0	0				
2- There is an easy model for controlling the physical resources (storage-RAM-CPU).									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	23	16	21	6	0	3.87	1.032	Strongly Agree	77%
Percent	34.8	24.2	31.8	9.1	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. The resources are dynamically assigned according to users' needs.
2. There is an easy model for controlling the physical resources (storage-RAM-CPU).

- **On-Demand Self-Service**

Table 7 presents the arithmetic means, standard deviations, and cloud computing's significance as an indication of On-Demand Self-Service.

Table 7: Evaluating of the Sample Items according to the On-Demand Self-Service Indicator

3- Self-control of resources available without the need of the service provider.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance

frequency	13	32	16	5	0	3.81	.846	Agree	76%
Percent	19.7	48.5	24.2	7.6	0				
4- User can self-control resources in an easy and flexible way.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	26	7	21	12	0	3.71	1.193	Strongly Agree	74%
Percent	39.4	10.6	31.8	18.2	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:
1. Self-control of resources available without the need of the service provider.
2. User can self-control resources in an easy and flexible way

- **Network Access**

The arithmetic means, standard deviations, and significance of cloud computing with respect to the Network Access indicator are shown in Table 8.
Table 8: Evaluating of the Sample Items according to the Network Access Indicator

5- The user can access the data of the cloud or upload the data to the cloud from anywhere									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	39	15	12	0	0	4.42	.780	Strongly Agree	88%
Percent	59.1	22.7	18.2	0	0				
6- Always provide Internet access while using a service									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	27	28	11	0	0	4.27	.705	Agree	85%
Percent	409	42.4	16.7	0	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. The user can access the data of the cloud or upload the data to the cloud from anywhere
2. Always provide Internet access while using a service

- **Maintenance**

The following Table 9 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of Maintenance.

Table 9: Evaluating of the Sample Items according to the Maintenance Indicator

7- The servers are easily maintained and the downtime is very low									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	9	30	27	0	0	3.74	.700	Agree	75%
Percent	13.6	45.5	40.9	0	0				
8- testing and implementing product upgrades and new releases									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	9	27	25	5	0	3.63	.834	Agree	73%
Percent	13.6	40.9	37.9	7.6	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. The servers are easily maintained and the downtime is very low
2. Testing and implementing product upgrades and new releases

- **Cost**

The following Table 10 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of cost.

Table 10: Evaluating of the Sample Items according to the cost Indicator

9- Cloud computing reduces capital expenses (like the cost of buying a data center in your university).									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagr	means	Std. Deviation	Orientation	Relative importance

					ee				
frequency	14	23	19	6	4	3.60	1.093	Agree	72%
Percent	21.22	34.8	28.8	9.1	6.1				
10- Cloud computing reduces the cost of buying new software licenses in your university.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	7	20	26	9	4	3.29	1.014	Neutral	66%
Percent	10.6	30.3	39.4	13.6	6.1				
11- The Elasticity reduces the cost of cloud computing									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	8	37	21	0	0	3.81	.649	Agree	76%
Percent	12.1	56.1	31.8	0	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. The Elasticity reduces the cost of cloud computing
2. Cloud computing reduces capital expenses (like the cost of buying a data center in your university).
3- Cloud computing reduces the cost of buying new software licenses in your university

- **Pay as You Go**

The following Table 11 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of Pay as you go.

Table 11: Evaluating of the Sample Items according to the Pay as you go Indicator

12- Offering the flexibility to pay only for the modules/functionality you need when and where you need them									
	Strongly	Agree	Neutral	Disagree	Strongly	means	Std. Deviati	Orientation	Relative importa

	Agree				Disagree		on		nce
frequency	27	23	16	0	0	4.21	.792	Strongly Agree	84%
Percent	40.9	34.8	24.2	0	0				

It is clear from the table that the percentage of the opinions of the study sample who view the Pay as you go indicator as strongly supportive to the paragraph (Offering the flexibility to pay only for the modules/functionality you need when and where you need them) has a big role in the evaluation of the cloud with the relative importance of (84%).

- **Measured Service**

The following Table 12 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of Measured Service.

Table 12: Evaluating of the Sample Items according to the Measured Service Indicator

13- The user is billed based on the amount of resources they use.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	28	18	16	4	0	4.13	.932	Strongly Agree	83%
Percent	42.4	27.3	24.2	6.1	0				
14- Cloud computing provide means to capture, monitor, and control usage information for accurate billing.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	27	13	20	6	0	3.97	1.055	Strongly Agree	79%
Percent	40.9	19.7	30.3	9.1	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. The user is billed based on the amount of resources they use.
2. Cloud computing provide means to capture, monitor, and control usage information for accurate billing.

- **Service level Agreement (SLA)**

The following Table 13 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of SLA.

Table 13: Evaluating of the Sample Items according to the SLA Indicator

15- You are satisfied with the achievement of security condition mentioned in the SLA.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	18	26	22	0	0	3.95	.777	Agree	79%
Percent	27.3	39.4	33.3	0	0				
16- You are satisfied with the achievement of availability condition mentioned in the SLA									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	17	35	14	0	0	3.97	.724	Agree	79%
Percent	25.8	53.0	21.2	0	0				
17- You are satisfied with the achievement of the support condition mentioned in the SLA									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	16	32	18	0	0	3.71	.818	Agree	74%
Percent	24.2	48.5	27.3	0	0				
18-You are satisfied with the achievement of the cost condition mentioned in the SLA.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
freque	41	9	16	0	0	3.71	.876	Strongl	74%

ncy								y Agree	
Percent	62.1	13.6	24.2	0	0				
19- The SLA provides a list of all services provided by the cloud provider with a full definition of each service									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	11	27	24	4	0	3.74	.867	Agree	75%
Percent	16.7	40.9	36.4	6.1	0				
20- SLA is one of the most important criteria you have to in evaluating cloud computing services.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	12	30	18	6	0	4.23	.734	Agree	85%
Percent	18.2	45.5	27.3	9.1	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. SLA is one of the most important criteria you have to in evaluating cloud computing services.
2. You are satisfied with the achievement of availability condition mentioned in the SLA.
3- You are satisfied with the achievement of security condition mentioned in the SLA.
4- The SLA provides a list of all services provided by the cloud provider with a full definition of each service.
5- You are satisfied with the achievement of the support condition mentioned in the SLA.
6- You are satisfied with the achievement of the cost condition mentioned in the SLA.

- **Support**

The following Table 14 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of Support.

Table 14: Evaluating of the Sample Items according to the Support Indicator

21- The diversity (in support channels) has a big role in the evaluation of the cloud.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	14	23	25	4	0	4.18	.779	Neutral	84%
Percent	21.2	34.8	37.9	6.1	0				
22- The support channels provided to your university are diversity									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	26	28	12	0	0	3.92	.731	Agree	78%
Percent	39.4	42.4	18.2	0	0				
23- The level that provided for your University (24/7)									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	26	23	17	0	0	3.60	1.373	Strongly Agree	72%
Percent	39.4	34.8	25.8	0	0				
24- The level of support provided to suitable with the nature of your work.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	15	31	20	0	0	3.84	.814	Agree	77%
Percent	22.7	47.0	30.3	0	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. The diversity (in support channels) has a big role in the evaluation of the cloud
2. The support channels provided to your university are diversity
3- The level of support provided to suitable with the nature of your work.
4- The level that provided for your university (24/7).

- **Security**

The following Table 15 shows the arithmetic means, standard deviations and the importance of cloud computing in terms of the indicator of Security.

Table 15: Evaluating of the Sample Items according to the Security Indicator

25- The cloud provides complete security for educational sensitive data									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	25	9	18	8	6	3.47	.783	Strongly Agree	69%
Percent	37.9	13.6	27.3	12.1	9.1				
26- When using data Backup service, the data is secured enough.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	13	32	18	3	0	3.53	.900	Agree	71%
Percent	19.7	48.5	27.3	4.5	0				
27- The connection used for data transmission is encrypted enough									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	5	27	28	6	0	3.69	.737	Neutral	74%
Percent	7.6	40.9	42.4	9.1	0				
28- The cloud protects enough all your data in case of natural disasters.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	11	19	30	6	0	3.98	.757	Neutral	80%
Percent	16.7	28.8	45.5	9.1	0				
29- Cloud computing reduces the cost of buying new software licenses in your university.									

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	10	24	32	0	0	3.53	1.251	Neutral	71%
Percent	15.2	36.4	48.5	0	0				
30- The Elasticity reduces the cost of cloud computing.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	17	29	20	0	0	3.94	.827	Agree	79%
Percent	25.8	43.9	30.3	0	0				
31- Actual percentage of availability (uptime and downtime) provided in your university is enough									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	17	20	16	7	6	3.37	.794	Agree	87%
Percent	25.8	30.3	24.2	10.6	9.1				
32- Your level of availability is appropriate for the nature of work and the type of used applications in your university.									
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	means	Std. Deviation	Orientation	Relative importance
frequency	20	21	25	0	0	4.05	.711	Neutral	81%
Percent	30.3	31.8	37.9	0	0				
33- The availability issues are being resolved as soon as possible when contacting with the cloud provider.									
	Strongly	Agree	Neutral	Disagree	Strongly	means	Std. Deviati	Orientation	Relative importa

	Agree				Disagree		on		nce
frequency	37	15	14	0	0	3.92	.685	Strongly Agree	78%
Percent	56.1	22.7	21.2	0	0				

It is also clear from the table that the most important elements according to the relative importance standard are as follows:

1. Actual percentage of availability (uptime and downtime) provided in your university is enough
2. Your level of availability is appropriate for the nature of work and the type of used applications in your university.
3- The cloud protects enough all your data in case of natural disasters.
4- The Elasticity reduces the cost of cloud computing.
5- The availability issues are being resolved as soon as possible when contacting with the cloud provider.
6- The connection used for data transmission is encrypted enough.
7- Cloud computing reduces the cost of buying new software licenses in your university.
8- When using data Backup service, the data is secured enough.
9- The cloud provides complete security for educational sensitive data.

– **Coefficient Of Variation**

Coefficient of variation measure the degree of dispersion value form the arithmetic means, when Coefficient of variation value reduces, it indicates the approved of all questionnaire sample opinions and agreement over the importance of every indicator. To measure the variability of the different answers of each question around its mean and compare this variability among the different questions.

Table 16: Coefficient Variation for all indicators

Indicators	Coefficient variation	Ascending Order
Resources Pooling	22.44%	10
On-Demand Self-Service	21.24%	9
Network Access	15.53%	1
Maintenance	19.53%	7
Cost	19.13%	6
Pay as you go	18.82%	5
Measured Service	20.58%	8
Service level agreement	15.90%	2
Support	17.97%	3

Security	18.29%	4

It is clear from the previous table that Coefficient Variation value ranges between the highest Coefficient Variation for Resources Pooling indicator (22.44 %) and the lowest Coefficient Variation for Network Access indicator (15.53%), which means that Network Access the best in terms of Coefficient Variation. Therefore, the lowest indicator in terms of Coefficient Variation can be ordered as follows:

1. Network Access
2. Service level agreement (SLA)
3. Support
4. Security
5. Pay as you go
6. Cost
7. Maintenance
8. Measured Service
9. On-Demand Self-Service
10. Resources Pooling

13. Conclusion

The most significant discovery is that, in terms of cost advantages, cloud computing is perfect for institutions. Nonetheless, using cloud computing is not as advantageous in terms of security. Adopting private cloud computing is more cost-effective and secure for colleges due to these advantages.

The study also concluded that universities in Egypt give more importance to the SLA, Security and Support as indicators of cloud computing evaluation than other indicators such as Maintenance, Measured Service, and Resources Pooling.

The most prominent cloud computing services offered at academic information centers at universities, Microsoft Office 365, Google Apps and Windows Azure.

The main benefits of using cloud computing in universities by study participants are reduced hardware infrastructure, software, IT support costs, Disaster recovery capabilities and Business continuity and Scalability on demand / flexibility of IT resources.

The main obstacles to using cloud computing in universities is availability of services and/or data concerned problems, security issues, speed issues, dissatisfaction with vendor offerings/pricing and performance issues.

The most important companies which provide cloud computing service offered at academic information centers at universities Microsoft and Google.

All indicators point out to the existence of a degree of high important in evaluate the reality of the use of cloud computing applications in the universities in Egypt.

All indicators point out to the existence of a degree of agreement for advantages of the services cloud computing provides to the IT centers in universities in Egypt and that it is a technology which suits the requirements of Enterprises through the use of the tools and means of technology.

14. Recommendations:

The following are some suggestions that may be made regarding the adoption of cloud computing technology at universities, based on prior findings from the study and statistical analysis:

• University management should be informed about ongoing developments in cloud computing technology and the significance of its use.

• University management should have a strategy to adopt cloud computing, and its uses in IT operations.

• The university should incorporate cloud computing technology into its operations, as it is an appealing technological and financial option to the university.

• Academic institutions ought to provide conferences, seminars, and training sessions for their IT personnel concerning the nature, significance, and application of cloud computing technology.

•To reduce security concerns, the institution is able to store non-sensitive data and apps on public cloud servers.

• The institution can set up a hybrid cloud, which includes a private cloud to protect data security and secrecy and a public cloud to house non-sensitive and public applications.

15. Future work

Because cloud computing is a relatively new issue in the IT industry, the study discovered that there is little research on the technology generally in the Arab world. Thus, the door is open for more scholarly investigation into this technology. The following subjects were recommended by the study as potential areas for further investigation:

- Carry out research on the adoption roadmap for cloud computing in the academic process.
- Carry out research about the Ministry of Higher Education's use of cloud computing to monitor and track all university activities.
- Carry out research on how mobile cloud computing is being adopted in the academic process and how it affects students' activities.

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