A MODEL FOR ADOPTING CLOUD COMPUTING IN GOVERNMENT SECTOR: CASE STUDY IN IRAQ

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ABSTRACT

A MODEL FOR ADOPTING CLOUD COMPUTING IN GOVERNMENT SECTOR: CASE STUDY IN IRAQ

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Cloud computing is a delivery of on-demand computing resources such as servers, databases, storage, networking, software, analytics and more over the Internet on a pay-for-use basis. The users can from anywhere at any time control these resources via a simple software interface, which facilitates its usage, and helps in getting rid from many details and internal processes. This technology is not currently widely utilized in public sector institutions, especially in the case of Iraq for different factors and reasons. The main objective of this research is to identify the most critical factors preventing cloud computing adoption in government institutions in Iraq by developing a conceptual model for cloud technology adoption that integrates the theories of TOE, Iacovou et al. and DOI. The key factors influencing the adoption of cloud technology have been investigated and determined through literatures review. To achieve research objectives, this study used the methodologies of quantitative research, and a self–administered questionnaire has been used as an essential tool to collect primary data that has been analyzed through the statistical SPSS program. Moreover, CloudAnalyst simulator is used to identify the real time performance for cloud technology environment, and two algorithms have been

applied via this tool, namely the AHP technique which used to obtain the weight of variables depending on the questionnaire results, and ECDSA algorithm which used to identify the privacy and security of cloud technology. Finally, a thorough set of guidelines have been proposed in order to help Iraqi government institutions to move to cloud environment in an effective manner.

Keywords: Cloud Computing, public sector, government institution, DOI, TOE, Iacovou et al., CloudAnalyst, AHP, ECDSA.

OZ

HÜKÜMET SEKTÖRÜNDE BULUT BILIŞIM TEKNOLOJILERINI KULLANMAYA YÖNELIK BIR MODEL: IRAK'TA ÖRNEK-OLAY INCELEMESI

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Bulut hesaplama, kullanım süresi üzerinden Internet sunucular, veritabanları, depolama, ağ, yazılım, analiz ve daha fazlası gibi isteğe bağlı bilgi işlem kaynaklarının bir sunumudur. Kullanıcılar, herhangi bir yerden, bu kaynakları, kullanımını kolaylaştıran ve birçok ayrıntıdan ve iç süreçten kurtulmaya yardımcı olabşlen basit bir yazılım arayüzü üzerinden kontrol edebilir. Bu teknoloji, kamu kurumlarında, özellikle de Irak'ta farklı faktörler ve nedenlerle yaygın olarak kullanılmamaktadır. Bu araştırmanın temel amacı bulut teknolojisinin benimsenmesi için TOE, Iacovou ve DOI kuramlarını bütünleştiren kavramsal bir model geliştirerek Irak'taki devlet kurumlarında bulut bilişiminin benimsenmesini önleyen en kritik faktörleri tanımlamaktır. Bulut teknolojisinin benimsenmesini etkileyen başlıca faktörler literatür taraması ile incelenmiş ve tespit edilmiştir. Araştırma hedeflerine ulaşmak için bu çalışma nicel araştırmanın metodolojilerini kullanmış ve istatistiksel SPSS programı ile analiz edilen birincil verileri toplamak için kendinden

yönetilen bir anket kullanılmıştır. Ayrıca bulut teknolojisi ortamı için gerçek zamanlı performansı belirlemek için CloudAnalyst simülatörü kullanılmış ve bu araçla iki algoritma uygulanmıştır: AHP tekniği, anket sonuçlarına göre değişkenlerin ağırlığını elde etmek için ve ECDSA algoritması bulut teknolojisinin mahremiyetini ve güvenliğini tanımlamak için kullanılmıştır. Son olarak, Irak hükümet kurumlarının bulut ortamına etkili bir şekilde geçmesine yardımcı olmak için eksiksiz bir kılavuz seti önerildi.

Anahtar Kelimeler: Bulut Bilişim, Kamu Sektörü, Devlet Kurumu, DOI, TOE, Iacovou ve ark., CloudAnalyst, AHP, ECDSA

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
App	Application
BW	Bandwidth
CC	Cloud Computing
CSP	Cloud Service Provider
DC	Data Center
DOI	Diffusion of Innovation
DSA	Digital Signature Algorithm
M.	Mean
S. D.	Standard Deviation
ECDSA	The Elliptic Curve Digital Signature Algorithm
HW	Hardware
ICT	Information and communications technology
IS	Information System
IT	Information Technology
PC	Personal Computer
SLA	Service Level Agreement
SPSS	Statistical Package for the Social Sciences
SW	Software
TOE	Technology, Organization and Environment (TOE) Framework
US	User Base
VM	Virtual Machine

CHAPTER 1

INTRODUCTION

1.1 Background

Cloud computing is among the key technologies in the range of Internet of things which considered as the third wave in the world in information industry after the innovations of computer and Internet [1]. The cloud technology has gradually taken its way amongst small, medium, large organizations and now governments and public sector [2].

Cloud computing can be defined as “an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of-service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource into appropriate blocks" [3].

Various transactions of commerce and industry are presently utilizing computing cloud computing resources, which have been classified as one of the ten leading technologies of the 21st century [4]. According to International Data Corporation (IDC), the marketplace of cloud services is currently going into an "innovation stage" that enhances innovative cloud solutions and cause massive shift toward using it. IDC predicts that at the coming year of 2018, as a minimum, fifty percent of IT spending is going to be cloud-based, achieving sixty percent of all IT infrastructure, and sixty to seventy percent of the entire technology, services and

software spending in the year of 2020 [5]. Besides, Deloitte predicts that procuring of IT technologies is going to step up in the coming two and half years from 361 to 547 billion dollar. At this rate, IT-as-a-Service is going to stand for further than fifty percent of IT spending in the years of the 2021/2022 [6, 7].

Several governments have been put their plans to the gradual migrating for Cloud environment, as they find this as an opportunity to enhance the outcome of business by redundancy removal, increment agility and offering IT services at less possible expenses [8]. Cloud computing frees institutions from the need to set up an information technology infrastructure and enables them to rent resources (electricity, hardware and software) and pay only for the used services [9]. Additionally cloud computing increases flexibility and offers rapid elasticity, broad network access, and superior performance for organization to grow.

One of the most important cloud technology opportunities for the public sector is the capability to allocate ICT resources along with various agencies [10] However, prior migrating to cloud, government decision-makers must take into consideration the possible savings, boosted collaborative abilities and operational features with other issues like security, availability and privacy. There are various issues which can be barriers to adopt cloud such as: regulatory framework for CC that aims to ensure the availability, accessibility, data privacy at a nationwide [11]; lack of awareness, low Internet connection, low security of cloud services, trust absence and low interoperability with current systems [12].

Obviously, the cloud is not a panacea for all institutions and although, the institutions gain diverse benefits from adopting cloud technology, an effective adoption in any institution requires a full understanding of various dynamics and expertise in various domains. Most earlier studies on cloud computing have concentrated on technical and operational issues. Little studies have handled the cloud adoption from organizational or governmental perspectives especially in Iraq.

This research provides an advanced overview of cloud technology, outlines some of the main features and critical challenges it can deliver to government sector. In order to achieve this goal, the researcher adopts technology, organization and

environment (TOE) framework along with diffusion of innovation (DOI) and Iacovou et al. theories which provide a depth understanding of relevant constructs for organizational cloud adoption. As well as a thorough investigation study will be performed to help the government recognize the reasons for not adopt cloud computing yet. Furthermore, this research will use CloudAnalyst simulator as it useful tool to measure the real time performance of cloud computing environments and enable users to realize a simulation with a large degree of configurability and flexibility. Finally propose guidelines that can help Iraqi government institutions to move to cloud environment in an effective manner

1.2 Literature Review

The major notion of cloud computing is originated in 2004. Formerly, the cloud symbol was represented the Internet concept before 1994. In 2006, when Amazon Web service (AWS) was primarily initiated a utility computing source, the fundamental nature of cloud computing had been begun for the industry. The scheme of an "intergalactic computer network" was set up in the 60s by J.C.R. Licklider, who was in charge for facilitating the expansion of ARPANET (Advanced Research Projects Agency Network) in 1969 [13].

Accordingly, cloud computing is somewhat new to the literature. Generally, it has been initiated beyond 90s, and it has been more improved after millennium stage. The name of cloud had been created for the reason that the sent data couldn't be tracked anymore when moving towards it destination. In the former years of cloud computing, the Amazon institution was dynamic in the field of cloud computing. This institution was previously a huge investing society in cloud computing, including huge data centers which usually merely employ eight to twelve percent of its computing power. The remaining computing power was held in reserve for compulsory peak usage. Amazon institution launched cloud computing to save expenditures in these enormous data centers. In the year of 2006, Amazon institution started to supply cloud computing for customers in all over the world. Subsequently Google and IBM have shown a big significance for cloud computing

and begun to invest it as potential and promising tool in the field of information technology [14].

In the case of Iraq, the advances of E-Governance and cloud technology are still very low. However, according to [15] Iraq has an implementation rate of 25% of planned E-government online services. We perceive there is better setting up of E-government processes than cloud computing project which is still near the ground. These limitations results from many deteriorating factors, most of them attributed to bad safety situations, political issues and the dominant corruptions in Iraqi institutions [16].Cloud based E-government has numerous gains to organization like less distributed data storage, cheaper resources availability, more security control, more scalability, and responsibility.

The Iraqi authority is in the sensitivity levels of expanding an E-government and cloud computing schemes in an atmosphere which depends on pioneering inspirations; these inspirations will initiate impulses toward a positive and prosperous future [17]. Because of the bad security situations since 2003, Iraq realizes itself toward special conditions with how to go forward to be in a way of development.

The Ministry of Science and Technology and the Ministry of Communication have positioned pre-steps for establishing the infrastructure of E-government in Iraq with the aid of USAID since 2004. These ministries declared that the stage after the year 2010 would represent the communication networks achievement in Iraq for E-government project preparation to provide various services to citizens and public organizations [18].

Wahsh and Dhillon [19] performed empirical study about applying cloud computing for e-governance in Iraq. The findings of this study demonstrate that technology readiness and trust have no noteworthy weight on E-government adoption via cloud computing. On a wider viewpoint, non-technological factors necessitate further consideration than technological factors.

Mohan et al. [20] suggested cloud prototype project for the University of Technology (UTC) in Iraq. This project facilitates E-services and applications to be

accessible through a web site page like Google drive or Microsoft office. This project assists Iraqi universities as a solution to decrease the expenditure of information technology constraints, time provision and makes it easy to use for Higher Education in Iraqi institutions.

Another study conducted by Hashim and Hassan [21], in this study the social and technological factors to adopt cloud technology in educational institutions in Iraq have been explained. Their conceptual model and scientific survey was based on unified theory of acceptance and use of technology (UTAUT). This study has been conducted through academic staff, students, and non-academic staff of Kufa University in Iraq using stratified sampling procedures.

Al-Khayat et al. [22] proposed general model composed of six service layers, with several characteristic for adopting and applying cloud technology for serving engineering institutes and colleges to be capable to perform an educational cloud technology plainly, readily and transforming them from the vortex of modernization and maintenance of infrastructure. The proposal model enables developers to generate reusable and elastic layers to offer services efficiently to their students, employees, and faculty. As well as it helps in reducing time, effort, and cost.

Al-Ani and Ibrahim [23] suggested a well-organized cloud background for Iraqi Ministry of Higher Education and Scientific Research. The technique used is reliant on the number of things that could take place from universities in the ministry. The load can be managed by duplicate data and applications in some servers set up in the center, east, and west of Iraq. The load as well can be restricted by signifying use of load balance and routing protocol algorithms.

In the Alazawi et al. [24] study, ITS (intelligent transportation systems), C2C (car to car), C2I (car to infrastructure) and VANETS (vehicular ad hoc network) terms have been exploited using mobile and Cloud computing technologies. They presented an intellectual disaster managing system. This system’s structural design and components have been illustrated and determined by modeling and simulations and its effectiveness have been displayed in terms of improved disaster evacuation characteristics in Ramadi city in Iraq.

In this thesis a comprehensive study about cloud computing adoption in the Iraqi governmental sector will be conducted based on an efficient questionnaire and empirical cloud computing model using CloudAnalyst simulator as compared with above studies which are based on only survey analysis or conceptual models or some proposed managerial steps. As well as, this study suggests comprehensive guidelines to a successful adoption of cloud technology in the Iraqi governmental institutions.

1.3 The Major Objectives of This Study

Cloud computing technology has important effects in all over the world. It affects citizen's daily life, economy, business and the way of public services delivered to citizens. This technology is not currently widely utilized in public sector institutions, especially in the case of Iraq for different factors and reasons. This research investigates the abilities of public sector institutions and their level of readiness, and proposing a conceptual model for cloud technology adoption, by integrating DOI, TOE and Iacovou et al. theories to identify the most critical factors preventing cloud computing adoption in government sector in Iraq. As well as a thorough investigation will be conducted to assist the government institutions to perceive the reasons for not adopting the cloud technology yet, and motivate them to adopt cloud technology by proposing comprehensive guidelines. Additionally, CloudAnalyst simulator will be used to identify the real time performance for cloud technology environment, as well as employing two algorithms through this tool, namely AHP technique to obtain the weight of variables according to the questionnaire results, and ECDSA algorithm which will used as a way to measure the security and privacy of cloud technology.

1.4 Layout of Thesis

This thesis is prearranged as follows:

- Chapter One: In this chapter, the problem background, literature review of the history of cloud computing, and the related studies in Iraq, are provided in this chapter. Lastly, the main aims of this study are indicated briefly in this chapter.
- Chapter Two: It includes the general definitions of cloud computing, the architecture of cloud technology (deployment and service models), Cloud computing network are presented in this chapter. Finally, a comparison between cloud and other technologies will be illustrated in this chapter.
- Chapter Three: It discusses the three adoption models that used in information systems (IS) and their related factors. Finally, a proposed conceptual model for cloud adoption in Iraq will be given in this chapter.
- Chapter Four: This chapter explains the used routine to do this study. It starts with describing the overall methodology in this thesis, the research procedure, data investigation methods and the resources used to carry out this study.
- Chapter Five: It stands for the area where the survey results, as well as the results of CloudAnalyst tool, were discussed in this chapter.
- Chapter Six: It describes the findings of the whole thesis, research's guidelines, and recommendations for future studies.

CHAPTER 2

CLOUD COMPUTING OVERVIEW

2.1 Introduction

This chapter presents general idea about cloud computing in theory. The objective of this chapter is to draw attention to preceding studies about cloud computing definitions that has common characteristics with the theme of this thesis. There will be some points to be discussed in general, including the deployment model of cloud, its delivery models and essential cloud computing network elements. This chapter will also consist of the cloud computing difference in accordance with other technologies.

2.2 Definition of Cloud Computing

Various cloud computing definitions have been offered by literature. These definitions cover a range of perspectives and contain devious degrees of details.

According to Lin et al. [25] "Cloud computing is a nascent business and highly disruptive technology concept with different meanings for different IT professionals. For application and IT users, it is IT as a service (ITaaS), delivering computing, storage, and applications over the Internet from centralized data centers. For Internet application developers, it is an Internet-scale software development platform and runtime environment, whereas for infrastructure providers and administrators, it is massive, distributed data center infrastructure connected by IP networks"

There are descriptions that identify a cloud as restructured edition of computing service [26]. Another defines cloud computing as" whatever thing you can access exterior to your firewall, even outsourcing" [27].

McFedries [28] clarified cloud term as "cloud computing, in which not just our data but even our software resides within the cloud, and we access everything not

only through our PCs but also cloud-friendly devices, such as smart phones, PDAs... the mega computer enabled by virtualization and software as a service, this is utility computing powered by massive utility datacenter".

Wang and Laszewski [29] defined cloud computing as " A computing Cloud is a set of network enabled services, providing scalable Quality of Service guaranteed, normally personalized, inexpensive computing platforms on demand, which could be accessed in a simple and pervasive way" .

In terms of Quality of Service (QoS), cloud technology is defined as " A large pool of easily usable and accessible virtualized resources, these resources can be dynamically reconfigured to optimum resource utilization ,this pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLA's" [30].

In Cisco's point of view, cloud term has been explained as:
"Cloud computing is a broad term but in our view maps to methods that deliver infrastructure, services, and software via the network on demand, and at scale, Cloud is based on a foundation of virtualization, in which pools of (virtualized) resources are dynamically organized for the benefit of software applications and services" [31]. Likewise, clouds are described as " virtualized hardware, and software plus the previous monitoring and provisioning technologies" [32].

In accordance with Rajan and Jairath [33], cloud computing has been illustrated as "the next generation model of computing".

A different meaning has been reported from Mark who defined cloud computing as "It basically refers to the delivery of information technology (IT), including software, via the public Internet or private networks based on Web standards" [34].

IEEE Computer Society defined Cloud as "A paradigm in which information is constantly stored in servers on the Internet and cached temporarily on clients that include desktops, entertainment centers, computers, notebooks, handhelds, etc." [35].

This thesis considers the characterization of National Institute of Standards and Technology (NIST), USA, that defined 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" [36].

2.3 Cloud Computing Deployment Models

NIST has identified four models or types of cloud computing that can be implemented to meet the various needs of clients and/or providers. Those models are public, private, community, and hybrid that differ in the location of the infrastructure, which party is responsible for management and maintaining the system, and who can use system resources? [37].

2.3.1 Public Clouds

Public cloud providers offer the access to multiple services to many individuals and institutions over the Internet so they can benefit from the provided services and share resources. Amazon, Google and Force.com are the major public cloud providers who are offering reliable and efficient services at low costs to institutions of different sizes [38, 3].

The public cloud model offers many benefits over other models. In particular the financial cost for new projects has significantly decreased, as you pay only to the amount of resources used. Also public cloud providers create the illusion of unlimited resources and provide a high on-demand scalability and elasticity to customers [39]. However, there are many drawbacks associated with public cloud such as:

- The location of data is unknown, since data is stored beyond the firewall of the institution.
- The data is stored in multiple places, perhaps in different countries, and many countries have regulations to store data only inside the country.
- Various factors can affect the availability on public cloud for example cloud services requires high Internet connectivity and cloud services could be unavailable

because of resources failure which can caused by limited hardware capacity as well as potential attacks such as denial of service attacks (DoS) [4].

2.3.2 Private Cloud

A cloud computing infrastructure specifically built to serve an institution to fit the specific institution requirements. It can exist on or off premises, the institution itself can take charge of management or it could be managed by CSP [40]. This kind of cloud is often suitable for larger institutions and gives them greater control over the cloud infrastructure [3]. Most institutions prefer to adopt this kind of deployment model due to many reasons such as:

- The need to increase and promote the employment of existing in-house resources.
- Overcoming security, privacy and trust concerns [38].

However, there are some drawbacks of using private cloud such as:

- Limited scalability and flexibility to meet the grow requirements over the years [41].
- It requires a large set of investment and operational outlay as well as staff with highly technical skilled which increases the cost [42].
- The security of your data becomes totally institution's responsibility so the defense against all potential attacks must be done within the institution [43].

2.3.3 Community Cloud:

Multiple institutions can share cloud infrastructure and support a particular society who has the same issues like mission, security, policy, and regulations. This kind of cloud can be administrated by the institutions itself or through a second party and can be located in or off institutions' premises [44]. It merges the benefits of private cloud where the employees could focus on their core missions and public clouds in terms of security and sharing resources between employees [4].

Benefits of a community cloud include:

- Satisfies on demand requirements of the institutions by secure, private multi-renter cloud system.

- Large scalability.
- Minimize the financial cost by eliminating owned IT infrastructure and applications licenses requirements.
- Quickly implementation, less development time, and simple access to cloud environments.
- It has a high ability of storage and backup.
- Developed analytics solutions [45].

Drawbacks of community cloud are:

- Multiple global industries that somewhere and sometimes can be affected by natural disasters and other events like war can use community cloud for disaster recovery and business continuity [45].
- All employees share a stable quantity of storage and BW.
- Trust and security concerns because of potential hackers [40].

2.3.4 Hybrid Cloud:

"It is a combination of two or more different cloud models (private, community, public) each one remains a unique entity, but is bound together by standardized technology that enables data and application portability" [46].

Institutions can have many advantages by using hybrid cloud such as:-

- Keeping sensitive data and critical applications in its own private cloud while regular data and non-critical applications is outsourced to public cloud [47 , 42].
- This model takes the advantages of all the models which are part of it such as data security and privacy of private cloud as well as scalability and low cost of public cloud [46].
- It offers more flexibility than both public and private clouds.
- Promote institutional agility, by benefits from public cloud in times of high usage; the institution can face little outages and minimal downtime

Drawbacks of hybrid cloud

- A security risk that may come from integrates of different types of clouds.
- Concerns about how manage different platforms at same time.
- Portability and compatibility are considered to be main issues in hybrid clouds [4].

2.4 Cloud Based on Delivery Models

Cloud computing servers set up three services classified principally into three models. SaaS model represents the top-layer which delivers applications on demand. PaaS model represents the middleware layer which offers platform and/or application services in cloud environment. Finally IaaS model represents an elastic infrastructure of multi data center services which are connected by the Internet [25].

2.4.1 Software as a Service (SaaS)

"Software as a service is the highest level in the abstraction of service layers. The software services are hosted on the infrastructure of the cloud provider, and are delivered over a network" [41] . The application will be run on cloud environment, and there is no need to install or run them in client computers anymore. Also the applications could be accessed at any time from any place on-demand as in web browser.

In SaaS model all users' applications are organized in an individual logical platform in order to achieve an economical scale and optimize services such as (availability, speed, security, maintenance and disaster recovery) [38]. This kind of service is useful to customer institutions as it eases the administration of applications, enables perfect homogeneity to versions among application users as well as supplies global accesses and cooperation [41]. Examples of SaaS are social applications such as Gmail, Twitter and Facebook [3].

The underlying cloud infrastructure such as (storage, operating systems, network, servers and individual application abilities) does not get managed or controlled by clients, with the possible exception of configuration settings of each clients-specific application [48].

2.4.2 Platform as a Service (PaaS)

In PaaS, clients create applications on the CSP's infrastructure utilizing programming languages offered by cloud provider, for instance generate a web-based

network for clients. This platform might contain the capability of hosting control networks, servers, the upgrades of APPs, in order to facilitate building and checking web applications [37]. The clients do not control or manage the underlying cloud infrastructure such as (storage, network, operating systems or servers). However, they have control onto the installed applications and host the application configuration environment [48].

Expressly, an appropriate environment will be offered to the developers to create applications without the cost and complexity of purchasing and managing the underlying layers of hardware and software [26]. Various instances of PAAS can be found in a cloud environment like, Google App Engine, Microsoft Azure, Amazon Elastic Beanstalk, EngineYard , Mendix [49,50].

2.4.3 Infrastructure as a Service (IaaS)

"IaaS is the most general form of cloud services. It refers to lower-level services such as the access to virtual machines, storage services, databases or queue services which are required to build an application environment from scratch" [50].The clients cannot manage the core infrastructure of cloud, however they have control onto storage, operating systems, diffused apps, and perhaps determine the components of networking as in firewalls and load balancers [48].

This enables clients to have diverse computing resources like (savings, processing, storage or networks). It allows them run hypothetical software, including operating systems and applications. The clients will have a complete control on storage, operating systems and particular applications. As well as the clients will have limited control on the facilities of networks [51]. As compared with SaaS and PaaS, users of an IaaS solution have to assume all security sides except physical security. As well as the cost of IaaS is higher than the other two models [52]. The three major IaaS providers nowadays are GoGrid, Amazon and Mosso [50].

2.5 Cloud Computing Network

In most cases, there are three core elements in cloud computing which are: the servers, the data centres and the clients [53]. All of them are connected throughout the Internet with each other and they are visible as network configurations.

2.5.1 Data Centres and Distributed Servers

Data centres usually include the services that customers would like to acquire at any time they require them. This DC is often a wide space that has the entire servers offering these services and saving and operating them. It is as well probable to comprise virtual servers that decrease the total real servers and required space [54]. Distributed servers stand for groups of servers which are not in single position. Distributed servers' present elevating elasticity since there is no matter for their locality, as well as they have connection to the Internet. It is easy to conduct backing up to other servers. Moreover, there are no restrictions in extending the cloud [53].

2.5.2 Clients

Clients represent in general ordinary laptops or desktop PCs. Other kinds of clients, at the present time, can be mobile phones [55]. The mobile phones are essential for cloud computing. They supply big levels of mobility to ones who are attempting to access the cloud. As a general rule, there are two classes of clients to discriminate which are mobile, thin and thick clients. Mobile clients are always with mobile phones. Thin clients are operated by means of isolated software and hardware. Whatsoever a user perceives, it is recognized by the server and not by user personal hard disk with operating system. In contrast, thick clients employ their hard disks and regularly use the cloud via a web browser [53].

2.5.3 Users

Understandably, after the clients, the users will be appeared. No users means no reason for a cloud existing. By cloud technology, four dissimilar sorts of users can be classified as follows [14]:

- Web browser Infrastructure developers

- Service creators
- Stipulation and Integration specialists
- Ending users

The (Internet-infrastructure) developers in the cloud stand for experts who expand and keep up the cloud. These developers should make assurance and develop the entire integrated services. Their duty is to present ending users with a simple interface, and maintaining the complication issues at the least possible levels.

Service authors or creators are very different from developers although in many cases they end up with overlapping tasks. Where developers focus on providing all services, authors focus on the services of entities that may be directly used. However, some developers may not be fully aware of all cloud technologies and focus on the flexibility available in using cloud services [56].

Integration and provisioning specialists are truly further concentrated on the end-user solutions. Their tasks are interfacing with end users, and attempt to satisfy end users' requirements. End users ultimately contain the uppermost significance as explained before. They suppose that their cloud services comprise comprehensible and unproblematic interfaces, sustaining information terms. In addition, they must be well protected from all kinds of risks. A number of users can sign up cloud services for hours, and a number of them for years. These diverse end-users must assemble identical services as they possibly will comprise uniformly vital data streams into the cloud. The service also relies on the Service Level Agreement (SLA) [14]. SLA is built in a service agreement between the dual parties. This agreement shows that these types of services are definite by only single party to the other. It explains, for instance, the performance conformity, security and compatibilities.

2.6 Cloud Computing in Comparison with Other Technologies

Cloud computing definition might overlap with other technologies. This section is in relation to stating the term of cloud computing accurately and the differences in accordance with other comparable technologies. Mostly, these technologies have been created before cloud computing, and the users are further familiar with them. Thus, it is essential to distinguish cloud computing from these technologies.

The Autonomic computing systems are the first systems that have been mixed with cloud technology. This type of computing varies in the way it works. The aim of autonomic computing is to offer systems of independent work [57]. This means that they must be capable to do self-management. They must test and solve failures themselves. It is similar to cloud due it also composed of systems of large computer that have high level of guidance from experts.

There are more accurate differences between cloud computing and grid computing. Grid computing concentrates on wide range, while cloud computing offers services for both larger and smaller ranges. Grid computing typically provides consistently high performance, and (the main feature) cloud computing delivers performance as needed [26].

Another comparison can be done with the mainframes. Although the difference may be obvious with mainframes, however, there are similarities. They can be seen as a cloud, but the mainframe allows access to the staff in a large institution and it is fully centralized, as well as in terms of performance. The mainframe provides consistently high performance, while cloud computing just provides it as necessary [14].

Also there are similarities and differences between cloud computing and traditional IS outsourcing. Cloud computing outsources computing resources, while Information system outsourcing tries to outsource both experts and physical resources. In cloud environment the data is stored by CSP, but it is controlled by the institution itself or by another party, in contrast, the storage of data in traditional IT outsourcing can be in or off institution's premises, but it is always controlled by another party. A contract in cloud it is “one to many” relationship while In IS outsourcing it is a “one to one”. Decreasing cost is one of the motives behind both adopting cloud and outsourcing, but there are cost differences between models. In cloud computing the price is pay as you go, while traditional outsourcing includes primary upfront costs [4].

Finally, the comparison with service-oriented computing, cloud computing is also service-oriented. But service-oriented computing further concentrates on technologies that can be run in software as a service (SaaS), while cloud technology concentrates on offering computing services instead of techniques.

CHAPTER 3

CONCEPTUAL FRAMEWORK

3.1 Introduction

Recently, information technology (IT) is globally considered as a fundamental tool in promoting the competitiveness of a nation's economy, and it has important implications for the productivity of an organization. Cloud computing plays an essential role in IT service fields and enables the rationalization of the investments of information technology by the dynamic customization of resources rented as a service. The impacts of using IT including cloud computing will only be realized when they are widespread adopted. Consequently, it is necessary to know the constraints of IT accreditation and understand theoretical models that are related to innovation adoption.

In this chapter, adoption models that are used in information systems (IS) and their related factors will be discussed. The three models discussed are: the technology, organization, environment (TOE) framework [58], diffusion of innovation (DOI) theory [59], and Iacovou et al. model [60]. Finally, a proposed conceptual model for cloud adoption in Iraq will be given in this chapter.

3.2 Theories of IT Adoption in Cloud Computing

The fail or success of any information technology adoption plan is specified through external and internal factors. Various theories have been improved to study these factors and determine the conditions required for the successful innovation adoption at both organizational and individual levels [4].

The eminent theories that are adopted in literature are the technology acceptance model (TAM) [81] theory of planned behavior (TPB) [62], Iacovou et al.(1995) model, unified theory of acceptance and use of technology (UTAUT) [63], DOI [59], and the TOE framework [58].

Several studies have shown that the integration of similar structures to the study of the adoption of a particular technology through these theories facilitate the development of conceptual model which helps to recognize the more influential factors in new technology adoption [64].

This study adopts TOE, DOI and Iacovou et al. models for their wide acceptance in the adoption of new technology as well as they offer a solid and theoretic extension in the researches related to the adopt of technological inventions. In the following sections these models and selected factors associated with each model will be explained in detail.

3.2.1 Technology, Organization, Environment (TOE) Framework

The framework of TOE had been initiated in 1990 by Tornatzky and Fleischer. It categorizes three facets of an institution's background that influence the adoption and enforcement of technological innovation that is corresponding to technological, organizational, and environmental contexts as depicted in Figure 1. The 1st context represents the domestic and peripheral technologies related to the institution. This comprises the existing applications and the equipment and technical infrastructure inside the institution, in addition to the collection of accessible technologies outside the institution [51]. The 2nd context describes the institution in terms of its field, status, size, readiness and management structure. The 3rd one represents the internal and external stress associated with an institution such as market competition, regulatory concerns, policies, and government reinforcement [58].

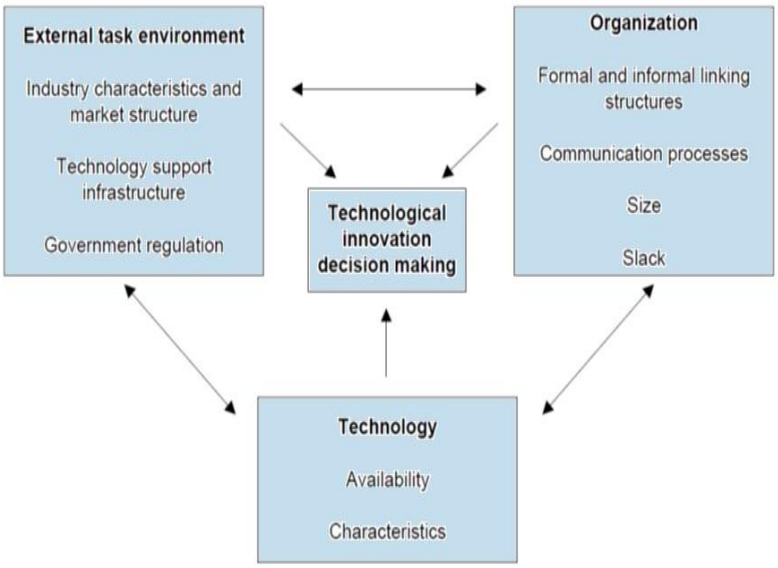

Figure 1 **Technology-Organization-Environment framework** [58]

The TOE framework has been utilized in a diverse of information system adoption settings involving ERP, E-commerce, the tracking of patient RFID, open systems, and electronic data exchange [65].

This model is agreed with the DOI model, wherein Rogers [59] highlights individual distinctiveness, and the domestic and peripheral features of the institution, which correspond to the technology and organization (TOE) framework, but the TOE framework as well has an innovative and significant constituent, which is environment background. The TOE structure creates Rogers' innovation diffusion speculation that enhanced explaining intra-institution innovation diffusion [66].

3.2.1.1 TOE: Technological Factors

Technological factors include all technologies related to the organization, whether technologies already used in the organization or those that are available on the market but are not use anymore. The organization's current technologies are essential in the process of adoption since they put an end to the scale of technological change that can be done by the organization. There are three types of changes resulting from adoption of innovation :(1) Incremental change, (2) Synthetic change, (3) Discontinuous change. The incremental change which produced by adopt of

Innovation provides new version or new characteristic to the current technology. “Synthetic change represents a middle point of moderate change, where existing ideas or technologies are combined in a novel manner”. Discontinuous change represents big deviations from the existing technology or operations [67].

There are many technological factors that affect the adoption of cloud computing for any large, medium or small enterprise. These critical factors should be thoroughly determined before making the choice to implement cloud technology. These factors are explained below as follows: -

3.2.1.1.1 Availability

As pointed out by Heidi (2016) “The term availability is used to identify the period of time when a service is available, and the time needed by a system to respond to a request made by a user” [68].

In the digital age system of the 21st century, networks and applications should be available "24 hours" a day. Availability and reliability are critical to continue both operations and productivity of business [69]. The systems of some institutions are required to be available due to the critical services they offer, thus their processes cannot be stopped or delayed because of service outage [70].

Availability is frequently expressed as a percentage pointing how much uptime is expected from a certain component or system in an offered period of time, availability of “five nines (99.999%)” mean in a year there is more than 5 minutes of downtime and "four nines (99.99%)” is nearly 53 minutes of downtime during the same period. There are various factors that can cause service downtime such as:

- There are diverse possibilities for hackers because of the dynamic dependence for cloud. The whole system of cloud could be blocked due to usual attack of Denial of Service on just a single service [71].
- Failure in upgrade the servers to intake more data and counting the burdens of intensive work.
- Failure in move and upgrade obsolete applications which are no longer supported by the cloud provider.

- Unavailability of system due to downtimes as result of routine tasks (e.g.: system maintenance upgrades and patches programs [69].
- The systems of cloud are Internet based, therefore your access is completely depending on your Internet connection which could be down at any time [72], due to:

- Problems in the carrier or the Internet service provider.
- Local loop wiring problems.
- Failure in the equipment of local office network [73].

Systems with high availability can be automatically recovered when failure of component or server. Thus it is essential to choose CSP who provides highly available service to assure a minimum amount of service outages [68].

3.2.1.1.2 Reliability

"Refers to the ability of a system to fulfill its intended function in a proper manner as expected . It involves ensuring a high quality of service to end users, with a high transmission rate, minimum rate of errors, and fast recovery" [9].

Reliability is one of the most important metrics in the institution. Reduce or rise the risk of technical and business to the institution's end users and its external clients are depending on the improvement or drop of reliability. The capability to meet SLA's relies on uptime, guarantee of availability, reliability of servers and manageability [69].

Cloud technology can be more reliable if it is more adaptable as well as more fault tolerant to the variable cases. It is hopeless to have a cloud which is totally free from fails. Diverse kinds of failures exist in the cloud environment like the failures of (overflow, timeout, missing of resource, database, network, hardware and software). It is not simple to examine the reliability of CC because of grouping of various factors which contribute to the construction of the cloud [74]. It is fundamental to have a highly reliable service level because it implied mean how the clients will agree to the service outage at any definite standard [75].

3.2.1.1.3 Security

Security refers to the level of procedures in place to protect information or the system from unauthorized access or any other security events [9].
Catteddu and Hogben [76] created a variance among different risks and classified them into four categories in general. These categories are: technological concerns which are like the security concerns, lawful concerns, and organizational policy concerns which are more related to vendors.

The physical location of the cloud can be anywhere; consequently, as a buyer you often are not familiar with the location of your data at a specific time. Precisely, they can include their services in other countries that have other legal issues. This can be created in other security standards for a particular country and put at risk the organization in the environment of cloud service [77]. Because of privacy issues some nations prohibit the storage of critical information outside the borders of the country [78], so there is ordinarily expectation that not every institution is permitted to go into public clouds. Explicitly, there will be an augment in the employment of private clouds [14], however this is matters when the data is stored in a place that is prone to warfare or disasters [70], thus for such places it may be better to investigate in cloud technology in safer country.

CSP manages the infrastructure including servers, networks, and storage devices. they should implement and operate suitable controls for infrastructure involve (staff training, physical position security, firewalls of network) because if there is a weakly control in physical access, hackers can attack the system even if it is protected via encryption and firewalls. If an attacker can access your data they will be able to steal the whole servers, spy on your activities and business, manipulate your information, return forged data, and your customers will be redirected to illegal sites [71, 79].

Another security concern is that it might be impossible to delete data in an appropriate and error-free way. One reason is that there are extra copies of data in diverse places, as well as the destroyed disk also includes data from other customers. Unnecessary information is supposed to be destroyed completely. However, due to the physical feature of the storage environment, the removed information may still

exist and could be backed up. This is likely to create a risk for disclosure of sensitive customer information. Moreover, the customer could not get rid from the outage of the cloud computing service, and this is the moment that the mechanisms of cloud service provider do not work accurately. These conditions bring vast deject to customer trust [79].

Ultimately, the safety and security of personal data will be the customer's responsibility even it located in the premises of the CSP. The failure of the encryption key or the loss of your access code will cause difficulty for the customers of cloud technology [71].

Most users have Internet Explorer1, Firefox2 or Chrome3 installed and use it to connect to the cloud. This link is another security risk and needs protection. Browser security is something that depends on the provider of the browsers. The browsers are used to navigate to the cloud, but also to navigate to other websites. These browsers have to read scripts that are used on the websites. It is important that browsers can detect the difference between malicious scripts that could be made for controlling browser information. This security measure is depended on the browser used for Firefox, Chrome or Internet Explorer [14].

3.2.1.1.4 Privacy

Privacy is defined as "confidentiality of data, where only authorized users can access it" [9].

In cloud computing environment the clients outsource for the store of their information to a server off their premises, which is managed by a CSP. Through outsourcing, clients lose their actual control on data when it is saved in a remote server and delegation of control to an untrusted third party or CSP [70].

During data access and computing, customers do not even realize where the data being stored and which tools perform the tasks of computing [80]. The processing power of the computer or storage purchased by the clients through the cloud service can be in another nation or can be divided between diverse nations. Although its cost and efficiency advantages, cloud computing raises laws issues by exporting client's information abroad [79]. The cloud computing service provider establishes the held

policy details. Assume that the providers have the capability to create modifies in their policies. It will entirely modify the privacy for clients. For instance, if the extra data by the cloud users is secluded in the groundwork made up policy being employed. Altering policies that will tolerate approaching in this data for third parties can be a severe risk based on the significance of data that is being adopted [81]. Another example is that cloud providers could extract information from different organizations in the cloud. They could visualize information that could be revealed by any means. It could also detect information that is commercially valuable for them. The important fact here is that most cloud customers are typically not attentive of the whole policy. Consequently, they do not be familiar with risk kinds that they are exposed to when access their information into the cloud [14].

The privacy concerns vary according to various scenarios of cloud and could be split into four sub categories as the following:

1- How the clients will be enabled to have control on their information while storing and handling information in the cloud environment, avoiding theft, malicious use, and illegal resale?

2- How to ensure replications of data in the jurisdiction and the coordinated situation, where copying user data to different appropriate sites is the usual option, avoiding the loss of data, leak, unauthorized adjustment or invention?

3- Who is responsible for ensuring legal restrictions on private information?

4- To which extent subcontractors of cloud participate in processing that could be accurately identified and verified [80].

Applying strict laws and regulations are necessary to decline the effect of using cloud computing. However, organizations will still need software running on their own servers in order to keep the information which is legally bounded to a certain set of rules. It is better to use to a cloud type such as (private, community or hybrid) that allow clients to store their data in their own datacenters. This enables them to determine how they want to protect their data, also they will be the only organization that is able to access this data. They can choose when and whether or not they want to share this information with certain organization.

3.2.1.1.5 Feasibility

Feasibility can be defined as "An analysis and evaluation of a proposed project to determine if it is technically feasible within the estimated cost, and will be profitable".

Studies of feasibility address issues such as how and where the organization works. They offer comprehensive details of the business to define whether and how it could succeed and act as a worth tool to evolve an effective business plan [82].

There are several studies showing the capabilities provided by the cloud. Cloud technology causes the advantages of online life, the growth of economy, achieves profits for all clients, increase innovation and overcomes barriers of cross-border [83].

According to Bhowmik [84] Cloud technology is more tolerant in the state of component failure, as it is feasible to carry on the service even after several components fail, offering a possibility for replacement or recovery of these components without disabling the service. This increases the availability of resources and minimizing the amount of time that often impacts the business.

Matthews [85] argued that the use of cloud access control and physical security management is actually equivalent to increasing Internet protection and reducing threats rather than the traditional legacy of local server systems. Additionally, Cloud Supports real-time guarantees for multiple tasks (e.g.: high CPU utilization, scalable, messaging, Latency insurance for implement tasks in VMs, insulate between VMs, sharing VMs resources in both real and non-real times, data analysis, etc.) [86].

3.2.1.1.6 Trust

Trust can be defined as "the extent to which one party is willing to depend on something or somebody in a given situation with a feeling of relative security, even though negative consequences are possible" [87].

The adoption of cloud technology faces some challenges (e.g.: privacy and security challenges, organizational challenges, lawful challenges and compliance challenges). All these challenges are related to the concern of trust between

customers and cloud providers, since CC are calling on institutions to trust providers to manage their data and information technology resources. It would be interesting to realize whether these challenges are because of the legislation lack in most nations regarding privacy and data protection or depend on the environment and size of the institution and if it has spread its business globally.

There is another issues related with trust factor which may influence customers' decision of adopt cloud technology such as:

- Institution Reputation: Trust is established by the reputation use. Institution's reputation is depended on the basis of previous performance or interactions, and is used to determine or reach its behavior in the future.
- The physical location of the institution: it is a critical factor that impacts the decision of institution to migrate to cloud environment for multiple reasons. Firstly, Lack of international regulations or policies to protect data in the cloud. Secondly, some CSP store data in another nation without revealing any information to customers.
- Disaster Recovery Issues: What will you do if your CSP is exposed to a privacy violation or expiration of compliance, involving continuation of business and the plans of disaster recovery?
- Integrity Issues: This concerns customers that need to ensure that the service provider performs the accurate type of operations on the data. As well as the need to guarantee that data processed or saved in the cloud has not been corrupted.
- Confidentiality issues: This excites questions like how sensitive information would be stored in the cloud and whether the cloud does not leakage or harm customer's critical data confidentiality.

To construct clients, trust, cloud technology needs to be concerned with the feelings of possible customers and handle the threats linked with cloud computing in a way that customers feel protection and safety to move to cloud technology [88].

3.2.1.2 TOE: Organizational Factors

The organizational factors reflect the organization's characteristics and resources, involving its size, amount of slack resources, interaction among employees, communication processes inside the organization's [14], formalization degree, centralization degree, administrative structure and human resources [64]. There are various ways in which these factors influence the decisions of adoption and implementation. For example, the methods of linking the internal subsidiary units of the organization or the internal boundaries boost innovation. Multifunctional teams and staff with formal or informal connections with other administrations or partners in the value chain are further examples of such methods. The factors of organization size, organization culture, IT readiness and cost, and their impact in the adoption of cloud technology are discussed specifically as follows: -

3.2.1.2.1 Organization Size

The organization size is defined by the number of employees, the amount of investments, the target market and annual revenue [9].

There are conflicting views on the impact of the size of the institution on the adoption of new technology. In the cost side cloud technology is best suited for small and medium-sized enterprises, this because of significant cost benefits such as few preliminary investment, less cost of resource ownership and capability to eliminate the activities of software administration [89]. Other studies have indicated that smaller organization do not voluntarily accept the new technologies, though they are more able to innovation adaptation.

For the large organizations, they usually have further flexibility in their resources and thus allocate additional organizational resources such as technical, financial and human resources, therefore they can deal with the risks associated with the adoption of any novel information technology innovation [90, 91]. While other studies have shown that the big sized organization may not tend to move to cloud environment, where there are too many employees in various branches in various regions [51].

3.2.1.2.2 Organization Culture

"Organization culture refers to shared assumptions, values and beliefs which govern how people behave in organizations" [92].

Culture is essential since it shapes:

- What the institution considers to be "right decisions"
- What employees deem the suitable behaviors and what the kind of interaction among them within the institution.
- How persons, working groups and the institution as a whole deal with tasks assigned to them
- The institution's ability to change and openness.

Each organization develops and keeps a unique culture that offers guidelines and borders for the behavior of the institution's members [93].

There are diverse characteristics of cultures depending on the kind of organization, whether it is military or civilian, and its mission, policies, regulations and staff awareness. Geographical location (subculture) is another factor affecting the culture characteristic, a subculture may emerge from the individual characteristics for both managers and employees, and the various conditions in which the work is implemented [94], as well as region setting whether it is rural, urban or suburban [95].

Several cultures in organizations give high value to invention, encourage their staff to take risks and innovate in the implementation of their works in order to remain faithful and motivated towards the management. The culture of some other organizations ensures that diverse training programs are implemented in the workplace to improve staff skills, and the administration does honest efforts to raise staff knowledge to develop their professional competence [93].

When an organization determines the need to turn to strategical direction, implement a novel technology, or enter innovative operations, the traditional culture might obstruct the evolution unless it also changes. Thus the success of main organization change plans is often reliant on internal cultural change.

The culture of any organization cannot be altered directly. What could be altered are behaviors and operations. The staff will be equipped and trained to perform their works in new ways. Thus the culture of the organization will be gradually changed [96].

3.2.1.2.3 Technology Readiness

"Government Agency IT Readiness reflects the agency technical resources and existing IT infrastructure and the ability to change and redesign processes. In addition to non-technical readiness, employee's readiness is important and reflects their skills and knowledge for implementing the new redesigned tasks" [97, 90].

The modern technology adoption is influenced by the IT readiness of institutions because of the need to provision of fundamental equipment, application support, networking (Internet service provider (ISP) redundancy, high Internet connection and the capacity of bandwidth), physical supplies and security strategies [91,98, and 99].

Organizational readiness Composed of many components. What we must realize is that we are looking at to a large extent change in participation practice: A change in both processes and skills. Which means re-refine skills and re-equip the technical in the best way in order to provide the ability to perform the works in cloud environment [100].

One of the major aims of moving to cloud environment is to decrease the cost of computing services through outsourcing to third party entity and focusing on essential business. By doing so, there will be no necessity for any information technology infrastructure in the organization, and they will require much less number of facilities and equipment, therefore all the load and stress will be on the CSP, and they will be responsible for the readiness of IT infrastructure. The government institutions will still require a good IT infrastructure, however on a much minimal scale compared to the cloud provider [51].

3.2.1.2.4 Cost

"An amount, that has to be paid or given up in order to get something. In business, cost is usually a monetary valuation of effort, material, resources, time and

utilities consumed, risk incurred, and opportunities forgone in production and delivery of a goods or service" [101].

Organizations should balance all costs and advantages related with cloud technology, at the long and the short period [102].

There are many concerns that need to be taken into consideration when making the decision of moving to cloud environments such as:

- Migration Costs

It involves replacement of existing devices which are incompatible with cloud computing, re-coding older application technology, re-coding to act with its environment .Moreover, the integration of complex systems with the cloud services can lead to higher costs [4, 89].

-Bandwidth Cost

Although organizations can save money from both hardware and software with cloud technology, they can bear high bandwidth fees from their CSP. The cost of bandwidth can be low for not intensive data that returns for small applications on the Internet; however, it can be quite expensive when the organization creates a 'multi-terabyte' database accessible through cloud environment [103].

-Extra Storage Cost

The cloud service provider may put a constant storage limit, and the customer then has to pay for additional storage fees. The storage amount and the fees for extra data usage differ among cloud providers and contract kinds, and they are one of the matters to be considered as part of SLA [4].

There are a lot of benefits for extra storage such as more security, the ability of loading large files and more features for collaboration with your team [104].

- **Ongoing Cost**

All types of services in business come with a cost; the storage of cloud is no exception. When choosing to store the data in the cloud, the organization gets rid of the requirement of costly servers at home that can reach to a massive upfront cost. Storing data in the cloud environment is an ongoing expense, instead of being a bargain for one time.

Although the cloud technology enables the clients to minimize the cost of HWs and SWs, the total cost may end up higher than you expect on the long-term, CC means you purchases services, thus instead of one-time capital costs become ongoing operating costs [105].

In the end, the ongoing cost of data maintaining in cloud environment may overtop the cost of internal storage and security. This might be especially correct for customers or small businesses that typically do not pay for servers or big quantities of hard drive storage.

- Hidden Cost

The IT firms will also be in charge for application maintaining, monitoring and troubleshooting in case of service outage. Furthermore, each time there is necessity to apply upgraded or patch, extra IT resources will be need. In that case, IT organization should train current staff and/or hires new staff [106]. Moreover, hidden costs can involve disaster recovery, application modification, and insurance from data loss [102].

Assessing the real costs of moving from the traditional platform to the cloud is tricky. Thus, it is hard for the organization guess what actual cost utility from this move [89].

3.2.1.3 TOE: The Environmental Factors

The environmental factors involve in this study are industry type, government support, and regulatory concern. In accordance with TOE theorem, environmental

factors can affect the cloud adoption. Namely, these factors can impede or promote an implementation of cloud computing as follows:

3.2.1.3.1 Government Support

It is the financial and administrative help provided by the government to facilities the investment in the new project. There are many forms of government support such as:

- Valuable technology projects that constrain by specified factors should be addressed by the governments.
- Develop measures that stimulate greater managerial and innovative capabilities within organizations, thereby growing their possibility for outgrowth development and investment in skills and technology.
- Remove the disincentives to technological innovations adoption.
- Regulation barriers to entree should be decreased, and this could be done through the reform and modernization of the institutional and regulation framework within which the innovative activity has been executed [107].
- Decrease the financial barriers to the adoption of technology, throughout sharing of cost, loans, grants and other financial methods.
- Develop utilities, physical infrastructure, availability of novel technology devices, software, and other technically resources [108].
- Present necessary training and researches programs to acquire the wanted skillfulness to utilize of cloud technology [51].

Although there are many studies that stress the importance of the government support factor in facilitating the adoption of cloud computing, there is a study by Ratten [109] argued that cloud technology often requires from firms invest in the infrastructure of Internet without government support need.

3.2.1.3.2 Regulatory Compliance

“Regulations are sets of policies that govern the use of sensitive business data. The main intent of these regulations is to protect consumers’ privacy and provide

security by enforcing attributes such as confidentiality, integrity, availability, and accountability (CIAA)" [110].

Prior moving data and applications to cloud environment, it is essential to recognize accurately the specified regulations which are applied and the pertinent requirements or obligations enforced on both clients and cloud providers such as data preservation, data security, interoperability, and subjugation to authorities. This enables clients to categorize the legal matters and the associated legal threats, and accordingly realize what will be the effects of these factors on the data or applications that being moved to cloud environment [111].

Lawful challenges of CSP are more liable to lawful and regulatory issues and obligate to maintain and process clients' data in particular jurisdictions that offer data security and privacy as promised in their service level agreement [79]. It's critical for clients to ensure that the SLA covers all their requirements of compliance and security. Agreements of IaaS usually require more responsibility to data and software on the clients, while agreements of SaaS usually make software and data the responsibility of the provider. Agreements of PaaS located somewhere in the middle [112]. Accordingly, it's essential that clients accurately evaluate their SLA to ensure they understand properly their responsibilities and liabilities. Moreover, clients must know how many 9's provided by cloud service provider in SLA's (uptime guarantee should be between 99.9% to 99.999) [113].

3.2.1.3.3 Industry Type

"A classification that refers to a group of companies that are related in terms of their primary business activities, in modern economies, there are dozens of different industry classifications, which are typically grouped into larger categories called sectors"]114].

Each industry contains its unique type of technology dynamics. Consequently, there is a need to understand cloud technology dynamics in main industries to understand how the future of cloud will be in these industries.

Cloud technology has been affected by five main industries which are (health care, financial services, education, retail, and manufacturing) [115]. More

specifically, industries in terms of being (private or governmental) ; (civilian or military) can be differ in their decision to move to the cloud.

Several researchers think that adoption in the fast-growing industries is higher, while in ripe or decreasing industries, the practices of innovation are not obvious.

First remark, there are significant variations in the cloud adoption rate. The 1st factors seem to be those that can create digital "pure play" along with the old industry for instance, emerging digital banking from branch networks, or E-commerce competing with high-end retail stores and shopping malls. There is a slowdown in cloud adoption in health care and education due to regulation limitations and less intense competitive environments.

Manufacturing presents a more complicated problem, integrating the cloud into physical structures like machines, factories, and aggregation lines [115].

The adoption of cloud technology in the public sector is tricky and not as easy as it is in the private sector where only the Chief Executive Officer's (CEO) decision is need. The governments have to take a multilevel decision over this matter and policy preparation in a timely manner. Moreover, government may be faced with different challenges in migrating to cloud environment such as: Regulatory setting for cloud to ensure the security, reliability, and data privacy nationally [11].

Additionally, civilian Institutions tend to move to CC more than military Institutions, since they have more experts staff, so they more willing to adopt cloud technology, while military institutions have more resistance towards cloud adoption because of reliability and security concerns [51].

3.2.2 Diffusion of Innovation (DOI) Theory

The DOI theory was developed by Rogers," DOI is a widely used model to explain why and how adoption of new ideas and technologies occurs at individual and organizational levels" [9]. This theory offered the foundation for adoption of other technology theories like TOE and TAM. This theory is composed of two sides, which are diffusion and the innovation. Diffusion is the operation through which

innovation is publishing among the employees of the institution over time, innovation represents “an idea, practice, or object perceived as new by an individual or other unit of adoption” [116, 4].

Rogers [116] defined innovation decision-making as “an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation”. According to Rogers, there are five procedures in making an innovation decision which usually follow each other chronologically, and seek to search through a person or any other decision-making unity which moving from initial knowledge to full innovation use. These procedures involve (i) knowledge (ii) persuasion (iii) decision (iv) Implementation (v) confirmation, as shown in Figure 2. During these procedures the period length necessary to make any decision for an individual unity or any other unity can be highly differing, and can be a significant means to distinguish the types of adopters [117,118].

The phase of persuasive occurs, if the attitude of a person is positive or negative toward innovation, however “the formation of a favorable or unfavorable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection”. People form their attitude after their knowledge about innovation, and therefore persuasion follows the phase of knowledge in the process of decision-making related to innovation. Moreover, Rogers argued that while the knowledge stage is focusing on cognizance, the persuasion stage is focusing on emotional (about feeling). Consequently, the person is participating in more sensibility manner with innovation in the persuasion phase. The uncertainty degree about the work of innovation and the reinforcement from colleagues impacts individuals’ beliefs and opinions about innovation [117].

The DOI theory posits that there are five technological attributes that have a direct impact on the new technology adoption rate. These attributes are relative advantage, complexity, compatibility, testability and observability. Rogers [119] defines these aspects as follows: -

- Relative advantage: “The degree to which an innovation is perceived to be better than the idea it supersedes”.

- Compatibility: “The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters”.
- Complexity: “The degree to which an innovation is perceived as relatively difficult to understand and use”.
- Testability: “The degree to which an innovation may be experimented with on a limited basis”.
- Observability: “The degree to which the results of an innovation are visible to others” [119, 9].

DOI theory considers innovations as being transmitted by particular channels over time and within a certain social system. It is believed that Individuals are having various degrees of readiness to use innovations, and in general it is noted that the portion of the population that adopts an innovation is usually spread over time. Dividing the population into segments makes the separation of individuals into the subsequent five classes of individual innovativeness from initial to the newest adopters: “innovators, early adopters, early majority, late majority, laggards”. The innovation procedure in institutions is extremely complicated. In general, it involves a figure of individuals, possibly involve both opponents and supporters of the innovative idea, each of them has a role in the decision of embrace innovation. According to DOI theory at organization level, there are some independent variables which are associated with innovativeness as “individual (leader) characteristics, internal organizational structural characteristics, and external characteristics of the organization”. Individual characteristics represent the attitude of administrator toward change. Internal characteristics of the structure of organization involve observations where “centralization is the degree to which power and control in a system are concentrated in the hands of a relatively few individuals”; “formalization is the degree to which an organization emphasizes its members’ following rules and procedures”; “interconnectedness is the degree to which the units in a social system are linked by interpersonal networks”; “organizational slack is the degree to which uncommitted resources are available to an organization”; “size is the number of employees of the organization” .Finally “External characteristics of organizational represents system openness” [59, 120].

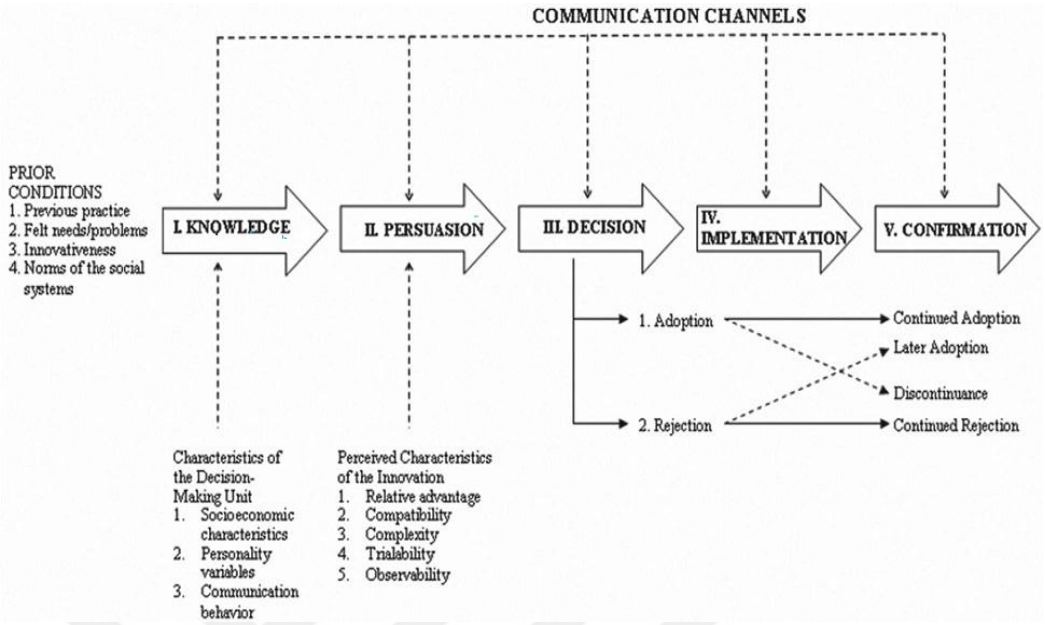

Figure 2 **: Diffusion of innovations (DOI)** [116].

3.2.2.1 D O I : Technological Factors

Based on DOI theorem, there are five technological factors that affect the adoption of cloud computing. In this study we choose two of these factors which are explained in details as follows:

3.2.2.1.1 Complexity

"Complexity refers to the degree of difficulty involved in using new technology". This factor usually considered to be a significant element by the organization prior its decision to adopt any new technology [9].

Cloud technology, mobility and big data have been used by organizations of all sizes. Generally, these technologies have generated a variety of innovative services and applications that increase collaboration, productivity, and satisfaction of clients, however, a lot of these advantages need management for both applications and service that depend on a complex collection of infrastructure techniques [121]. Regarding cloud computing complexity, it can be categorized to services management complexity and applications complexity.

(a) Services Management Complexity

Changing environment requires some necessities such as remote device control, maintain the vision in virtualized resources, and attaining service level agreements required for crucial business applications. The management of efficient service is hard when the services depend on dynamically shared resources, and there will be even more challenges when some of the resources are in the public cloud and some of them are in the organization's premises. With the adoption of new technologies or approaches by IT institutions, they rarely cancel current technologies and approaches and stay providing infrastructure services and host applications inside institution. Consequently, there are different challenges that have to be addressed by IT administrators of integrating management data to the emerging and traditional environments and require an individual tool that provides visibility into all technical areas that include a particular service [121].

(b) Applications Complexity

The complication of the applications and the technology infrastructure depends on how IT has been adopted by an institution. It is comparatively tricky to a cloud environment adaption in an institution that employs high customized or localized applications [122]. Furthermore, it can be difficult and costly to move from one cloud platform to another for applications reconfiguration to meet the new host requirements [72]. If this evolves from the diffusion of technologies across a period of time, the level of complexity will definitely be high, in which case the transition to the cloud environment will be hard [122]. The rapidity at which applications would change in CC will impact both the security and System Development Life Cycle (SDLC). Modern security methods and re-design of traditional solutions are necessary to work with cloud platform. The mechanisms of traditional security may not function well in cloud environments since they are complicated architecture consisting of a set of various technologies [123]. The complexities of both security and flexibility are increasing with virtualization and automation which are the basics of cloud technology. The new risks involve: -

- Dynamically virtual machines (VMs) relocation.

- Increase the numbers of infrastructure layers of management and protection.
- Many applications and operating systems for each server.
- Removal of physical boundaries among systems.
- Tracking SWs manually [124].

3.2.2.1.2 Compatibility

"Compatibility refers to the ability of the existing application to be compatible with the cloud" (Alkhater et al., 2014), and according to Rogers [119] "Compatibility refers to the degree to which innovation fits with the potential adopter's existing values, previous practices and current needs". Compatibility was seen as an essential factor in the adoption of any innovation [119, 125, and 126]. When technology is compatible with labor application systems, organizations are likely to consider the adopting of new technology. However, when a technology is largely incompatible, main modifications will be required in processes that require a great degree of learning [127].

Unexpected decline in both cost and time can be caused by application's compatibility especially when there is a lack of migration plan to cloud technology, so organization should be sure whether its applications can be re-grouped, addressed or virtualized to in the new cloud environment.

There are (18-24) months to overtake the next upgrade in the traditional migration, and a lot of organizations cannot wait all this time, also there is lack of information technology(IT) resources needed to support the efforts of migration [128].

Invalid integration in cloud migration includes transferring large quantities of data and essential configuration changes, for example processing of network. Deep changes in the design of IT infrastructure requires for moving part of an infrastructure to an external CSP, for instance security and network policies. Poor integration resulting from interfaces incompatibility or conflicting policy implementation can trigger 'functional' and 'non-functional' effects [71].

There are other operational concerns due to lack of standards in CC, there may be compatibility problems among the cloud, data and resources in various cloud, or anywhere else in the client's organization [129].

Compatibility issues can arise when clients wish to switch from one cloud provider to another because the service of storage provided by a cloud service provider may not be compatible with another provider's service [79].

Service provider will lock an organization into a service for a specified period. Typically, the way of tools, methods or regular data formats that can guarantee application, data and service portability, during this period it can be hard for the customer to move from one CPS to another or move services and data back to an in-house information technology environment [130], as well as the infrastructure used by CPS may cause compatibility issues with cloud applications instituted on other platforms.

3.2.3 Iacovou et al. (1995) Model

"Iacovou et al., analyzed inter-organizational systems (IOSs) characteristics that have capacity to effect organizations to adopt IT innovations in the context of Electronic Data Interchange (EDI) adoption" [64]. Its frame is proper for the purpose of clarifying inter-organizational systems (IOSs) adoption. It composed of three factors **:(1)** '**Perceived benefits'** which describe the comparative advantage level that technology could offer to the institution. It creates essential constructive benefits, which are direct and indirect benefits. Direct benefits "measure operational cost savings and other internal efficiencies arising from the IT adoption", while indirect benefits "measure the opportunities that originate from the adoption of IT". For example, we may mention improved service delivery and the ability to re-engineer processes. It has been found that perceived benefits have an efficient impact on adoption, affect and integration (dependent variables). **(2)'Organizational Readiness (OR)**' it considers as a critical determinant of effective adopt of IT innovation. It acts as a catalyst that encourages institutions to the new technology adoption. A study conducted by Molla and Licker [131] asserts that organizational factors, particularly human resources among other institutions,

affect adoption more than environmental factors. (OR) identified two structures: (a) **technological readiness** "it refers to the level of using information technology (IT) and administration in the institution". It was found to be positively relative with dependent variables; (b) **'financial resources'** that gained to pay for install and implement of the following improvements, and the expenditures for the use of EDI. **(3)** '**External pressure'** defined as a factor affects the environment of institution. It composed of two structures: (a) 'the Imposition of trading partner' that indicate to the possibilities of imposing a large institution on a smaller institution in inter-institution relations, and (b) 'competitive pressure' that measures the EDI capacity level of the institution with respect to its competitors in the same type of industry, Figure 3 illustrated these three factors of Iacovou et al. model. As portion of later research, some authors suggested that the structures of model be included in other studies to specify the impact of each factor in the adoption study in better way. This model could also be deployed to a larger institution in another country to expand its generalization [64].

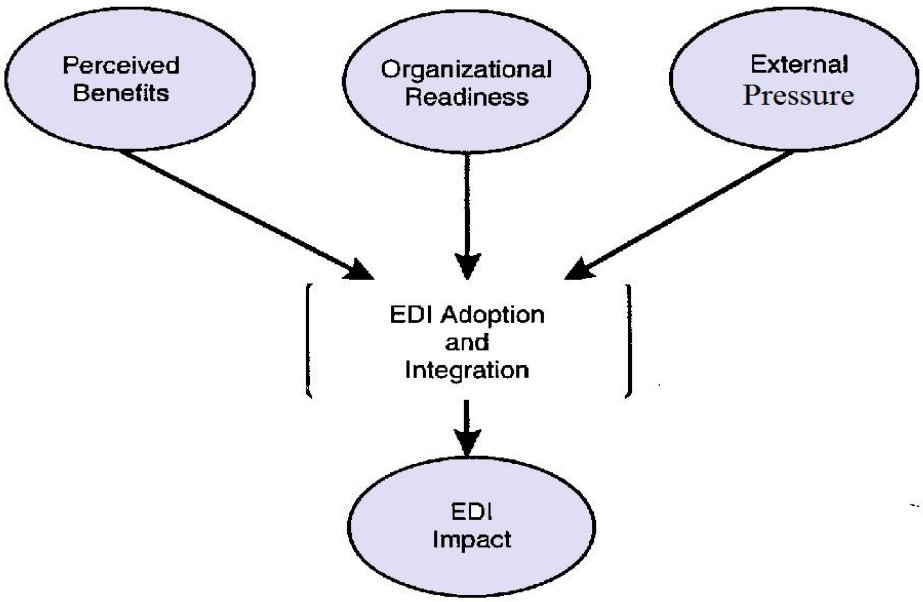

Figure 3 **: Iacovou et al. Model** [60]

3.2.3.1 **Iacovou et al.: Technological and organizational Factors**

Iacovou et al. [60] model has the same technological and organizational factors that previously mentioned in TOE framework.

3.2.3.2 Iacovou et al.: Perceived Benefits Factors

Cloud computing is one of the most useful pieces of technology that has been used to a great extent throughout the world. CC is the next effective stage in the development of services and products for on-demand information technology. It provides diverse benefits for both institutions and individuals from varied sides, specifically security, economic, and technical [4], thus business of diverse sizes, forms and industries are transforming to cloud services.

3.2.3.2.1 Direct Benefits

There are a lot of direct benefits in using cloud technology, these benefits are explained below as follows:

(a) Increase Security: Cloud computing has fundamental capabilities to enhance security and stability, thus security risks of cloud should be balanced with its particular security benefits.

Businesses need ensure availability, protection against hackers, high data security, and regulatory compliance in their cloud so diverse levels of control in the infrastructure of network offer by cloud provider to ensure protection and business continuity. This is an essential item in creating a suitable work environment for organizations around the globe [132].

Security measures (e.g.: filtering, patch management, hypervisors) are better when performed on a larger scale. Thus, organizations can have better protection with the same amount of investment in security. To provide significant defensive measures for example protection against DDoS attacks, cloud providers reallocate resources (encryption, authentication, filtering, etc.) [133]. Also there is a centralized data storage in cloud, applications and data are stored in a secure warehouse which contains multiple computers [134, 135], this minimize the risk of loss of information due to various accidents such as a laptop crash, virus, etc., which can damage institution valuable information [136].

(b) Cloud Disaster Recovery: **"**strategy that involves storing and maintaining copies of electronic records in a cloud computing environment as a security measure, to provide an organization with a way to recover data and/or implement failover in the event of a man-made or natural disaster" [137]. The process of backing up and restoring are easier than storing the data on your PC because all your information is stored in the cloud. Additionally, most cloud service providers are skilled experts and they can handle recovery of information, thus the entire operation simpler than other traditional data storage techniques [138].

(c) Cost Effectiveness: cloud has the possibility to minimize information and communications technology expense by virtualizing capital assets such as disk storage into a readily affordable operating expense [31]. Because companies don't have to buy equipment, create and operate a data center, they don't need to spend big monetary on hardware, software and services which can be outsourced to the provider while with traditional computing, organizations may spend millions before get any worth from their investment in IT infrastructure as well as the need for less space and reduced staff and maintenance expenses [139, 140].

The reduction of on-premises infrastructure also removes their related operational expense in term of power, cooling and administration costs [4]. Additionally, with the feature of pay-as-you-go, computing resources can be accessed and charged based on their usage which will achieve the requirements of institution at comparatively low cost, for instance with Windows Azure, you pay by the amount of GB for storage and by the number of hours for computing [50, 42].

(d) Accessibility: Cloud computing allows users to be more flexible, it gives them the ability to work anywhere at any time using web-enabled devices such as smart phones, tablets and laptops [51, 142]. Consequently, cloud technology provides more mobility to users. They can login into any mobile device and access their company's resources (files, applications, projects) wherever they are, enabling them to better balance their work with their life, this flexibility maximize users' productivity [4].

There are three different technologies to access the Internet that can be used by smartphones

- Using a wireless connection such as Wi-Fi by subscribing with an Internet service provider (ISP) [143].
- Using regular Wi-Fi provided in airport, hotels, coffee shop, etc.
- Using Internet access services provided by mobile phone network [144].

(e) Automation: It is the allocation of suitable offerings that keeping with the requirement of the users. It manages the client need and try to provide high quality services according to their goals. There are set of cloud service providers who collaborate by adapting specific manner (1) to cope with customer necessities, (2) discover the required services, (3) allotment of services [145]. The evident vast advantage is that end users do not need to boost the IT infrastructure or have the knowledge needful to evolve and maintain the infrastructure, expansion environment or application updates, as was the case previously. The onus has been eliminated and another one is taking care of all that. Users are now able to focus on their core tasks by outsourcing all the responsibilities of IT infrastructure [146].

(f) Virtualization: This feature plays an essential role in cloud computing as it equips computing services and a virtual storage to cloud customers. According to Herrero [147], virtualization defines as "allocate multiple virtual machines on a single physical machine and share the underlying hardware resources". There are multiple benefits of virtualization such as: -

- **Minimize expenses**: You will pay bills only for what you actually used, minimize the need to purchase hardware as well as energy saving.

- **Isolation among users**: Each user will be separated from the other users, as a result each user cannot even access other's data and do not know information about data and usage of other users.

- **Dynamical resources**: Easily reallocated virtualized storage and computational resources, for example you can create more virtual servers or turning off existing ones in minutes [148].

- Resource sharing: Virtualization techniques enable multiple users to utilize several virtual resources which split from a one big resource. The users will be enabled to run various operating systems and various applications from one physical PC [148, 149].

(g) Maintenance and Fault Tolerance: Cloud service provider are responsible for keeping the system up all the times, if a component fails they immediately replace it, also the systems often replicated in multiple data centers to ensure highly reliability or least service downtime [50].

(h) Scalability: Unlimited resources of cloud technology such as bandwidth, processors, servers, hard drives and storage could be dynamically increased or decreased in any quantity at any time to meet the change in demand [150]. This feature allows institution to support their business growth without expensive changes to its existing IT systems. Thus, an institution can pay only for its requirements and remove unnecessary resources. Other benefits include get rid of associated costs of IT such as system optimization, employment and training IT staff, delivery of equipment and installation, or adjustment of IT capabilities. It also assists institutions to prevent the possibility of loss in time and money when they are unsuccessful in upgrading an expensive in-house IT readiness [151].

(i) Automatic Software Updates: Additionally, software-related benefits of cloud computing are that customers do not have to make a choice between outdated software and high updates costs. When the application is web-based, upgrades happen automatically and when user log in to the cloud, the newest version of the software will be available. This allows users to immediately take advantage of the newest features and saving extra time and money, instead of spend days working on software updates or waiting for the software to be purchased and installed [136]. Also users do not have to worry anymore about the hackers who are stalking their systems trying to exploit any chances of not updating their protection software.

(j) Unlimited Storage Capacity: Cloud computing affords clients to have a limitless memory storage capacity. Any storage space can be obtainable on demand and it ranges from a little Mbytes (megabytes) to hundreds of Tbytes (terabytes). Therefore, users should not worry again about the capacity of memory in their computers or loss of information because the data is automatically duplicated in the cloud, so nothing is ever lost even though there are emergency situations such as fire, flash damage or PC crash [136, 152], also the company can get rid of expensive upgrades for its computer hardware [146].

(k) Location Independent: It is concept that helps efficient delivery of applications and data from the cloud, regardless of where they actually reside and where the actual user resides [153].

(l) Increased Collaboration: Cloud applications are allowing employees access, edit and share files anytime and from anywhere, they will be able to make various things together and even they do it better. File sharing in cloud help them receive critical updates in real time and provide employees with a complete sight in their collaborations which results in increasing their efficiency and productivity [154].

3.2.3.2.2 Indirect Benefits:

Cloud services enable to accomplish tasks more quickly, for example you can consume more compute, network, and storage resources automatically in minutes [155].

The flexibility which cloud provides and the ability to access your online databases from anywhere at any times as well as the ability of collaboration in real time, have many benefits such as: -

- Enabling employee to be more effective and increase the levels of productivity.
- Enhancing the motivation and performance of employees [156].
- Boosting employee satisfaction [157].
- Promoting the loyalties of employees [158].
- Minimizing the need to travel to conduct business [159].

3.3 The Proposed Conceptual Model

Integrating the structures of two or more theoretic models has led to improve the understanding of a complicated information technology (IT) or the technological innovations adoption compared to the usage of a single theoretic model for the same study [64]. Thus, this research integrates the structures or factors from the models of TOE, DOI and Lacoveo et al. to evolve a proposed conceptual framework for the study of adopting cloud computing within the government organizational level. Figure 4 illustrates the adopted conceptual framework of this study.

The framework of Technology, Organization, and Environment (TOE) offers a multi-context lens for organizational level analysis or IS adoption in institution [58, 60]. DOI is "a theory of how, why, and at what rate new ideas, technology, and process innovation spread through an organization, a society, or a country" [160]. The TOE frame includes environmental factors that are not exists in DOI theory, so it will be more capable to interpret the adoption of innovation within the institution, and it increases the capability to depict conditional inputs of any developing country Including Iraq for IT innovation and implementation. Rui [161] argued that *"compared to 'Rogers' (1995) innovation diffusion model, the TOE framework (or those TOE-like frameworks) overcomes the domination of the technical perspective and provides a useful analytical tool to distinguish between the inherent qualities of an innovation and the motivations, capabilities, and broader environmental context of the adopting organization*". Moreover, the implementation of TOE framework helps to support and promote what has been overlooked in the DOI theory such as the specific technological and regulatory conditions for any industry [162]. Perceived benefits which are derivative from Iacovou et al. model have an effective impact on the adoption and integration of any new technology within an organization.

The proposed conceptual model of this study therefore is derived from strong IT adoption theories, and have been empirically investigated and demonstrated to be an important starting point for comprehending the adoption of cloud computing .the

'TOE framework', 'Iacovou et al. model' and the 'DOI theory' provide a strong and theoretic extension in the researches related to the adopt of technological inventions. after a comprehensive review of the information system (IS) innovations, these theories considered the most appropriate theoretical basis for understanding the adoption of cloud computing at the organization level [51].

There are seventeen factors which might influence the adoption and continued utilization of cloud technology has been included on this conceptual model. Precisely, factors for each of the contexts within the models of TOE ,DOI and Lacovuo et al. were formulated and supported, which include: TOE: Technological Factors (availability, reliability, security, privacy, feasibility, trust); TOE: Organizational Factors (cost, organization size, organization culture, technology readiness); TOE: Environmental Factors (government support, regulatory concerns, industry type); DOI: Technological Factors (complexity, compatibility); and Iacovou: Perceived Benefits Factors (direct benefit, indirect benefits).

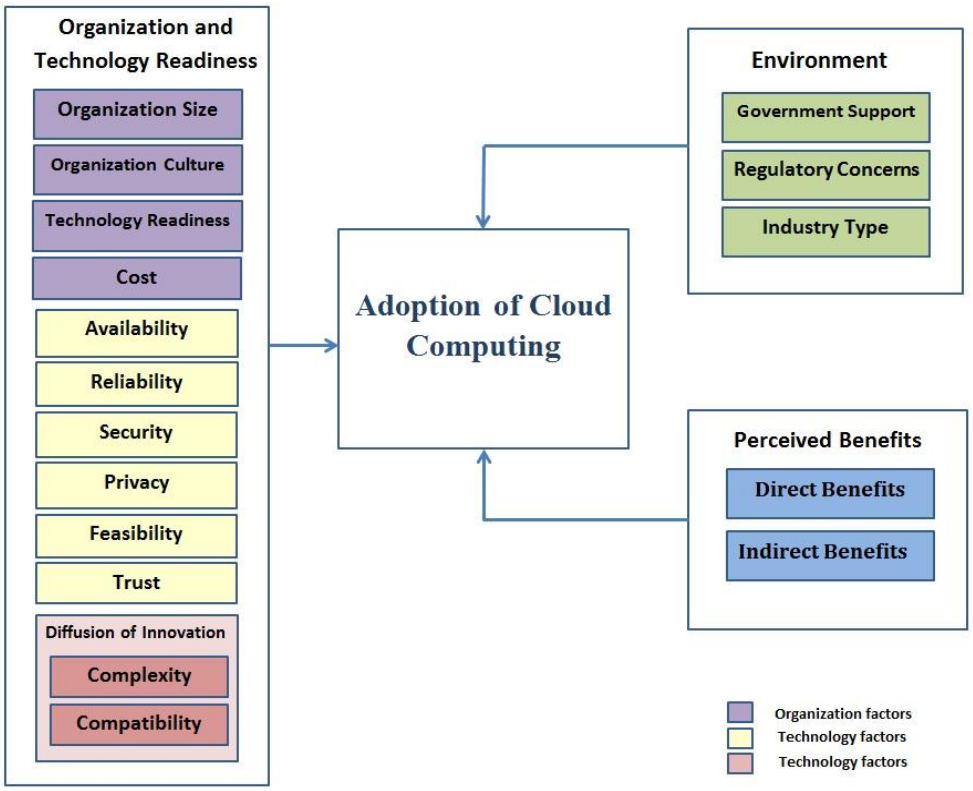

Figure 4 **: Proposed Conceptual Model of Cloud Computing Adoption at the Organizational Level**

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter consists of two main parts. The first part describes the methodology used to do this research. It begins with discussing methodology used in general in research design section. Besides it discusses the data resources, research strategy, and finally data analysis techniques. The second part includes an explanation of the simulation tools in general and the CloudAnalyst tool and its settings in particular. In addition, the research includes two methods that were employed through CloudAnalyst tool, namely AHP technique that used to obtain the weight of variables according to the questionnaire results, as well as ECDSA algorithm that used to identify the privacy and security of cloud computing.

4.2 Research Design

The research designs can be interpreted as organizing the activity of the research, which include the collection of data in ways that probably help in achieving the research objectives [163]. This study is quantitative and explanatory in nature, and a cross-sectional survey is utilized to achieve research's aim of identifying the critical factors that influences cloud computing adoption at the government organizational level in Iraq. This research developed a conceptual model for the adoption of cloud technology in Iraqi government sector. In this model there are seventeen independent variables quoted from TOE, Iacovou et al. and DOI Theories to predict the intent of adoption (the dependent variable). In order to analyze quantitative data of the study, the self–administered questionnaire has been used as an essential tool to collect prime data that will be analyzed through the statistical program SPSS. Data collection was being carried out through an individual administration and on-line survey by mailing the link to participants. The main factors that affecting cloud

adoption was explained to the participants using a video provided a long with hard copy questionnaire and online survey. Since the research attempts to know the government organization's perspective in cloud adoption, the organizational level unit has been used for analysis. Study participants were desired to be: IT managers, programmers, computer engineers and professors/academics who have knowledge on information technology in institutions belonging to different types of ministries in Iraq, these participants would serve as the voice of the organization regarding the migration to cloud environment.

4.3 Research's Population and Industries Sample:

Population "is the total of all elements that share some common set of the characteristics" [164]. It is essential in quantitative research that the used sample reflects the features of the population under study and that the outcomes drawn from the study apply to the entire population [163].

There are numbers of criterion have been set for the participants, which include:

- They must be working in a government institution in Iraq.
- They preferably have academic or administrative positions, such as top managers, department managers, and section managers.
- Lecturers, supervisors, teachers, engineers, and programmers were targeted.
- Technicians who utilized information technology (IT) on a daily basis for a wide set of processes were included.
- They must have relation in the field of computers, information technology (IT) or information system (IS) within their institutions for several reasons: Firstly, employees of general administration may not have the technical knowledge necessary to survey completion, this supposition may be various in other industries such as 'High Education' and 'Science and Technology' ministries. Second, employees who have knowledgeable in information technology, the existing systems and infrastructure of the institution have a greater vision of the technological landscape and are in a better position to provide a new technology adoption perspective, support of (application development platforms, infrastructure of IT, networks, databases and SW applications).

For another industry types sample, there are some of ministries which targeted in this study such as Ministry of Higher Education and Scientific Research, Ministry of Electricity, and Oil Ministry. Other Ministries were included, which are Ministry of Science and Technology, and Ministry of Education. In addition, there are some institutions that already adopted cloud computing also included in this study such as The Central Bank of Iraq and General Company for Electronic Systems.

4.4 Research Strategy

This research could be deemed as explanatory, since we are trying to link ideas to derive the reason and effect, to clarify what is going on in the adoption process in order to do that research insights have been collected from two different sources. First source was an accurate review of the literature in this area to realize what has already been done and is displayed in our review of the mechanism of adopt cloud technology and the second source is to employ a survey for data collection from organizations in a quantitative manner.

4.4.1 Quantitative Phase

"Quantitative research is used to quantify the problem by way of generating numerical data or data that can be transformed into usable statistics. It is used to quantify attitudes, opinions, behaviors, and other defined variables, and generalize results from a larger sample population". Research uses commensurable data for fact-finding and pattern detection in research. The methods of data collection in quantitative research are much more organized than qualitative research; these methods involve diverse forms of surveys for example online surveys and/ or paper surveys [165]. This research used only quantitative method for collecting data without employing any data from qualitative method like interview, because it relied on theoretical and literature review such as (articles, previous studies, Master and PHD thesis, books, academic magazines, reports, and scientific websites) to gain depth insights into the potential factors that may affect the adoption of cloud

computing in the Iraqi government sector in general and the sub-issues related to each factor.

The use of quantitative techniques seems to be the most vastly used strategy for data collection from the other alternatives for the study adoption of information and communication technology (ICT) since the survey assists to investigate the relationships between independent and dependent variables. Also the survey aids connect with a large population to collect data on the same issues, often by asking the same questions to everyone.

The cross-sectional survey with self-completion questionnaires was considered the most suitable methods for collecting data. They have been applied later to collect the required data on cloud computing adoption, and to reveal the impacts of independent variables on organizations want to migration to cloud computing environment [163]. For the assigned survey, my own personal contacts, special online groups and confident social links from Iraq have been used. To answer the survey questions more than hundred and twenty requests between paper questionnaire and online survey were given directly or sent by e-mail to employees in several Iraqi governments' organizations. An explaining video was also presented on the advantages and disadvantages of cloud computing to increase participants' awareness of this technology and raise the level of survey response. There are a lot of employees who could not participate in the survey, because they were either avoided or in vacation or they had a lot of works.

There were 125 responses in total. 25 of these responses were excluded and could not be utilized in the analysis due to large portions of the survey were incomplete for example, some parts or questions were left blank, or had the same selection on all items of the Likert scale, such as all three or all fives, or select a lot of 'I do not know'. Consequently, about 83.333 % of responses had been obtained although reminding messages and e-mails had been sent to get the greatest response. However; the rate of responses was satisfactory and included significant suggestions. There are a lot of ministries targeted in this study such as Ministry of Electricity, Ministry of Higher Education and Scientific Research, Oil Ministry, Ministry of Science and Technology, Ministry of Education, and Ministry of Water Resources, in these

ministries several department are included such as (IT, Planning, Operation, Commercial, and Implementation) departments, this is because the sample included programmers, engineers, technicians, etc., who their work is not limited to the IT department, they distributed in many sections whose daily work is based on the use of information technology.

4.4.1.1 Questionnaire Design

This study adopted the technique of self-questionnaire, due to the fact that it is necessary to ensure that participants have a well knowledge of the issues surrounding each factor that may affect adoption, it was taken into account that the wording of the questions should cover all aspects of the literature review, so a number of clear sub-questions were prepared for each factor in order to obtain correct results that reflect what the participant thought about the importance of each factor. The questionnaire was prepared in the English language (see Appendix A), and then it is translated into Arabic. The paper questionnaire was distributed in Arabic because it has a lot of words which the employees may not familiar with, so the Arabic copy can be better understood and easier and faster to answer. The questionnaire can be categorized into three main parts:

First Part: Explains the purpose of the questionnaire and that it will just be used for statistical analysis in quite confidentiality, in order to encourage participation in the survey and to obtain a high response. As well as this part include a simple and clear definition of cloud computing.

Second Part: Contains set of inquiries about the affiliation information of the participants such as their role, department, their organization size and ministry. As well as set of basic questions about direct and indirect benefits of cloud computing.

Third Part: This part includes 91 sub-questions that utilized in studying the technology, organization and environment factors. These questions have been evaluated through five point Likert scale. This part addressed the following factors: security, privacy, availability and reliability, cost, complexity, organization size, organization culture, feasibility, trust, IT readiness, regulatory, compatibility and

government support concerns. The last question is a free question that enables us to collect diverse ideas and suggestions.

4.4.1.2 Online Survey

An online survey is the second main method employed in this study, which has been done by using the email with link to URL survey, there are a lot of advantages of using online survey such as: -

- It provides an effective mechanism for collection of the data from a broad sect of participants who represent several Iraqi governments' organizations.
- The participants could choose an appropriate time to respond and have enough time to analyses the questions and think in their answering.
- It provides participants greater privacy and convenience, compared with the interviews.
- It helps to get rid of the administrative things that must be done when going directly to government institutions, such as obtain permission to conduct the questionnaire and gather the employees
- Lastly, it is an easier way to follow-up, involves low cost via sending e-mails, and the ease of doing so with this kind of surveys where researchers could contact participants by mobile or send follow-up reminders, to raise the response rate for the survey.

4.5 Video Contents

This research also includes video preparation to provide the necessary knowledge about the cloud concept, as well as the advantages and disadvantages of cloud technology. To achieve this goal, the video was prepared in English and then translated into Arabic. The video was shown by the data show to respondents who have been provided with the questionnaire in paper form, as well as the video was placed on the computers for both managers and employees who did not attend the presentation of the video. For the online survey, the video was uploaded to YouTube: (https://www.youtube.com/watch?v=r2esl9ThoNA&feature=youtu.be), and then the

both links of online survey and YouTube were placed in each email that was sent to the respondents.

The following represent the contents of the video:

Governments and public sectors are constantly looking for means to develop their services. Thus, restructuring and the use of technology are needed to improve the worthiness and efficiency of business processes. Cloud technology is one of the modern technological trends which props these efforts.

So what is cloud computing?

"It is a system that enables storing of data and applications on remote servers and accessing them via the Internet rather than saving or installing them on your personal or office computer".

The cloud accessible through the cloud computing system interface, that could be as easy as using a service of web that hosts the whole required files and applications for your business?

Simple examples of cloud are Gmail and Dropbox, if you've ever checked your email online you've already used cloud. You can log remotely into web e-mail account by a browser, but your account storage will not be at your computer, but it is stored in the CSP server.

So why we should choose cloud computing?

There are multiple direct and indirect benefits of utilizing cloud technology:

Mobility:

Do you ever encounter the problem of being in another city or country and you cannot get access to your files which are stored in your personal computer, CD, or flash memory?

Cloud computing allows you to be more flexible, it offers you the capability to work from any place at any time from any smart phone, thus, none of your data will be restricted to a single place or hard drive.

Cloud disaster recovery:

What if your document is stolen or if these documents get burned, or what if your laptop gets shuttered, but with cloud you will never worry about losing your data

ever again. Copies of electronic records are maintaining in cloud computing environment to provide an organization with a way to recover data and failover in the event of an accident or natural disaster.

Security:

- Your data are stored in a huge secret data warehouse full by computers.
- Minimize the risk of data loss because of accident, virus.
- Cloud used encryption method to protect against internal and external threats.
- You will have a secure sign-in process.

Limitless storage:

Do you have a lot of stuff (applications, files)?

With cloud computing instead of restricted area of the hard drive of your computer, you could store all you stuff in the World Wide Web of Internet.

It is an easy and affordable way to run your business, you just plug in higher utility service and your applications can run in a shared data center it much faster in performance and cost far less.

Automation:

CSP handle the entire operations of hosting, restoring, monitoring, data backup, maintenance, and offering technical support. If you are suffering from a problematic technical issue, cloud based support can remotely view your system, diagnose a problem, and fix any software related issues you may face.

Software updates:

You can use cloud based software instead of buying software directly and installing it locally on your computer. You do not have to worry about regular software updates and security patches because your service provider takes care of that for you.

Virtualization:

"Allocate multiple virtual machines on a single physical machine and share the underlying hardware resources" , for example we have one server that replaces 12 physical machines with fewer physical machines that you need to purchase, now you

lowered your capital expense, instead of having to buy 12 machines, you only have to buy one, also with virtualization you will have centralized management that means instead of having to manage 12 individuals machines you only have to manage one server and all the updates or patches that you need to do for each of those individual machines you can just push through from one central location. Additionally, virtualization enable you to run multiple applications and operating systems from your computer at the same time, so you can use software programs which it is either not installed on your systems or running in alternative operating systems.

Scalability:

Unlimited resources of cloud technology such as bandwidth, processors, servers, hard drives and storage could be dynamically increased or decreased in any quantity at any time to suit rising number of clients. Cloud has the ability to build and expand in minutes. While the traditional way to meet variable business requirements, the institution needs to invest both money and time in order to expand its information technology infrastructure such as HW, SW and services. This sizing operation could be slow and institution is often incapable to realize optimal usage of IT infrastructure.

Cost Saving:

- Pay as you use: Fees are based on consumption.
- Reduced the high cost of electricity, hardware and software which can be outsourced to the provider.
- Help the institution avert capital expenditure on extra infrastructure resources for premises, and immediately expand or reduce the scope, according to requirements of business.
- It is cost effective: Which means you are going to be getting out more than what you put.it is up of %05 less than what you are currently paying for security and maintaining your own servers and software.

But even with all these benefits, there are still possible problems; the two major concerns are both security and privacy, since you let another company handling your

significant information, so this company will be allowed to watch them. There are many concerns such as: -

-Who administrate and could access data?

-Where the warehouse of data?

-What applicable laws to your data protection?

- Do you know when the data is hacked?

- After service termination, does the data stay in cloud system?

But these problems could be solved by adopting either private or community cloud:

Private Cloud: It is a cloud computing infrastructure specifically built to serve one association to fit the specific association requirements. It can be existing on or off premises, the association itself can take charge of management or it could be managed by. Here you will have greater control, but its cost is higher.

Community Cloud: Multiple institutions can share cloud infrastructure and support a particular society who has the same issues like mission, security, policy, and regulations. This kind of cloud can be administrated by the institution itself or through a second party and can be located in or off institutions' buildings. This kind has cost saving capacity, because the financial side is divided among the organizations.

Another security issue in the cloud is that, the site and cloud computing services can be exposed to the risk of penetration. The biggest concern for cloud's companies is their reliability and reputation; therefore, they do anything possible in order to protect your information, but also need to secure your information:

- Have authentication technique.
- Do not reuse or share your password on different websites.
- Use difficult passwords.
- There are also licensing practices where you could list the employees who are authorized to reach specific applications, for instance, employees may be allowed to utilize only certain applications saved in the cloud that are regarding to their business.

Another concern in the cloud is **Cost**:

- Cloud companies charge you monthly or annual fees, and the monthly fees could be high.
- When you need additional computing resources you get another server which contains other virtual machines and these could be larger or smaller virtual machines depending on the business needs, everything comes at a cost, so there is something to pay for each of these machines, of course the smaller the machine the less expense.
- Organizations can save money from both hardware and software with cloud technology. The cost of bandwidth can be low for not intensive data that returns for small applications on the Internet; however, it can be quite expensive when the organization for the intensive applications.

Complexity: Cloud technology is simple to use from end user side; users will be able to access computing resources without the need for any support but complexity can appear when an organization decide to manage cloud system itself this complexity can come from:

- Augmentation in the infrastructure layers to administrate and protect diverse applications and operating systems for each server
- It can be complex reconfigure your applications to meet the requirements of a new host.
- Elimination of physical boundaries between systems.
- It is hard to administrate all the complex functions of cloud technology; it does not include any direct participation of IT department. It is the responsibility of the CSP, to manage and disseminate information in the enterprise.

Availability and Reliability

The system is wholly depending on the Internet and it does not function when there is an Internet breakdown, which can cause:

- When your Internet connection is down, but you can overcome this problem by using Internet access services provided by mobile phone network.
- Internet outage that can come from cloud service provider, so to ensure that the service in the cloud is reliable and running well all the times, you should choose

service provider who gives you guarantees service level, that means availability of up to "99.55%" which is equivalent to "1.83" days of outage per year or three hours per month.

Now after you know the advantages and disadvantages of cloud technology do you think it is better to adopt this technology or still use traditional system for organization's premises?

4.6 Data Analysis Techniques

To achieve the research goal, the researcher used quantitative data analysis method. There are two major processes that have been used to analyze the collected data. In the 1st process the quantitative data has been tabulated by utilizing Microsoft Excel. The 2nd process consists of statistically analyzing the quantitative responses using (SPSS 24). The following statistical method is used in this study:

1- 5 Point Likert Scale Type.
2- Descriptive Analysis.
3- Select Cases Filter.
4- Compute Variables.
5- Cronbach's Alpha for Reliability Statistics.

4.6.1 (5) Point Likert Scale Type:

In order to test the impact of research a conceptual model on the cloud technology adoption, 5 points Likert scale systems were applied from the seventh question and above. "The Likert scale is an interval scale that is used to ask respondents to indicate whether they agree or disagree about a given subject by rating a series of mental beliefs or behavioral belief statements" [164].

The questionnaire scale was encoded in a " 5-point Likert-type scale" ranging from 1 "unimportant" to 5 "most important", there is (I don't know) option in the case of non-knowledge of participant as follows:

Option 1: unimportant
Option 2: less important
Option 3: important

Option 4: very important

Option 5: most important

Option 6: I do not know

4.6.2 Descriptive Analysis:

The study used descriptive statistics in the interpretation and analysis of data. They describe the data and involve the different forms of the average that may employ to measure the level of data, and statistics like the standard deviation that is used for spread measurement. The mean values were utilized to determine the average response for each sub questions of each factor. Also, the total average for mean values was calculated in order to know which factors have obtained a rate of more than 4 according to the Likert scale, which reflects the high importance of this factor according to the participants' perspectives. Additionally, explains the top three sub question mean magnitudes for security, privacy, availability and reliability, cost, complexity, organization size, organization culture, feasibility, trust, IT readiness, regulatory, compatibility and government support concerns respectively.

For standard deviation of a group of numbers is a measure of the prevalence of values from the mean value.

4.6.3 Select Cases Filter:

The select cases method in SPSS enabling users to identify certain cases of data based on a diversity of user-defined conditions. This is helpful when the user focus on sub-groups within set of data. In this study, this method was used to separate the (responses of managers from the responses of employees); (responses by large institutions from small and medium size); (responses according to ministries); (responses according to participants' departments), for the most influential issues on the adoption of cloud technology in Iraqi government institutions.

4.6.4 Compute Variables:

Compute variables are used when you need to calculate a new variable, intensifying several primary data points at one point. For instance, when utilizing

unified questionnaires, it may be a necessity to compute the sum and/or several scores of sub-sections rather than analyzing each question separately.

In this study this method was used as a way to find the percentage of each critical factor. Firstly, the total mean of each factor's sub-questions was put under one specific name for example security, privacy.... etc. via compute variables. Secondly, descriptive statistics were used to find the mean to the set of main factors that were formed in the previous step. Finally, to compute the percentage of each factor, the following equation was applied:

Value in percentage (%) = mean*100/5

Where mean represents the average of response for each main factor in total, which multiply by the number 100, in order to obtain the percentage in %, and divided on 5, due we used five point Likert scale.

4.6.5 Reliability of the Research:

" The reliability of an instrument is the degree of consistency which measures the attribute" [166]. The less variance in frequent measurements of the feature that achieved by the tool. the greater reliable it is.

After applying the questionnaire and handling the data via SPSS program, the questionnaire reliability has been calculated by utilizing Cronbach's coefficient alpha method for each critical factor in the study.

4.7 Cloud Simulation Tools

Some of main features of cloud computing is: scalability, on-demand access, flexibility, cost reducing, minimum infrastructure administration, and independence of location. Investment in the cloud can reach trillions of dollars. In the real world, it is not possible, for system managers, specialists in the cloud as well as researchers to obtain the actual infrastructure of the cloud, to conduct real-time experiences and execute new algorithms and procedures. Cloud simulation plays an essential role in minimizes infrastructure complexity, analyzing threats of security, implementing new algorithms, thorough quality measurement and infrastructure performance. Several CC simulators tools have been developed to assist system managers,

specialists in cloud, researchers and network responsible in measuring the performance of cloud environments in the real time [167], and help them to focus on quality issues of specified component under various scenarios.

The main benefits of using cloud simulators are as follows:

1- There is no capital cost included. Cloud technology has shifted from the cost of capital expenditure to operating cost. Additionally, by using cloud simulation tool users can get rid of the installation and maintenance costs.

2- Obtaining better results: The usage of such tools assists to alter the inputs and parameters in a very easy manner as well as getting better and accurate outputs.

3- Risk evaluation at an early phase: Due the simulation tools do not include any cost during the running as in the status of existence on the cloud, so that client can determine and solve any risk which is related with any parameter or with the design.

4- Easy to learn: If the client has a good knowledge of programming and language, then he will not have a problem with simulation tools [168].

4.7.1 CloudAnalyst

CloudAnalyst is a simulator tool that uses Graphical User Interface (GUI) derived from Cloud Sim, as show in figure 5. It has a number of expanded characteristic and abilities, and it can be used to examine the performance of wide scaled application of Internet in cloud environment and detach the simulation testing practices from programming practices. Furthermore, it allows a user to conduct simulations repetitively, and perform set of simulation experiments with simple changes in parameters in an easy and fast way. Simulator tool supports the evaluating the tools of social network depending on the geographical allocation of data centers and users.

CloudAnalyst is considered as a strong simulation framework for the deployment of data centers in real-time, and load balancing monitoring, monitoring of cloud cluster and following the data of data center in real time. It enables users to save the configuring of simulation in XML files, and exporting live results in PDF format. The main characteristic of this simulator are as follows:

- **GUI:** CloudAnalyst has an easy-to-use graphical user interface for setting up and displaying the results of all types of cloud computing tests.
- **Definition of simulation by a high degree of flexibility and configuration**: It is equipped with models featured by a high degree of control of test by the entities of modeling like memory, data centers, VMs, bandwidth and storage.
- **Loop experiment**: CloudAnalyst simulation scenarios can be saved and looped them over and over through conducts many different simulations, and the results can be saved in 'XML' and 'PDF ' files.
- **Effective outcome**: CloudAnalyst offers graphical outcomes for the results of simulation on the format of tables and graphs, regardless a great amount of the statistical data [167].

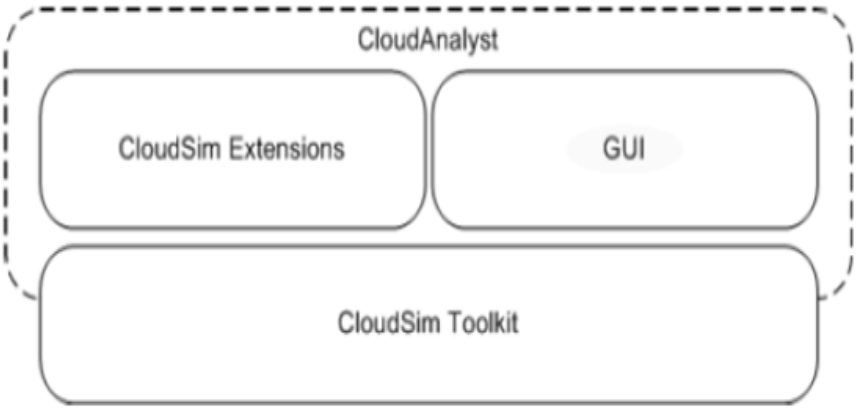

Figure 5 **: CloudAnalyst Structure**

4.7.1.1 Simulation Setting

(a) Assign User Bases: Using the entities of user base to define application users and their geographical allocation, and other characteristics for example users number, usage frequency and usage pattern like peak hours. This is prepared on the "main tab" of screen of the simulation configuration**.**

(b) Data Centers Determination: Use the tab of data centers in the dialog box of configuration to select the data centers that user want to utilize in the simulation. The selection of every aspect of hardware and of data centers can conduct in this place.

(c) Customizing the Devices of VMs in Data Centers: As soon as data centers are generated, the user needs to assign VMs in these data centers in order to the emulator application through the main tab of the screen of configuration. The data center specified in the above step will not include in the simulation unless it is customized in this step. As well as you can during this step customize multiple kinds of VMs in the same data center.

(d) From the advanced tab in the screen of configuration, the user may need to review the advanced parameters and make the necessary modified for them.

(e) From the screen of Internet characteristics, the user may need to review the bandwidth and network latency, or modified them [169].

4.7.1.2 Cloud Analyst Startup

When CloudAnalyst starts, the foremost screen appears with a map of the world on the center of the screen. CloudAnalyst divides the world in to six regions located in the six central continents. These regions are: R0 which represents North America; R1 which represents Latin America; R2 which represents Europe; R3 which represents Asia; R4 which represents Africa; R5 which represents Australia. Those regions are used in distributing DCs and UBs during configuration process.

4.7.1.2.2 Cloud Analyst Configuration:

The screen of configure simulation consists of three main tabs as the following:

4.7.1.2.2.1 Main Configuration Tab

1. **'Simulation time'**: It represents the period of simulation that could be specified in hours, days or minutes.

2. '**User Bases Table'**: Each user base represents a set of users that are deemed one unity in simulation, and they are responsible of traffic in the simulation. Thousands of users can be represented by a single user base but is configured as a single unit, and the traffic that created in bursts of simultaneous represents user base size. Each user base has configurable fields such as (name, region, request per user per hour, etc.)

that appear in a single row in the table. The buttons of add and remove that reside near to the table could be utilized in adding or removing user bases from the configuration [170,171].

3. ‘Application Deployment Configuration’: This table shows the number of virtual machines (VMs) which are specified for the application in every data center from the tab of data centers, along with a virtual machine details. The fields are as following:

1- ‘Data Center’: The names of data centers that are created in the tab of data center is representing in this drop down list.

2- ‘Number of VMs’: represent the number of VMs that will be assigned to the application from the chosen data center.

3- ‘Image size’: The size of a single VM image which is measured in bytes.

4- ‘Memory’: Represents the memory amount that available in each VM.

5- ‘BW’: Represents the bandwidth amount that available in each VM.

The button of "Save Configuration" lets the users save the configuration that was created as a file. The simulation files have the extension (. sim). While, using the button of "Load Configuration" the users can download the prior saved simulation configuration [170].

4. ‘Service Broker Policy’

The routing of traffic among user bases and data centers is managed by service broker technique that determines which data center must support requests of each user base. The existing version of Cloud Analyst executes three kinds of service brokers that employing a various routing policy.

1- ‘Proximity-Based Routing Service’: In this case proximity is the fastest path to the data center of the user base based on network response time. The service broker will direct the traffic of user to the nearest data center in terms of transition latency.

2- ‘Optimized Routing Performance’: The performance of all data centers will be monitored actively by the service broker, and routes traffic to the data center which is estimated to provide the best response time to the user at queried time.

3- ‘Reconfigure the Router Dynamically’:

This is an expansion of proximity-based routing, where there is a high similarity in the logic of routing, but the service broker is endured with more responsibility for expanding application deployment scale on the basis of the load it faces. This is achieved by increasing or decreasing the number of virtual machines distributed in the data center, based on present processing times as compared to the best processing time could be ever achieved [172].

4.7.1.2.2.2 Data Center Tab

The most important entity in the CloudAnalyst tool is existed in the controller tab of data center. The data center configuration can be defined by data center tab. The top table lists the DC, and the user can add or remove DC to the configuration, through the Add/Remove buttons that reside near the table [170].

A single DC controller is assigned to a single CloudSim. The management activities of data center such as creating and destructing a VM, is managed by datacenter as well as it directing user requests from online user bases to the VMs. It can also be seen as the interface used via CloudAnalyst to reach the heart of the CloudSim tool function.

When the users choose a DC from this table, a 2^{nd} table will appear under it with the server machines details in the data center [170,171].

4.7.1.2.2.3 Advanced Tab

The Advanced tab includes some main parameters that use to the whole simulation.

1. ‘User Grouping Factor in User Bases': This parameter clarifies the simulator how many users should be considered as a special set to create traffic. The number shown here will be utilized as the number of requests that performed by a single InternetCloudlet .

2. 'Request Grouping Factor in Data Centers’: This simulator parameter shows the number of requests that must be handled as a single processing unit for instance a lot of these requests are grouped together and allocated in a single virtual machine as a one unit.

3. 'Length of executable instruction (bytes)': This is the key parameter that impacts the length of execution of a request. This is the same as the parameter of ‘‘GridletLength’’ that utilized in GridSim [170,171].

4. ‘Load Balancing Policy’:

Load balancing is an effective and crucial concept in cloud technology, which can be defined as "A method for distributing workload on the multiple computers or a computer cluster through network links to achieve optimal resource utilization which maximizes throughput and minimizes overall response time" [173]. It reduces the total wait time for resources as well as avoiding overloading resources. In this algorithm, the traffic is split among servers, so that the sent and received of data could be done without extreme delay. It applies a different scheduling algorithm that specifies which server should receive the request. Additionally, it will ensure efficient resource allocation and resource scheduling as well as tasks. Effective provisioning of resources, resource scheduling as well as tasks will assure the following:

• Resources can be accessed easily.

• Resources are utilized professionally under low / high load condition.

• Minimize the cost of utilizing resources.

• Load balancing increases productivity to the highest level and at minimal response time.

There are two kinds of load balancing algorithms:

(a) 'Static load balancing algorithm': "Static load balancing is a load balancing algorithms that distributes the workload based strictly on a fixed set of rules such as input workload" [174]. In this algorithm the load does not relied on the present situation of the system but it demands knowledge about the resources of the system and application

(b) 'Dynamic load balancing algorithm':" This algorithm has more flexibility than the static algorithm, and it does not depend on prior knowledge but relied on the present situation of the system [174], that involves processing client’s requirements such as memory, power, data and performance [173]. "Dynamic load balancing

algorithms are those algorithms which search for the lightest server in the network and then designated appropriate load on it" [175].

Generally Load Balancing tab includes three main algorithms:

1- 'Round Robin Algorithm':

Round Robin is a static algorithm of load balancing, where slices are appointed to each operation in an equal part and circular style. The time is divided here into multiple segments and each node is given a certain time period. Each node is given quantitatively, and in this specific quantum node has to implement its processes.

The user must not wait if the request accomplishes in quantum time. Otherwise, the user has to wait for the next slot. This algorithm is not priority–oriented scheduling, where each function is processed to available VM in circular arrange. Due to the load picking randomly, these causes the status where some nodes are loaded thick and some loaded more moderately. Consequently, this leads to imbalance of loads from the system [174].

2- 'Throttled Load Balancer (TLB)':

It is a dynamic algorithm of load balancing, where the user first asks the load balancer to find an appropriate VM to implement the requested process. In cloud technology, there may be multiple cases of the VM. These virtual machines could be assembled according to the kind of requests that could be handled. Whenever a user submits a request, the load balancer will first search for that group that can address that request and assign the process to a low instance of that group. These types of dynamic algorithms are being experimentally executed through the cloudAnalyst tool that gives results with regard to the VM [173].

3- 'Equally Spread Current Execution (ESCE)':

It is a dynamic algorithm of load balancing, which addresses the operations based on their priority. It sets the priority via checking the size of the operation. The load in this technique distributes randomly via first checking the size of the operation, and then transmitting the load to a VM which is less loaded. Load balancer is known as "spread spectrum technique", because it distributes the load on various nodes. There is a clear improvement in both response and processing time in ESCE algorithm. All

tasks are spread equally, and a full computing system is loaded at balanced way, and without any untapped VMs. Because of this feature, there is a decrease in the cost of the VMs and the cost of data transfer [175].

4.7.1.2.2.4 'CloudAnalyst Internet Characteristics':

Different Internet properties are typical simulations which involve the latency amount and bandwidth that should be allocated among regions, the traffic amount, and information of the present performance level for DCs [170].

4.8 The Proposed Methods:

This study includes using AHP technique to get the weight of the influential critical factors in cloud adoption depending on the questionnaire results, as well as using ECDSA technique to prove the security and privacy of cloud environment, through CloudAnalyst software usage.

4.8.1 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a practical and efficient technique used for solve a large variety of multi-criteria decision-making problems in cloud computing [176,177]. Cloud service quality standards have been developed hierarchically using analytic hierarchy process technique. The AHP-based model has facilitated the process of mapping over the cloud layers and arranged the selected cloud services for clients [178].

It enables for the resolution of problems with various tangible and intangible factors (criteria) by creating a ratio scale identical to the priorities of the existing alternatives. The AHP is distinguished from other multi criteria methods by its flexibility and its capability to test inconsistencies. AHP is simple to understand, it can address both quantitative and qualitative data effectively, and it does not include onerous mathematics [179,177]. It is appropriate for implementation in multiple processes such as: (planning, producing decision alternatives, defining priorities, selecting optimum policies or plans, determining the distributions of resource,

identifying requirements, performing result prediction or risk evaluation, estimate performance, achieve optimization) [180] . As well as AHP helps in analyzing the problem into smaller components, this enables decision maker to concentrate on fixed number of criteria at one time [176].

Generally, the AHP is a Multiple-criteria Decision-making (MCDM)technique that can get the weights of factors. Several studies applied MCDM for services selection and AHP was the widely used method. MCDM have the ability to evaluate factors that influence cloud computing acceptance, furthermore it can provide insight into concerns affect the acceptance of technology users [181].

4.8.2 The Elliptic Curve Digital Signature (ECDSA) Algorithm

Cloud technology has created new opportunities and risks for authentication. The security must be the essential step in the cloud to achieve full protection by applied an integral security strategy. There are rising requests for an applicable authentication to access data and services for both organizations and customers.

According to Sathish et al. [182] cloud computing security "is the set of control-based technologies and policies designed to comply with the rules and regulations framed by the provider team to support and protect information, data applications and infrastructure associated with cloud computing use".

" The Elliptic Curve Digital Signature Algorithm (ECDSA) is a public key cryptosystem used for creation and verification of digital signatures in securing data uploaded by the cloud users".

The digital signature algorithm (DSA) is" an electronic signature used to authenticate the identity of the user of the services provided over the cloud, by using this technique, the user must provide the appropriate login or access credentials before they can have access to the information or application they want to use" [183]. The ECDSA algorithm is the elliptic curve peer of DSA and serving the same objectives of generation of key, generation of signature, and verification of signature [182].

This useful technology provides a shorter key and length of signature at the same level of security of other algorithms such as RSA. This decreases the size of data that has to be moved and stored in cloud environment [184]. There are many reasons which make small keys more efficient than large keys. They have faster algorithms for creating signatures due to the mathematic includes least numbers, and they denote to smaller confirmation and minimal pass of data in order to found a secure connection. This lead to faster connections and quicker websites loading times [182].

ECDSA algorithm need pairs of both public and private keys which utilized for the creation of digital signature as well as verification with consider to a special set of ‘domain parameters’. These parameters can be public and they can be popular to a group of clients. They can stay stable for a long period of time [185]. This algorithm protects against a large set of side channel attacks which include cache attacks, also faces memory detection attacks [186].

In general, the size of bit for the public key supposed to be required for ECDSA is around twice security level size in bits. For instance, at ‘80’ bits security level, an attacker needs to create an equivalent around ‘280’ signature to discover the private key [187], therefore digital signature algorithm has been considered one of the most distinguish digital signature algorithms utilized nowadays.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Introduction

This chapter analyzes the findings of the study as an attempt to determine the critical factors that influences cloud computing adoption at the government organizational level in Iraq. Paper questionnaires and online survey were the prime methods for collecting the data were used in this study.

The structure and analysis of the survey questions were based on the theoretical framework given in chapter (3) that was developed from the integration of three IT adoption theories. The data were analyzed via using 'Statistical Package for Social Sciences ' version 24 as illustrative in detail in chapter (4).

The questionnaires results can be categorized into two parts. The first part represents inquiries responses about the affiliation information of the participants such as their role, department, their institution’s size and ministry, as well as the overall responses about direct and indirect benefits of cloud computing. The second part represents the responses about the other variables of the study. These questions are corresponding to security, privacy, availability and reliability, cost, complexity, organization size, organization culture, feasibility, trust, IT readiness, regulatory concerns, compatibility and government support factors respectively. The last part involves the answers of free question that enables us to collect ideas and suggestion. Also the study findings will be discussed in general in this chapter.

Finally, cloud simulation setting and results based on original CloudAnalyst software package, as well as an explanation of how AHP and ESDCA methods will be performed through CloudAnalyst tool, are illustrated in this chapter.

5.2 Survey Results

The survey results present 100 responses to each question by the participants. The description of the response of each inquiry has been done. These inquiries contain various details, in an attempt to offer a well perception of the issues related to each factor.

Generally, the participants indicated various importance levels for the issues regarding cloud computing, that derived from organizational, technological and environmental factors.

From tables 3-15 the issue "**Continuation and disaster recovery plans**" has the highest mean value (M = 4.47; SD = 0.926) from trust factor, followed by "**You do not have data and available service during interruption or potential attack**" (M = 4.42; SD = 0.955) from availability and reliability factors, followed by "**if its use is safer than using a traditional system**?" (M = 4.40; SD = 0.953) from feasibility factor, followed by "**Security practices**" (M = 4.39; SD = 0.994) from trust factor, followed by "**Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner**" (M = 4.39; SD = 0.898) from regulatory concern factor, followed by "**Information assurance practices**" (M = 4.39; SD = 0.886) from trust factor. The lowest from the whole issues are "**The organization is very supportive to changes**" (M = 3.12; SD = 1.305), and "**Most persons in this organization are encouraged to make suggestions for improvement**" (M = 3.21; SD = 1.266) from organization culture factor. The overall collected data and discussion about survey outcomes can be analyzed as follows: -

5.2.1 Participants Role

The first was question about the role of participants in the institution. Most participants are employee with 53%, followed by section managers with 25%, followed by 13% for department managers and 9% for top managers as depicted in Figure 6. The different opinions of managers and employees will be explained in the next sections.

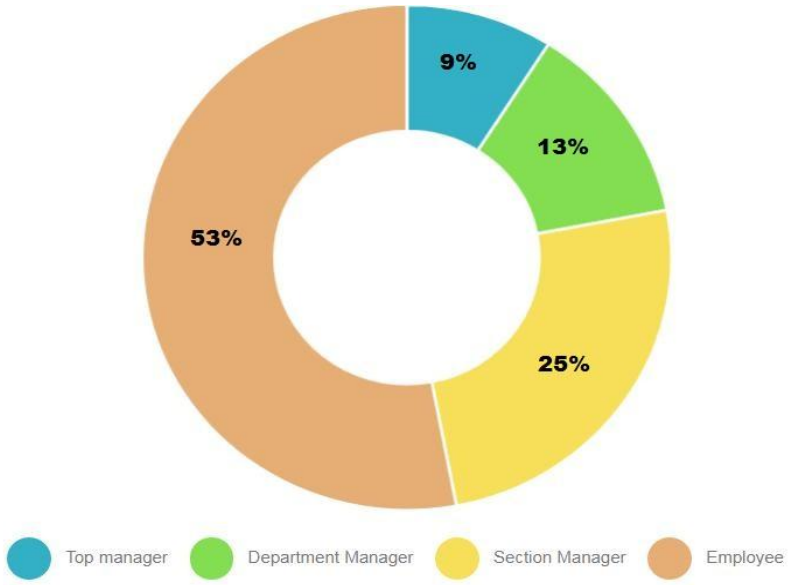

Figure 6: **Institution role for survey participants**

5.2.2 Participants Departments

The second inquiry is about the specific department of participants at their institutions, the majority of them are from IT department with 50 %, followed by planning department with 20%, followed by 15% for operation department and 15% for other departments as illustrated in Figure 7. Other departments included in this survey are commercial, developing and implementation departments.

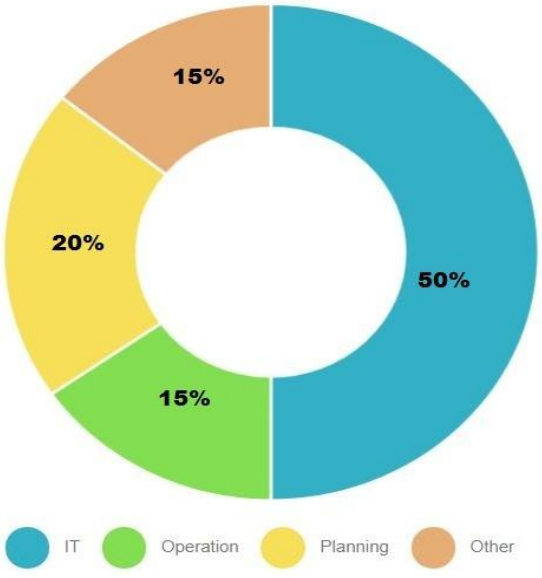

Figure 7 **: Participants departments' percentages at their institutions**

The results of the study show that all participants from IT departments considered that the most important issues affecting the adoption of cloud computing are: "**Continuation and disaster recovery plans**" from trust factor which got the highest mean value (M = 4.46; SD = 0.908), followed by the issue **"If the real-time performance for cloud service is high?"** from feasibility factor which got **(**M = 4.44 ; SD = 0. .884 **),** followed by **"You do not have data and available service during interruption or potential attack"** from availability and reliability factors with (M = 4.44; SD = 0.787) , followed by **"Security practices" and "Information assurance practices"** from trust factor which got (M = 4.40; SD = 1.010) and (M = 4.40; SD = 0.881) respectively .

According to the participants from operation department the most important issues are "**If it will be beneficial and profitable?"** and **"If it is feasible within the estimated cost?"** from feasibility factor which got (M = 4.67; SD = 0.617) and (M = 4.60; SD = 0. .632) respectively, followed by **"Information assurance practices "with** (M = 4.60; SD = 0. 632) from trust factor, followed by "**If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?"** from government support with (M = 4.47; SD = 1.060), followed by the issue **"If its use is safer than using a traditional system?"** from feasibility factor with (M = 4.47; SD = 0. .990), followed by "**Compliance for standards and regulations"** from trust factor with (M = 4.47; SD = 0. 743).

Regarding the participants from planning department the issue "**Compliance for standards and regulations"** from trust factor with (M = 4.58; SD = 0.769) got the highest mean value, followed by "**If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?"** from government support which got (M = 4.53; SD = 1.060), followed by "**Another company may get control over your information"** from security factor with (M = 4.53; SD = 0.905), followed by the issue **"Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner"** from regulatory concern

factor which got (M = 4.47; SD = 1.124), followed by "**If its use is safer than using a traditional system?"** from feasibility factor with **(**M = 4.47; SD = 0. 743**).**

5.2.3 Organization size

For institution size, 250-500 employee group is the highest size as results from adopted survey with 37%, while for 10-50, 50-100, 100-250, and 500-1000 employee groups are 12%, 20%, 7%, and 24 % as explained in Figure 8.

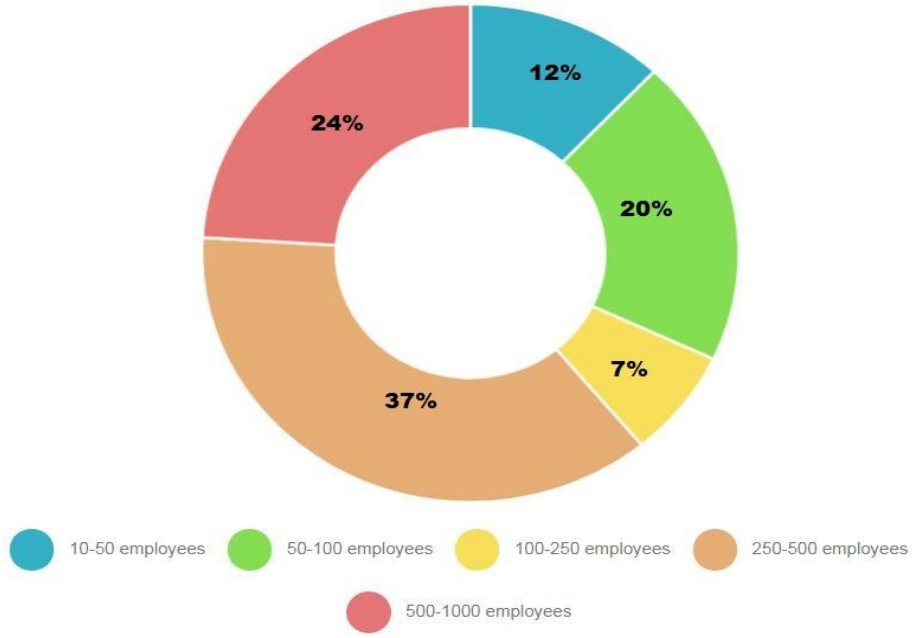

Figure 8 **: Institution size based on survey participant**

(a) The study findings show that, for institution with size (10-50) the most critical issue is "**I do not know who can access the system and what they can access"** from privacy factor which got the highest mean value (M = 4.83; SD = 0.835), followed by the issue **"You do not have data and available service during interruption or potential attack**" from availability and reliability factors which got (M = 4.58; SD = 1.165), followed by "**Another company may get control over your information"** from security factor which got (M = 4.58; SD = 0.900), followed by **"If it is feasible within the estimated cost?"** from feasibility factor with (M = 4.5; SD = 0.798).

(b) For institution with size (50-100) the most critical issue is "**If the cloud service provider offers a Service Level Agreement (SLA) that ensure a high up-time guarantee (**between 99.9% to 99.999%)?**"** from regulatory concerns that got a highest mean value (M = 4.40; SD = 0.995), followed by the issues **"If the service to underlying applications is continuous even after the failure of one or more components in any layer?"** and "**If its use is safer than using a traditional system?**" from feasibility factor which both of them got (M = 4.40 ; SD = 0.883), followed by "**Security practices"** from trust factor with (M = 4.40; SD = 0.821), followed by "**If it will be beneficial and profitable?"** from feasibility factor with (M = 4.40; SD = 0.821).

(c) For institution with size (250-500) the most critical issue is "**Continuation and disaster recovery plans"** from trust factor which got the highest mean value (M = 4.78; SD=0.630), followed by **"If the cloud service provider offers a Service Level Agreement (SLA) that ensure a high up-time guarantee (between 99.9% to 99.999%)?"** from regulatory concerns which got (M=4.59; SD=1.040), followed by the issue **"If its use is safer than using a traditional system?"** from feasibility factor which got (M = 4.59; SD = 0.832).

(d) For institution with size (500-1000) the most critical issue are as follows "**Don't have full control over your data when the service provider outside your country"** from privacy factor which got the highest mean value (M = 4.56; SD =0.768).

- **"Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner"** from regulatory concerns which got (M = 4.56; SD = 0.651).
- **"If the real-time performance for cloud service is high?"** from feasibility factor with (M = 4.52; SD = 0.823).
- **"If all or some existing applications and devices have the ability to be compatible with the cloud environment?"** from compatibility factor with (M = 4.52; SD = 0.823).
- **"If we can upgrade to cloud-friendly versions, or replacing incompatible applications?"** from compatibility factor with (M = 4.52; SD = 0.77).

- **“Information assurance practices”** from trust factor with (M = 4.52; SD = 0.77).
- **“If the existing IT applications can be integrated with cloud system?”** from IT readiness factor with (M = 4.52; SD = 0.653).

5.2.4 Industry Type

For the question about ministry belonging of institutions, the majority of them are from Ministry of Higher Education and Scientific Research with 36%, followed by Ministry of Electricity with 35%, then 23% for Oil Ministry, and 6% for other Ministries as illustrated in Figure 9. Other Ministries which included in this survey are Ministry of Science and Technology, Ministry of Education, and Ministry of Finance.

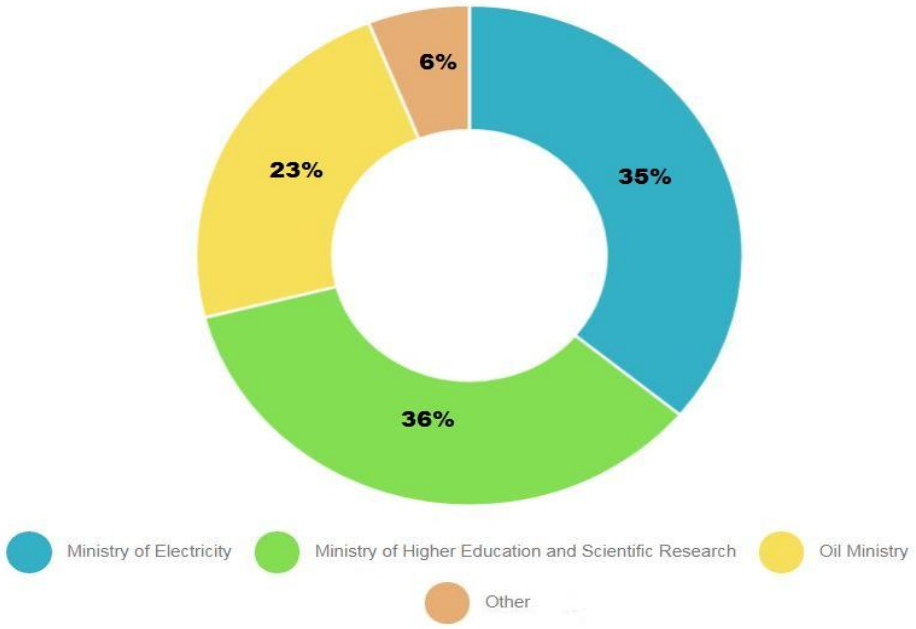

Figure 9 **: Ministry affiliation of survey participants**

- The findings of study show that, for Ministry of Electricity the most important issue is “**Continuation and disaster recovery plans”** from trust factor which got the highest mean value (M = 4.71; SD = 0.667), followed by the issue **“If its use is safer than using a traditional system?”** from feasibility factor which got (M = 4.60; SD = 0.775)**,** followed by **“If the government support through policies and regulations will facilitate the adoption of cloud computing technology?”** from

government support factor with (M = 4.40; SD = 0 .850), followed by **"Information assurance practices"** from trust factor with (M = 4.40; SD = 0. 698).

- Regarding the Ministry of High Education the most important issue is "**Reputation**" from trust factor which got the highest mean value (M = 4.5; SD = 0.971), followed by the issue "**If the existing IT applications can be integrated with cloud system?"** from IT readiness factor which got the highest mean value (M = 4.33; SD = 1.042), followed by **"The large organizations are more capable to adopt cloud services because they have enough financial, technical and human resources?"** from organization size factor which got (M = 4.33; SD = 1.042), followed by **"Security practices"** and **"information assurance practices"** from trust factor which got (M = 4.31; SD = 1.215) and (M = 4.31; SD = 1.142**)** respectively, followed by **"If we can upgrade to cloud-friendly versions, or replacing incompatible applications?"** from compatibility factor which got (M = 4.31; SD = 1.117).

- For Ministry of Oil the most important issue is "**If the cloud service provider offers a Service Level Agreement (SLA) that ensure a high up-time guarantee (between 99.9% to 99.999%)?"** from regulatory concern factor which got the highest mean value (M = 4.83; SD = 0.662), followed by the issue **"You do not have data and available service during interruption or potential attack"** from availability and reliability factors which has (M = 4.83; SD = 0.388), followed by **"If all or some existing applications and devices have the ability to be compatible with the cloud environment?"** from compatibility factor with (M = 4.74; SD = 0.541), followed by **"Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner"** from regulatory concerns factor with (M = 4.74; SD = 0.541), followed by "If the real-time performance for cloud service is high?" from feasibility factor which got (M=4.70; SD = 0.56), followed by **"Another company may get control over your information"** from privacy factor with (M = 4.70; SD = 0.470), followed by **"Continuation and disaster recovery plans"** from feasibility factor with (M = 4.70; SD = 0.470), followed by **"If the security of data centers for**

service provider is within the legal, regulatory and business needs?" from regulatory concern factor with (M=4.70; SD = 0. 470).

5.2.5 Perceived Benefits

The study findings show that, the benefits of cloud computing are one of the features that will encourage government institution in deciding move to cloud environment.

The following elements in direct benefits received the most attention from the participants, limitless storage has the greatest interest got which 89 responses, followed by mobility got 83 responses, followed by software update which got 80 responses. Other direct benefits have drawn attention are: cloud disaster recovery, scalability, virtualization, cost saving, automation, and security benefits of cloud respectively.

For indirect benefits the following elements received the most attention from the participants, " **Cloud services enable users to accomplish tasks more quickly, for example you can customize more computers, network, and storage space automatically in minutes** " which got 84 response, followed by "**Enhance the efficiency and the capability of the work"** which got 79 response, followed by "**The flexibility to work outside of the office environment or outside of normal business hours leads to increased employee satisfaction, because they are not restricted to be at the desk"** which got 73 response.

Other indirect benefits have drawn attention are increased employee satisfaction, because they are not restricted to be at the desk, enable your team to be effective and increase productivity due to the ability to access your online databases from anywhere at any times, reducing the need to travel to work, and increase employee loyalty respectively.

To conclude based on direct and indirect benefit inquiries of survey, the perceived benefits of cloud technology have a positive impact in motivating government sector to migrate to cloud environment. Table 1 and table 2 explain the choice rates for direct and indirect benefit items.

Table 1**Responses to direct benefits items by survey participants**

What are the direct benefits that can lead your institution to adopt cloud computing?								
Mobility	**Cloud disaster recovery**	**Security benefits**	**Limitless storage**	**Automation**	**Software updates**	**Virtualization**	**Scalability**	**Cost saving**
83	77	47	89	51	80	68	71	57

Table 2 **Responses to indirect benefits items by survey participants**

What are the indirect benefits that can lead your institution to adopt cloud computing?						
Cloud services enable users to accomplish tasks more quickly, for example you can customize more computers, network, and storage space automatically in minutes	**Enhance the efficiency and the capability of the work**	**The capabilities afforded by Cloud Computing promotes employees motivation and performance**	**The flexibility of cloud services and the ability to access your online databases from anywhere at any times enable your team to be effective and increase productivity.**	**The flexibility to work outside of the office environment or outside of normal business hours leads to increased employee satisfaction, because they are not restricted to be at the desk**	**Reducing the need to travel to work**	**Increase in employee loyalty which resulting from the integration of remote business practices in the company**
84	**79**	**52**	**68**	**73**	**50**	**33**

5.2.6 Security Issues

The results of this study show that security issues are the main concern preventing government institutions from moving to cloud environment. This factor is one of the most annoyed challenges for institutions, it makes them hesitant to migrate to cloud.

Particularly the issue "**Access or control of your information by someone else"** has a highest mean value (M =4.15; SD=1.149), followed by the issue **"Loss of information due to accident, viruses, …., etc."** which got (M = 4.15 ; SD = 0.999), followed by "**If it is safer to use local cloud(private or community cloud) within your city or country?"** which got (M=3.98; SD=1.303), followed by "**No other copies of files are available somewhere else when they are deleted from the**

cloud environment" with (M=3.96; SD=1.136). Another important issue is the possibility of using cloud computing in unstable places, because Iraq is currently in a critical situation, but the impact of this issue is expected to decrease when the situation in Iraq will be more stable. The possibility of system failure is also a concern in cloud since in the case of failure of one of the programs or devices; the users may not be able to complete their works. Also, the results show that the participants prefer to store their information in their computer and at their office, they suppose this is safer than cloud environment, as illustrate in table 3.

From managers and employees points of view, security factor considered as a major issue, based on concerns have been selected by managers, this factor got the average (3.93), especially the issue "**Access or control of your information by someone else**" has the highest average (4.18). For the employees' security factor got the average (3.98) especially the issue "**Loss of information due to accident, viruses etc."** got the highest average (4.19).

In summarize, security is a significant factor that influencing the adoption of cloud technology in the government's institutions, and has a high priority. In cloud environment the institution store its data in more secure places which using encryption techniques ,and because the situations in Iraq is unstable, Iraqi government needs to increase awareness of the importance of adopting this technology through all kinds of necessary support programs such as training programs and financial and administrative support with the legislation of strict privacy standards and laws to ensure that the data is being handled in a high level of privacy and security.

Table 3 **Responses to security concerns items by survey participants**

What are your main concerns regarding the security issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
The possibility of system failure (in case of failure of one of the programs or devices)	**4**	**11**	**28**	**23**	**31**	**3**	**3.75**	**1.209**
Access or control of your information by someone else.	**5**	**5**	**12**	**28**	**48**	**2**	**4.15**	**1.149**

Continuation of table 3

Loss of information due to accident, viruses, ….,etc.	**2**	**4**	**18**	**30**	**45**	**1**	**4.15**	**0.999**
No other copies of files are available somewhere else when they are deleted from the cloud environment	**4**	**7**	**18**	**34**	**34**	**3**	**3.96**	**1.136**
The storage of your information must be in your computer in your office, no somewhere else	**7**	**9**	**21**	**32**	**28**	**3**	**3.74**	**1.244**
The possibility of using cloud computing in unstable places such as Mosul	**8**	**8**	**19**	**35**	**26**	**4**	**3.75**	**1.266**
If it is safer to use local cloud (private or community cloud) within your city or country?	**5**	**11**	**16**	**23**	**39**	**6**	**3.98**	**1.303**
Average Total							**3.92**	**1.187**

5.2.7 Privacy Issues

The results of the study reveal that privacy issues are one of the most critical concerns that influencing cloud technology adoption in government institutions, and this factor may lead to reluctance from migration idea.

Particularly the issue "**Another company may get control over your information"** has a highest mean value (M=4.30; SD=1.040), followed by the issue "**I do not know who can access the system and what they can access"** with (M= 4.17; SD=1.146), followed by "**Don't have full control over your data when the service provider outside your country"** with (M=4.13; SD=1.160), there are several other concerns such as, in cloud computing environment the clients outsource the storing of their information to a server off their premises, which is managed by a CSP, and customers do not even realize where the data being stored and which tools perform the tasks of computing, another issue is that cloud computing raises laws issues by exporting client's information abroad, as explain in table 4.

According to study results, privacy factor considered as major issue from all levels and positions of participants, based on the issues that have been chosen by managers, this factor got the average (4.11), especially the issues **"I do not know who can access the system and what they can access**" which has the highest average (4.27). For the employees this factor got the average (4.12), especially the issue "**I don't have full control over your data when the service provider outside your country**" got the highest average (4.28).

Privacy is a very influential factor and should be taken into account from government institutions, and has a highest priority. In order to reduce the risk of

privacy to accepted levels, all information must be encrypted and maintained electronically in more secure locations protected through using of authentication and confidential passwords to prevent unauthorized access by others.

Table 4 **Responses to privacy concerns issues by survey participants**

What are your main concerns regarding the privacy issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
Keeping data physically outside the institution	**2**	**10**	**16**	**24**	**46**	**1**	**4.08**	**1.134**
Another company may get control over your information	**3**	**2**	**17**	**20**	**56**	**2**	**4.30**	**1.040**
Different privacy laws between countries would lead to privacy loss for us	**2**	**10**	**32**	**24**	**29**	**3**	**3.77**	**1.127**
Don't have full control over your data when the service provider outside your country	**3**	**8**	**15**	**25**	**45**	**4**	**4.13**	**1.160**
I do not know who can access the system and what they can access	**6**	**2**	**13**	**30**	**46**	**3**	**4.17**	**1.146**
I do not know where the information is stored	**4**	**7**	**19**	**20**	**47**	**3**	**4.08**	**1.195**
Average Total							**4.09**	**1.134**

5.2.8 Availability and Reliability Issues

The findings of this study show that availability and reliability requires major attention before cloud computing adoption in government institutions.

Particularly the issue "**You do not have data and available service during interruption or potential attack"** has a highest mean value (M = 4.42 ; SD = 0.955) and it is the second most influential issues in this study, followed by the issue "**Access of cloud is fully depending on your Internet connection which can be interrupted at any time"** with (M=4.06; SD=1.205), followed by "**Your business process cannot be delayed or stopped when the service provided by cloud service provider goes down"** with (M=3.85; SD=1.175), another concern is that, in the case of Internet outage there is extra expense which come from using Internet access services provided by mobile phone network, as show in table 5.

Respondents noted that these issues are very significant, based on the managers, this factor got the average (4.03). For the employees this factor got the average

(4.01). Both of them were focused on the issue "**You do not have data and available service during interruption or potential attack** "that has the highest average (4.52) and (4.34) respectively.

To conclude, availability and reliability are considered critical factors by all levels of participants in this study. These factors will not be a hindrance if the SLA is seriously considered and taken this fact into account.

Table 5 **Responses to the availability and reliability issues by survey participants**

What are your major concerns regarding the availability and reliability issues?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
Access of cloud is fully depending on your Internet connection which can be interrupted at any time	**7**	**6**	**8**	**33**	**45**	**1**	**4.06**	**1.205**
Additional cost that can come from using Internet access services provided by mobile phone network in the case of Internet outage	**9**	**12**	**31**	**20**	**26**	**2**	**3.48**	**1.299**
Your business process cannot be delayed or stopped when the service provided by cloud service provider goes down	**5**	**7**	**25**	**25**	**37**	**1**	**3.85**	**1.175**
You do not have data and available service during interruption or potential attack	**2**	**3**	**9**	**26**	**57**	**3**	**4.42**	**0.955**
Average Total							**3.95**	**1.159**

5.2.9 Cost Issues

The results of this study show that cost is a highly influential factor in the adoption of cloud technology in government institutions.

Particularly the issue "**Hidden cost of back up, restore, disaster recovery and problem solving"** has a high mean value (M=3.96; SD=1.109), followed by the issue "**The cost of installation and reconfiguration of applications can be high"** with (M = 3.91; SD =1.055), followed by "**It costs more to have a good storage and security system"** with (M=3.89; SD=1.127), another issues are that, the bandwidth can be quite expensive for data intensive applications such as 'multi-terabyte' database accessible through cloud environment. Also, in cloud technology, government's institution purchases services, thus instead of one-time capital costs it

has ongoing operating costs which may end up higher than expect on the long-term as illustrate in table 6**.**

The findings show that the participants from all levels and posts found cost is an important factor that should take into account before the adoption decision, according to selected concerns by managers, this factor got the average (3.86), especially the issue "**The cost of installation and reconfiguration of applications can be high** " has the highest average (4.05) .For the employees this factor got the average (3.89), especially the issue " **Hidden cost of backup, restore, disaster recovery and problem solving** " , got the highest average (4.04).

Given the current situation in Iraq, the cost is one of the most important reasons that prevent the Iraqi government from adopting the new technology, so it needs to search for alternate technical solutions that reduce spending on the one hand and elevate the level of performance on the other hand, most of the participants showed interest in using this new technology, unless some of them find that adoption is far away until the economic situation of the institution will be improved.

Table 6 **Responses to cost issues by survey participants**

What are your big concerns about the cost issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S.D**
Extra cost of bandwidth for intensive data applications	**6**	**10**	**18**	**26**	**36**	**4**	**3.88**	**1.281**
It costs more to have a good storage and security system	**4**	**8**	**19**	**35**	**32**	**2**	**3.89**	**1.127**
The cost of installation and reconfiguration of applications can be high	**2**	**9**	**19**	**38**	**30**	**2**	**3.91**	**1.055**
Hidden cost of back up , restore, disaster recovery and problem solving	**3**	**8**	**18**	**35**	**33**	**3**	**3.96**	**1.109**
Ongoing operating cost can be more expensive in the long term, because you buy services instead of hardware and software	**8**	**15**	**31**	**20**	**24**	**2**	**3.43**	**1.281**
Average Total							**3.81**	**1.171**

5.2.10 Complexity Issues

In the view of the institutions, this factor might prevent them from adopting cloud technology. The results show that the complexity of managing the services of cloud computing may repel government institutions from moving forward with using cloud technology. Particularly the issue "**The reconfiguration of your applications to meet the requirements of the new host can be complex"** has a highest mean value (M= 3.97; SD=1.046), followed by the issue "**The complexity of maintaining and keeping up the date of operating systems, applications and underlying hardware if we manage the cloud environment"** with (M=3.81; SD=1.228), followed by "**The migration to cloud computing will bring additional complexities in overall management of IT resources"** with (M=3.77; SD = 1.238). Also, the result also reveal that government institutions may need a third party to manage cloud system especially at the beginning of cloud computing adoption, another issue is that, IT organization should train current staff and/or hires new staff in order to be capable to manage cloud system, as explain in table 7.

From managers and employees points of view, complexity factor considered as an important issue, according to selected concerns by managers, this factor got the average (3.87), especially the issue " We may need a third party to manage cloud system at least at the beginning of adoption" has the highest average (4.11) .For the employees this factor got the average (3.83), especially the issue "The reconfiguration of your applications to meet the requirements of the new host can be complex" got the highest average (4.00).

In summarize, this factor was seen to be significant by different levels of participants and should be taken earnestly in the adoption process.

Table 7 **Responses to complexity issues by survey participants**

What are your big concerns about the Complexity issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S.D**
The reconfiguration of your applications to meet the requirements of the new host can be complex	**0**	**12**	**18**	**33**	**35**	**2**	**3.97**	**1.049**
The migration to cloud computing will bring additional complexities in overall management of IT resources	**6**	**13**	**14**	**33**	**33**	**1**	**3.77**	**1.238**
We may need a third party to manage cloud system at least at the beginning of adoption	**5**	**14**	**17**	**30**	**32**	**2**	**3.76**	**1.240**
The complexity of maintaining and keeping up the date of operating systems, applications and underlying hardware if we manage the cloud environment	**5**	**12**	**15**	**38**	**25**	**5**	**3.81**	**1.228**
It is difficult to have high skill staffs that are required to manage cloud system	**7**	**15**	**19**	**29**	**29**	**1**	**3.61**	**1.270**
Average Total							**3.78**	**1.205**

5.2.11 Organization Size Issues

According to the results of the study, the size of the institution may have a negative or positive effect on migration to cloud environment.

According to the study results, the issue "**The large organizations are more capable to adopt cloud services because they have enough financial, technical and human resources"** has a highest mean value (M = 4.04; SD = 1.109), followed by the issue "**The large organizations have more flexibility in their resources, so they are able to experiment with new innovation"** which got (M=3.90; SD= 1.124), followed by "**The small and medium sized organizations may gain more benefits from cloud computing as they do not have to invest in infrastructure and applications"** with (M = 3.59; SD = 1.364). Another issue regarding institutions size factor is that the large institution might have more resistance toward adoption where there are too many employees in various branches in various regions, as show in table 8.

From managers and employees points of view, organization size factor can affect the adoption process, according to managers, this factor got the average (3.72), especially the issue "**The large organizations are more capable to adopt cloud services because they have enough financial, technical and human resources**"

has the highest average (3.89). For the employees this factor got the average (3.81) they also found the issue "**The large organizations are more capable to adopt cloud services because they have enough financial, technical and human resources**" is more influential which got the highest average (4.13).

In brief, organization size is an important factor that could influence cloud technology adoption in the government sector, and the impact of this factor is perceived in a different way according to the size of adopted institution

Table 8 **Responses to organization size issues by survey participants**

According to your opinion, how does the institution size influence the adoption of cloud computing?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I Don't know**	**M.**	**S. D.**
The large institutions are more capable to adopt cloud services because they have enough financial, technical and human resources	**2**	**9**	**17**	**30**	**39**	**3**	**4.04**	**1.109**
The large institutions have more flexibility in their resources, so they are able to experiment with new innovation	**0**	**16**	**18**	**28**	**36**	**2**	**3.90**	**1.124**
The large institutions may not tend to adopt cloud computing, where there are a very large number of employees situated in different branches in various areas	**8**	**15**	**28**	**20**	**27**	**2**	**3.49**	**1.307**
The small and medium sized institutions may gain more benefits from cloud computing as they do not have to invest in infrastructure and applications	**9**	**13**	**24**	**22**	**28**	**4**	**3.59**	**1.364**
Average Total							**3.76**	**1.226**

5.2.12 Organization Culture Issues

The results of study reveal that the institution's culture has a large impact on the cloud technology adoption.

Particularly the issue "**The geographical location of organization can affect the adoption of cloud technology, for example scalable or central regions may more tend to adopt cloud computing than unstable regions or Suburbs"** has a highest mean value (M= 3.99 ; SD =1.078), followed by the issue "**The prevailing beliefs and attitudes in the organization can obstacle from adopting cloud computing because it involves new ways in using , storing, sharing data and applications"**

with (M = 3.82; SD = 1.226), followed by "**Organization culture such as habits, visions and systems can be reorganized to adopt useful new technology"** with (M = 3.53; SD = 1.210). Also the findings of study show that, there were two issues that got the lowest percentage compared to other issues to all factors of the whole study "**The organization is very supportive to changes**" which got (M = 3.12; SD = 1.305) and "**Most persons in this organization are encouraged to make suggestions for improvement**" which got (M = 3.21; SD = 1.266), as illustrate in table 9. From managers and employees points of view, culture considered as an influential factor in adoption decision, according to selected concerns by managers, this factor got the average (3.40). For the employees this factor got the average (3.74). Both of them were focused on the issue "**The geographical location of organization can affect the adoption of cloud technology, for example scalable or central regions may more tend to adopt cloud computing than unstable regions or Suburbs"** that has the highest average (3.95) and (4.09) respectively.

To conclude, the culture in the government institutions could be a barrier toward cloud technology adoption; however, there are several studies show that the culture of the institution could be gradually changed if diverse training is implemented in the workplace to improve staff skills, applying suitable rules, and adopting awareness programs.

Table 9 **Responses to organization culture issues by survey participants**

What do you think about the cultural attitudes in your institution?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
The prevailing beliefs and attitudes in the institution can obstacle from adopting cloud computing because it involves new ways in using , storing, sharing data and applications	**4**	**14**	**16**	**31**	**32**	**3**	**3.82**	**1.226**
The institution is very supportive to changes	**13**	**18**	**34**	**15**	**19**	**1**	**3.12**	**1.305**
Most persons in this institution are encouraged to make suggestions for improvement	**11**	**17**	**32**	**21**	**18**	**1**	**3.21**	**1.266**
Institution culture such as habits, visions and systems can be reorganized to adopt useful new technology	**5**	**14**	**32**	**24**	**22**	**3**	**3.53**	**1.210**
The geographical location of institution can affect the adoption of cloud technology, for example scalable or central regions may more tend to adopt cloud computing than unstable regions or Suburbs	**2**	**8**	**19**	**34**	**34**	**3**	**3.99**	**1.078**
Average Total							**3.53**	**1.217**

5.2.13 Feasibility Issues

Feasibility is a very critical factor that could influence the decision of cloud technology adoption and has a highest priority. This factor requires a comprehensive investigation to ascertain some of the most important issues addressed in this study such as the issue "**if its use is safer than using a traditional system?"** that has a highest mean value (M = 4.40; SD = 0.953) and this issue related to security concern and represents the third most influential issues in this study, followed by the issue "**If the real-time performance for cloud service is high?"** which got (M=4.34; SD=0.945), followed by "**If it will be beneficial and profitable?"** which got (M = 4.34; SD =0.879) that related to availability and reliability factors, followed by "**If the service to underlying applications is continuous even after the failure of one or more components in any layer?"** with (M=4.26; SD =1.001) which also related to availability and reliability factors, there are several other issues which should be considered such as "**If it is feasible within the estimated cost?"** and **"If it will be beneficial and profitable?"** which are related to cost factor "**If it is technically feasible?"** that is related to compatibility factor, as illustrate in table 10.

The findings showed that both managers and employees focused on the feasibility of cloud computing as this technology would increase the institution's performance in a large degree. Depending on the issues that have been chosen by the managers, this factor got the average (4.32), especially the issue "**If its use is safer than using a traditional system?**" has the highest average (4.60). For the employees this factor got the average (4.26), especially the issue " If it will be beneficial and profitable?" got the highest average (4.42). To conclude, the results showed that feasibility is an essential perspective for both type and size of project. When the government institutions decide to migrate to cloud environment it takes a big step toward a huge project that can completely change the way the institution works, therefore a comprehensive study of feasibility is necessary to define whether and how they could succeed, and to ensure that CC would add more value to their institutions.

Table 10 **Responses to feasibility issues by survey participants**

What are the important things that you look for if you decide to adopt cloud computing?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
If it is technically feasible?	**5**	**8**	**12**	**31**	**41**	**3**	**4.04**	**1.197**
If it is feasible within the estimated cost?	**1**	**5**	**16**	**27**	**49**	**2**	**4.24**	**0.986**
If it will be beneficial and profitable?	**0**	**5**	**11**	**30**	**53**	**1**	**4.34**	**0.879**
If the service to underlying applications is continuous even after the failure of one or more components in any layer?	**2**	**4**	**13**	**31**	**47**	**3**	**4.26**	**1.001**
If the real-time performance for cloud service is high?	**1**	**6**	**8**	**29**	**55**	**1**	**4.34**	**0.945**
if its use is safer than using a traditional system?	**1**	**6**	**8**	**23**	**61**	**1**	**4.40**	**0.953**
Average Total							**4.27**	**0.994**

5.2.14 Trust Issues

The results show the important of trust factor between the customer (government institutions) and cloud service provider (CSP), regardless whether the trust factor is concerning to technological or managerial matters.

The findings of the study show that, the participants consider some major characteristics for the selection of cloud service provider, particularly "**Continuation and disaster recovery plans"** got the highest mean value (M = 4.47; SD = 0.926) and it is the first most influential issues in this study, followed by the issue "**Security practices"** which got (M=4.39; SD=0.994),followed by "**Information assurance practices"** with (M=4.39; SD=0.886) which also one of the most influential factor in this study, followed by "**Reputation"** with (M=4.25; SD= 1.167), as show in table 11.

It is essential to know what the CSP preparation in the cases of security or privacy violation or expiration of compliance, involving continuation of business and the plans of disaster recovery. Another issue affect trust is a lack of international regulations or policies to protect data in the cloud, therefore the participants need to know what the applied practices for Information assurance, and the degree of compliance for standards and regulations. Also, they need to ensure that if the company of cloud server provider has a good reputation, this depended on the basis

of previous performance or interactions, and is used to determine or reach its behavior in the future. Additionally, there is another issue associated with trust factor such as the physical location of CSP's company because government's institution outsources their data out of their premises in another nation, and there is lack in legislation in most nations regarding privacy and data protection.

The study findings show that the participants from all levels and posts found trust is very important factor. For managers, this factor got the average (4.23), especially the issue "**Security practices**" has the highest average (4.47). For the employees this factor got the average (4.24), especially the issue "Continuation **and disaster recovery plans** "got the highest average (4.45).

To summarize, trust is one of the most crucial factor that can impact the institution's decision to migrate to cloud environment, and has the highest priority. Especially the plans for continuation and disaster recovery considered the most influential issue in this study. As Iraq is currently in a critical situation, and there is a possibility of attacks at any time, therefore the government sector needs to ensure the effectiveness of CSP plans for such situations.

Table 11 **Responses to trust issues by survey participants**

What would you consider as the main characteristics for the selection of cloud service provider?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
Reputation	**4**	**6**	**12**	**21**	**53**	**4**	**4.25**	**1.167**
Company location, size and number of clients	**2**	**10**	**29**	**30**	**28**	**1**	**3.75**	**1.067**
Security practices	**3**	**3**	**9**	**23**	**61**	**1**	**4.39**	**0.994**
Information assurance practices	**1**	**3**	**11**	**27**	**57**	**1**	**4.39**	**0.886**
Compliance for standards and regulations	**1**	**7**	**13**	**34**	**43**	**2**	**4.17**	**0.995**
Continuation and disaster recovery plans	**1**	**5**	**8**	**19**	**66**	**1**	**4.47**	**0.926**
Average Total							**4.24**	**1.006**

5.2.15 IT Readiness Issues

Cloud technology requires an appropriate IT infrastructure readiness for both cloud service provider and client. The study findings show the importance of this

factor and it might prevent government institutions from moving forward with adopting cloud technology.

Particularly the issue "**If your organization provides high Internet connection and bandwidth to gain the benefits of using cloud technology?"** has a highest mean value (M=4.33; SD=1.055), followed by the issue "**If the existing IT applications can be integrated with cloud system?"** which got (M = 4.27; SD =1.062), followed by "**If the existing IT infrastructure supports the additional cloud service demands?"** which got (M=4.22; SD=1.069). Several issues in this factor received the interest of participants such as the institution ability of the existing IT (infrastructure, applications and systems) to support the additional cloud service demands. Another issue is whether CSP is willing to be responsible for the readiness of IT infrastructure, and if they will bear all the load and stress, as explain in table 12.

The findings show that both managers and employees considered that IT infrastructure readiness is a very critical factor to cloud adoption. Depending on the issues which have been selected by the managers, this factor got the average (4.20) especially the issue **"If the existing IT applications can be integrated with cloud system?**" has the highest average (4.44). For the employees this factor got the average (4.13), especially the issue **"if your organization provides a high Internet connection and bandwidth to gain the benefits of using cloud technology?"** got the highest average (4.36).

In summary, participants from different levels and posts confirmed on the need to carefully consider the IT readiness factor before making a decision to adopt cloud technology, and this factor has a highest priority. In order to ensure successful adoption, there is a need to provision of fundamental equipment, application support, networking (Internet service provider (ISP) redundancy, high Internet connection and the capacity of bandwidth), physical supplies and security strategies.

Table 12 **Responses to IT readiness issues by survey participants**

What are your main concerns about the IT infrastructure readiness issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
If your desktop hardware and operating system environment are ready to support cloud service requirements?	**2**	**8**	**15**	**29**	**45**	**1**	**4.10**	**1.068**
If the existing IT infrastructure supports the additional cloud service demands?	**1**	**9**	**11**	**29**	**46**	**4**	**4.22**	**1.069**
If your institution provides a high Internet connection and bandwidth to gain the benefits of using cloud technology?	**3**	**5**	**10**	**21**	**60**	**1**	**4.33**	**1.055**
If the existing IT applications can be integrated with cloud system?	**3**	**6**	**9**	**26**	**55**	**1**	**4.27**	**1.062**
If migrating the existing system to cloud environment is difficult?	**2**	**8**	**16**	**39**	**34**	**1**	**3.98**	**1.025**
If IT infrastructure readiness will be the responsibility of service provider?	**3**	**5**	**23**	**32**	**36**	**1**	**3.96**	**1.053**
Average Total							**4.14**	**1.055**

5.2.16 Regulatory Concerns

Study findings show that, it is necessary to have powerful laws and regulations governing all processes and relationships between both parties involved in cloud technology adoption at the nationalist level. The participants considered this factor is very significant, and its related issues must be taken in consideration before migrating applications or data to a cloud computing environment.

Particularly the issue "**Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner"** has a highest mean value (M=4.39; SD=0.898), and represents the fourth most influential issue in this study, followed by the issue "**If the cloud service provider offers a Service Level Agreement (SLA) that ensure a high up-time guarantee (between 99.9% to 99.999%)"** with (M=4.33; SD=1.207), followed by "**Applicable legislation and regulations in the case of non-compliance with standards"** with (M=4.27; SD=1.043), as explain in table 13.

There are several other issues that got the interest of participants such as 'what resources are being used? for what purpose? by whom? and under what laws and policies?'. Another issue is whether the security of data center of the CSP is within

the legal, regulatory and business requirements. Another concern is that; they want to know if there is legislation in Iraqi government that could prevent them from adopting such technology. The study findings reveal that the regulatory issues are considered by all levels of participants as a major concern that could influence the adoption of cloud technology in government's institutions. Based on the issues that have been chosen by managers, this factor got the average (4.30), especially the issues "**Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner**", and "**If the cloud service provider offers a Service Level Agreement (SLA) for your services? If so, does it have a high up-time guarantee, for example from 99.9% to 99.999%?**" have the highest average (4.53) and (4.5) respectively. For employees this factor got the average (4.20), they also interested in the issue "Applicable **information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner**", which got the highest average (4.34).

To conclude, regulatory concern is one of the most critical factors and can influence governmental institutions decision to migrate to cloud environment, and will contribute in solving any problems and issues that might occur between the parties concerned in this service in the future. The Iraqi government must impose a set of laws, policies and standards to be the basis of evolving the adoption process and to ensure that the data is being processed in a secure and legally compliant manner.

Table 13 **Responses to regulatory concerns issues by survey participants**

What are the main things you want to ensure before migrating applications or data to a cloud computing environment?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
Applicable legislation and regulations in the case of non-compliance with standards	**1**	**8**	**11**	**26**	**51**	**3**	**4.27**	**1.043**
Laws, regulations and policies which will be applied to all uses of cloud services within the institution (what resources are being used?, for what purpose? and by whom?)	**0**	**5**	**17**	**30**	**47**	**1**	**4.22**	**0.917**
Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner	**2**	**2**	**9**	**30**	**56**	**1**	**4.39**	**0.898**
If the security of data centers for service provider is within the legal, regulatory and	**1**	**4**	**12**	**40**	**42**	**1**	**4.21**	**0.891**

Continuation of table 13

business needs?								
If there is a legislation for not transmitting the data outside the institution?	**4**	**12**	**14**	**26**	**41**	**3**	**3.97**	**1.235**
If the cloud service provider offers a Service Level Agreement that ensure a high up-time guarantee (between 99.9% to 99.999%)?	**3**	**5**	**16**	**20**	**44**	**12**	**4.33**	**1.207**
Average Total							**4.23**	**1.032**

5.2.17 Compatibility Issues

According to study findings compatibility was seen as a key factor in the cloud technology adoption. From the institution perspective, when technology is compatible with labor application systems, organizations are likely to consider the adopting of new technology. Consequently, the perceived incompatibility of cloud technology with the already applied technologies of the institution can negatively impact the adoption process. The participants of all positions and levels considered several issues that must be taken into consideration before migration decision. Particularly the issue "**If there will be incompatibility of data when we want to move from one cloud service provider to another?"** has a highest mean value (M =4.22; SD=1.021), followed by the issue "**If all or some existing applications and devices have the ability to be compatible with the cloud environment?"** with (M = 4.22; SD=1.011), followed by "**If we can upgrade to cloud-friendly versions, or replacing incompatible applications?"** with (M=4.21; SD=0.998). There are other issues which have a high concern such as, how long does their institution need to make the current system and applications compatible with the cloud, because if the migration process takes a long time, for example more than 18 months, they may not be able to wait so long. Another issue is whether cloud technology will be consistent with institution's present values and needs, as illustrate in table 14.

According to study results, the compatibility factor from the managers' point of view got the average (4.05), especially the issue "**If all or some existing applications and devices have the ability to be compatible with the cloud environment?** " has the highest average (4.24). For the employees this factor got the average (4.06), especially the issue **"If we can upgrade to cloud-friendly versions, or replacing incompatible applications?"** got the average (4.25).

In brief, compatibility is a critical factor when the institution decides to adopt cloud technology. The procedural and technical requirements for cloud need to be consistent and compatible with the existing technology and values requirements of the adopted institution, otherwise, the weakness of the integration of existing systems with the new ones can lead to an opposite status.

Table 14 **Responses to compatibility issues by survey participants**

What are your main concerns about the compatibility issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
If all or some existing applications and devices have the ability to be compatible with the cloud environment?	**1**	**8**	**11**	**29**	**50**	**1**	**4.22**	**1.011**
If we can upgrade to cloud-friendly versions, or replacing incompatible applications?	**2**	**4**	**14**	**34**	**43**	**3**	**4.21**	**0.998**
How much time could it take to make our system and applications compatible with cloud (days, weeks, months)?	**4**	**5**	**18**	**37**	**33**	**3**	**3.99**	**1.096**
If there will be incompatibility of data when we want to move from one cloud service provider to another?	**1**	**5**	**17**	**30**	**42**	**5**	**4.22**	**1.021**
If using cloud will fit with our existing values, previous practices and current needs?	**4**	**12**	**22**	**32**	**28**	**2**	**3.74**	**1.169**
Average Total							**4.08**	**1.059**

5.2.18 Government Support issues

The study findings reveal that the Iraqi government support for cloud computing adoption is one of the most essential factors that would encourage government institutions to move to cloud. Particularly the issue "**If the government support through policies and regulations will facilitate the adoption of cloud computing technology?"** has a highest mean value (M=4.24; SD=0.955), followed by the issue "**If the government will provide necessary training programs and researches for acquisition the required skills in the use of cloud technology"** with (M=4.21; SD =0.977), followed by "**If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?"** with (M=4.19; SD=1.080).

There are several other issues that got the interest of participants such as decrease the financial barriers to the adoption of technology, throughout sharing of cost, loans, grants and other financial methods. Also, there is a need for administrative support

through fewer meetings and permits to facilitate adoption process, as illustrate in table 15.

Participants confirmed that this factor is very significant, according to selected issues by managers, this factor got the average (4.12), especially the issue "**If the government support through policies and regulations will facilitate the adoption of cloud computing technology?**" has the highest average (4.36). For the employees this factor got the average (4.09), especially the issues "**If the government will provide necessary training programs and researches for acquisition the required skills in the use of cloud technology?**" and "**If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?"** got the highest average (4.21).

Government's support is a critical factor when the institution decide to adopt cloud technology, and it have a great role in speeding up and facilitating the cloud technology adoption in the government sector through remove the disincentives to technological innovations adoption, decreased barriers to entree, develop measures that stimulate greater managerial and innovative capabilities within organizations, and develop utilities, physical infrastructure, availability of novel technology devices, software, and other technically resources.

Table 15 **Responses to the government support issues by survey participants**

What are your main concerns about the government support issue?								
''1'' is very unimportant level, ''2'' less important level, ''3'' important level, ''4'' very important level and ''5'' is as the most important level								
	1	**2**	**3**	**4**	**5**	**I don't know**	**M.**	**S. D.**
If the government support through policies and regulations will facilitate the adoption of cloud computing technology?	**1**	**5**	**14**	**30**	**49**	**1**	**4.24**	**0.955**
If the government will provide necessary training programs and researches for acquisition the required skills in the use of cloud technology?	**1**	**6**	**13**	**33**	**45**	**2**	**4.21**	**0.977**
If the government will help institutions to overcome any financial limitations?	**1**	**6**	**22**	**29**	**40**	**2**	**4.07**	**1.018**
If the government will provide the necessary administrative support for cloud adoption, such as the need for the least number of meetings and permits	**2**	**7**	**19**	**30**	**39**	**3**	**4.06**	**1.081**
If the government will set strong laws regarding data storage and privacy to protect data and information for the institutions?	**2**	**7**	**14**	**27**	**47**	**3**	**4.19**	**1.080**
If your institution needs the government support to adopt cloud technology?	**5**	**19**	**24**	**13**	**35**	**4**	**3.66**	**1.365**
Average Total							**4.07**	**1.079**

5.2.19 Free Question Answers

Special opinions and suggestions have been obtained which will be useful to put cloud technology into practice and serious enhancement. Based on some opinions of survey participants, the barriers that slow down the development of cloud environment in Iraq in terms of technical, political, Information and communication Technology (ICT) issues for example, the electricity and Internet connection must be studied and addressed. Another opinion is that, there is necessity for official gateway of cloud technology in Iraqi governmental organizations that provides various prospective works and studies on the performance enhancements and transforms in the online service usage. This gateway as well shows to be necessary in the expansion and growth of future government diagram for inspiring electronic transactions and encouraging investments in Iraq.

Additionally, other participants' saw that E-governance based on cloud technology in Iraq is strategic and has numerous gains to organization like less distributed data storage, cheaper resources availability, more security control, more scalability, and responsibility.

5.3 General Findings

Data analysis reveals that all the targeted government institutions in our study support the cloud technology adoption; however, there was difference in support levels. For example, Ministry of Higher Education and Ministry of Science and Technology in Iraq, have a well knowledge of the latest technological trends, also there are some institutions which already adopted cloud computing such as University of Technology in Baghdad, The Central Bank of Iraq, and the General Company for Electronic Systems ,the participants from these institutions have given a positive attitude toward cloud computing adoption in Iraqi governmental institutions and giving some idea and suggestions.

However, during the survey in other government's institutions, the researcher realized that a lot of employees are not familiar with the concept of cloud computing, and some of them their knowledge limited to some cloud services such as Gmail,

Yahoo Mail, Dropbox or ICloud application in IPhones, these participants showed interested in adopting cloud technology, unless some of them find that adoption is far away until the economic situation and IT readiness of the institution will be improved. Also, there is a need to develop strong laws and regulations to protect their privacy, security, and preventing occur any problems in the future.

The study findings indicated that all organizational, technological and environmental factors have a significant impact on the adoption of cloud technology, at different levels ranging from important to most important levels. Generally, the factors influencing the adoption of cloud technology in the government sector were identified in terms of their relative importance based on the questionnaire results as follows: feasibility 85.4%, trust 84.7%, regulatory concerns 84.6%, IT readiness 82.9% , privacy 81.8% , compatibility 81.5%, government support 81.4%, availability and reliability 79%, industry type 79%, security 78.5%, cost 76%, complexity 75.7%, organization size 75%, organization culture 70,7%, direct benefits 70%, and indirect benefits 63%.

Table 16 represents the critical issues that are higher than the very important level based on Likert scale, which were arranged based on their higher mean value, down to the issues that have the less mean values, This table also reflects the number of times each factor is repeated, and thus helps us to highlight the importance of each factor, and shows the reason of got some factors the highest percentage, whenever the number of related issues of each factor is increased, the importance of the factor is increased as well.

Table 16 **The important issues that is higher than (4) in the Likert scale**

The Issues	Related Factor	Total average
Continuation and disaster recovery plans	Trust	4.47
You do not have data and available service during interruption or potential attack	Availability and Reliability	4.42
if its use is safer than using a traditional system?	Feasibility	4.40
Security practices	Trust	4.39
Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner	Regulatory concern	4.39
Information assurance practices	Trust	4.39

Continuation of table 16

If it will be beneficial and profitable?	Feasibility	4.34
If the cloud service provider offers a Service Level Agreement (SLA) that ensure a high up-time guarantee (between 99.9% to 99.999%)	Regulatory concern	4.33
If IT infrastructure readiness will be the responsibility of service provider?	IT readiness	4.33
Another company may get control over your information	Privacy	4.30
If your desktop hardware and operating system environment are ready to support cloud service requirements?	IT readiness	4.27
Applicable legislation and regulations in the case of non-compliance with standards	Regulatory concern	4.27
If the service to underlying applications is continuous even after the failure of one or more components in any layer?	Feasibility	4.26
Reputation	Trust	4.25
If it is feasible within the estimated cost?	Feasibility	4.24
If the government support through policies and regulations will facilitate the adoption of cloud computing technology?	Government support	4.24
If there will be incompatibility of data when we want to move from one cloud service provider to another?	Compatibility	4.22
If all or some existing applications and devices have the ability to be compatible with the cloud environment?	Compatibility	4.22
Laws, regulations and policies which will be applied to all uses of cloud services within the institution (what resources are being used?, for what purpose? and by whom?)	Regulatory concern	4.22
If the existing IT infrastructure supports the additional cloud service demands?	IT readiness	4.22
If we can upgrade to cloud-friendly versions, or replacing incompatible applications?	Compatibility	4.21
If the government will provide necessary training programs and researches for acquisition the required skills in the use of cloud technology?	Government support	4.21
If the security of data centers for service provider is within the legal, regulatory and business needs?	Regulatory concern	4.21
If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?	Government support	4.19
I do not know who can access the system and what they can access	Privacy	4.17
Compliance for standards and regulations	Trust	4.17
Access or control of your information by someone else.	Security	4.15
Loss of information due to accident, viruses, ….,etc.	Security	4.15
Don't have full control over your data when the service provider outside your country	Privacy	4.13
If your desktop hardware and operating system environment are ready to support cloud service requirements?	IT readiness	4.10
Keeping data physically outside the organization	Privacy	4.8

Continuation of table 16

I do not know where the information is stored	Privacy	4.8
If the government will help institutions to overcome any financial limitations?	Government support	4.7
If the government will provide the necessary administrative support for cloud adoption, such as the need for the least number of meetings and permits	Government support	4.6
If it is technically feasible?	Feasibility	4.04
The large institutions are more capable to adopt cloud services because they have enough financial, technical and human resources	Organization size	4.04

Table 17 shows the reliability of field study based on Cronbach's Alpha. Cronbach's alpha is ranged from 0.503 to 0.837 which is considered good Cohen, [190]. The lower value (0.503) is come from the conflicting views on the impact of the size of the institution on the adoption of new technology from participants' point of view. George and Mallery [189] had given the following criteria to determine Cronbach's Alpha value as follows: "≥ .9 – Excellent, ≥ .8 – Good, ≥ .7 – Acceptable, ≥ .6 – Questionable, ≥ .5 – Poor, and < .5 – Unacceptable". The Cronbach's Alpha equals (0.964) for the entire critical factors questions which illustrates an excellent reliability of the questionnaire. Thus, it can be said the researcher proved that the survey extremely reliable and valid to be deployed in Iraqi governmental institutions.

Table 17 **The Reliability of Field Study**

Variable	**Number of items**	**Cronbach's Alpha**
Feasibility	6	0.836
Trust	6	0.848
Regulatory Concerns	6	0.819
IT Readiness	6	0.810
Privacy	6	0.783
Compatibility	5	0.729
Government Support	6	0.837
Availability and Reliability	4	0.696
Security	7	0.766
Cost	5	0.775
Complexity	5	0.810
Organization Size	4	0.503
Organization Culture	5	0.742
For Full items	72	0.964

Table 18 explains the top three sub-question mean magnitudes for security, privacy, availability and reliability, cost, complexity, organization size, organization culture, feasibility, trust, IT readiness, regulatory concern, compatibility, and government support concerns respectively.

Variable	Top Three Sub-Questions
Security	Access or control of your information by someone else
	Loss of information due to accident, viruses, …..,etc.
	If it is safer to use local cloud(private or community cloud) within your city or country?
Privacy	Another company may get control over your information
	I do not know who can access the system and what they can access
	Don't have full control over your data when the service provider outside your country
Availability and Reliability	You do not have data and available service during interruption or potential attack
	Access of cloud is fully depending on your Internet connection which can be interrupted at any time
	Your business process cannot be delayed or stopped when the service provided by cloud service provider goes down
Cost	Hidden cost of back up , restore, disaster recovery and problem solving
	The cost of installation and reconfiguration of applications can be high
	It costs more to have a good storage and security system
Complexity	The reconfiguration of your applications to meet the requirements of the new host can be Complex
	The complexity of maintaining and keeping up the date of operating systems, applications and underlying hardware if we manage the cloud environment
	The migration to cloud computing will bring additional complexities in overall management of IT resources
Organization Size	The large organizations are more capable to adopt cloud services because they have enough financial, technical and human resources
	The large organizations have more flexibility in their resources, so they are able to experiment with new innovation
	The small and medium sized organizations may gain more benefits from cloud computing as they do not have to invest in infrastructure and applications
Organization Culture	The geographical location of organization can affect the adoption of cloud technology, for example scalable or central regions may more tend to adopt cloud computing than unstable regions or Suburbs
	The prevailing beliefs and attitudes in the organization can obstacle from adopting cloud computing because it involves new ways in using , storing, sharing data and applications
	Organization culture such as habits, visions and systems can be reorganized to adopt useful new technology
Feasibility	if its use is safer than using a traditional system?
	If the real-time performance for cloud service is high?
	If it will be beneficial and profitable?
Trust	Continuation and disaster recovery plans
	Security practices
	Information assurance practices
IT Readiness	If your organization provides a high Internet connection and bandwidth to gain the benefits of using cloud technology?
	If the existing IT applications can be integrated with cloud system?
	If the existing IT infrastructure supports the additional cloud service demands?

Continuation of table 18

Regulatory concern	**Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner**
	If the cloud service provider offers a Service Level Agreement (SLA) that ensure a high up-time guarantee (between 99.9% to 99.999%)
	Applicable legislation and regulations in the case of non-compliance with standards
Compatibility	**If there will be incompatibility of data when we want to move from one cloud service provider to another?**
	If all or some existing applications and devices have the ability to be compatible with the cloud environment?
	If we can upgrade to cloud-friendly versions, or replacing incompatible applications?
Government Support	**If the government support through policies and regulations will facilitate the adoption of cloud computing technology?**
	If the government will provide necessary training programs and researches for acquisition the required skills in the use of cloud technology?
	If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?

5.4 CloudAnalyst Outcomes

The outcomes of CloudAnalyst have been divided into two parts; the first part represents the different types of configurations that have been applied in the original CloudAnalyst tool and their most important results. The second part represents the outputs which came from employing AHP and ECDSA algorithms into CloudAnalyst tool.

5.4.1 Outcomes of original CloudAnalyst tool

In this study, more than 40 configurations were conducted on the original program of CloudAnalyst. Different numbers of (user databases, user grouping number for each UB, and DC) were used in various regions, as well as the different algorithms for both load balancing policy (‘Round Robin’, ‘Throttled’, and ‘Equally Spread Current Execution) and service broker policy('Proximity-Based Routing Service', 'Optimized Routing Performance', 'Reconfigure the Router Dynamically') have been applied, for the purpose of testing the performance for CloudAnalyst tool in all different cases (Appendix B represents all the conducted configurations). In this chapter the researcher will discuss only the configurations which observed them giving important results. There are three tables in this section, generally, the first table represents the different parameters have been set to the program, and the two

other tables reflect the results that collected from different 45 configurations, more details as follow:

Table 19 represents different configurations have been performed by using different inputs for simulation duration, number of user bases, the selected regions for each user base, user grouping number for each user base, number of data centers, selected regions for each data center, selected load balancing method, selected service broker method, number of virtual machines for data center, and request grouping for each data center respectively.

Table 20 represents the results for the previous configurations, in term of overall response time based on the total average in millisecond, data center processing time based on the total average in millisecond, response time by region, data center request servicing times, specified the chosen user base and data center, the maximum and minimum results for the average, and the best response time was for which user base and for which region respectively.

Table 30 represents the results for the previous configurations, in term of total virtual machine cost in dollar, total data transfer cost in dollar, total cost of different data centers, selected data centers, the minimum and maximum cost for employing virtual machines, specified the best virtual machine cost, the minimum and maximum data transfer cost, and specified the best data transfer cost respectively.

Table 19 **Configurations parameters**

Simulation Configuration	Simulation Duration	UB No.	Region For users	User grouping No for Each UB	No. of DC	Regions	Load Balancing grouping	Service Broker Policy	No of VM for DC	Request Grouping for each DC
Configuration 2	30 mins	6	UB1,UB2,UB6/R2, UB3/R3,UB4,UB5/R 4	10	7	R0,R1,R2,R3,R5	Round robin	Optimize response time	5	10
Configuration 6	95 mins	9	All UBs in R4	100	10	DC1,DC2/R2, DC3,DC4/R3, DC5,DC6,D7/R4 DC8,DC9,DC10/R1	ESCE	Optimize response time	9	20
Configuration 7	2 hours	10	All UBs in R3	120	12	DC1,DC2,DC3/R2, DC4,DC5,DC6,DC7/R 3, DC8,DC9,DC10/R4, DC11,DC12/R1	Throttled	Optimize response time	9	20
Configuration 10	60 mins	12	All UBs in R3	150	12	DC (1,2,3,4)/R2, DC(5,6,7,8,9,10)/R3, DC(11,12)/R4	ESCE	Optimize response time	10	20
Configuration 17	95 mins	15	All UBs in R3	220	15	All DCs in R3	Round robin	Dynamically reconfiguring router	15	30
Configuration 18	95 mins	16	All UBs in R3	230	16	All DCs in R3	ESCE	Dynamically reconfiguring router	15	30
Configuration 23	2 hours	19	All UBs in R3	300	20	All DCs in R3	Round robin	Closest data center	18	30
Configuration 24	30 mins	20	All UBs in R3	300	20	All DCs in R3	ESCE	Closest data center	18	30
Configuration 30	60 mins	23	All UBs in R3	300	22	All DCs in R3	ESCE	Dynamically reconfiguring router	6/10	40
Configuration 31	60 mins	23	All UBs in R3	300	22	All DCs in R3	Throttled	Dynamically reconfiguring router	6/10	40
Configuration 32	60 mins	23	All UBs in R3	300	22	All DCs in R3	Round robin	Dynamically reconfiguring	6/10	40

Continuation of table 19

								router		
Configuration 36	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Round robin**	**Closest data center**	**6/10**	**30**
Configuration 37	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Round robin**	**Optimize response time**	**6/10**	**30**
Configuration 38	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Round robin**	**Dynamically reconfiguring router**	**6/10**	**30**
Configuration 39	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**ESCE**	**Closest data center**	**6/10**	**30**
Configuration 40	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**ESCE**	**Optimize response time**	**6/10**	**30**
Configuration 41	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**ESCE**	**Dynamically reconfiguring router**	**6/10**	**30**
Configuration 42	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Throttled**	**Closest data center**	**6/10**	**30**
Configuration 43	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Throttled**	**Optimize response time**	**6/10**	**30**
Configuration 44	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Throttled**	**Dynamically reconfiguring**	**6/10**	**30**

Table 20: **Results of CloudAnalyst configurations**

Simulation Configuration	**Overall response time Avg (ms)**	**Data Center processing time Avg (ms)**	**Details**	**For UB& DC**	**From-to Avg (ms)**	**The best response Avg (ms)**
Configuration 2	**135.50**	**0.45**	**Response Time by Region**	**UB1-UB6**	**50.01-300.89**	**50.01 to UB2 from R2**
			Data Center Request Servicing Times	**DC1-DC7**	**0.44-0.49**	**0.44 to DC6 from R2, DC(1,2,3,4,5):0.00**
Configuration 6	**50.36**	**0.71**	**Response Time by Region**	**UB1-UB9**	**50.08- 50.62**	**50.08 to UB7 from R4**
			Data Center Request Servicing Times	**DC1-DC10**	**0.69- 0.72**	**0.69 to DC6 from R4 DC(1,2,3,8,9,10) : 0.00**

Continuation of table 20

Configuration 7	**50.05**	**0.62**	**Response Time by Region**	**UB1-UB9**	**49.24-50.90**	**49.24 to UB6 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.61- 0.64**	**0.61 to DC(5,6) from R3 DC(1,2,3,8,9,10,11,12):0.00**
Configuration 10	**49.81**	**0.50**	**Response Time by Region**	**UB1-UB12**	**48.61- 50.52**	**48.61 to UB7 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.46-0.55**	**0.46 to DC(5,8) from R3 DC(1,2,3,4,11,12):0.00**
Configuration 17	**51.75**	**1.97**	**Response Time by Region**	**UB1-UB15**	**50.73-52.36**	**50.73 to UB9 from R3**
			Data Center Request Servicing Times	**DC1-DC15**	**1.76-2.23**	**1.76 to DC(10,6) from R3**
Configuration 18	**50.86**	**1.05**	**Response Time by Region**	**UB1-UB16**	**49.83-51.45**	**49.83 to UB11 from R3**
			Data Center Request Servicing Times	**DC1-DC16**	**0.89-1.20**	**0.89 to DC10 from R3**
Configuration 23	**50.24**	**0.55**	**Response Time by Region**	**UB1-UB19**	**49.71- 50.68**	**49.71 to UB7 from R3**
			Data Center Request Servicing Times	**DC1-DC19**	**0.51- 0.60**	**0.51 to DC(9,16) from R3**
Configuration 24	**50.16**	**0.53**	**Response Time by Region**	**UB1-UB20**	**48.53-51.21**	**48.53 to UB13 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.42-0.61**	**0.42 to DC3 from R3**
Configuration 30	**50.43**	**0.68**	**Response Time by Region**	**UB1-UB23**	**49.82**	**49.76 to UB10 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.58**	**0.52 to DC8 from R3**
Configuration 31	**50.44**	**0.68**	**Response Time by Region**	**UB1-UB23**	**49.58 - 51.33**	**49.30 to UB12 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.63- 0.77**	**0.63 to DC13 from R3**
Configuration 32	**50.66**	**0.91**	**Response Time by Region**	**UB1-UB23**	**50.03-51.50**	**50.03 to UB12 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.83-0.99**	**0.83 to DC12 from R3**
Configuration 36	**50.28**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.55-50.83**	**49.55 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.49-0.57**	**0.49 to DC(9,13,15,16) from R3**
Configuration 37	**50.17**	**0.52**	**Response Time by Region**	**UB1-UB20**	**49.55-50.89**	**49.55 to UB14 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.46-0.57**	**0.46 to DC19 from R3**
Configuration 38	**50.76**	**1.02**	**Response Time by Region**	**UB1-UB20**	**49.92-50.93**	**49.92 to UB2 from R3**
			Data Center Request	**DC1-DC20**	**0.94-1.10**	**0.94 to DC10 from R3**

Continuation of table 20

			Servicing Times			
Configuration 39	**50.28**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.40-50.87**	**49.40 to UB5 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.45-0.59**	**0.46 to DC5 from R3**
Configuration 40	**50.17**	**0.52**	**Response Time by Region**	**UB1-UB20**	**49.51-50.83**	**49.51 to UB6 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.46-0.56**	**0.46 to DC13 from R3**
Configuration 41	**50.39**	**0.64**	**Response Time by Region**	**UB1-UB20**	**49.42-50.94**	**49.42 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.54-0.72**	**0.54 to DC18 from R3**
Configuration 42	**50.28**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.61-50.80**	**49.61 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.49-0.59**	**0.49 to DC2 from R3**
Configuration 43	**50.17**	**0.52**	**Response Time by Region**	**UB1-UB20**	**49.52-50.99**	**49.52 to UB14 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.46-0.57**	**0.46 to DC13 from R3**
Configuration 44	**50.33**	**0.58**	**Response Time by Region**	**UB1-UB20**	**49.47-50.88**	**49.47 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.51-0.65**	**0.53 to DC20 from R3**

Table 21: **Results of CloudAnalyst configurations**

Simulation Configuration	**Total Virtual Machine Cost ($)**	**Total Data Transfer Cost ($)**	**Total cost**	**For DC**	**The Cost for VM From-to**	**Best VM cost for DCs**	**The Cost for D.T From-to**	**Best D.T cost for DCs**
Configuration 2	**1.51**	**0.19**	**1.70**	**DC1-DC7**	**0.20-0.25**	**0.20 for all of Them except DC7/R3(0.25)**	**0.03-0.16**	**0.03for DC7/R3 DC(1,2,3,4,5):0.00**
Configuration 6	**12.51**	**0.84**	**13.35**	**DC1-DC5**	**0.63- 1.43**	**0.63 to DC10/R1**	**0.26- 0.29**	**0.26 for DC5/R4 DC(1,2,3,4,8,9,10):0.00**
Configuration 7	**19.20**	**1.17**	**20.37**	**DC1-DC12**	**0.80-1.80**	**0.80 to DC12/R1**	**0.25-0.32**	**0.25 for DC7/R3 DC(1,2,3,,8,9,10,11,12):0.00**
Configuration 10	**10.90**	**0.71**	**11.61**	**DC1-DC12**	**0.40-1.00**	**0.40 to DC12/R4**	**0.10-0.14**	**0.10 for DC8,DC7/R3**

Continuation of table 21

								DC(1,2,3,4,11,12):0.00
Configuration 17	**135.28**	**1.39**	**136.68**	**DC1-DC15**	**6.81-9.47**	**6.81to DC15/R3**	**0.08-0.10**	**0.08 for DC7,10,13/R3**
Configuration 18	**141.79**	**1.48**	**143.28**	**DC1-DC16**	**8.29-9.61**	**8.29 to DC3/R3**	**0.08-0.10**	**0.08 for DC3,8,14/R3**
Configuration 23	**71.21**	**2.21**	**73.43**	**DC1-DC19**	**3.20- 3.60**	**3.20 to DC18,19/R3**	**0.09- 0.13**	**0.09 for DC5/R3**
Configuration 24	**17.84**	**0.59**	**18.43**	**DC1-DC20**	**0.80-0.90**	**0.80 to DC18,19/R3**	**0.02-0.04**	**0.02 for DC(2,6,9)/R3**
Configuration 30	**61.47**	**1.35**	**62.82**	**DC1-DC22**	**2.56- 3.35**	**2.56 to DC7**	**0.05-0.08**	**0.05 for DC6/R3**
Configuration 31	**62.25**	**1.35**	**63.60**	**DC1-DC22**	**2.74-4.32**	**2.74 to DC8**	**0.06-0.08**	**0.05 for many DCs**
Configuration 32	**62.34**	**1.35**	**63.69**	**DC1-DC22**	**2.71- 4.46**	**2,71 to DC15**	**0.05-0.08**	**0.05 for DC3/R3**
Configuration 36	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.10**	**0.07 to R15**
Configuration 37	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.08-0.10**	**0.08 to R10**
Configuration 38	**135.06**	**1.75**	**136.81**	**DC1-DC20**	**5.87-7.13**	**5.87 to DC10/R3**	**0.08-0.10**	**0.08 to DC(10,11,20,1,3,7)**
Configuration 39	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC6/R3**
Configuration 40	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC (7,14)/R3**
Configuration 41	**133.32**	**1.75**	**135.07**	**DC1-DC20**	**6.15-7.28**	**6.15 to DC6/R3**	**0.07-0.11**	**0.07 for DC5/R3**
Configuration 42	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC(6,12)/R3**
Configuration 43	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC8/R3**
Configuration 44	**132.32**	**1.75**	**134.07**	**DC1-DC20**	**6.05-7.16**	**6.05 for DC19**	**0.07-0.10**	**0.07 for DC(1,6,20)/R3**

5.4.1.1 Results

The most important matters observed in many configurations are that, the data center must be within one of the regions where there is at least one user base, otherwise there will be no results from this data center, as illustrate in the field (the best response time) from table 20, and the field (Best D.T cost for DCs) from table 21, for the configurations (2, 6, 7, 10) respectively. However, if there is not data center in the region of user base, data center from another region will serve the user base.

From the configuration 17 and above all user bases were selected from the region3 because Iraq is located within the region 3 which representing the continents Asia, as well as all data centers were selected from the same region. The most important things observed in these configurations are that dynamically reconfiguration method has the highest virtual machine cost, data transfer cost, and total cost of different data centers when compared with the other algorithms of service broker policy, as presents in table 21 for configurations (17,18, 23, 24, 30, 31, 32) respectively.

For the configurations 36 to 44, there are similar choose of each (simulation duration, number of user bases, the selected regions for each user base, user grouping number for each user base, number of data centers, and selected regions for each data center), while the algorithms of both load balancing and service broker policies have been changed so that each algorithm of the load balancing worked with each algorithm of the service broker, the most important results were

1- The algorithm of reconfigure dynamically from service broker policy has a highest total virtual machine cost when compared with the algorithms of proximity based routing service and optimized routing performance, as shows in table 21 for configurations (38, 41, 44) respectively.

2- When the optimize response time algorithm was used with any type of load balancing policy, better results were obtained in overall response time and data center processing time when compared to the results of other service broker algorithms, as shown in table 20 for configurations (37,40,44) respectively.

In general, there are different results for each configuration for more than one side in most cases for example, in term of virtual machines cost, data transfer cost, overall response time data center processing time, as well as the data center that has the best

performance and their regions. There can be several reasons for these differences as follow:

1- Due to the distribution of cloud infrastructure, applications could be spread in various geographic locations, and the app distribution chosen affects its performance for clients resides away from data centers.

2- Because of the random access of the load in cloud environment some servers will be slightly loaded or remain in idle status, while other servers are loading heavily. Scheduling efficiency and allocating resources is an important feature of cloud technology where the performance of the system is estimated. The characteristics examined have an effect on optimization the cost, which can be achieved by improving response time and data center processing time. For example, in ESCE algorithm tasks are spread equally, and a full computing system is loaded at balanced way, and without any untapped VMs. Because of this feature, there is a decrease in the cost of the VMs and the cost of data transfer.

3- The CloudAnalyst tool includes three routing methods within the service broker policy in order to direct the user's request to the best data center. This causes various results based on the chosen method as follow:

- In the service of proximity-based routing, the broker selects the shortest route from the user base to the data center by just depending on the latency of network. This may overload the nearest data center and its connection channel since it is not considered the bandwidth of the channel.
- In optimized routing performance policy, the best path will be selected by the broker depending on both the workloads of data center and network latency, in order to obtain the best response time depending on the response time of last task. This will be circulated on the situation of any other data center, but if the present load of any DC is zero, it will not be identified except if the client waits for a particular amount of time. This may leave the idle data center without assigning any tasks even if it was the nearest one or the less latency, and the bandwidth path of available network is the highest.
- The dynamic reconfiguration is comparable to the proximity-based routing; however, the broker is endured with more responsibility for expanding application deployment scale on the basis of the load it faces. This is achieved by increasing or decreasing the number of virtual machines distributed in the data center, based on

present processing times as compared to the best processing time could be ever achieved.

5.4.2 AHP and ECDSA Outputs

The next sections explain how CloudAnalyst has been performed through the usage of ESDSA and AHP techniques.

5.4.2.1 Outputs of AHP Technique

This study examined the performance of cloud computing technology via CloudAnalyst simulator tool, as well as it conducted a literature review and used it as a base to prepare a comprehensive questionnaire, which is used as a mean to specified how experts, administrators and staff ranked and identified critical factors that affecting the adoption of cloud computing in the Iraq government's institutions. Specifically, the procedure of study included development of a conceptual model, and the calculation of weights of hierarchical variables based on the results of the study survey, to achieve this goal, the study used AHP technique to get the weights of the most influential factors, thus provides insight about the concerns affecting the acceptance of this technology

Based on the findings of the study, the most influential factors are: feasibility, trust, regulatory concern, IT readiness, privacy, compatibility, government support, availability and reliability, and security, while the less influential issue are coming from organization culture factor. Although the security factor got less percentage compared with the most critical factors ,but most of the issues have been highlighted are coming from security concerns for example, “if its use is safer than using a traditional system", and " You do not have data and available service during interruption or potential attack”, and "Security practices”, and "Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner”, and "Continuation and disaster recovery plans", for the last issue, it also reflects security concern because one of the issues addressed in recovery plans is (what the CSP plan when they exposed to a security violation) .

Due of using AHP technique in our program, when we choose the factors above, a message will appear "the most influential factors in adopting cloud computing in the government sector".

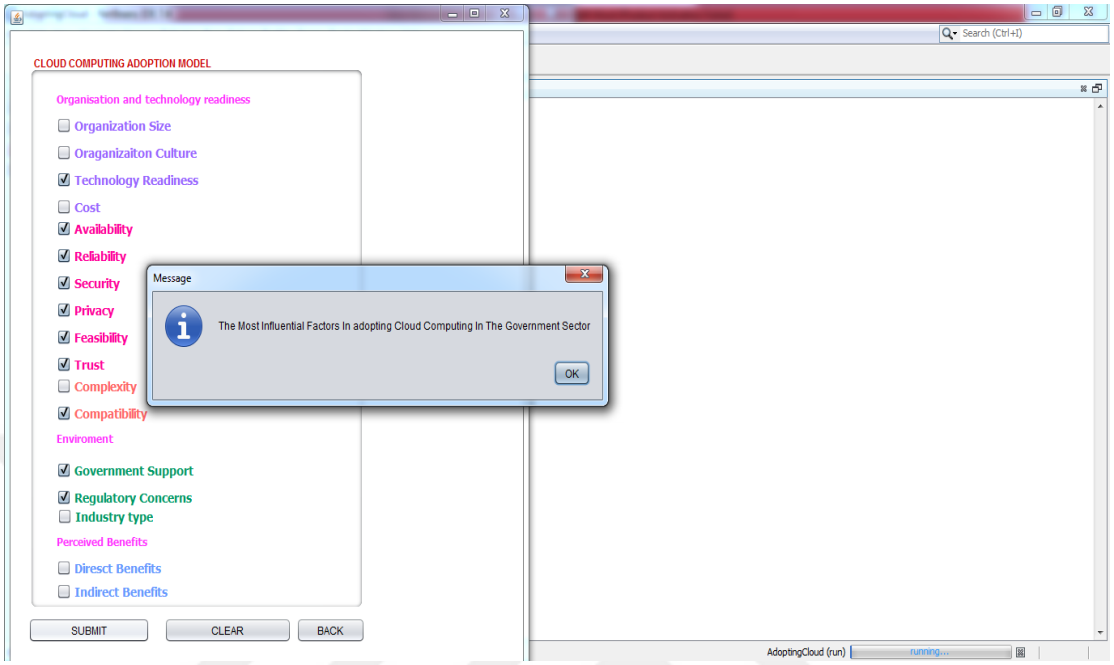

Figure 10: **Most Influential Factors Massage**

And when we choose the organization culture factor, a message will appear "the less influential factor in adopting cloud computing in the government sector",

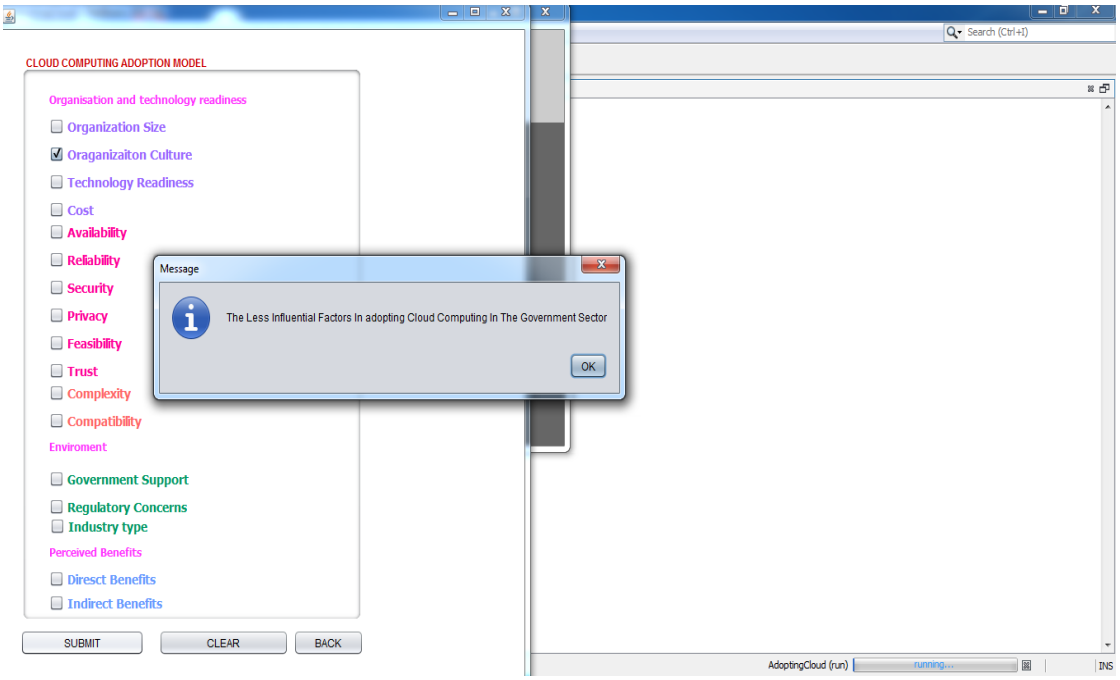

Figure 11: **Less Influential Factors Massage**

As well as when we select all factors, a message will appear "Factors Affecting the Adoption of Cloud Computing Adoption in the Government Sector".

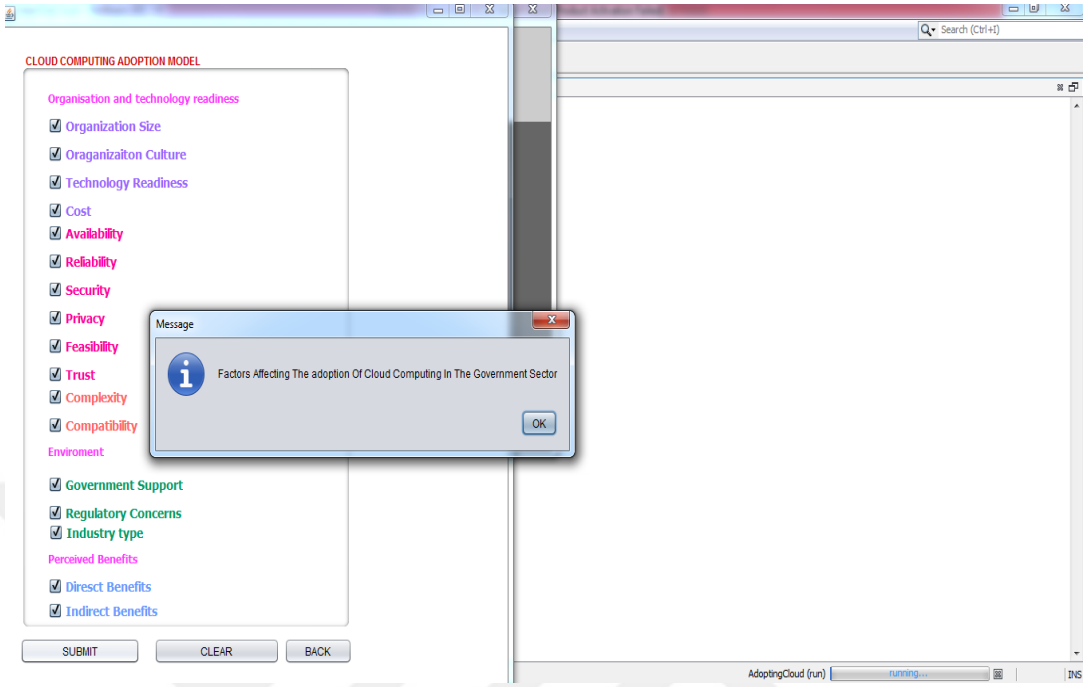

Figure 12: **Factors Influence the Adoption Massage**

Additionally, if we choose direct and indirect benefits factors a message will appear "Factors Encourage Cloud Computing Adoption in the Government Sector".

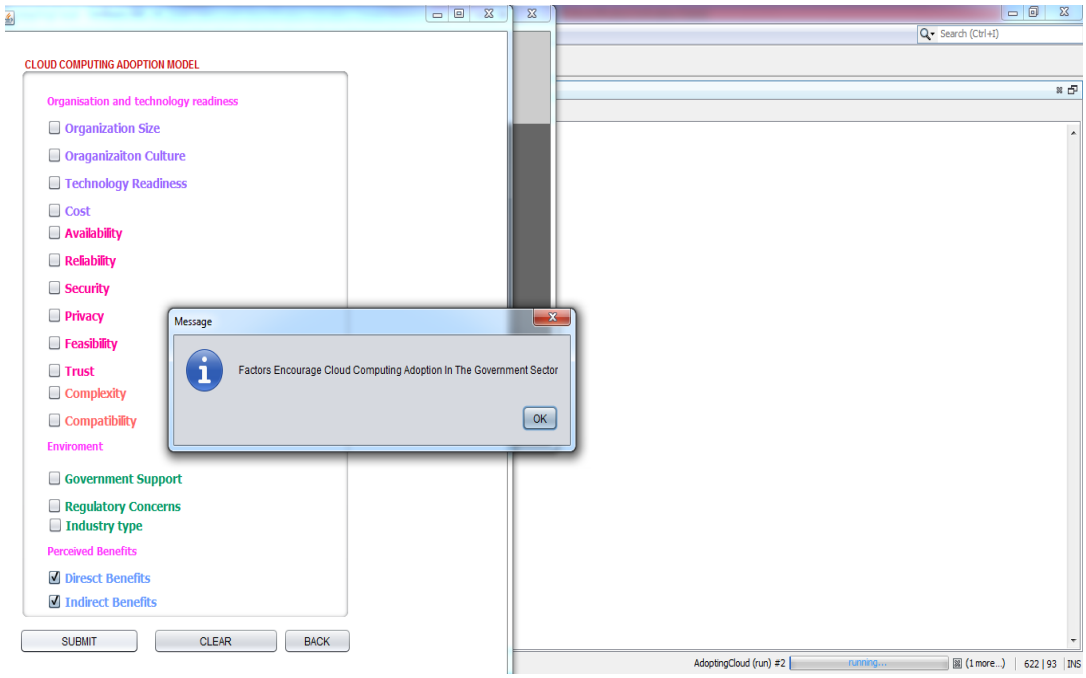

Figure 13: **Factors Encourage the Adoption Massage**

5.4.2.2 ECSDA Output

Security of both sent and stored data can be main concerns when storing sensitive data in the cloud provider storage. Therefore, there are raising requests for an applicable authentication to access data and services for both organizations and customers. The cloud service provider needs to do all the necessary preparations to provide client's data security, privacy, and regulatory compliance.

Many organizations have multiple levels of licensing. For example, front-line staff may have limited possibilities to access data stored on the system of cloud, while the human resources head may have larger possibilities to access multiple files. The approach of cloud storage constitutes a potential security risk to institution particular data. Furthermore, having a password to protect storage is not enough where the password could be hacked by hackers.

Digital signatures are utilized as a means of providing data integrity, authenticity, and ensure not refusing it. Basically, when a digital signature is accepted, the receiver can be guaranteed that the message has actually been sent by the source and has not been changed during the transmission.

ECDSA includes the following main steps:

- **'ECDSA Key Generation'**

The main generation algorithm calculates the public and private key to be used in the processes of signature and verification, where the private key is utilized to generate signatures, while the public key is copied and delivered for signatures validation.

- **'ECDSA Signature Generation'**

The ECDSA is utilized to reveal unauthorized modifications and document identity verification. This signature is represented as a binary number and is calculated using a set of parameters and rules.

- **'ECDSA Signature Verification'**

Finally, signature authenticity will be proved by verification method, where the signature will be accepted or rejected.

In this study because of employing ECDSA algorithm, in order to use CloudAnalyst tool the user should first make a registration with his/her name and password.

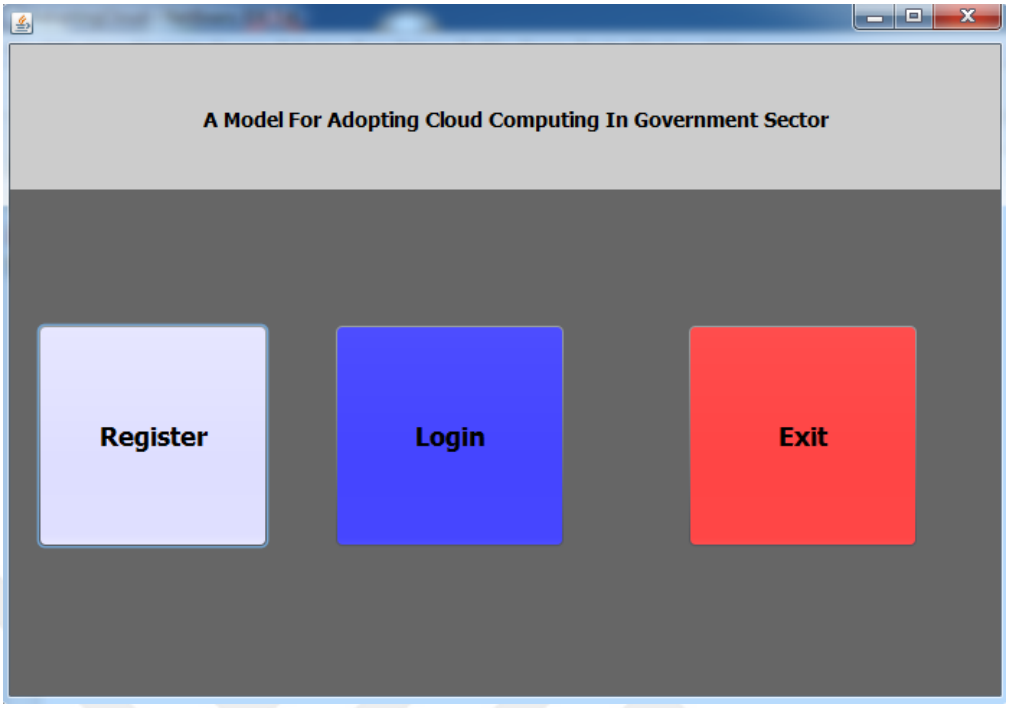

Figure 14: **User Registers and Login**

Figure 15: **User Registers**

Then a message will appear “Register is successful your signature is…”.

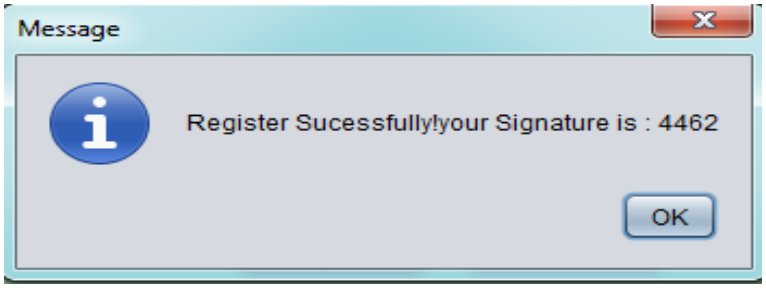

Figure 16: **Message of Successful Registering**

After that, the user should login by using his/her name, the generated signature, and password.

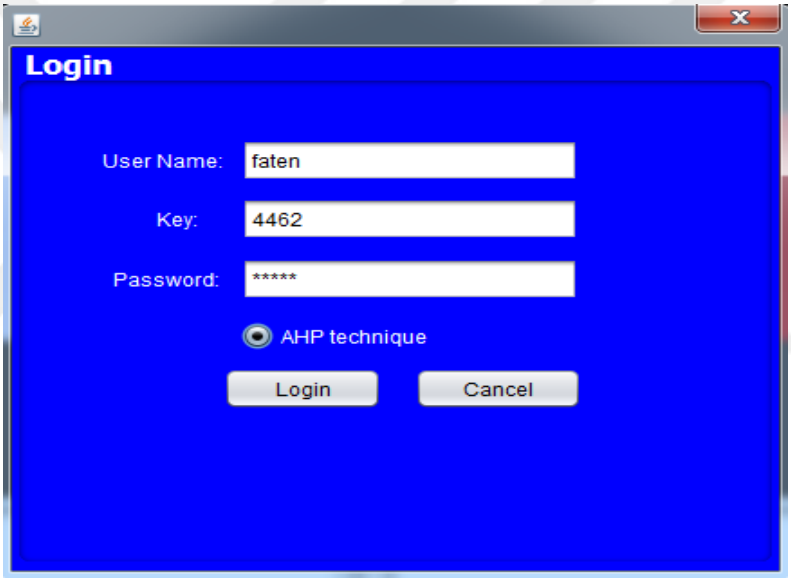

Figure 17: **User Login**

After evaluated the influential factors on the cloud technology adoption via AHP technique, a message will appear to prove validity of the signature, as well as two messages which show the specific times of the encryption and decryption for ECDSA process will appear respectively, which are “Encryption key generated at ‘the time’ milliseconds” and “Decryption generated at ‘the time ‘millisecond”.

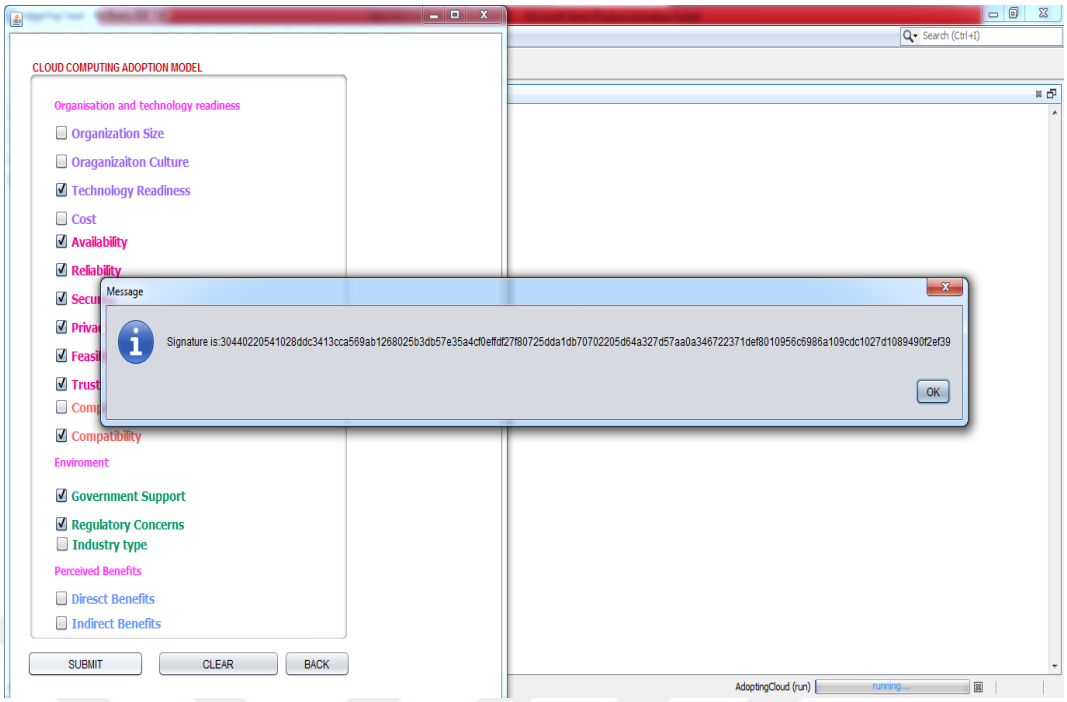

Figure 18: **Verification of Signature**

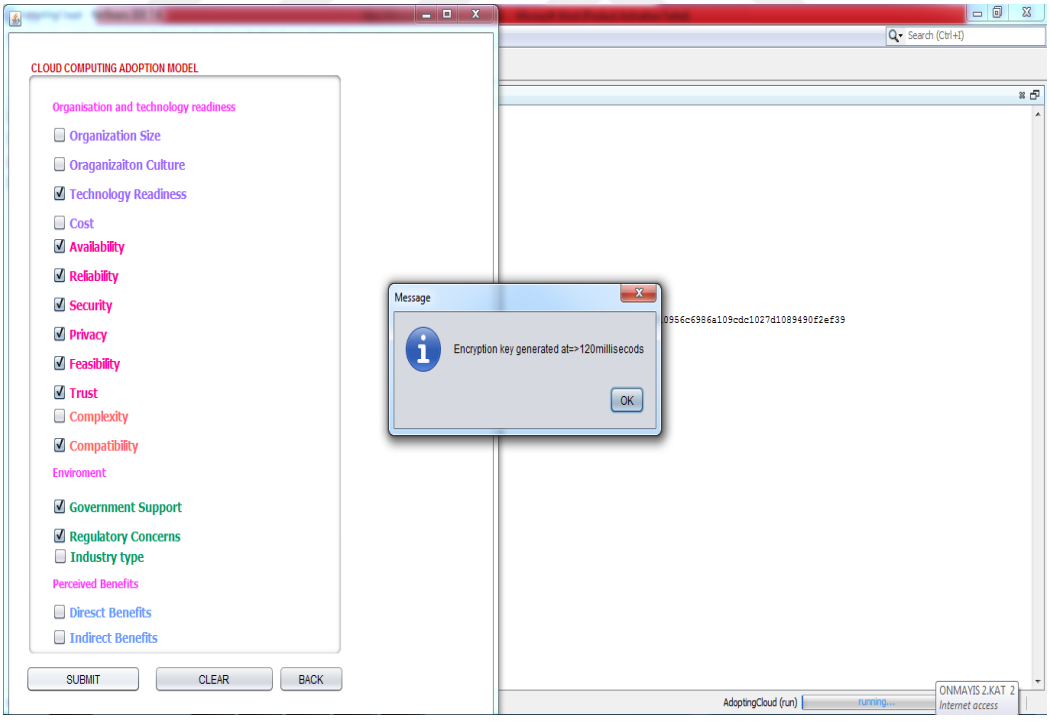

Figure 19: **Encryption Execution Time**

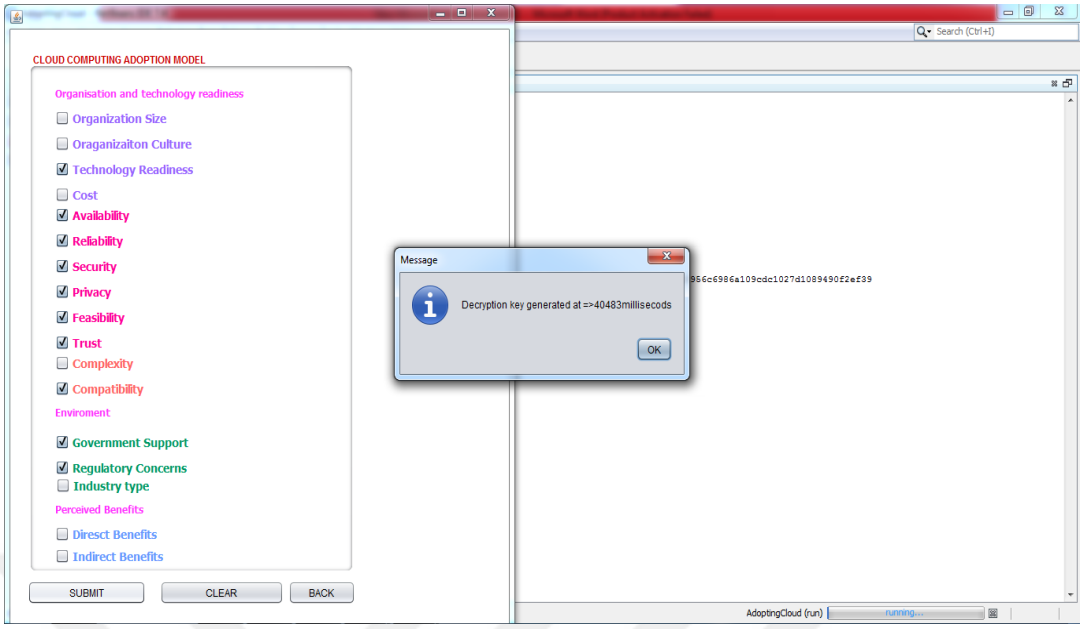

Figure 20: **Decryption Execution Time**

In this stage a file named EDTime which represents the time of both encryption and decryption process, will be created automatically in the code folder, this file can be a kind of virus and must be removed before each new simulation process. Then we will access the interface of cloudAnalyst program and set its parameters. After run the simulation the final report will appear which includes normal results of cloudAnalyst as well as the taken time by both encryption and decryption processes. Therefore, this research provides a proof of the possibility of overcoming both security and privacy concerns in cloud environment, where ECDSA algorithm is utilized to reveal unauthorized modifications and document identity verification, so users must provide appropriate login before they can access the information and applications they want to use, also this algorithm provides a short key and length of signature with a high level of security, it protects against a large set of side channel attacks which include cache attacks and memory detection attacks, while in the traditional system the information could be lost by accidents, or could be hacked. Thus, cloud system is more secure than the traditional systems.

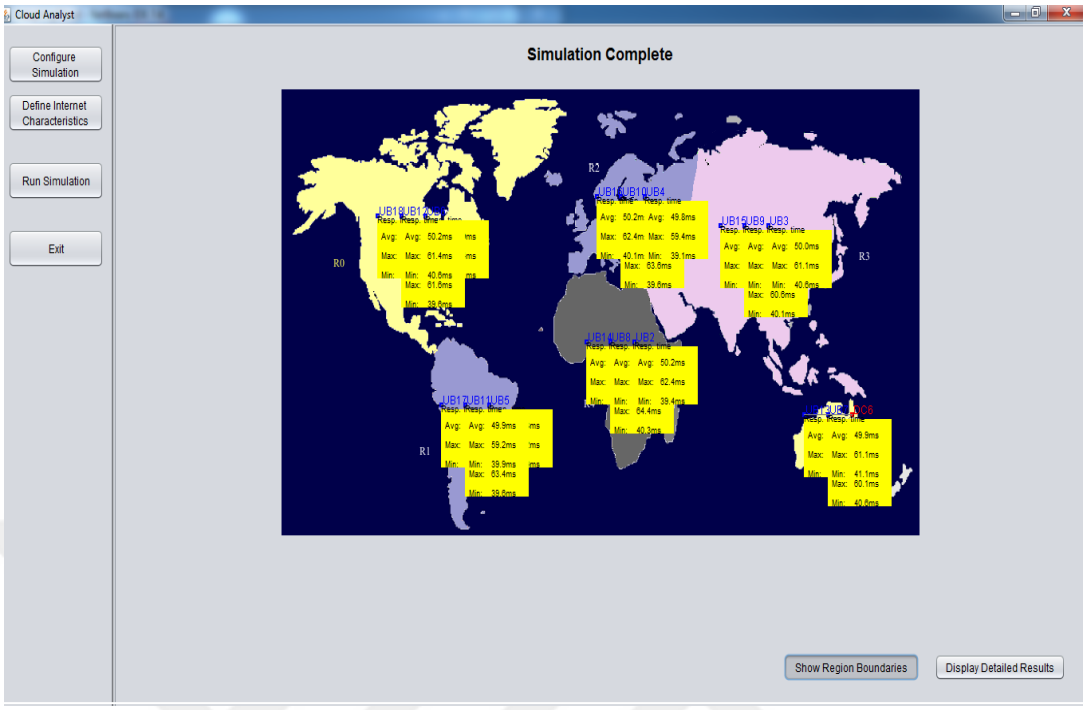

Figure 21: **Simulation Results**

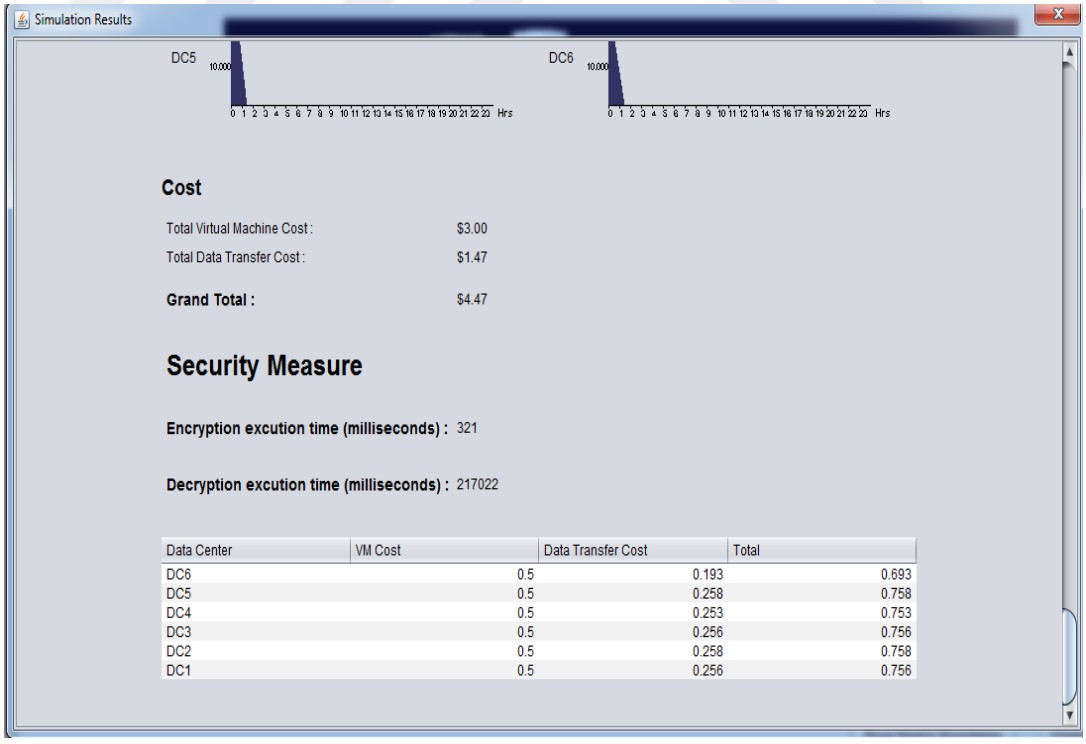

Figure 22: **Security Measure Results in the Final Report**

CHAPTER 6

CONCLUSIONS, GUIDELINES AND FUTURE WORK

6.1 Conclusions

The main contributions of this thesis are:

1- Develop a conceptual framework for cloud technology adoption based on TOE, DOI and Iacovou et al. theories in order to analyze the technological, organizational, and environmental challenges that prevent many government institutions with different IT infrastructures readiness and systems from taking the advantages of cloud technology.

2- Assist the government institutions to perceive the reasons for not adopting the cloud technology yet, by conducting a thorough investigation in the factors affecting the adoption process.

3- Provide a proof that cloud system is more secure than the traditional system by employing ECDSA algorithm via Cloudanalyst simulator, which can overcome both privacy and security concerns in cloud environment.

4- Help Iraqi government institutions in migrating to cloud environment in an effective manner by proposing a set of guidelines.

In this study the concluding remarks can be classified into questionnaire outcomes and CloudAnalyst outcomes as follows:

6.1.1 Questionnaire Outcomes

The first part of this study tried to identify the most critical factors preventing cloud computing adoption in Iraqi government institutions. To reach this aim, a thorough investigation was conducted by using a questionnaire which includes a number of clear sub-questions that prepared for each factor, assuming that it is necessary to ensure that participants have a well knowledge of the issues surrounding each factor that may affect cloud adoption.

The participants assigned various importance levels for the issues regarding cloud computing that derived from organizational, technological and environmental factors. Generally, the factors that influence cloud adoption in the government sector are identified in terms of their relative importance based on the questionnaire results are as follows: feasibility 85.4%, trust 84.7%, regulatory concerns 84.6%, IT readiness 82.9%, privacy 81.8%, compatibility 81.5%, government support 81.4%, availability and reliability 79%, industry type 79%, security 78.5%, cost 76%, complexity 75.7%, organization size 75%, organization culture 70,7%, direct benefits 70%, and indirect benefits 63%.

Particularly, the issue "**Continuation and disaster recovery plans**" got the highest mean value (M=4.47; SD=0.926) from trust factor, followed by the issue "**You do not have data and available service during interruption or potential attack**" which got (M=4.42; SD=0.955) from availability and reliability factors, followed by "**if its use is safer than using a traditional system**?" which got (M= 4.40; SD=0.953) from feasibility factor, followed by "**Security practices**" with (M= 4.39; SD=0.994) from trust factor, followed by "**Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner**" with (M=4.39; SD=0.898) from regulatory concern factor, followed by "**Information assurance practices**" with (M=4.39; SD=0.886) from trust factor. Most of these issues related to security concerns, consequently, they reflect the importance of security factor. The lowest from the whole issues are "**The organization is very supportive to changes**" which got (M=3.12; SD=1.305), and "**Most persons in this organization are encouraged to make suggestions for improvement**" which got (M=3.21; SD=1.266) from organization culture factor.

We believe that the results of this study are specific to Iraq or other countries which have similar critical situation, and they may be quite different in other developing countries. Generally, in most emerging and developing economies, people utilize free services of cloud computing, like e-mail and social networks over the Internet, but the adoption of cloud technology is much less than in developed countries although developing countries could gain a lot of benefits from adopting cloud technology. Besides the critical factors there are other challenges that can

affect the adoption, which show differences according to the country status. These challenges can be lack of cloud awareness, fear of losing job in the workforce in information technology field, social impact, lack in motivation, access Internet of affordable broadband is not satisfactory enough in many nations, and there are not adequately law and regulatory frameworks to handle concerns related to privacy and protection of data, as well as inadequate security particularly in unstable nations such as Iraq. Thus, a set of essential and yet vital preparation are needed to smooth cloud adoption process. Furthermore, a specified model based on the present status of the country is very necessary.

The conceptual model of this research is based on strong theories (TOE+DOI +Iacovou et al.) which are used to derive seventeen of organizational, technological and environment factors, using both paper questionnaire and online survey. The questionnaire survey completed a random sample of 100 managers and employees of various levels from several Iraqi ministries. SPSS software has been used to analyze the results. Also, this study includes conducting a lot of configurations via using CloudAnalyst to determine the real time performance of cloud technology environment. Additionally, this tool has been used to employ two algorithms, which are AHP technique that used to get the weight of the influential factors in cloud technology adoption based on the questionnaire results, as well as ECDSA algorithm that used as a way to prove the possibility of overcoming both privacy and security concerns of cloud environment.

Table 22 represents a comparison between this study and other studies, in terms of the used theories, methods, samples, as well as in terms of results and the used tools.

Table 22 **Comparison between this study and other studies**

Work & case study	Tools	Methods/(factors if found)	Details
Wahsh &Dhillon[19] Case Study: cloud computing for e-governance in Iraq	Survey, SPSS, and AMOS	"Systematic Literature Review (SLR)" Factors : "complexity, compatibility, top management support, relative advantage, IT knowledge security, IT readiness and trust "	This study findings present that "complexity, top management support, IT knowledge, compatibility, security, relative advantage" have a significant effect on cloud computing adoption for the implementation of E-government in Iraq, while technology readiness and trust factors do not have a large impact on the implementation of E-government by cloud computing. Some results of this study are compatible with our results which show that compatibility, complexity, security have a significant effect on cloud adoption, on another hand, it is not compatible with our study results which show that technology readiness and trust are from the most influential factors in the adoption process.
Hashim &Hassan [21] Case Study: "adopt cloud technology in educational institutions in Iraq".	questionnaire ,SPSS , class sampling techniques	"unified theory of acceptance and use of technology (UTAUT)" Factors:" performance expectancy, effort expectancy, social influence, facilitating conditions, security , Trust, behavioral intention and use behavior"	The results show that the performance expectancy is the most significant factors impacting the behavioral intention to employ cloud technology, followed by the factors of 'expected effort', 'social impact', 'security', and trust. Behavioral intention' and 'facilitating conditions' have great impact on the behavior of using the services of cloud technology. Some this study results are compatible with our results which show that trust and security have a significant effect on cloud adoption. Otherwise it uses different theory and factors.
Mohan et al. [20] Case Study: “cloud prototype project for University of Technology (UTC) in Iraq”.	SUS questionnaire	"Vaishnavi Research Methodology"	This project assists the universities in Iraq as a solution to minimize the cost of IT requirements, reduce the time, and easiness the usage for education in Iraqi universities. Specialized units will be established to develop knowledge and contribute to solving the matters facing the Iraqi education sector in universities. Furthermore, the UTC system usage decreases the request for HR, and it will assist the student to remotely communicate with the university's professors. System evaluation has been done by 40 participants (managers, employees, professors, and students), who found the system is useful and simple to use. The participants in our study also assign that, the indirect benefits of cloud computing such as reducing cost, time, complexity, and increase the effectiveness of work are useful features in cloud technology.

Continuation of table 22

Al-Khayat et al. [22] Case Study: cloud computing platform for the higher education colleges and institutions of Iraq	Practical steps	The proposed model kind can be either a "Public cloud" in order to work outside institutes and colleges premises, or "hybrid cloud", where a private cloud is connected to one or more exterior services (if they previously occur within institutes and colleges).	This study proposed general model composed of six service layers, with several characteristic for adopting and applying cloud technology for serving engineering institutes and colleges to be capable to perform an educational cloud technology plainly, readily and transforming them from the vortex of modernization and maintenance of infrastructure. The proposal model enables developers to generate reusable and elastic layers to offer services efficiently to their students, employees, and faculty, as well as reducing time, effort, and cost. The participants in our study also assign that, the indirect benefits of cloud computing such as reducing cost, time, and increase the effectiveness of work are useful features in cloud technology.
Al-Ani.&Ibrahim [23] Case Study: "cloud background for Iraqi Ministry of Higher Education and Scientific Research".	Procedural Steps	"Load Balance (LB), Routing Protocol (RP)' clusters (servers)	This study proposed an effective cloud environment for the Iraqi Ministry of 'Higher Education and Scientific Research'. Load control is proposed by employing load balancing and routing protocol algorithms, it suggests using 'round-robin' or 'biasing' as an example of load balancing, and 'IGRP' or 'EIGRP' as an example of routing algorithms. To solve the problem of high load, a solution of clusters (servers) has been suggested. The proposed approach relied on the number of access that could happen from the ministry's universities. The load has been managed by replication of data and apps in many servers spread in the west, middle, and east of Iraq. The results of our study indicate that, the overall response time and data center processing time are enhanced by using the optimize response time algorithm from service broker policy, due to its ability of routing the traffic to the data center which estimates to give the best response time.
Alazawi et al. [24] Case Study: "disaster evacuation characteristics in Ramadi city in Iraq".	"Modelling and simulations through the (LWR) and macroscopic models"	"ITS (intelligent transportation systems), C2C (car to car), C2I(car to infrastructure) and VANETS (vehicular ad hoc network), flow and volume interchangeably"	The system of this study is capable of collecting information from many sources and places, and it qualified for making efficient resolutions and strategies, and to disseminate information in real time to vehicles and other nodes. The effect of the disaster on real town transfer environment has been modeled and compared with the situation of their system of disaster administration. The study reports significant advantages coming from using the system in term of traffic improvement and traffic flow balancing and ease evacuation. The results of our study show that, the used of optimize response time from service broker policy is enhancing the time, due it routes the traffic to the DC which estimates to give the best response time.
Harfoushi et al. [188]	questionnaire, SPSS	"technology- organization - environment framework (TOE)" Factors: Relative Advantage,	The results of this study show that all factors had a significant impact on the hospitals' intention to move to cloud, and the technological factor had the greatest effect on the decision making. Some results of this study are compatible with our results which indicate

Continuation of table 22

Case study: "adoption of cloud technology in Jorden hospitals"		Complexity, Compatibility, Top Management Support, Technological Readiness, Competitive Pressure, Trading Partner Pressure, Vendor Scarcity	that the advantages of cloud have a positive effect on cloud adoption, and "complexity, compatibility, technological readiness, and vendor scarcity (correspond to trust factor)" have a significant effect on cloud adoption process.
Nouf & Robert & Gary [9] Case Study: Cloud Computing in Saudi Arabia	Interview, and SPSS	"TOE, DOI, and institutional theories" Factors:" availability , reliability, security, privacy, trust, relative advantage, compatibility, complexity, top management support , organization size, technology readiness, compliance with regulations, competitive pressure , physical location"	This study results indicate that all the chosen factors have a significant impact on cloud adoption unless the competitive pressure factor did not have significant impact on the adoption process. Some results of this study are compatible with our results in term of "availability, reliability, security, privacy, trust, compatibility, complexity, organization size, technology readiness, and compliance with regulations" have a significant effect on the adoption process.
Alsanea [51] Case Study: Cloud Computing in Saudi Arabia	Survey, interview, SPSS, and AHP	"TOE and Iacovou et al. theories" Factors : "service quality , usefulness , security , privacy , trust , indirect benefits , industry type ,government support , top management support ,feasibility, organization structure , organization size , IT infrastructure readiness , direct benefits , organization culture , external pressure, regulatory concern , and culture" .	Some of this study results are compatible with our results which show that service quality , privacy , trust ,complexity ,government support ,feasibility ,security, and technological readiness have a significant effect on cloud adoption ,and organization culture has a less impact when compared with the other factors .There is there is difference in the importance level for direct and indirect benefits . In another hand, it is not compatible with our study results which show that regulatory concern is from the most influential factors in the adoption process.

6.1.2 CloudAnalyst Outcomes

More than 40 configurations have been done using CloudAnalyst tool. Generally, the data center must be in the same user bases regions in order to serve them, however, if there is not data center in the same regions, data center from another region will serve them.

When the researcher made a similar choice for all elements, with changing only the algorithms of load balancing and service broker policies, the most important results were:

1- The algorithm of reconfigure dynamically from service broker policy has a highest total virtual machine cost when compared with the algorithms of proximity based routing service and optimized routing performance.
2- When the optimize response time algorithm was used with any type of load balancing policy, better results were obtained in overall response time and data center processing time when compared to the results of other service broker algorithms.

Additionally, through employing ECDSA technique this study providing a proof of the possibility of overcoming both security and privacy concerns in cloud environment, where ECDSA algorithm is utilized to reveal unauthorized modifications and document identity verification, so users must provide appropriate login before they can access the information and applications they want to use, also this algorithm provides a short key and length of signature with a high level of security, it protects against a large set of side channel attacks which such as cache attacks and memory detection attacks, while in the traditional system the information could be lost by accidents, or could be hacked. Thus, cloud system is more secure than the traditional systems.

6.2 Research's Guidelines

Migrating organization's infrastructure to cloud environment demands a disciplined approach with a comprehensive plan. Moving to cloud involves both challenges and opportunities. This research offers guidance to assist organizations preparing for these challenges in an efficient manner. The following are several necessary steps that should be conducted to assure successful cloud migration.

- Evaluate organization current situation

An accurate evaluate of the present status is imperative, as it will set the basis for a lot of essential decisions that require to be made. A depth understanding of the existing technology information environment, what applications should migrate first to cloud, and the existing level of costs and resources, will assist making appropriate choices.

- **Assess organization's current infrastructure**

To get a better idea of the range and size of migration, the organization should be sure about its infrastructure readiness. The essential points to consider include:

1. What is the actual storage level that in the organization?
2. What type of databases is used in the organization?
3. What type of analytics software is currently used in the organization?
4. What is the range of readiness of the organization's current network environment?
5. What is the organization's downtime ratio?
6. How much data is being created and saved in the organization in every day, month, and year; and how rapid is that growth?

- **Determine which applications should migrate first**

Cloud environment may not always perfectly be suited to each application the organization uses. Thus, it is necessary to ensure which applications are better for migration. Small and not critical applications should be moved first, while the critical and larger applications should be moved later. This will accord enough time to the organization to know if the project of cloud or chosen cloud provider is worth, as well as the critical business processes are not be delayed from the start.

- **Perception the levels of current cost and resource**

Accurate analysis of present levels of cost and resources will assist the organization to identify deficiencies, determine domains for improvement, and afford a strong basis for comparison. Some key points include:

1. Identify all present costs (involving the cost of HW, SW, monthly and annual revenue, employees' salaries, etc.).

2. Defines each item that will be affected by cloud migration, and from where the savings will be derived.

3. Identify all the hidden costs involved, such as application maintaining, monitoring and troubleshooting in case of service outage. Furthermore, extra IT resources that are necessary to apply upgrading or patch, the cost of training the current staff and / or hires new staff. Moreover, hidden costs can involve disaster recovery, application modification, and insurance from data loss.

4. Determine the cost of high-density bandwidth, additional storage costs, capital expenditures, and operating expenses.

5. Make a comparison between currently and futurity cost levels.

- Choose the appropriate cloud deployment model

The key to obtain an effective cloud platform is selecting the right deployment model. There are weaknesses and strengths in the four deployment models. For example, public cloud provides complete usage of computing resources, it is greater scalable and 'cost-efficient ' than other models but it has more security issues. The private cloud overcomes the security and privacy concerns and there is greater control over data, but it cost more than the other models. Community cloud supports a particular people who have the same issues like mission, security, policy, and regulations. It minimizes the financial cost, but in this model all employees share a stable quantity of storage and BW. Finally, the hybrid cloud supplies scalability without limits, it is more ‘cost-efficient’, provides the necessary security, and large flexibility by offering the opportunity to its clients to explore various operational ways. However, the organization should choose an internal system of cloud management which props hybrid configuration in the case the organization need to increase manually or dynamically its available computing ability.

- Adopt the most appropriate cloud service models

Adopting software as a service (SAAS) offers entire apps to the users of cloud service; however, the organization will need solutions with thorough web services interfaces to smooth the integral with other systems. While, adopting platform as a service (PAAS) provides the ability to customize organization’s software. But the organization will need solution which correspond with staff skills at home, and being aware about the 'lock-in' situation from cloud providers, as well as consider selecting a platform which has a wide set of ready-made apps. Finally, adopting infrastructure as a service (IAAS) makes organizations have a full control over their data and

application, but IAAS is costing more than the other services, and the organizations need to consider the portability of their VMs as they might want to move them among clouds environment at some stage.

- Choose the appropriate cloud service provider

Selecting the right cloud provider is very necessary, since the successful or failure of the cloud project is strongly depending on the provider who offers the service; therefore, it is extremely essential to investigate the specific provider before outsourcing. There are a lot of points that should be taken into consideration such as:

- Government's organization must consider where the data would be stored. This is necessary due to legal compliance that comes with various places. Different countries have various laws on the information right, information security, protection of data, privacy, and various limitations levels. Thus, it is essential to have a legislation of strict privacy standards and laws to ensure that the data is being handled in a high level of privacy and security, as well as the institution should understand protecting local data requirements in a place or country where data will be saved before pledges.
- Before employing the services of any cloud provider, the organization should ensure that the cloud includes multiple options of security and isolation, strict security practices, solid security policies, identity administration, access control, mechanisms of authorization and documentation are at the proper level of control within the environment of cloud technology, and the additions or changes to apps and data can be made by only authorized individuals in the cloud as a means of assuring data confidentiality, privacy and security.
- In order to assure that the cloud services are reliable and work well at all times, a trustworthy provider is required. The selected CPS should ensure high level of services, where the availability and uptime are at least "99.9%". The provider must own redundancy of energy, multiple servers, system of cooling, high system of security, high Internet connection, and a large storage among other things to guarantee that the needed services are continuously available.
- Cloud provider must be trustworthy and reliable, so that adopters of cloud computing could be confident that they entrust their critical information to the appropriate party.

- It is necessary to know other cloud provider customers, who may conduct a similar work, the kinds of environments created by customers, and the outcomes achieved by these customers to have a well knowledge about the targeted cloud service provider.
- Negotiation on Service Level Agreement, is a quite necessary document," it is a binding contract between the government's organization and CSP". The SLA term must be negotiated and approved by the organization and the selected provider before signing the deal. This agreement should include many things such as:

• How to get rid from outages should be planned by the cloud provider through check for bugs, perform maintenance work, and updates must be scheduled at the times with low loaded system for example, at midnight or weekends.

• If the service is transferred to another provider, smooth transport should be ensured without delay, outage, or loss of data.

• In addition to service costs, all hidden costs for extra fees of any type, and conditions should be written in a clear font within the documents, and the organization should completely understand them before signing the service level agreement to prevent future misunderstandings.

• The selected cloud provider must ensure "99.9%" availability and has an instant plan for data recovery in the event of any disaster.

- Perform migration in gradual sequence

Migration to the cloud should not be carried out simultaneously, as mentioned previously; a gradual moved for the applications with less risk should be taken first. As well as, the culture of any organization cannot be altered directly. What could be altered are behaviors and operations. By providing the necessary training and researches programs, the wanted skillfulness to utilize cloud technology will be acquired, and the staff will be able to perform their works in new ways. Thus the culture of the organization will be gradually changed, and this leads to a successfully cloud adoption.

6.3 Recommendations and Future Work

For government institutions and researchers, the following recommendations are proposed:

1- This study can be used as example of examining cloud computing adoption in other developing countries. More investigations need to be performed in other countries with various technological levels to identify whether the critical factors specified in this study have a similar or different level of impact on the cloud technology adoption

2- This research integrates structures or factors from TOE, DOI and Iacovou et al. theories, to develop a proposed conceptual model. This model can be examined further through conduct future studies in private sector to determine the differences between cloud technology adoption in governments and the private sector.

3- It is recommended that any government institution that is willingness to adopt cloud computing should considered the proposed guidelines in order to increase the organization's awareness towards a successful adoption process.

4- This research has focused on the government organizational sector in determining external and internal factors and their impact on the strategies of cloud technology adoption. Future work can make more investigation to determine the factors that could affect the adoption of particular cloud models in some government or private institutions for example cloud deployment models or cloud service models, these researches can promote the process of decision making.

5- This research can be one of the major studies to identify the crucial factors that influence cloud technology adoption in government sector in Iraq In future work, other researchers can reuse the survey questionnaire and the independent variables in their researches if they are concerned in studying the change in the impact of crucial factors because of technologically and socially alterations over time.

6- The purpose of this study is to conduct a comprehensive investigation in the factors affecting the adoption process. Therefore, seventeen factors among the technological, organizational and environmental factors have been selected. Other researches can use the most critical factors based on the findings of this study in another institutions or places in Iraq, or they can use the three sub-questionnaire questions of each factor that got the highest average according to Likert scale, especially if the sample of working environment is so busy, where a lot of employees do not have enough time to answer all questions.

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APPENDIX A: SURVEY

Adopting Cloud Computing Technology in Iraqi Government Sector

Cloud computing: It is the delivery of on-demand computing resources such as servers, storage, databases, networking, software, analytics and more over the Internet on a pay-for-use basis. The user can from anywhere at any time control these resources through a simple software interface that simplifies and ignores many internal details and processes.

The Objectives of Survey:

1. Evaluating the factors affecting the adoption of Cloud Computing in the government organizations in Iraq.

2. Understanding the theoretical background of the problem by proposing a conceptual model for the adoption of Cloud Computing in Iraq.

3. Proposing a road map that can guide the government organizations in Iraq to adopt the Cloud Computing.

Please respond to all inquiries as well as possible. It will be extremely valued for your responses and comments. Thanks for Your Participation in This Survey!!!

1 **What is your role in the organization?**

- ☐ Top manager
- ☐ Department Manager
- ☐ Section Manager
- ☐ Employee

2 **Which department?**

- ☐ IT
- ☐ Operation
- ☐ Planning
- ☐ Other (Please Specify) .....

.....

3 **What is the size of your organization?**

- ☐ 10-50 employees
- ☐ 50-100 employees
- ☐ 100-250 employees
- ☐ 250-500 employees
- ☐ 500-1000 employees

4 To which ministry does your organization belong?

- [ ] Ministry of Electricity
- [ ] Ministry of Higher Education and Scientific Research
- [ ] Oil Ministry
- [ ] Other (Please Specify)

.....

.....

5 What are the direct benefits that can lead your organization to adopt cloud computing?

- [ ] Mobility
- [ ] Cloud disaster recovery
- [ ] Security benefits of cloud
- [ ] Limitless storage
- [ ] Automation
- [ ] Software updates
- [ ] Virtualization
- [ ] Scalability
- [ ] Cost saving

6 What are the indirect benefits that can lead your organization to adopt cloud computing?

- [ ] Cloud services enable users to accomplish tasks more quickly, for example you can customize more computers, network, and storage space automatically in minutes
- [ ] Enhance the efficiency and the capability of the work
- [ ] The capabilities afforded by Cloud Computing promotes employees motivation and performance
- [ ] The flexibility of cloud services and the ability to access your online databases from anywhere at any times enable your team to be effective and increase productivity.
- [ ] The flexibility to work outside of the office environment or outside of normal business hours leads to increased employee satisfaction, because they are not restricted to be at the desk
- [ ] Reducing the need to travel to work
- [ ] Increase in employee loyalty which resulting from the integration of remote business practices in the company

For the following factors based on scale of 1 to 5, consider "1" as unimportant level and "5" as the most important level or answer with " I don't know " in the case of Non-Knowledge. Please rate these factors which could restrict your organization from migration to cloud.

7 What are your main concerns regarding the security issue?

	1	2	3	4	5	I don't know
The possibility of system failure (in case of failure of one of the programs or devices)	☐	☐	☐	☐	☐	☐
Access or control of your information by someone else.	☐	☐	☐	☐	☐	☐
Loss of information due to accident, viruses, ...,etc.	☐	☐	☐	☐	☐	☐
No other copies of files are available somewhere else when they are deleted from the cloud environment	☐	☐	☐	☐	☐	☐
The storage of your information must be in your computer in your office, no somewhere else	☐	☐	☐	☐	☐	☐
The possibility of using cloud computing in unstable places such as Mosul	☐	☐	☐	☐	☐	☐
If it is safer to use local cloud(private or community cloud) within your city or country?	☐	☐	☐	☐	☐	☐

8 What are your main concerns regarding the privacy issue?

	1	2	3	4	5	I don't know
Keeping data physically outside the organization	☐	☐	☐	☐	☐	☐
Another company may get control over your information	☐	☐	☐	☐	☐	☐
Different privacy laws between countries would lead to privacy loss for us	☐	☐	☐	☐	☐	☐
Don't have full control over your data when the service provider outside your country	☐	☐	☐	☐	☐	☐
I do not know who can access the system and what they can access	☐	☐	☐	☐	☐	☐
I do not know where the information is stored	☐	☐	☐	☐	☐	☐

9 What are your major concerns regarding the availability and reliability issues?

	1	2	3	4	5	I don't know
Access of cloud is fully depending on your internet connection which can be interrupted at any time	☐	☐	☐	☐	☐	☐
Additional cost that can come from using internet access services provided by mobile phone network in the case of internet outage	☐	☐	☐	☐	☐	☐
Your business process cannot be delayed or stopped when the service provided by cloud service provider goes down	☐	☐	☐	☐	☐	☐
You do not have data and available service during interruption or potential attack	☐	☐	☐	☐	☐	☐

10 What are your big concerns about the cost issue?

	1	2	3	4	5	I don't know
Extra cost of bandwidth for intensive data applications	☐	☐	☐	☐	☐	☐
It costs more to have a good storage and security system	☐	☐	☐	☐	☐	☐
The cost of installation and reconfiguration of applications can be high	☐	☐	☐	☐	☐	☐
Hidden cost of back up , restore, disaster recovery and problem solving	☐	☐	☐	☐	☐	☐
Ongoing operating cost can be more expensive in the long term, because you buy services instead of hardware and software	☐	☐	☐	☐	☐	☐

11 What are your big concerns about the Complexity issue?

	1	2	3	4	5	I don,t know
The reconfiguration of your applications to meet the requirements of the new host can be complex	☐	☐	☐	☐	☐	☐
The migration to cloud computing will bring additional complexities in overall management of IT resources	☐	☐	☐	☐	☐	☐
We may need a third party to manage cloud system at least at the beginning of adoption	☐	☐	☐	☐	☐	☐
The complexity of maintaining and keeping up the date of operating systems, applications and underlying hardware if we manage the cloud environment	☐	☐	☐	☐	☐	☐
It is difficult to have high skill staffs that are required to manage cloud system	☐	☐	☐	☐	☐	☐

12 According to your opinion, how does the organization size influence the adoption of cloud computing?

	1	2	3	4	5	I don't know
The large organizations are more capable to adopt cloud services because they have enough financial, technical and human resources	☐	☐	☐	☐	☐	☐
The large organizations have more flexibility in their resources, so they are able to experiment with new innovation	☐	☐	☐	☐	☐	☐
The large organizations may not tend to adopt cloud computing, where there are a very large number of employees situated in different branches in various areas	☐	☐	☐	☐	☐	☐
The small and medium sized organizations may gain more benefits from cloud computing as they do not have to invest in infrastructure and applications	☐	☐	☐	☐	☐	☐

13 **What do you think about the culture in your organization?**

	1	2	3	4	5	I don't know
The prevailing beliefs and attitudes in the organization can obstacle from adopting cloud computing because it involves new ways in using , storing, sharing data and applications	☐	☐	☐	☐	☐	☐
The organization is very supportive to changes	☐	☐	☐	☐	☐	☐
Most persons in this organization are encouraged to make suggestions for improvement	☐	☐	☐	☐	☐	☐
Organization culture such as habits, visions and systems can be reorganized to adopt useful new technology	☐	☐	☐	☐	☐	☐
The geographical location of organization can affect the adoption of cloud technology, for example scalable or central regions may more tend to adopt cloud computing than unstable regions or Suburbs	☐	☐	☐	☐	☐	☐

14 What are the important things that you look for if you decide to adopt cloud computing?

	1	2	3	4	5	I don't know
If it is technically feasible?	☐	☐	☐	☐	☐	☐
If it is feasible within the estimated cost?	☐	☐	☐	☐	☐	☐
If it will be beneficial and profitable?	☐	☐	☐	☐	☐	☐
If the service to underlying applications is continuous even after the failure of one or more components in any layer?	☐	☐	☐	☐	☐	☐
If the real-time performance for cloud service is high?	☐	☐	☐	☐	☐	☐
if its use is safer than using a traditional system?	☐	☐	☐	☐	☐	☐

15 What would you consider as the main characteristics for the selection of cloud service provider?

	1	2	3	4	5	I don't know
Reputation	☐	☐	☐	☐	☐	☐
Company location, size and number of clients	☐	☐	☐	☐	☐	☐
Security practices	☐	☐	☐	☐	☐	☐
Information assurance practices	☐	☐	☐	☐	☐	☐
Compliance for standards and regulations	☐	☐	☐	☐	☐	☐
Continuation and disaster recovery plans	☐	☐	☐	☐	☐	☐

16 What are your main concerns about the IT infrastructure Readiness issue?

	1	2	3	4	5	I don't know
If your desktop hardware and operating system environment are ready to support cloud service requirements?	☐	☐	☐	☐	☐	☐
If the existing IT infrastructure supports the additional cloud service demands?	☐	☐	☐	☐	☐	☐
If your organization provides an excellent Internet connection and bandwidth to gain the benefits of using cloud technology?	☐	☐	☐	☐	☐	☐
If the existing IT applications can be integrated with cloud system?	☐	☐	☐	☐	☐	☐
If migrating the existing system to cloud environment is difficult?	☐	☐	☐	☐	☐	☐
If IT infrastructure readiness will be the responsibility of service provider?	☐	☐	☐	☐	☐	☐

17 **What are the main things you want to ensure before migrating applications or data to a cloud computing environment?**

	1	2	3	4	5	I don't know
Applicable legislation and regulations in the case of non-compliance with standards	☐	☐	☐	☐	☐	☐
Laws, regulations and policies which will be applied to all uses of cloud services within the organization (what resources are being used?, for what purpose? and by whom?)	☐	☐	☐	☐	☐	☐
Applicable information security and privacy standards to ensure that your data is being processed in a secure and legally compliant manner	☐	☐	☐	☐	☐	☐
If the security of data centers for service provider is within the legal, regulatory and business needs?	☐	☐	☐	☐	☐	☐
If there is a legislation for not transmitting the data outside the organization?	☐	☐	☐	☐	☐	☐
If the cloud service provider offers a Service Level Agreement that ensure a high up-time guarantee (between 99.9% to 99.999%)?	☐	☐	☐	☐	☐	☐

18 What are your main concerns about the Compatibility issue?

	1	2	3	4	5	I don't know
If all or some existing applications and devices have the ability to be compatible with the cloud environment?	☐	☐	☐	☐	☐	☐
If we can upgrade to cloud-friendly versions, or replacing incompatible applications?	☐	☐	☐	☐	☐	☐
How much time could it take to make our system and applications compatible with cloud (days, weeks, months)?	☐	☐	☐	☐	☐	☐

If there will be incompatibility of data when we want to move from one cloud service provider to another?	☐	☐	☐	☐	☐	☐
If using cloud will fit with our existing values, previous practices and current needs?	☐	☐	☐	☐	☐	☐

19 What are your main concerns about the government support issue?

	1	2	3	4	5	I don't know
If the government support through policies and regulations will facilitate the adoption of cloud computing technology?	☐	☐	☐	☐	☐	☐
If the government will provide necessary training programs and researches for acquisition the required skills in the use of cloud technology?	☐	☐	☐	☐	☐	☐
If the government will help organizations to overcome any financial limitations?	☐	☐	☐	☐	☐	☐
If the government will provide the necessary administrative support for cloud adoption, such as the need for the least number of meetings and permits	☐	☐	☐	☐	☐	☐
If the government will set strong laws regarding data storage and privacy to protect data and information for the organizations?	☐	☐	☐	☐	☐	☐
If your organization needs the government support to adopt cloud technology?	☐	☐	☐	☐	☐	☐

20 What are your suggestions or opinions (if any) for our survey regarding adopting cloud computing in Iraqi organizations?

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APPENDEX B: Simulation Results

Table 19 **Configurations parameters**

Simulation Configuration	Simulation Duration	UB No.	Region For users	User grouping No for Each UB	No. of DC	Regions	Load Balancing grouping	Service Broker Policy	No of VM for DC	Request Grouping for each DC
Configuration 1	30 mins	5	R1,R2,R3,R4,R5	10	6	R0,R1,R2,R3,R4,R5	Round robin	Closest data center	5	10
Configuration2	30 mins	6	UB1,UB2,UB6/R2, UB3/R3,UB4,UB5/R4	10	7	R0,R1,R2,R3,R5	Round robin	Optimize response time	5	10
Configuration3	45 mins	6	UB1,UB2,UB3/R4, UB4/R2,UB5/R3,UB6/ R1	20	3	R2,R3,R4	ESCE	Closest data center	10	10
Configuration4	90 mins	7	UB1,UB2,UB3/R4, UB4,UB5/R2,UB6/R3, UB6/R1	50	5	R1,R3,R4	ESCE	Optimize response time	10	10
Configuration5	90 mins	8	UB1,UB2/R4,UB3/R2 UB4/R5,UB5,UB6/R1, UB7/R2,UB8/R3	100	8	DC1,DC2,DC3/R4, DC4/R3,DC5,DC6/R2, DC7/R1,DC8/R0	Throttled	Dynamically reconfiguring router	8	20
Configuration6	95 mins	9	All UBs in R4	100	10	DC1,DC2/R2, DC3,DC4/R3, DC5,DC6,D7/R4 DC8,DC9,DC10/R1	ESCE	Optimize response time	9	20
Configuration7	2 hours	10	All UBs in R3	120	12	DC1,DC2,DC3/R2, DC4,DC5,DC6,DC7/R3, DC8,DC9,DC10/R4, DC11,DC12/R1	Throttled	Optimize response time	9	20
Configuration8	3 hours	11	All UBs in R3	150	13	DC1(1,2,3,4)/R2, DC(5,6,7,8,9,10)/R3, DC(11,12,13)/R4	Round robin	Dynamically reconfiguring router	10	20
Configuration9	60 mins	12	All UBs in R3	150	12	DC (1,2,3,4)/R2, DC(5,6,7,8,9,10)/R3, DC(11,12)/R4	Round robin	Optimize response time	10	20
Configuration10	60 mins	12	All UBs in R3	150	12	DC (1,2,3,4)/R2,	ESCE	Optimize	10	20

Continuation of table 19

						DC(5,6,7,8,9,10)/R3, DC(11,12)/R4		response time		
Configuration11	**60 mins**	**12**	**All UBs in R3**	**150**	**12**	**DC (1,2,3,4)/R2, DC(5,6,7,8,9,10)/R3, DC(11,12)/R4**	**Throttled**	**Dynamically reconfiguring router**	**10**	**20**
Configuration12	**60 mins**	**12**	**All UBs in R3**	**150**	**12**	**DC (1,2,3,4)/R2, DC(5,6,7,8,9,10)/R3, DC(11,12)/R4**	**ESCE**	**Dynamically reconfiguring router**	**10**	**20**
Configuration13	**60 mins**	**12**	**All UBs in R3**	**150**	**12**	**DC (1,2,3,4)/R2, DC(5,6,7,8,9,10)/R3, DC(11,12)/R4**	**Throttled**	**Optimize response time**	**10**	**20**
Configuration14	**90 mins**	**13**	**All UBs in R3**	**170**	**13**	**All DCs in R3**	**Round robin**	**Optimize response time**	**10**	**30**
Configuration15	**90 mins**	**14**	**All UBs in R3**	**200**	**14**	**All DCs in R3**	**ESCE**	**Optimize response time**	**15**	**30**
Configuration16	**90 mins**	**15**	**All UBs in R3**	**200**	**15**	**All DCs in R3**	**Throttled**	**Optimize response time**	**15**	**30**
Configuration17	**95 mins**	**15**	**All UBs in R3**	**220**	**15**	**All DCs in R3**	**Round robin**	**Dynamically reconfiguring router**	**15**	**30**
Configuration18	**95 mins**	**16**	**All UBs in R3**	**230**	**16**	**All DCs in R3**	**ESCE**	**Dynamically reconfiguring router**	**15**	**30**
Configuration19	**3 hours**	**16**	**All UBs in R3**	**240**	**16**	**All DCs in R3**	**Throttled**	**Dynamically reconfiguring router**	**16**	**40**
Configuration20	**2 hours**	**17**	**All UBs in R3**	**250**	**17**	**All DCs in R3**	**Round robin**	**Optimize response time**	**16**	**40**
Configuration21	**2 hours**	**17**	**All UBs in R3**	**250**	**18**	**All DCs in R3**	**ESCE**	**Optimize response time**	**16**	**40**
Configuration22	**2 hours**	**18**	**All UBs in R3**	**270**	**19**	**All DCs in R3**	**Throttled**	**Optimize response time**	**16**	**40**
Configuration23	**2 hours**	**19**	**All UBs in R3**	**300**	**20**	**All DCs in R3**	**Round**	**Closest data**	**18**	**30**

Continuation of table 19

							robin	center		
Configuration24	**30 mins**	**20**	**All UBs in R3**	**300**	**20**	**All DCs in R3**	**ESCE**	**Closest data center**	**18**	**30**
Configuration25	**30 mins**	**20**	**All UBs in R3**	**300**	**20**	**All DCs in R3**	**Throttled**	**Closest data center**	**18**	**30**
Configuration26	**60 mins**	**22**	**All UBs in R3**	**300**	**20**	**All DCs in R3**	**Round robin**	**Optimize response time**	**20**	**40**
Configuration27	**60 mins**	**22**	**All UBs in R3**	**300**	**20**	**All DCs in R3**	**ESCE**	**Optimize response time**	**20**	**40**
Configuration28	**60 mins**	**23**	**All UBs in R3**	**300**	**22**	**All DCs in R3**	**Throttled**	**Optimize response time**	**6/10**	**40**
Configuration29	**60 mins**	**23**	**All UBs in R3**	**300**	**22**	**All DCs in R3**	**Round robin**	**Closest data center**	**6/10**	**40**
Configuration30	**60 mins**	**23**	**All UBs in R3**	**300**	**22**	**All DCs in R3**	**ESCE**	**Optimize response time**	**6/10**	**40**
Configuration30	**60 mins**	**23**	**All UBs in R3**	**300**	**22**	**All DCs in R3**	**ESCE**	**Dynamically reconfiguring router**	**6/10**	**40**
Configuration31	**60 mins**	**23**	**All UBs in R3**	**300**	**22**	**All DCs in R3**	**Throttled**	**Dynamically reconfiguring router**	**6/10**	**40**
Configuration32	**60 mins**	**23**	**All UBs in R3**	**300**	**22**	**All DCs in R3**	**Round robin**	**Dynamically reconfiguring router**	**6/10**	**40**
Configuration33	**30 mins**	**3**	**All UBs in R3**	**10**	**3**	**All DCs in R3**	**ESCE**	**Optimize response time**	**5**	**10**
Configuration34	**30 mins**	**5**	**All UBs in R3**	**25**	**5**	**All DCs in R3**	**Throttled**	**Optimize response time**	**5**	**10**
Configuration35	**30 mins**	**10**	**All UBs in R3**	**50**	**10**	**All DCs in R3**	**Round robin**	**Optimize response time**	**5**	**10**
Configuration36	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Round robin**	**Closest data center**	**6/10**	**30**

Continuation of table 19

Configuration37	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Round robin**	**Optimize response time**	**6/10**	**30**
Configuration38	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Round robin**	**Dynamically reconfiguring router**	**6/10**	**30**
Configuration39	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**ESCE**	**Closest data center**	**6/10**	**30**
Configuration40	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**ESCE**	**Optimize response time**	**6/10**	**30**
Configuration41	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**ESCE**	**Dynamically reconfiguring router**	**6/10**	**30**
Configuration42	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Throttled**	**Closest data center**	**6/10**	**30**
Configuration43	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Throttled**	**Optimize response time**	**6/10**	**30**
Configuration44	**90 mins**	**20**	**All UBs in R3**	**200**	**20**	**All DCs in R3**	**Throttled**	**Dynamically reconfiguring**	**6/10**	**30**

Table 20: **Results of CloudAnalyst configurations**

Simulation Configuration	**Overall response time Avg (ms)**	**Data Center processing time Avg (ms)**	**Details**	**For UB& DC**	**From-to Avg (ms)**	**The best response Avg (ms)**
Configuration1	**50.26**	**0.48**	**Response Time by Region**	**UB1-UB5**	**50.17-50.71**	**49.79 to UB3 from R3**
			Data Center Request Servicing Times	**DC1-DC6**	**0.45-0.55**	**0.45 to DC6 from R5 DC1 did not have RST**

Continuation of table 20

Configuration2	**135.50**	**0.45**	**Response Time by Region**	**UB1-UB6**	**50.01-300.89**	**50.01 to UB2 from R2**
			Data Center Request Servicing Times	**DC1-DC7**	**0.44-0.49**	**0.44 to DC6 from R2, DC(1,2,3,4,5):0.00**
Configuration3	**125.89**	**0.47**	**Response Time by Region**	**UB1-UB6**	**50.02 -502.98**	**50.02 to UB4 from R2**
			Data Center Request Servicing Times	**DC1-DC3**	**0.42-0.57**	**0.42 to DC1 from R2**
Configuration4	**121.34**	**0.49**	**Response Time by Region**	**UB1-UB7**	**49.78-297.16**	**49.78 to UB6 from R3**
			Data Center Request Servicing Times	**DC1-DC5**	**0.47-0.62**	**0.47 to DC1/R4 & DC5/R1**
Configuration5	**69.88**	**1.64**	**Response Time by Region**	**UB1-UB8**	**50.78- 203.40**	**50.78 to UB3 from R2**
			Data Center Request Servicing Times	**DC1-DC5**	**2.15-1.57**	**2.15 to DC11 from R1**
Configuration6	**50.36**	**0.71**	**Response Time by Region**	**UB1-UB9**	**50.08- 50.62**	**50.08 to UB7 from R4**
			Data Center Request Servicing Times	**DC1-DC10**	**0.69- 0.72**	**0.69 to DC6 from R4 DC(1,2,3,8,9,10) : 0.00**
Configuration7	**50.05**	**0.62**	**Response Time by Region**	**UB1-UB9**	**49.24-50.90**	**49.24 to UB6 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.61- 0.64**	**0.61 to DC(5,6) from R3 DC(1,2,3,8,9,10,11,12):0.00**
Configuration8	**59.37**	**9.67**	**Response Time by Region**	**UB1-UB11**	**58.53- 60.12**	**58.53 to UB8 from R3**
			Data Center Request Servicing Times	**DC1-DC13**	**9.13- 9.96**	**9.13 to DC10 from R3**
Configuration9	**49.81**	**0.50**	**Response Time by Region**	**UB1-UB12**	**48.52- 50.53**	**48.52 to UB7 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.48- 0.52**	**0.49 DC5 from R3 DC(1,2,3,4,11,12):0.00**
Configuration10	**49.81**	**0.50**	**Response Time by Region**	**UB1-UB12**	**48.61- 50.52**	**48.61 to UB7 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.46-0.55**	**0.46 to DC(5,8) from R3 DC(1,2,3,4,11,12):0.00**

Continuation of table 20

Configuration11	**50.31**	**0.63**	**Response Time by Region**	**UB1-UB12**	**49.52- 50.95**	**49.52 to UB1 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.61-0.66**	**0.61 to DC(6,810)from R3 DC(1,2,3,4,11,12):0.00**
Configuration12	**50.30**	**0.63**	**Response Time by Region**	**UB1-UB12**	**49.58- 50.94**	**49.58 to UB1 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.56-0.70**	**0.56 to DC5 from R3 DC(1,2,3,4,11,12):0.00**
Configuration13	**49.81**	**0.50**	**Response Time by Region**	**UB1-UB12**	**48.75- 50.53**	**49.58 to UB7 from R3**
			Data Center Request Servicing Times	**DC1-DC12**	**0.48-0.52**	**0.48 to DC(6,8) from R3 DC(1,2,3,4,11,12):0.00**
Configuration14	**50.16**	**0.52**	**Response Time by Region**	**UB1-UB13**	**49.10-50.65**	**49.10 to UB11 from R3**
			Data Center Request Servicing Times	**DC1-DC13**	**0.47-0.55**	**0.47 to DC8 from R3**
Configuration15	**50.14**	**0.52**	**Response Time by Region**	**UB1-UB14**	**49.51-50.75**	**49.51 to UB13 from R3**
			Data Center Request Servicing Times	**DC1-DC14**	**0.45-0.59**	**0.45 to DC11 from R3**
Configuration16	**50.30**	**0.53**	**Response Time by Region**	**UB1-UB15**	**49.66-50.71**	**49.66 to UB(11,14) from R3**
			Data Center Request Servicing Times	**DC1-DC15**	**0.49-0.61**	**0.49 to DC2 from R3**
Configuration17	**51.75**	**1.97**	**Response Time by Region**	**UB1-UB15**	**50.73-52.36**	**50.73 to UB9 from R3**
			Data Center Request Servicing Times	**DC1-DC15**	**1.76-2.23**	**1.76 to DC(10,6) from R3**
Configuration18	**50.86**	**1.05**	**Response Time by Region**	**UB1-UB16**	**49.83-51.45**	**49.83 to UB11 from R3**
			Data Center Request Servicing Times	**DC1-DC16**	**0.89-1.20**	**0.89 to DC10 from R3**
Configuration 19	**50.99**	**1.35**	**Response Time by Region**	**UB1-UB16**	**50.42-51.57**	**50.43 to UB11 from R3**
			Data Center Request Servicing Times	**DC1-DC16**	**1.24-1.41**	**1.24 to DC15 from R3**

Continuation of table 20

Configuration20	**50.28**	**0.59**	**Response Time by Region**	**UB1-UB17**	**49.75-50.77**	**49.75 to UB10 from R3**
			Data Center Request Servicing Times	**DC1-DC17**	**0.55-0.62**	**0.55 to DC13 from R3**
Configuration21	**50.13**	**0.58**	**Response Time by Region**	**UB1-UB18**	**49.63-50.50**	**49.63 to UB5 from R3**
			Data Center Request Servicing Times	**DC1-DC18**	**0.55-0.63**	**0.55 to DC9 from R3**
Configuration22	**50.15**	**0.60**	**Response Time by Region**	**UB1-UB18**	**49.46-50.90**	**49.46 to UB17 from R3**
			Data Center Request Servicing Times	**DC1-DC18**	**0.55-0.65**	**0.55 to DC2 from R3**
Configuration23	**50.24**	**0.55**	**Response Time by Region**	**UB1-UB19**	**49.71- 50.68**	**49.71 to UB7 from R3**
			Data Center Request Servicing Times	**DC1-DC19**	**0.51- 0.60**	**0.51 to DC(9,16) from R3**
Configuration24	**50.16**	**0.53**	**Response Time by Region**	**UB1-UB20**	**48.53-51.21**	**48.53 to UB13 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.42-0.61**	**0.42 to DC3 from R3**
Configuration25	**50.16**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.84 -51.09**	**49.84 to UB12 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.41-0.60**	**0.41 to DC15 from R3**
Configuration26	**50.30**	**0.62**	**Response Time by Region**	**UB1-UB22**	**49.30-51.35**	**49.30 to UB1 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.56-0.72**	**0.55 to DC14 from R3**
Configuration27	**50.30**	**0.62**	**Response Time by Region**	**UB1-UB22**	**49.29-51.13**	**49.29 to UB18 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.54-0.68**	**0.54 to DC20 from R3**
Configuration28	**50.24**	**0.58**	**Response Time by Region**	**UB1-UB23**	**49.75-50.91**	**49.75 to UB11 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.52-0.65**	**0.52 to DC15 from R3**
Configuration29	**50.34**	**0.58**	**Response Time by Region**	**UB1-UB23**	**49.30-51.16**	**49.30 to UB12 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.53-0.67**	**0.53 to DC17 from R3**

Continuation of table 20

Configuration30	**50.43**	**0.68**	**Response Time by Region**	**UB1-UB23**	**49.82**	**49.76 to UB10 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.58**	**0.52 to DC8 from R3**
Configuration31	**50.44**	**0.68**	**Response Time by Region**	**UB1-UB23**	**49.58 - 51.33**	**49.30 to UB12 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.63- 0.77**	**0.63 to DC13 from R3**
Configuration32	**50.66**	**0.91**	**Response Time by Region**	**UB1-UB23**	**50.03-51.50**	**50.03 to UB12 from R3**
			Data Center Request Servicing Times	**DC1-DC22**	**0.83-0.99**	**0.83 to DC12 from R3**
Configuration33	**50.03**	**0.48**	**Response Time by Region**	**UB1-UB3**	**49.87- 50.32**	**49.87 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC3**	**0.47- 0.48**	**0.47 to DC3 from R3**
Configuration34	**50.08**	**0.41**	**Response Time by Region**	**UB1-UB5**	**49.75-50.35**	**49.75 to UB4 from R3**
			Data Center Request Servicing Times	**DC1-DC5**	**0.40-0.42**	**0.40to DC5 from R3**
Configuration35	**50.19**	**0.47**	**Response Time by Region**	**UB1-UB10**	**49.78-50.72**	**49.78 to UB1 from R3**
			Data Center Request Servicing Times	**DC1-DC10**	**0.45-0.52**	**0.45 to DC1 from R3**
Configuration36	**50.28**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.55-50.83**	**49.55 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.49-0.57**	**0.49 to DC(9,13,15,16) from R3**
Configuration37	**50.17**	**0.52**	**Response Time by Region**	**UB1-UB20**	**49.55-50.89**	**49.55 to UB14 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.46-0.57**	**0.46 to DC19 from R3**
Configuration38	**50.76**	**1.02**	**Response Time by Region**	**UB1-UB20**	**49.92-50.93**	**49.92 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.94-1.10**	**0.94 to DC10 from R3**
Configuration39	**50.28**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.40-50.87**	**49.40 to UB5 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.45-0.59**	**0.46 to DC5 from R3**
Configuration40	**50.17**	**0.52**	**Response Time by Region**	**UB1-UB20**	**49.51-50.83**	**49.51 to UB6 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.46-0.56**	**0.46 to DC13 from R3**

Continuation of table 20

Configuration41	**50.39**	**0.64**	**Response Time by Region**	**UB1-UB20**	**49.42-50.94**	**49.42 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.54-0.72**	**0.54 to DC18 from R3**
Configuration42	**50.28**	**0.53**	**Response Time by Region**	**UB1-UB20**	**49.61-50.80**	**49.61 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.49-0.59**	**0.49 to DC2 from R3**
Configuration43	**50.17**	**0.52**	**Response Time by Region**	**UB1-UB20**	**49.52-50.99**	**49.52 to UB14 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.46-0.57**	**0.46 to DC13 from R3**
Configuration44	**50.33**	**0.58**	**Response Time by Region**	**UB1-UB20**	**49.47-50.88**	**49.47 to UB2 from R3**
			Data Center Request Servicing Times	**DC1-DC20**	**0.51-0.65**	**0.53 to DC20 from R3**

Table 21: **Results of CloudAnalyst configurations**

Simulation Configuration	Total Virtual Machine Cost ($)	Total Data Transfer Cost ($)	Total cost	For DC	The Cost for VM From-to	Best VM cost for DCs	The Cost for D.T From-to	Best D.T cost for DCs
Configuration1	**1.47**	**0.16**	**1.63**	**DC1-DC5**	**0.20-0.25**	**0.20 to DC1 in R4**	**0.00-0.03**	**0.03 for all**
Configuration2	**1.51**	**0.19**	**1.70**	**DC1-DC7**	**0.20-0.25**	**0.20 for all of Them except DC7/R3(0.25)**	**0.03-0.16**	**0.03for DC7/R3 DC(1,2,3,4,5):0.00**
Configuration3	**1.88**	**0.27**	**2.15**	**DC1-DC3**	**0.38-0.75**	**0.38 to DC3/R4**	**0.05-0.14**	**0.05 for DC2/R3**
Configuration4	**6.75**	**0.62**	**7.38**	**DC1-DC5**	**0.75-1.50**	**0.75 to DC5/R1**	**0.04-0.21**	**0.04 for DC4/R1**

Continuation of table 21

Configuration5	**58.73**	**0.71**	**59.43**	**DC1-DC8**	**6.74-7.73**	**6.74 to DC1/R4**	**0.05- 0.18**	**0.05 for DC3/R4**
Configuration6	**12.51**	**0.84**	**13.35**	**DC1-DC5**	**0.63- 1.43**	**0.63 to DC10/R1**	**0.26- 0.29**	**0.26 for DC5/R4 DC(1,2,3,4,8,9,10):0.00**
Configuration7	**19.20**	**1.17**	**20.37**	**DC1-DC12**	**0.80-1.80**	**0.80 to DC12/R1**	**0.25-0.32**	**0.25 for DC7/R3 DC(1,2,3,,8,9,10,11,12):0.00**
Configuration8	**154.63**	**1.92**	**156.55**	**DC1-DC13**	**1.20- 23.17**	**1.20 to DC13**	**0.28- 0.35**	**0.28 for DC7/R3 DC(1,2,3,4,11,12,13):0.00**
Configuration9	**10.90**	**0.71**	**11.61**	**DC1-DC12**	**0.40-1.00**	**0.40 to DC12/R4**	**0.11-0.13**	**0.11 for DC8,DC7/R3 DC(1,2,3,4,11,12):0.00**
Configuration10	**10.90**	**0.71**	**11.61**	**DC1-DC12**	**0.40-1.00**	**0.40 to DC12/R4**	**0.10-0.14**	**0.10 for DC8,DC7/R3 DC(1,2,3,4,11,12):0.00**
Configuration11	**26.73**	**0.71**	**27.44**	**DC1-DC12**	**0.40-3.75**	**0.40 to DC12/R4**	**0.11-0.13**	**0.11for DC5,DC9,DC10/R3 DC(1,2,3,4,11,12):0.00**
Configuration12	**26.37**	**0.71**	**27.08**	**DC1-DC12**	**0.40-3.75**	**0.38 to DC3/R4**	**0.11-0.13**	**0.11 for DC7,DC9/R3 DC(1,2,3,4,11,12):0.00**
Configuration13	**10.90**	**0.71**	**11.61**	**DC1-DC12**	**0.40-1.00**	**0.40 to DC12/R4**	**0.11-0.14**	**0.11 for DC8,DC7,DC5/R3 DC(1,2,3,4,11,12):0.00**
Configuration14	**18.76**	**1.14**	**19.90**	**DC1-DC13**	**1.50 for all Except 0.75 to DC12**	**0.75 to DC12/R3**	**0.07-0.10**	**0.07 for DC11/R3**
Configuration15	**30.76**	**1.23**	**31.99**	**DC1-DC14**	**1.50 for all Except 0.75 to DC10**	**0.38 to DC3/R3**	**0.07-0.10**	**0.07 for DC2,DC8/R3**
Configuration16	**31.51**	**1.32**	**32.83**	**DC1-DC15**	**0.75-2.25**	**0.75 to DC15/R3**	**0.08-0.10**	**0.08 for DC(1,2,3,7,10,,12,14,15)/R3**
Configuration17	**135.28**	**1.39**	**136.68**	**DC1-DC15**	**6.81-9.47**	**6.81to DC15/R3**	**0.08-0.10**	**0.08 for DC7,10,13/R3**
Configuration18	**141.79**	**1.48**	**143.28**	**DC1-DC16**	**8.29-9.61**	**8.29 to DC3/R3**	**0.08-0.10**	**0.08 for DC3,8,14/R3**
Configuration19	**375.33**	**2.79**	**378.12**	**DC1-DC16**	**22.84-23.92**	**22.84 to DC7**	**0.16-0.19**	**0.16 for DC3/R3**
Configuration20	**54.41**	**1.98**	**56.39**	**DC1-DC18**	**3.20 for all**	**3.20 for all**	**0.10-0.13**	**0.10 for DC11/R3**

Continuation of table 21

Configuration21	**57.61**	**1.98**	**59.59**	**DC1-DC18**	**3.20 for all**	**3.20 for all**	**0.09-0.13**	**0.09 for DC13/R3**
Configuration22	**60.81**	**2.10**	**62.91**	**DC1-DC19**	**3.20 for all**	**3.20 for all**	**0.09-0.13**	**0.09 for DC(2,4)/R3**
Configuration23	**71.21**	**2.21**	**73.43**	**DC1-DC19**	**3.20- 3.60**	**3.20 to DC 18, 19/R3**	**0.09- 0.13**	**0.09 for DC5/R3**
Configuration24	**17.84**	**0.59**	**18.43**	**DC1-DC20**	**0.80-0.90**	**0.80 to DC18,19/R3**	**0.02-0.04**	**0.02 for DC(2,6,9)/R3**
Configuration25	**17.84**	**0.59**	**18.43**	**DC1-DC19**	**0.80/DC19 to 0.90/ for all**	**0.80 to DC19/R3**	**0.02-0.04**	**0.02for DC(2,10,20)/R3**
Configuration26	**39.80**	**1.29**	**41.09**	**DC1-DC20**	**2.00 for all except 1.80 to DC20**	**1.80 to DC20/R3**	**0.05-0.08**	**0.05 for DC(7,8,9,14,18)/R3**
Configuration27	**39.80**	**1.29**	**41.09**	**DC1-DC20**	**2.00 for all except 1.80 to DC20**	**1.80 to DC20/R3**	**0.05-0.08**	**0.05 for DC(4,7,12,14)/R3**
Configuration28	**13.20**	**1.35**	**14.55**	**DC1-DC22**	**0.60 for all except 1.80 to DC20**	**0.60 for all except 1.80 to DC20**	**0.05-0.08**	**0.05 for DC(5,11)/R3**
Configuration29	**13.20**	**1.35**	**14.55**	**DC1-DC22**	**0.60 for all except 1.80 to DC20**	**0.60 for all except 1.80 to DC20**	**0.06-0.08**	**0.06 for DC(5,11,2,10,20,8,19,18,17,15)/R3**
Configuration30	**13.20**	**1.35**	**14.55**	**DC1-DC22**	**0.60 for all except 1.80 to DC20**	**0.60 for all except 1.80 to DC20**	**0.05-0.08**	**0.05 for DC5/R3**
Configuration30	**61.47**	**1.35**	**62.82**	**DC1-DC22**	**2.56- 3.35**	**2.56 to DC7**	**0.05-0.08**	**0.05 for DC6/R3**
Configuration31	**62.25**	**1.35**	**63.60**	**DC1-DC22**	**2.74-4.32**	**2.74 to DC8**	**0.06-0.08**	**0.05 for many DCs**
Configuration32	**62.34**	**1.35**	**63.69**	**DC1-DC22**	**2.71- 4.46**	**2,71 to DC15**	**0.05-0.08**	**0.05 for DC3/R3**
Configuration33	**0.76**	**0.10**	**0.86**	**DC1-DC3**	**0.25 for all**	**0.25 for all**	**0.03 for all**	**0.03 for all**
Configuration34	**1.27**	**0.15**	**1.42**	**DC1-DC5**	**0.25 for all**	**0.25 for all**	**0.03 for all**	**0.03 for all**
Configuration35	**2.51**	**0.30**	**2.81**	**DC1-DC10**	**0.25 for all**	**0.25 for all**	**0.03 for all**	**0.03 for all**
Configuration36	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.10**	**0.07 to R15**
Configuration37	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.08-0.10**	**0.08 to R10**
Configuration38	**135.06**	**1.75**	**136.81**	**DC1-DC20**	**5.87-7.13**	**5.87 to DC10/R3**	**0.08-0.10**	**0.08 to DC(10,11,20,1,3,7)**

Continuation of table 21

Configuration39	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC6/R3**
Configuration40	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC (7,14)/R3**
Configuration41	**133.32**	**1.75**	**135.07**	**DC1-DC20**	**6.15-7.28**	**6.15 to DC6/R3**	**0.07-0.11**	**0.07 for DC5/R3**
Configuration42	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC(6,12)/R3**
Configuration43	**18.01**	**1.75**	**19.76**	**DC1-DC20**	**0.90 for all**	**0.90 for all**	**0.07-0.11**	**0.07 for DC8/R3**
Configuration44	**132.32**	**1.75**	**134.07**	**DC1-DC20**	**6.05-7.16**	**6.05 for DC19**	**0.07-0.10**	**0.07 for DC(1,6,20)/R3**