DEVELOPING DECISION MODEL FOR CLOUD COMPUTING USAGE IN DEVELOPING COUNTRIES: CASE STUDY FOR MIDDLE EAST

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To my parents....

ABSTRACT

Information Technology these days play a big role in all sectors, but there are some difficulties and problems faced by users of Information Technology of the most important cost and the lack of sufficient flexibility when there is a need to develop, for this cloud computing took great importance in the world of technology, because its services are trying to provide solutions to the problems and difficulties of traditional computing. Especially in developing countries, such as Middle East countries, which are the case study for this thesis, this thesis aims to develop a decision model helps in making the decision to move to cloud computing for companies and organizations in the Middle East and analyze the results of decision model to determine the readiness of the Middle East countries to move to cloud computing. The studies and previous research not provide decision model of a special in the Middle East, but studies was dependent on the analysis of data cloud computing in developed countries, so that this thesis is trying to provide a decision model special for companies and organizations in developing countries. Data were collected in this thesis by conducting interviews with specialists in information technology and business in the Middle East, in addition to the questionnaire online participated in 119 participants used the data to develop a decision model of the which was applied to 73 companies and organizations in the Middle East is the main findings of analysis of the results of model application is that the countries of the Middle East are ready to move to cloud computing from the business and technical perspective but there are problems in side cloud computing services providers for the geographic dimension of their data centers for the region and the absence of large agencies provide services in the region.

Keywords: Cloud computing, technology, Middle East, decision model, distributed computing, grid Computing.

ÖZET

Bulut bilişim günümüzde tüm sektörlerde önemli bir rol oynamaktadır. Bilişim teknolojileri kullanıcıları maliyet konusunda ve ihtiyaçlara göre geliştirilmesi yönünden esnekliğin olmayışı açısından önemli zorluklarla karşılaşmaktadır. Bulut bilişim geleneksel bilişim bilimlerinin karşılaştığı zorluklara çözümler sunmaya çalıştığından teknoloji dünyasında büyük önem kazanmıştır.Bu tezin vaka çalışmaları kapsamında, özellikle gelişmekte olan Orta Doğu ülkelerine odaklanılmıştır. Tezin amacı Orta Doğu'daki kurumların bulut bilişime geçme kararını alabilmeleri için bir karar modeli geliştirmek, bu karar modelinin sonucunda ise Orta Doğu ülkelerinin bulut bilişime geçiş için hazır olup olmadığının belirlemesi yönünde analiz yapmaktır.Bu konuda daha önce yapılan çalışmalar ve araştırmalar Orta Doğu için ayrı bir karar alma modeli önermemekte ve gelişmiş ülkelerdeki bulut bilişim verilerine dayalı analizden oluşmaktadır. Burdan yola çıkarak, bu tez özellikle gelişmekte olan ülkelerdeki iş dünyası, kurum ve kuruluşlar için karar modeli sunmayı amaçlamaktadır. Tez için toplanan veriler Orta Doğu'daki bilişim teknolojileri alanında ve diğer firmalarda çalışan uzmanlar ile yapılan mülakatlara dayanmaktadır. Bunun yanında, karar modelini oluşturmak için 73 ayrı firma ve kurumdan 119 katılımcının cevapladığı online anket gerçekleştirilmiştir. Karar modelinin uygulanması sonucu edinilen ana bulgularda, iş dünyası ve teknik perspektife göre Orta Doğu ülkeleri bulut bilişime geçişe hazırdır, fakat bölgedeki veri merkezleri konusunda coğrafi yönden bulut bilişim hizmeti tedarikçileri açısından ve bölgede hizmetleri tedarik edecek büyük ajansların bulunmaması problem teşkil etmektedir.

Anahtar Kelime: Bulut bilişim, teknoloji, Orta Doğu, karar modeli, distributed computing, grid computing

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LIST OF ABBREVIATIONS

API: Application Programming Interface

ASP: Application Service provider

AWS: Amazon Web Services

CapEx : Capital Expenditure

CRM: Customer Relationship Manager

EC2: Elastic Compute Cloud

ERP: Enterprise Resource Planning

GQM: Goal Question Method

IaaS: Infrastructure as a Service

IDC: International Data Corporation

ISO : International Standardization Organization

ISOAMM: independent Service Oriented Maturity Model

LAN: Local Area Network

OpEx: Operational Expenditure

PaaS: Platform as a Service

REST: Representational State Transfer

S3: Simple Storage Service

SaaS: Software as a Service

SLA: Service Level Agreement

SOA: Service Oriented Architecture

SOAP: Simple Object Access Point

SSL: Secure Sockets Layer

VM: Virtual Machine

VPC: Virtual Private Cloud

VPN: Virtual Private Network

WSDL: Web Service Description Language

CHAPTER 1

INTRODUCTION

Information technology in all its forms has become the backbone of modern life by having a big role in all sectors of science, medicine, and military. Every organization, company or institution has an information system that consists of data inputs, processes and information outputs. Information technology helps to manage and analyze information systems. The efficiency and speed of information systems management depend on the capacity of information technology infrastructure in the system. Computing capabilities of information technology has been evolving and as a result becoming more accurate and faster, but at the same time more complex and expensive. Nowadays, large amounts of financial resources are spent on information technology for the development and maintenance (Catteddu & Hogben, 2009), for this reason high computing capacity has become monopolized by big companies and developed countries. As for the case of small and medium business owners and developing countries, it is very difficult to have well-developed infrastructure in information technology. However the emergence of cloud computing showed the features of a new era of information technology. According to this, services are offered to customers allowing them to the latest technology and computing capabilities without buying expensive infrastructure. This is a great opportunity for small and medium business, and third world countries to develop their systems and their abilities, as a result reducing the technological gap between them and the developed countries. Cloud computing could be a technical solution with an economic impact and with help of this technology, it is possible to develop many corporations and organizations.

1.1 Problem Statement

The problem is the decision to move from traditional computing to cloud computing (Fedriksson & Augustssons, 2011). In order to make a decision there must be sufficient information about the subject and the examples of previous experiences to help in the decision-making process (Menzel et al., 2011). The lack of clarity in cloud computing and its services is a problem facing the movement of decision to adopt cloud computing. After the

emergence and spread of cloud computing technology, many questions arose about cloud computing technical service (Hendler, 2008) and its impact on business (Marston, 2010). Therefore this questions must highlight and investigate the factors that contribute into the adoption of cloud computing and present solutions to the challenges facing the adoption of cloud computing.

1.2 The Aim of the Thesis

The aim of this thesis is to develop a decision model, which will help in the process of making a decision to move from traditional computing to cloud computing in companies or organizations in Middle East. Using this model determines the extent of the readiness of the organization or company that wants to move to cloud computing, through the evaluation of the alternatives offered by cloud computing services and the risk assessment facing the organization or company when adopting cloud computing.

1.3 Important of the Thesis

Currently, there are no suitable decision models available for the Middle East countries. The culture, social structure, and economic structure are different from those of developed countries. Hence, one cannot use existing decision models. As a result, this thesis fills the gab in this area.

1.4 Limitations of the Study

This thesis has the following limitations:

1. This study is limited by the period that begins from March 2013 until January 2014 depending on the models mentioned in this study.
2. This study discusses the features mentioned in the result chapter.
3. This study is limited to Middle East countries.
4. This study is limited to the item in interview questionnaire and develop decision model.

1.5 Overview of the Thesis

This section briefly explains the components of the thesis:

Chapter One: This chapter displays the object and purpose of the thesis, and its importance, as well as the obstacles and difficulties that interface work in this thesis, in the first quarter as well as an explanation of the contents of the chapters of the thesis

Chapter Two: This chapter presents studies related to cloud computing. Most of these studies and research on cloud computing were done in recent years. The topic of cloud computing itself has recently emerged and there are not large numbers of studies present. This section includes explanation for each case study.

Chapter Three: This chapter consists of a brief history about distributed computing and cloud computing definition, as well as explaining the cloud computing architecture. It also mentions the most important cloud computing providers and gives a brief idea about their services, in addition to this it explains cloud computing from a business perspective.

Chapter Four: This chapter explains the data collection method used through interviews with specialists and an online questionnaire. In addition to this, it explains the respondents' profile and how the questions were designed.

Chapter Five: This chapter offers a model that facilitates the decision making process of moving from traditional computing to cloud computing. It also identifies the people who are interested in cloud computing. This model consists of ten questions; each question represents an aspect. There are three answers for each question and each answer is assigned a mark. These marks will be gathered to get the final total, which will show whether the decision to move to cloud computing is correct, or not. In this chapter, all model questions and the distribution of marks for the answers are explained.

Chapter Six: In this chapter, the case studies, how to apply the model of decision analysis and the results of model are explained.

Chapter Seven: It is the final chapter in the thesis. It includes a review of all chapters of the thesis, the recommendations and possibilities for future research.

CHAPTER 2

RELATED RESEARCH

2.1 Overview

The cloud computing in recent years has become the focus of attention of all those interested in information technology, but there is still a lack of clarity in the concept of cloud computing. This is because cloud computing is still a new concept. As for the studies related to the topic of my thesis, everything published about cloud computing is important for my research. The aim of my thesis is to reduce the complexity in understanding cloud computing. It also presents cloud computing as a new model in information technology field which means that there is only a small number of research conducted on cloud computing. In addition to this, the area of this research study is the Middle East countries and this increases the difficulty of finding researches or studies related to this topic, but there are some master's thesis written in Europe and America. These theses which are related to the goal of my thesis helped me to reduce cloud computing complexity and the decision to move to cloud computing.

2.2 Related Research

Shimba (2010) present a set of steps (Roadmap) for companies seeking to adopt cloud computing. The purpose of the roadmap was to build bridges of trust between service providers and cloud computing customers or users. According to this thesis, the issue of trust is the most important criteria that make customers feel secure with the adoption of cloud computing. The issue of trust is part of the security for the author and it is one of the top priorities in overcoming challenges in cloud computing. The author has chosen to provide a guide for organizations and steps to increase trust and guide organizations willing to move to cloud computing to facilitate the decision-making process and create a road map for cloud computing (ROCCA). The researcher deals with the difficulties facing the spread of cloud computing and the most important of these difficulties and problems are security problems. The author mentions the most important security challenges in cloud computing, which are the following:

- Loss of governance,
- Lock-in,
- Isolation failure,
- Malicious insider,
- Insecure or incomplete data deletion,
- Data interception,
- Management interface compromise.

The author conducted an online questionnaire at first, which focused on the challenges facing cloud computing prompt for workers in the field of information technology and cloud computing. The second questionnaire was directed at with cloud computing service providers. After analyzing the results of the questionnaires and studying the factors affecting the adoption of cloud computing from the point of the customers and the provider and identify the difficulties and problems, the author had developed a roadmap "ROCCA". This road map was intended for use by managers as a guide facilitates the process of moving to cloud computing. The following Figure 2.1 ROCCA illustrates the roadmap. In Figure 2.1 all ROCCA phases and the steps for each phases.

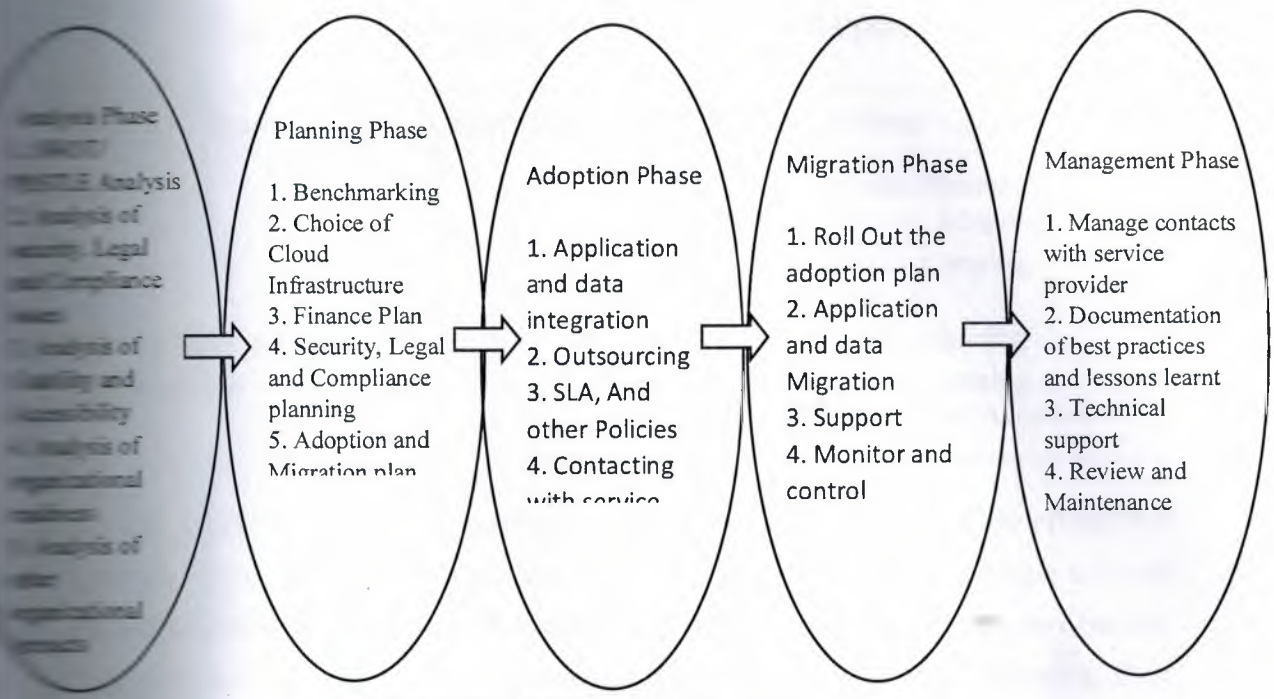


Figure 2.1: ROCCA (Shimba, 2010)

As noted in the previous figure, ROCCA (road map) consists of the following five phases:

- Analysis phase,
- Planning phase,
- Adoption phase,
- Migration phase,
- Management phase,

Table 2.1 summarizes the challenges that ROCCA solved by the five phases as follows:

Table 2.1: Challenges which were solved by ROCCA (Shimba, 2010)

Challenge Chapter Phase	Challenge Chapter Phase	Challenge Chapter Phase
Trust	3	Analysis, Planning and migration, Adoption
Security	4	Analysis, planning, Migration
Legal and Compliance	4	Analysis, planning
Organizational	5	Analysis, Planning, Migration and Adoption

Marston et al. (2010) presented an analytical overview of cloud computing. They offered this analysis through an article published in the "Elsevier journal. The title of the article is Cloud computing the business perspective". The continuing evolution of the IT infrastructure became more expensive and complex. For this reason, cloud computing is a suitable alternative. They define cloud computing 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 in appropriate blocks. The authors suggested, for specialists in information systems, topics to study these topics. Its five categories are:

1. Cloud computing economics,
2. Cloud computing and IT strategy/policy issues (including security),
3. Technology adoption and implementation issues,
4. Cloud computing and green IT,
5. Regulatory issues.

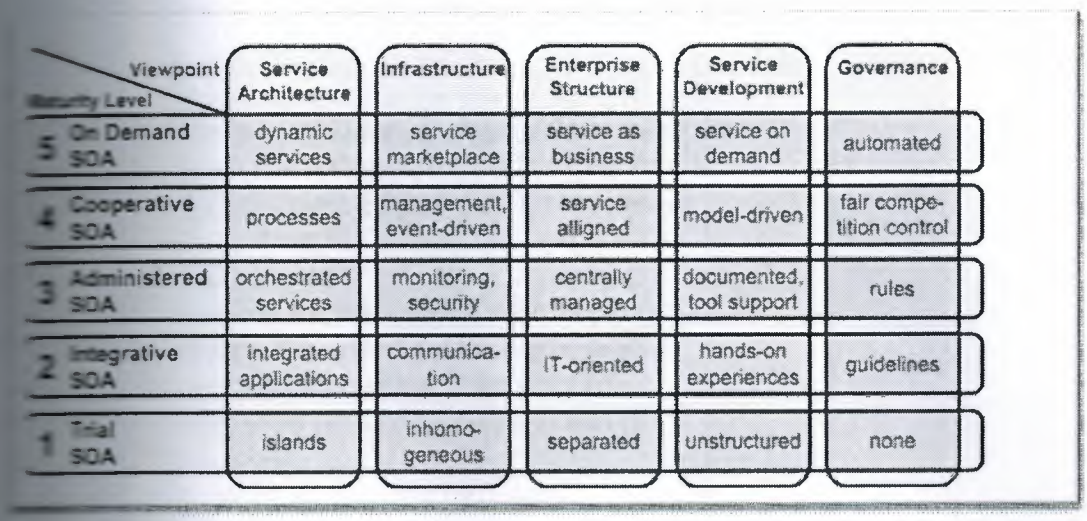
Fredriksson & Augustssons (2011) aimed to facilitate the decision-making process to move to cloud computing. This thesis was presented for Master's Degree Program, Software

Engineering and Technology in Chalmers University of Technology University of Gothenburg, Department of Computer Science and Engineering in Sweden. It highlights the problem of the high cost of information technology and the problem of the lack of flexibility to increase the possibility of infrastructure for Information Technology (IT). It also aimed to prove that cloud computing is a suitable solution to the problems of traditional IT. The authors of this thesis explain that cloud computing is not a new idea and it is Application Service Provider (APS). But after the development of technologies, the shape of the APS has changed, now it is supported by virtualization and Web 0.2 later became the cloud computing. In this thesis, Medus, a medium IT company in Sweden was selected as a case study for implementing the decision model for evaluating the possibility of the adoption of cloud computing. They have chosen the systems used in the company such as Backup, Demo Environment, Intranet, storage, email, conference tool and compared the performance of these systems in online mode (cloud computing) with on-premise performance. Summary of the theoretical framework of this thesis has been divided into different categories which are:

- Cloud computing mean.
- The consideration issues exist prior to adoption.
- The architectural prerequisites would benefit the use of cloud services.

The result of the theoretical framework is a model decision that consists of three levels:

1. At first, it evaluates the maturity of Service Oriented Architecture (SOA). The evaluation process is done by iSOAMM which is an Independent SOA Maturity Model" Figure 2.3 illustrates the decision model.



Viewpoint / Maturity Level	Service Architecture	Infrastructure	Enterprise Structure	Service Development	Governance
5 On Demand SOA	dynamic services	service marketplace	service as business	service on demand	automated
4 Cooperative SOA	processes	management, event-driven	service alligned	model-driven	fair competition control
3 Administered SOA	orchestrated services	monitoring, security	centrally managed	documented, tool support	rules
2 Integrative SOA	integrated applications	communication	IT-oriented	hands-on experiences	guidelines
1 Trial SOA	islands	inhomogeneous	separated	unstructured	none

Figure 2.2: Maturity level (Rathfelder & Groenda, 2008)

Note in Figure 2.1 there are five levels of maturity of the SOA are:

- Trial SO,
- Integrative SOA,
- Administrated SOA,
- Cooperative SOA,
- On demand SOA.

Also note in Figure 2.2 that there are five different aspects which have been tested at all levels. The five aspects are:

- Service Architecture,
- Infrastructure,
- Enterprise structure,
- Service Development,
- Governance.

2. Secondly, it has chosen any system suitable for the implementation of cloud computing and systems are evaluated by the Scorecard as in the following Figure 2.3.
3. A survey of cloud computing services in today's market and compared the services of traditional computing to choose which one is the best for the organization.

Aspect	Weight (1-3)	Score (1-10)	Total Score
How varying is the demand and usage rate of the system? This can be seen as the amplitude of usage of the system? (The higher the score, the higher the demand (amplitude))	3		
With which frequency is the system used? This can be seen as the frequency of the usage, i.e. is it used in intervals or is it used constantly? (The higher the score the, the less constant is the usage)	2		
How mission critical is the system for the organization? (The higher the score, the less critical is the system)	3		
In which state of growth is the organization and the market? (The higher the score, the steeper the growth curve)	1		
How strict are the governmental and industry rules and regulations that the system needs to follow? (The higher the score, the less rules and regulations for the system to follow)	2		
How important is it for the organization that the system supports a specific technology, solution or platform? (The higher the score, the less important it is)	I		
How advanced are the integration requirements for the system? (The higher the score, the less advanced are the integration requirements)	2		
How strict are the internal regulations that the system needs to follow? (The higher the score the less strict are the internal regulations)	3		
How does the organization prefer their expenses? (The higher the score, the more inclin operational expenses rather than capital expenses)	I		
How important are high quality requirements for the system? (The higher the score, the less important requirements)	2		
		Total Score:	

Figure 2.3: Scorecard (Fredriksson & Augustsson, 2011)

The authors have used for this thesis SOA. The reason for this choice is the similarity of the concept of cloud computing with the SOA.

In Boksebeld (2010) the characteristics of cloud computing, such as on-demand self-service, broad network access, measured Service, resource pooling and rapid elasticity are examined. The impact of these characteristics on the architectural enterprise and the success of the project were also studied. The author used the Zachman Framework to compare the performance of the enterprise when it adopts cloud computing technologies, to the case when it adopts traditional techniques to make a decision in order to choose the best performers among them.

The author has two hypotheses. The first hypothesis was "Cloud computing impacts the operational layers in an enterprise architecture framework" which means when companies adopt cloud computing it does not change the way companies work, but it provides facilities to the implementation of work strategies. This hypothesis was tested by Zachman framework as in Figure 2.4a.

	What	How	Where	Who	When	Why
Contextual						
Conceptual						
Logical						
Physical						

Figure 2.4a: Zachman framework (Zachman, 1987)

The second hypothesis is cloud computing results in a greater project success. This hypothesis reflects the impact of cloud computing on the success of the project. It is also tested with Zachman framework as in the following Figure 2.5. Based on the hypothesis testing, it shows that cloud computing has a positive impact on the way of implementation of the work. The second result is that the projects that adopt cloud computing have great chances of success

	Cloud	On premises
Time	4,2	2,5
Cost	4,3	1
Quality	4,3	3,5
Scope	4,6	4
Customer	4,4	4
Project members	4,3	3
Users	4,8	3,5
Partners	3,5	4
Stakeholders	4	
Total	4,2	3,2

Figure 2.4b: Zachman frameworks (Zachman, 1987)

Delgado (2010) conducted at Royal Institute of Technology (KTH) Stokholm, Sweden, has been accepted for the masters degree. This thesis tries to clarify concerns about cloud computing and analyze the factors that affect the performance of applications based on cloud computing, facilitating the process of selecting the provider of cloud computing services and the process of making a decision to move to cloud computing. In addition to this, this thesis has discussed the ways to prepare suitable offers of cloud computing services and SLA. It also specifically tries to solve the problems of the performance of applications executing on the cloud. The author relies on previous studies and experience to find out how to measure performance and to clarify the current criteria for the performance, which is currently available from suppliers. To solve problems and overcome challenges, the author decided to choose "Eucalyptus private cloud" as a case study to measure the level of performance of applications in a private cloud. The reason for choosing a private cloud is because it provides a controlled environment, on the contrary to public clouds. Isolation performance is tested in

computing through the test performance when resources are shared by virtualization. The following are the resources that have been tested:

- CPU Test,
- Memory Test,
- Disk I/O Test,
- Network Test.

After this test, the result is that the virtualization may be one of the reasons and the performances of a cloud-based application are not reliable and deterministic. The author has discussed the problems of Service Level Agreement (SLA). The author suggests three factors that should be available in every level SLA as follows:

1. *Availability:* The status of the service is defined as available when it can be reached and is operational and responsive, and is measured as a percentage of time.
2. *Response time:* The response time is the delay between when a request is sent by the user and when the response is received, as measured in seconds to some stated precision.
3. *Throughput:* The amount of work a cloud instance can do in a given time, measured in serving requests or transactions per unit of time.

Wilkilsen (2009) provided sufficient understanding of the opportunities offered by cloud computing. On the one hand, he investigates knowledge of the challenges facing the design of systems to work in an environment of cloud computing. This thesis looks for the appropriate systems for the adoption of cloud computing systems and to find this out the author has studied the characteristics of systems associated with the characteristics of cloud computing. This research is based on a case study, which is an architectural enterprise that serves as a platform for research. It is carried out in an environment of cloud computing, Amazon (EC2), to verify the possibility of the adoption of cloud computing for such enterprise despite the current difficulties including:

- Data centricity,
- Static scalability,
- Tight coupling,

- Latency requirement,
- Sensitive information,
- SLA requirements,
- Legacy technology.

The purpose of the case study is to show what is the best for enterprises such as search platform enterprise traditional systems or adoption of cloud computing systems. The author explains in the theoretical framework the architecture of cloud computing and techniques used in cloud computing services. The author then conducts a comparison between cloud computing and other models of distributed systems. All this is done in order to reach enough understanding of the opportunities offered by cloud computing services and the challenges facing it. After obtaining understanding the author explains the opportunity and challenges as in the following figure:

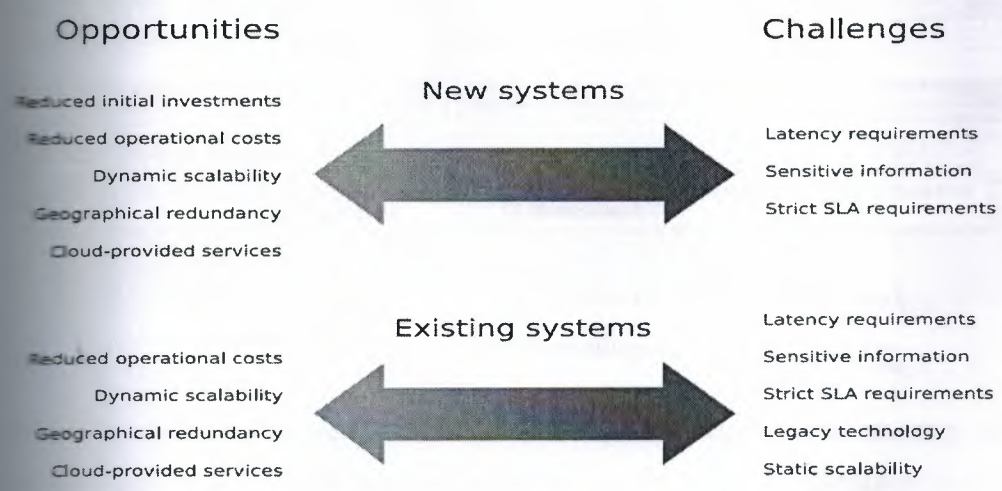


Figure 2.5: Comparison between traditional systems and cloud systems (Mikalsen, 2009)

Chamakkannu (2010) the research project of this thesis was how cloud computing changes the work way companies do through the move from traditional IT to cloud computing. The author develops a new framework for the operations of the telecommunications sector companies and studies if any telecommunications company can benefit from it. The Framework adopted was called "Enhanced Telcome Operation Map farm work" (e-tom) and it consists of three main parts.

1. *Strategy, Infrastructure & Product*: Covering planning and lifecycle management.
2. *Operations*: Covering the core of operational management.
3. *Enterprise Management:* Covering corporate or business support management.

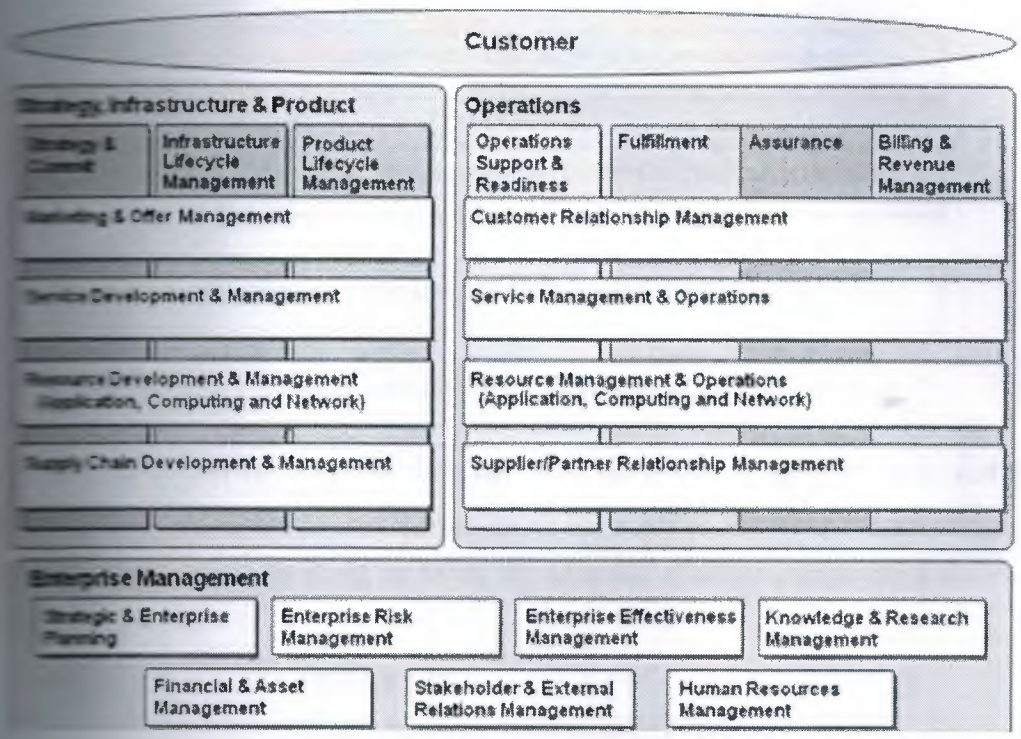


Figure 2.6: e-tom (Chinnakkannu, 2010)

The author collected the data needed to solve the problem of the research through interviews with experts in the telecom sector and in the field of information technology. More importantly, semi-structured interviews are conducted including face-to-face interviews, as well as open questions. Figure 2.7 illustrates the process of data collection.

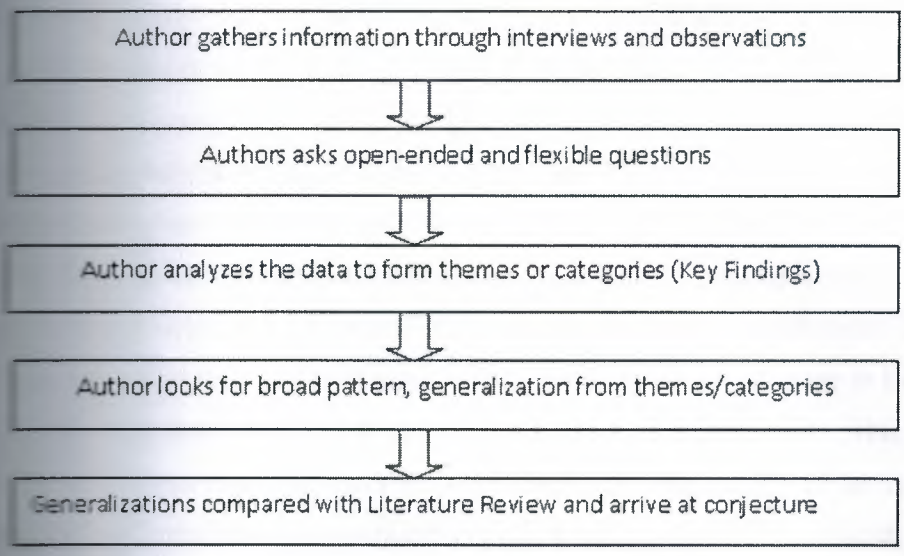


Figure 2.7: Data collection diagram (Chinnakkannu, 2010)

Through these interviews and the analysis of the study, the results of the research project show that adopting cloud computing in the telecommunications sector has a significant impact and would change the ways of working. In short, the adoption of cloud computing restructuring industry valued chains:

1. Redefining telecom operating model.
2. Leveraging Strategic alliances between telecom and IT firms.

Hoffa et al. (2009) given an idea of the experience of using cloud computing and its impact on scientific workflows. From the opinion of workflows, this test method showed an operating imbalance between positions in the local environment and the virtual environment from a wide network. Cloud computing which appeared to reach some of the problems of grid computing has become a substitute for it, but the difference between cloud computing and grid computing is dynamic scheduling and planning still regularly occurs. The problem of waiting without meeting the requirements on time in grid computing proved to be a problem frequently experienced by users, and the sharing of resources from a group of users downright resources will be available to you all the time. But cloud computing has solved this important problem. The user of cloud computing dealing with virtual servers work together through the internet and their management in dynamics and users dealing with virtual image in the cloud

computing may be ready and prepared. The virtualization image gives the possibility to use more of the environment on the same source at the same time. On the contrary, the main problems of the grid computing were heterogeneous environments, this forced the user to work in one system and put obstacles in front of the user. The solution came when it became possible for grid computing to use virtualization then the cloud computing appeared.

Saleem (2011) a thesis in School of Economics and Management Lund University in Sweden, covered the pros and cons of cloud computing, especially data security and costs. The author conducts interviews with responsible of cloud computing in Fox Mobile Group in Berlin. This was one of the companies that relied on cloud computing in their work. This company represents the view of customers or users of cloud computing. The goal of the interviews is to find out the pros and cons from the perspective of the company. On the other hand, regarding the perspective of the provider, the author has interviewed a provider of cloud computing services named DNS Europe.

The most important points agreed with the views (client and provider) yielded by the interviews, that there are 35 standard data security that should be taken into consideration before the adoption of cloud computing.The most important of these criteria are:

- Policy and organizational risks such as vendor lock-in, loss of governance, compliance challenges, and cloud provider acquisition.
- Technical risks such as data leakage, distributed denial of service attacks, loss of encryption keys, and conflicts between customer hardening procedures and cloud platforms.
- Legal risks such as data protection and software licensing risks.

Risks not specific to the cloud such as network problems, unauthorized access to data centers, and natural disasters (Catteddu & Hogben, 2009, p.24).

Sultan (2010) showed the benefits of SaaS in the field of education and gives a historical overview of cloud computing where it has started. The author considered cloud computing not as a new service that has been used in some companies and so-called Application service providers (ASP). The author attributed the delay in the spread of computing service to the cost and unavailability of broadband in the past. As for the web Server, it was the most prevalent XML based Server and transport protocols like (HTTP, TCP/IP) limiting the spread of the

service as a service cloud computing. The most important providers of web server technology are e Bay, Amazon and Google, and web services are the foundation of Enterprise Application Integration (EAI) and the EAI model which is known as the Service Oriented Architecture (SOA). It is one of the reasons for the success of cloud computing. Cloud computing services in the field of education is important and there are many universities which began relying on cloud computing to provide the requirements of students and professors from the University of California. These services include (Email accounts, Operation system, Applications, Hardware, Software, etc.) and the provision of management for Web developers who helped with the process of the development of web programming and web hosting. Amazon's Elastic Compute Cloud (EC2) provides a virtual computing environment that helps students to train in a more realistic way. In fact, cloud computing can attract academic institutes and the reason for this is the cost. Especially after the economic crisis, the requirements and services needed by the university administration will be expensive but relying on cloud computing will reduce the costs. Cloud computing became recognized as a real solution in many colleges and universities in the United States of America. As well as, Google initiative and IBM in 2007, announced that its students have improved their knowledge of Computer Science and applied parallel computing.

Buyya, Pandey & Vecchiola, (2010) explained the computing needs such as high performance, and the installation of computers and super clusters. Authors also explained how the situation has been changed after the spread of cloud computing and cloud computing features pay-as-you go as a payment method. Aneka, an enterprise in cloud computing solutions, has been singled out. Aneka provides high computing capacity depending on the private cloud, public cloud and it supports many programming models such as financial applications and scientific computing. It consists of a set of programs called containers which can be hosted on the resources of physical and virtual resources and communicate with each other through a network or the Internet.

Limester et al. (2010) focused on the business side of cloud computing. They have published a definition of cloud computing focusing on the business side this definition says that it is an IT deployment model, based on virtualization, where resources, in terms of infrastructure,

applications and data are deployed via the internet as a distributed service by one or several service providers. These services are scalable on demand and can be priced on a pay-per-use basis. Before declaring the definition of cloud computing, they compared a number of definitions from which they extracted the defining characteristics of cloud computing as illustrated in Table 2.2. The authors review the historical development of IT outsourcing and how it evolved into what we got right now. They analyze the challenges of IT outsourcing services and compare them with cloud computing. The challenges in the adoption of outsourcing IT services are similar to the challenges of cloud computing, which include the complexity of the decision to move from the internal IT to the IT outsourcing. As for features, there are other similarities that the most important advantages of outsourcing IT which was the economic factor, a flexible payment process. As for cloud computing, it had provided new basic techniques to meet the demands of users, such as computing and data storage and it had been providing these services through new suppliers in this area, such as Amazon, Google and Microsoft.

Table 2.2: A comparison of various cloud computing definitions (Limester et al., 2010)

Author	Service	Hardware	Software	Data	(Development) Platform	Pay-Per-Use	off-premise (public)	Scalability	No Upfront Commitment	Virtualization	SLA	Deterministic Performance	Internet/network	Automation
[illegible] et al. [1]	x	x	x			x	x	x	x				x	
[illegible]/Schrendt [2]	x	x				x		x		x				x
[illegible]/Marinos [3]	x	x	x					x		x			x	
[illegible] [4]		x						x		x	x			
[illegible] et al. [5]	x	x	x		x			x		x			x	
[illegible] [6]	x	x	x					x					x	
[illegible]/Gu [7]	x	x		x				x					x	
[illegible]/Knorr [8]	x	x	x		x								x	
[illegible] [9]	x	x				x		x					x	
[illegible] [10]	x	x	x	x		x		x	x				x	
[illegible]ries [11]	x	x	x	x						x				
[illegible] et al. [12]	x	x	x					x				x		
[illegible] et al. [13]	x	x			x	x		x		x	x			
[illegible]f et al. [14]	x	x				x		x					x	
[illegible] et al. [15]	x	x	x	x										
[illegible] [16]	x	x	x					x						
[illegible] et al. [17]	x	x			x	x		x		x	x			
Combinations	16	17	10	4	4	7	1	14	2	7	3	1	9	1

2.9 Summary

The studies related to the thesis are based on diversity. The purpose of this diversity is an attempt to cover all aspects of cloud computing. This is especially the case when cloud computing technology is seen by some as a destructive technology, and has an impact on the economics of the business and business administration.

The figures that have been selected had great value in all of the studies and research that was being mentioned in this thesis. In the end, it must be noted that the selection of these studies relied on the research and studies which have accompanied the spread of cloud computing, in order to benefit from this kind of research which considered the field of cloud computing in the Middle East that is still in its infancy.

CHAPTER 3

CLOUD COMPUTING

3.1 Overview

This chapter provides an answer to the question 'what is cloud computing? Through historical perspective computing models, and review of the cloud computing architecture (cloud computing service layers and deployment models), in addition to the most important suppliers and finally, the opportunities offered by cloud computing in business and its impact on the business.

3.2 Distributed Computing

Cloud computing did not appear suddenly, it is the result of the latest paradigm of distributed computing. The idea of distributed computing is an economical solution to reduce costs and at the same time it is a technical solution to use resources in another system in situations where the capacity of existing resources are not sufficient to implement the orders required for high performance computing .

Distributed computing began to spread in the same period with the advent of Information Technology in 1960. There were many differences regarding this, but the same concept of distributed computing is similar to what it is now. There was a large central computer 'mainframe computers' processing the data sent to it from different places either by telephone lines or groups punch cards and Mainframe operated independently not connected to any other device (Hayes, 2008).

After the advent of the personal computer (PC) in the eighties, a new paradigm of distributed computing appeared as a client–server, and a result of the evolution of the capabilities of the personal computer a client-server paradigm has become more widespread. Client-server is a group of personal computers connected to the server via a network and share files and data through Hyper Text Transfer Protocol (HTTP) (Fielding et al., 1999).

The model client-server is not fit for complex operations such as scientific equations or financial operations that require high performance computing such as supercomputers. However, super computers are not readily available and it is an expensive solution. The researchers and specialists in information technology field found a solution to this problem through another computing paradigm, that is cluster computing.

The concept of cluster computing filled the need for super computer by providing grouping of computers that work together to carry out complex operations, meaning that the group computers replaced super computer. These computers had to be homogeneous and worked in the same operating systems (Mikalsen, 2009).

2.5 Grid Computing

The working principle of grid computing is to borrow and share resources. Borrowing in the case of system resources is insufficient to accomplish the task in time or not and to share if there are idle devices in the system (Foster et al., 2001). There is no standard definition of grid computing, every side has a definition that is consistent with the method being used, but there is a general definition. This brief definition says that grid computing is a form of distributed computing that involves coordinating and sharing computing, application, data and storage or network resources across dynamic and geographically dispersed organization (Foster & Kesselmann, 2009). Apart from this, there is another definition which states that computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities. (Stanoevska-Slabeva et al., 2009). From the viewpoint of the IBM organization, this definition focuses on the positives of grid computing, that Grid computing allows you to unite pools of servers, storage systems, and networks into a single large system so you can deliver the power of multiple-systems resources to a single user point for a specific purpose. To a user, data file, or an application, the system appears to be a single enormous virtual computing system (Kourpas, 2006).

2.5.1 Gird computing services

Grid computing provides a parallel CPU capacity. The advantage of this capacity is that it is used by applications which have been programmed with a high parallel algorithm, which is ten

runs faster than the second method. The second method is based on the division of the tasks into sub tasks that distribute resources. In addition to a parallel CPU, capacity grid computing provides users a heterogeneous mix of resources (Hardware and software).

On the side of software, grid computing allows the use of software that is installed on the infrastructure of another system and this property, which gives programs license, allows the use of only one device. Often these programs have high cost (Mikalsen, 2009).

3.3.2 Grid computing reliability

One of the most important grid computing characteristics is large scale, the property of providing a large number of resources makes the performance better- When the problem occurs at the node, the grid computing management sends tasks to another node that provides continuity of work and do not stop, we should not forget that the resources of the gird computing are extended geographically and this is very important when converting tasks to the nearest location of resources, another characteristics of grid computing is the heterogeneity of resources. This means that there is a diversity of resources such as software, hard-ware, programs super computers to display devices and printers (Hashemi & Bardsiri, 2009).

The process of diagnosing the problem is another property added to the grid computing, where grid computing monitors tasks and checks if there are problems with their sources to provide alternative solutions (Mikalsen, 2009).

3.3.3 Grid computing management

The management of grid computing is done by its own software. The main software management is connected to other programs installed in all network nodes. As for the main software, it can determine the capabilities of the grid and what resources are available to send tasks to the appropriate node, as well as through this software, we can get usage reports for each node or user, these reports make it easier to measure the performance of the grid computing and by this piece of information the bills of use can be determined (Mikalsen, 2009).

As for the case of software, we have different functions in the nodes. The most important of these is the authentication for users, and then to prepare tasks for implementation yet to be received from the grid and send the results after finishing the job to grid computing. In

advanced grid computing system, there is another function which is to prioritize the implementation of the tasks (Jarząb et al., 2010; Saleem, 2011).

3.3.4 Grid computing development

After the rapid development of technology such as Virtualization and the increase in the internet connection speed and other similar developments as a whole. A shadow was casted on the grid computing, but this effect and the new environmental technology showed another model of computing alternative to grid computing which called cloud is computing. The debate continues about cloud computing and some believe it is a new version for grid computing. The subject of what cloud computing innovation is about and whether it is a foregone conclusion will be explained further in this thesis. Regarding the grid computing, grid spread has stopped in the past few years, the reason for this is the cloud computing, because it is easier and less expensive than grid computing (Abbas, 2004).

3.4 Cloud Computing

Cloud computing is a marketing term for the new distributed computing model. Cloud computing differs from other models because it offers computing resources as a service and resources are not shared by the participants. Distributed computing in the cloud computing is used from cloud computing providers, but customers do not know anything about the distribution of computing resources. Cloud computing users jointly compute services of their choice from a range of services such as infrastructure data storage servers, networks or rent applications, and customers have to pay for these services based on the amount they use (Mikalsen, 2009; Gutierrez et al., 2013). A payment method in the cloud computing service (pay- as- you-go) is the same payment method for organizations that provide electrical power. If we go back to the history of electric power, we find that providing electricity to a house or a factory was by buying a generator, the owner held the responsibilities for the maintenance work for the generator, to provide fuel and operate the generator. This is similar to what is currently happening in information technology (IT) sector, organizations depend on information technology in their work, and to provide this technology they have to buy computing resources in the form of infrastructure for information systems. This is expensive and in addition to purchase, there are operating expenses including maintenance and updates.

Similar to the change that happened in the supply of electric power, cloud computing means that there are big companies with giant generators and users pay a monthly bill based on the amount of use. The field of information technology is now heading the similar way as electrical power and cloud computing is the first step to this development (Saleem, 2011).

3.4.1 The definitions of cloud computing

Cloud computing is several techniques that have been compiled and developed, at the same time these technologies have roles in different environments such as (hardware, software). These totalitarian and overlapping concepts have produced more than one definition of cloud computing. Each one of the definitions represents the point of view of experts in their respective fields. However, there are definitions that the authors tried to cover all aspects of cloud computing, such as the following definitions:

Cloud computing is 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 (Patrick & Gallagher, 2011). A style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using Internet technologies. A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers (Buyya at el., 2008).

Clearly, in the previous definitions there are many aspects of cloud computing. These aspects and various characteristic of cloud computing will be described in this chapter, in addition to explaining the similarity in some cloud computing services with other technologies, this chapter will also clarify the relationship between cloud computing and these techniques, such as virtualization and grid computing.

3.4.2 Cloud computing characteristics

Cloud computing technology is complex and there are many aspects of it, which are limited to some of the properties agreed academically and technically. But there are five basic

characteristics adopted by the National Institute of Standards and Technology (NIST) which will be described and illustrated in the next section.

1- On demand, this characteristic allows cloud computing users to use different cloud resources such as servers, storage, networks, applications, etc. as needed and without any human intervention. In other words, when the customers want a higher computing capability to their own system, they do not need to buy new resources. They get the quantum and type they want from computing capacity in the form of service, provided by cloud computing a provider vendor. In some cases, computing capabilities increase and decrease automatically. The Amazon Web Service (AWS), Google, Microsoft and IBM are the most important providers in cloud computing (Mikalsen, 2009).

2- Board Network access is the characteristic which allows cloud computing users to access to resources in the cloud through a network such as internet and intranet from any device thick client or thin client such as laptop, smart phone, work station, PDA. This characteristic gives great flexibility to cloud computing users.

3- Resource pooling is the characteristic that provides cloud computing users a set of resources, which represents the infrastructure for any system such as servers, virtual machine, bandwidth, networks, storage, applications, etc. Cloud computing service providers use the model of the multi-talented resources to provide virtualization and physical resources. The advantage of these resources is that they are of the fastest installation, which means that it is possible for any user to add server to the computing capabilities of its system in a few minutes without waiting for days.

4- Rapid elasticity is the characteristic that allows cloud computing users to increase and reduce the computing capacity of the system quickly and flexibly. In some cases, this increases and decreases automatically, an example of this is Gift Shop, which has a web service for online sale requirement computing capabilities in the length of the year is different, during the holidays there are many customers buying products from the Web Site for a few days and work pressure ends after the holidays. Rapid elasticity characteristic has given the alternative solution to buy infrastructure to use for a few days use of the year. The solution in this case is the adoption of cloud computing services which will increase

or lessen the computing capabilities of the gift shop web's site quickly and automatically as needed days after the holidays, and the gift shop will get the bill based on the amount of use (Plummer et al., 2009).

5- Measurement service is the characteristic in cloud computing services that the monitor measures the amount of services used by the user. This characteristic extract uses service reports, and through the use these reports, it calculates customers bills. The measurement services increase trust between the customer and the provider.

In addition to the properties mentioned above, there are other cloud computing characteristics. But they are not unique to cloud computing and can be found in other techniques. The most important of these common properties are pay-as-you go model, massive scale availability of computing and storage capabilities, the use of virtualization technology, and geographical distribution of clouds. These characteristics are important in the business side of cloud computing (Miller, 2008; Vouk, 2008) which will be described in the next chapter of this thesis.

The following Figure 3.1 is a framework showing the NIST definition of cloud computing that includes the essential characteristics of cloud computing and secondary characteristics. In addition, it includes deployment models and service models of cloud computing which will be explained in the coming sections in chapter three.

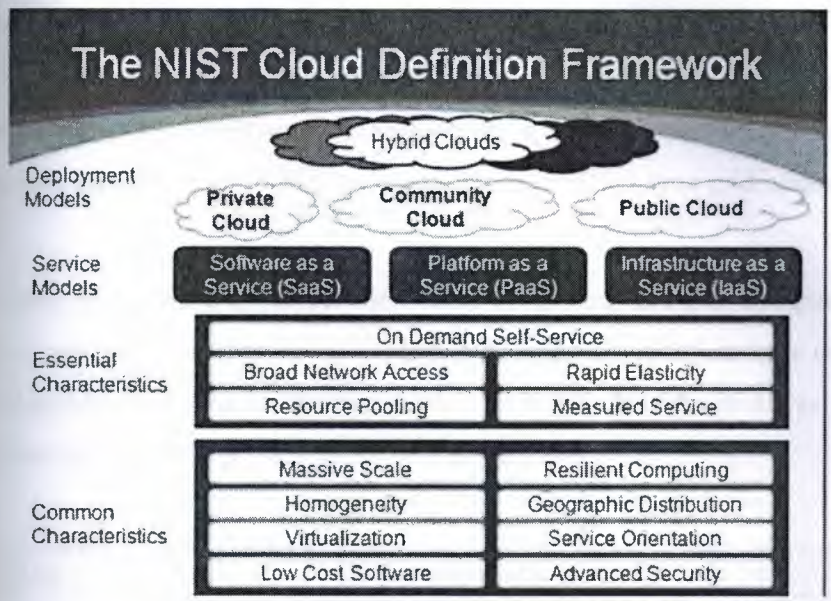


Figure 3.1: Cloud computing definition (Liu et al., 2011)

3.5 Cloud Computing from the Technical Perspective

As previously mentioned , cloud computing did not appear suddenly, but was a result of the evolution of many techniques, business models and computing models, therefore in the next section, the most important of these techniques and their relationship with cloud computing will be explained.

3.5.1 Cloud computing with grid computing

The grid computing is a technical solution and it aims to perform tasks that need high computerization. Grid computing work basis is organizing the sharing of computing resources for participants, who are often scientific institutes or organizations or groups or individuals. Participants agree on certain conditions for sharing their resources to get a variety of high computing capabilities instead of buying expensive infrastructure.

As for cloud computing, it is an economical solution to a technical problem. The cloud computing providers were inspired from the idea of providing different resources for the use of grid computing, but the difference is that cloud computing pool resources have one owner who is the provider (Foster et al., 2001; Jarząb et al., 2010; Chanchary & Islam, 2011). The customer no longer needs to share its own resources with any party. Cloud computing

provides computing capacity in the service form. So there is no doubt that cloud computing is the progressive development of grid computing which is its backbone. This change was the result of a focus on resource provision and services for a more independent economic basis as in cloud computing now, not only sharing computing capabilities as in grid computing (Foster et al., 2008).

Table 3.1 focuses on the differences between cloud computing and grid computing, and this table combines two tables for (Stanoevska-Slabeva & Wozniak, 2009) and the other table for (Hashemi & Bardsiri, 2012). As for the third table, it rewrote some the points as it focused on the fundamental differences.

Table 3.1: Gird and cloud computing differs

Grid Computing	Cloud Computing
The working concept in grid that uses several resources to accomplish one job at a specific time	In cloud of possible performs several tasks by a single source with the virtualization help, and the tasks nature is long and frequent.
Grid allows participants to have access to other participants Systems to some levels.	Cloud provides an isolated environment for the user and high level of abstraction by virtualization.
Dealing with grid computing is not easy for the users, configuration operations complex	Dealing with cloud computing is not difficult, configuration operations take minutes
Grid computing resources have several owners	In cloud computing provider is the owner of the resources
The goal of grid computing to increase computing capacity	The goal of cloud computing to increase computing capacity and minimize according to need and be done flexibly and quickly with virtualization help.
Payment type in grid computing is share costs	A payment method in cloud computing is a pay-as-you-go

Note in Table 3.1 that the key to most differences between cloud computing and grid computing is the virtualization, if you look at the subject from another angle we see that gird computing when supporting by virtualization technology, we have got cloud computing (Foster et al., 2008).

The following section will be about cloud computing and virtualization technology. The two following figures Figure 3.2a and 3.2b explain the deference in the jobs in grid computing and cloud computing

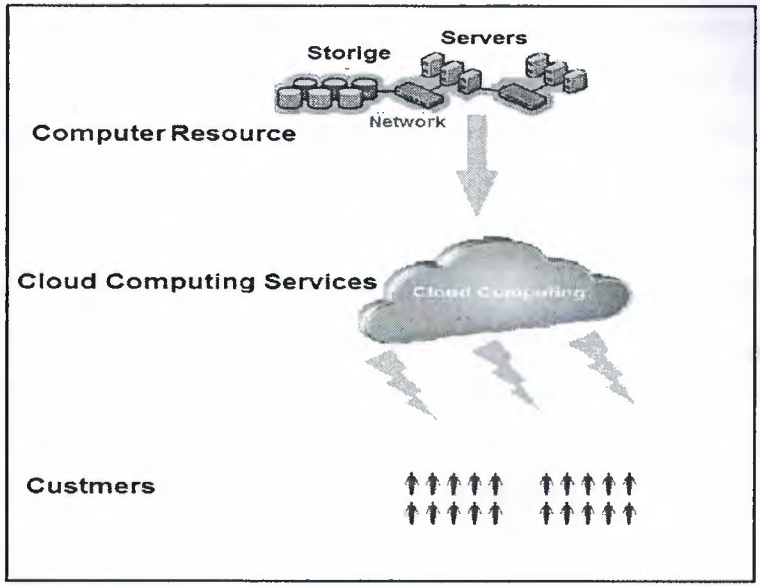


Figure 3.2a: Tasks in cloud computing

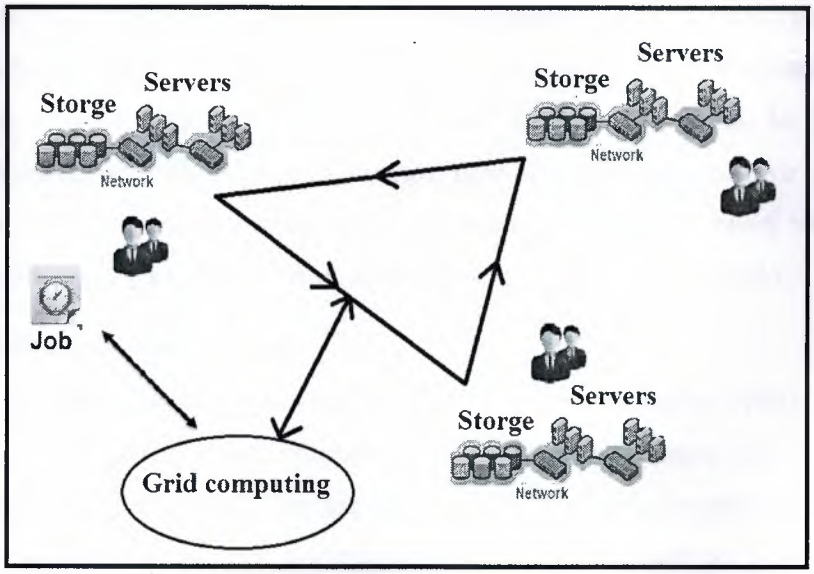


Figure 3.2b: Jobs in grid computing

3.5.2 Virtualization in cloud computing

Virtualization in the recent period has become the most frequent word in the conversation field of information technology, and also the most commonly used words. The idea of virtualization Technology started in 1960 through the cooperation of two companies IBM and MIT, but they were very simple and limited (Nichols, 2006).

The evolution of computer systems increased the complexity and infrastructure costs. One of the most complicated problems resulting from computer systems is the lack of interoperability between the Hardware and Software (Smith & Nair, 2005).Virtualization provides some solutions to technical problems and reduces the expenditure of resources (Gammage & Dawson 2008; Mikalsen, 2009). The following are features of virtualization.

- ***Abstraction:*** An abstraction has a large and important role in computer systems. It facilitates the makers of hardware and software work, because it provides time to the users or manufacturers instead of dealing with a huge amount of details that will lead to many mistakes, the abstraction provides more focus on the desired part. In addition to this, it provides the possibility of the implementation of the hardware and software in different environments (Smith & Nair, 2005).
- ***Isolation:*** Hosting more than one operating system or software on the same physical machine may affect system resource distribution among users, so virtualization provides isolation solution. Isolation is provided a constant share of system resources and services so that each user has its resources without affecting other resources. In the case if there is a problem for a user, other users and the rest of the system will not be affected. The traditional operating systems provide a simple type of isolation by multiple users, but it is not ideal because the scheduling priorities of resource use such as network traffic, memory usage and other have a negative effect on other users (Barham et al., 2003).

3.5.2.1 Virtualization architecture

One of the main components of virtualization is virtual machine (VM). Its software implementations of machines that execute programs as if there were VM Managed by a Virtual Machine Monitor (VMM), or the so-called Hypervisor (Delgado, 2010). VMM is installed on the physical machine to regulate the VM work, and to provide a suitable environment for their work. This means virtualization will be the layer between the OS and the

physical machine, so that the reason for the virtualization is to allow many operating system to work on the same hardware. The following figure shows the virtualization architecture in general.

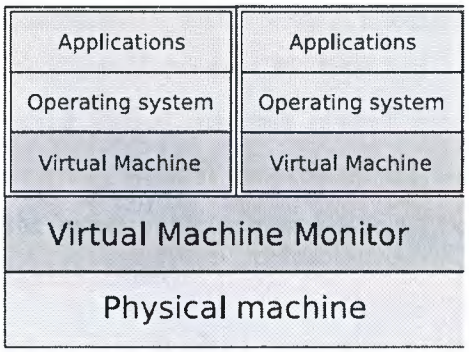


Figure 3.3: Virtualization architecture (Mikalsen, 2009)

The virtualization layer is possible to come in two forms, or on two types. The first of these is Hypervisor mentioned earlier and this type is allowed to communicate directly with the physical machine, which is faster and better. The second type is the hosted architectural, virtualization layer in this type is above the operating system. This type is not much used (Delgado, 2010). When installing more than one operating system on the physical machine, there will be more than one Instruction set processor, the implementation of this instruction needs mechanism translator. VMs provide translation processes or interpretation. These are some of the techniques that are used by the VM.

Full virtualization is the technique which is based on abstraction of the operating system from the underlying hardware, this is done without the knowledge of the guest by the hypervisor. Guest instruction processor set translated is done by binary translation (BT) Technology. The process of instruction interpretation has side effects such as delay of those found in the BT. BT is a technique offered by VMMs such as VMware or workstation (Asams & Agesen, 2006). The working principle of BT is the same as the working principle of Just-in time (JIT) compiler, it uses the dynamic programming environment such as Java. Host read the instructions in guest memory, then these instructions are classified. These instructions become grouped in the translation unit and after this it is grouped by the Intermediate Representation (IR). Unit translator, after preparing an instruction block of non-privileged instruction either which privileged instructions are rare (Asams & Agesen, 2006).

Para virtualization is the technique that is used with the open-source operating systems (Delgado, 2010). There is better performance in this case, because operating systems allow full access to a high level of information in the system. In addition to this, they allow communication between virtual machines, which reduces interruptions (Whitaker et al., 2002). Hardware assisted Virtualization manufacturers CPU Intel and AMD have created a memory data structured and they called virtual machine control block (VMCB), which allows execution of the instructions directly without the need for BT and par virtualization in some cases. This is done when the guest mode activates one CPU, CPU starts loading guest instructions from VMCB (Mikalsen, 2009).

Virtualization plays an important role in cloud computing especially that cloud computing relies on the virtualization servers. All cloud computing services need virtualization, characteristics of cloud computing service are flexibility, scalability and heterogeneous environment. All of these characteristics are solutions offered by virtualization. There has been a focus on the most important virtualization roles in the cloud computing (Koganti et al., 2013) which are explained in the next section.

Isolation in cloud computing is important because it provides isolation between the instances. It allows a large number of VMs works in same physical machine without affecting each other. The accuracy of the service depends on the instance's share of system resources, isolation as mentioned provides fixed share to each instance, which ensures good service (Mikalsen, 2009).

Heterogeneity is the difference between computer systems and this causes a problem between the old and new systems, and in addition, the need for organizations plurality of its resources to meet the business needs. Virtualization provides users with a solution to the heterogeneity and thus enables the user to install any old or new system on the physical machine and provide a special environment for any system. There is the possibility of providing more than one virtual server of a single traditional server. This saves the cost of buying more than one server in some cases, such as when an organization needs a server to database and another one for the web (Delgado, 2010).

Flexibility is the abstraction of computer systems by VM given the flexibility in the instance. Therefore ,when there is a need to increase capacity or an increase in the service, this is done by adding virtual machine, the process of adding M only takes minutes and can be removed any time. Thus, this is called flexibility and speed which are one of the most important characteristics of cloud computing (Mikalsen, 2009).

2.5.2.2 SOA with cloud computing

Increasing requirements of the business and its continued development, made the world of information technology one of the most important elements of business success. That information technology played a major role in improving business processes in a shorter time and lower costs .The business requirements constitute an important incentive for workers in the field of information technology to create and develop designs, services, software, hardware and technologies. Service Oriented Architecture (SOA) is architectural software services that offer interconnected aim to provide the needs of the business, including repetitive tasks such as check customer credit, opening new accounts and other tasks by linking services with other services to provide dynamic and more flexibility in dealing with data services. In the next section, the definition of the concept of the SOA will be illustrated.

SOA is a conceptual business architecture where business functionality, or application logic, is made available to SOA users, or consumer, as shared, reusable service on an IT network. Service in an SOA are models of business or application functionality to expose interface, and are invoked by message (Marks & Bell, 2006).

It is important to note that from the definition of SOA, the concept of SOA is to provide services through the network by the Enterprise Services Bus (ESB), service delivery, and scaling and support couples losers. Therefore, all the previous characteristics share similarity with cloud computing characteristics, especially in the layer of software as a service, which will be explained in the following sections. The SOA supports the adoption of cloud computing because it is an integrative technology and provides a suitable environment for cloud computing services. As it is the case for cloud computing at the same time it is possible to host the SOA.

Cloud Computing Services Model

The cloud computing services have three models, Max Well the first one was using the famous acronym "XaaS", and the X- here represents one of the following infrastructure services as a service or Platform as a service or Software as a service. In the next section, all of these services will be explained. Figure 3.4 illustrates the layers of cloud computing services.

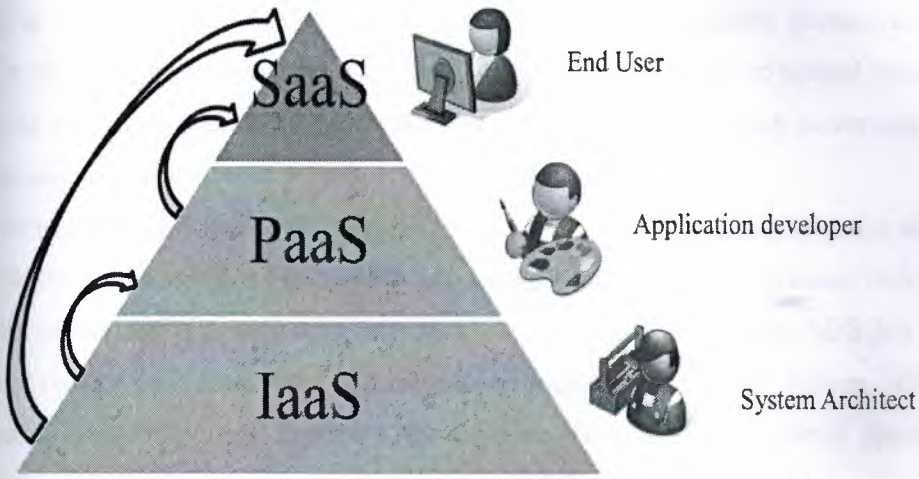


Figure 3.4: Cloud service layers (Delgado, 2010)

Infrastructure as a service (IaaS)

It is one of the most important cloud computing services. It provides a resource pool and these resources are data storage, computing and communications. IaaS provides these computer resources as a service which are controlled by a single interface and through Virtual Machine. These can be dealt by user flexibly with virtual servers, increasing computing capabilities which take only minutes. Data storage Infrastructure as a service offers data storage service in the cloud, allowing user to store data from anywhere and from different devices (desktop, computer, laptop and Smartphone) over the network. The service features are of high scalability and always available. Communication service, this service is not very widespread at the time of writing of this thesis, but it is foreseen that it will spread more in the future (Mikalsen, 2009). It provides a guarantee for quality of service by providing a secure network and low latency and high encryption. The most important providers of infrastructure as a service are the following:

- *Amazon*

Amazon offers the most prevalent model in the cloud computing services generally, and infrastructure services, especially its Elastic Cloud Computing EC2. EC2 provides to customers a virtual machine (VM) hosted on Amazon company servers in America or Europe, each virtual machine is called the instance each instance equals virtual private server capacity. EC2 features the possibility to choose an operating system for instance (Halder et al., 2012). EC2 provides preconfigured images for operation systems and the customer's choice, such as windows and Linux, and it is also possible to upload customer OS image to EC2. In addition, EC2 provides platforms for Database, web server and web application architectures.

Other services are Simple Queue Service (SQS) (Amazon, 2008).This service is for storing messages between the systems of various components in more than one instance and more than a data centre and the messages are stored in a queue real reliable. SQS job is to monitor and control stored messages in the queue through the interface (Mikalsen, 2009).

The Amazon Simple Storage Service (S3), this service provides a storage space for unlimited amounts of data. Data stored in the form of files in buckets, each bucket has a unique key, each key and bucket are one object. The data management processes in the S3 is not as advanced like modern relational database management systems (RDBMS). S3 provides a simple data base based on structured data, it is organized by domains. Queries can be used not all its functions, the query functionality found in Structured Query Language (SQL) (Amazon, 2013) through the name and value pairs domains. As for the process of adding data in S3 by using the REST protocol, here is one of the differences for Queries which supports the API. As for data downloading from S3 is through HTTP or Bit Torrent interface

Amazon Company provides an interface (console).Through console, customers manage services such as EC2. By this interface instances and network configuration and many other processes can be turned off and run Figure 3.5 illustrates the console (Amazon, 2013). Customer's request sending process and instructions made by HTTP with using SOAP or REST protocol.

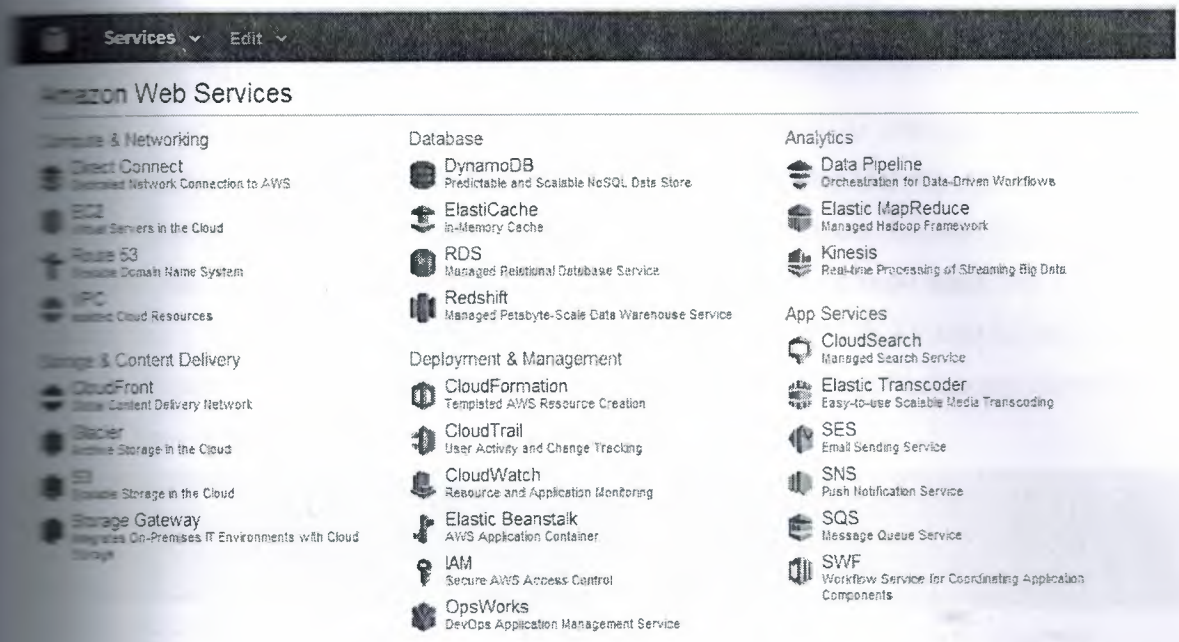


Figure 3.5: Console (Amazon, 2013)

- *Service level agreement and price model:*

Amazon Company owns pricing policy based on the customer's use at the hour for each instance, and pricing differs from one instance to another. In addition, customers pay versus network traffic to and from EC2, but for other services such as SQS and S3, the pricing method of SQS in instance for each process payment is made, in S3 the payment is made for each one GB (Juve et al., 2010). The contract between the provider 'Amazon' and the second party, who is the customer is called as Service Level Agreement. Amazon claims that it will provide services available to customers that will increase by 99.95% per year and in the case of breaching the conditions, the customer is entitled to claim for damages.

- ***Gogrid***

It depends on virtualization, hosted by a cluster of machines. Go grid offers the customer a range of cloud servers, the user chooses the server with an operating system which is either Windows or Linux. Go grid cloud servers have ready template form. The server configuration process is performed by the customer according to his needs such as RAM.

The process of choosing servers is configured through its customer portal (Fredriksson & Augustsson, 2011).

Gogrid provides customer portal for its customers interface to manage their virtual infrastructure such as the ability to save the server image (myGSI) my go grid server image. Through the customer portal which is illustrated by Figure 3.6, the increase and decrease can be applied to the server capacity and installing the F5load balancers. Gogrid is the first vendor that provides the Load Balancing service through F5 load balancers, it can be installed in minutes and it is free for all customers, F5 load balancers distribute traffic, prevent application downtime (Gogrid, 2013).

Figure 3.6: Customer portal (Gogrid, 2013)

Go grid cloud storage provides storage space with a private network connected with all customer accounts, for each customer10 GB free, after 10 GB the payment method is pay-as-you-go. Customers use FTP protocol to download data from Go grid cloud.

- *Service level agreement and price model:*

The pricing policy in Go grid is based on the principle rent resource in service form, unit pricing is the hour and the customer pays per hour to use RAM, CPU. Ratio services provision throughout the year is 100 per cent and it is responsible for the network traffic in the cloud providing solutions for latency, packet loss and jitter. In the case of non-compliance with the conditions the customer is compensated by Go grid credit.

3.6.2 Platform as a Service (PaaS)

This service is intended for software developers to facilitate application deployment by cloud computing. It facilities through provision dynamic programming environment supporting a wide range of programming languages, cloud platform service allows using the vendor resources on the programs or applications running. It provides high Scaling to developers. This service makes the developer focus more on the logic of the program and the rest of the things provided by the provider service, such as updating and deploying (Bomiface et al., 2009). The most important providers of these services

1- **Google App Engine**

Google, the giant company, provides these services, to enable software developers to upload their applications on Google's servers and access to computing resources for running developer's applications. In addition, it provides wide programming environments which support Java, Python and PHP programming languages. The run time environments provided by Google aims at applications running with safety access for rapid deployment. It becomes possible to use the application from user via internet or define Specific group by the developer. Payment policy depends on the pay-as-you-go for the resources usage such as storage and bandwidth, the developer decides the used resources amount (Google, 2013).

2- **Window Azure from Microsoft**

This service is provided by Microsoft Corp. Windows Azure is an operating system for cloud computing. It provides many services, including software environments and supports all important programming languages such as NET, Java, Python and PHP. Azure provides the possibility of sending messages between applications and services to developers by distributed message bus (Roloff et al., 2012). Data storage service in Windows Azure supports by the (SQL), this means that Azure supports structured and non- structured data. Payment policy in Azure is pay-as-you-go, with the possibility of providing a special price when a customer has a contract for 6 months and longer.

3.6.3 Software as a Service (SaaS)

This service allows users to rent applications, and SaaS is more prevalent among the users. SaaS enables its users to access their applications via the Internet from any device, any

place without the need to install software on the user's machine. The user can pay as much as the length of time that needs the program rather than the procurement of the software license, customer utilized automatic application updates (Murphet et al., 2009; Armbrustet al., 2009). The most important providers of software as a service are the following:

- **Salceforc.com**

  Salceforc provides many services, but the most important service is the Customer Relationship Management (CRM) applications. In conventional CRM applications the user should install the software on the local server or computer and prepare enough storage space. In conventional CRM application access to the data is only through the organization's network. Salceforce provides CRM applications, cloud computing user only needs a mobile phone or laptop to work on the application from anywhere using the Internet. Salceforc is responsible for providing resources for the application, and its duties are scalable resources on demand, automatically updated. Salceforc achieves the goal of software as a service through the applications which have features of flexibility and ease of access.

  The user responsibilities for managing resources vary in the three cloud computing services, and at the same time, they are different from the responsibilities and duties of the user to manage traditional resources.

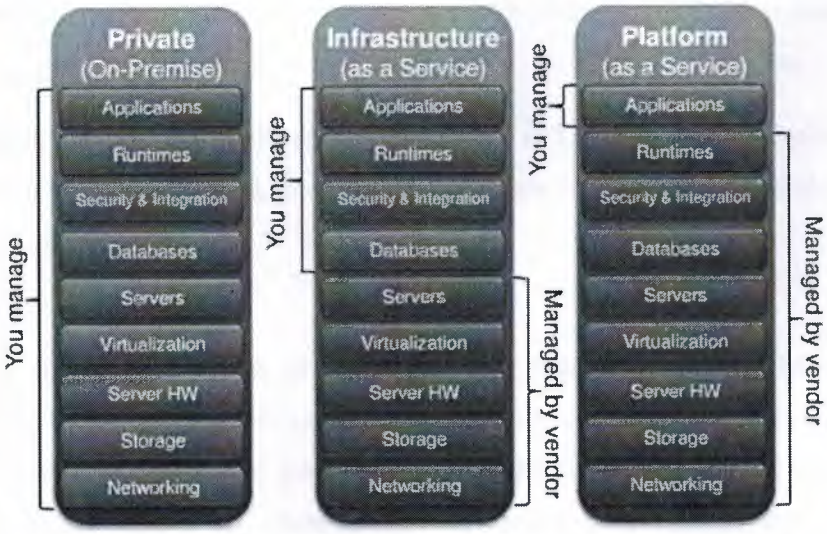


Figure 3.7: User responsibilities in cloud & traditional computing (Delgado, 2010)

3.7 Cloud Computing Deployment Models

The classification of cloud models depends on cloud architecture, the geographical location of the data centre and on the terms of the agreement between the supplier and the customer.

1- **Public cloud computing**

It is a collection of resources available to users via the Internet, the user can choose a cloud computing service provider and uploaded data or applications to the provider's cloud. Disadvantages in the public cloud are the unknown geographical location of data, which means that the user cannot choose the location of the data. This raises fears for the security and privacy, therefore it is not advised to store sensitive data in public cloud (Shimba, 2010).

2- **Private cloud computing**

This type of clouds is utilized by organizations that do not want to store data outside the geographical location of the organization and want to know the place of data. In private cloud, the customer is the owner of cloud, which is responsible for managing the cloud. Access to the private cloud is through a private network or intranet. In recent times, some of cloud computing providers issued a new private cloud version, which is a private cloud isolated inside public cloud, but it is not available to share with the public. This practice is known as virtual private cloud (Sotomayor et al., 2009; Fredriksson & Augustsson, 2011).

3- **Hybrid cloud**

It is the union between the public and private cloud, and is used by organizations that put sensitive data in a private cloud, and non-sensitive data in the public cloud (Sotomayor et al., 2009; Shimba, 2010).

4- **Community cloud**

This cloud serves to a group of customers or organizations which have the same requirements, such as universities and scientific institutes, so they share the cost of a single cloud. In some cases, the cost of sharing is managed by cloud customers or through a third party. Figure 3.8 shows all cloud computing deployment models and explains its relationship with the enterprise (Saleem, 2011). That all the shapes in the inside the box in Figure 3.8 are considered within the geographical location of the company or organization

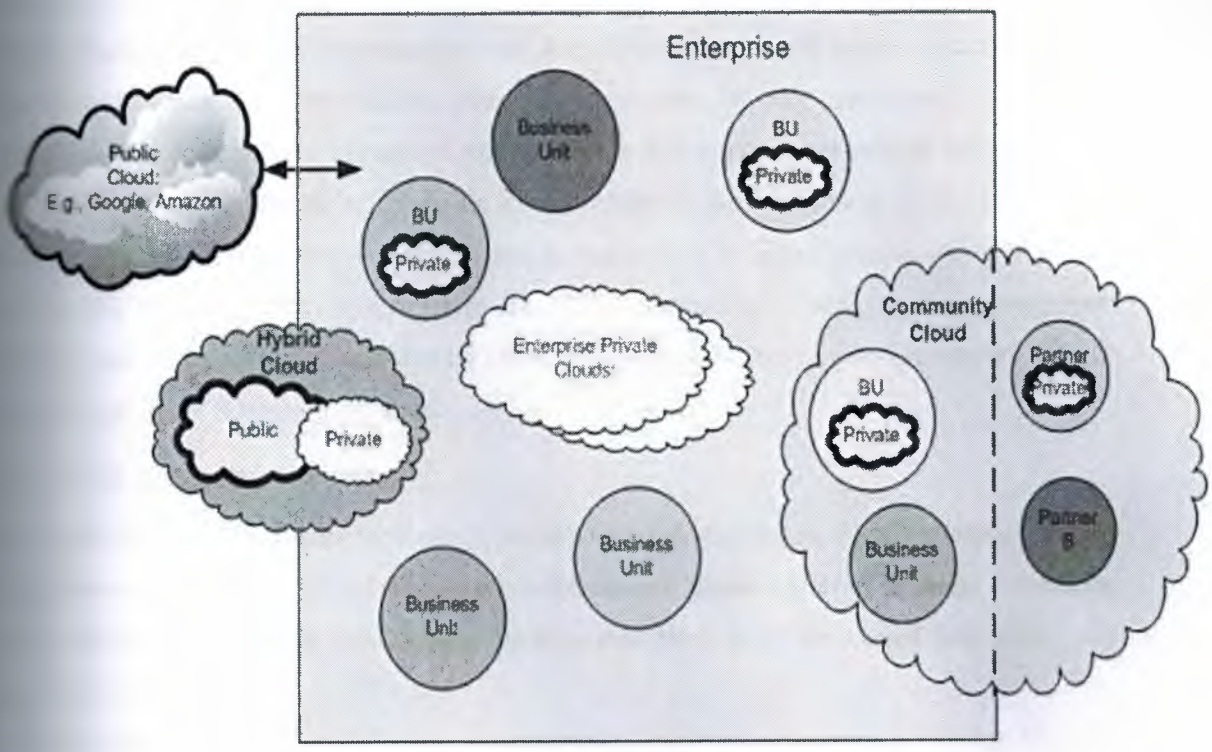


Figure 3.8: Cloud computing deployment models (Amini & Safavi, 2013)

3.5 Cloud Computing Business Perspective

The organizations and companies seek to offer and market their products or services to customers as efficiently and effectively as possible, including low costs and in short time. To achieve business goals, one must rely on information technology IT. So, in all the organizations and companies, there is an Information Technology department in the management structure, which consists of a cadre of IT staff, CIO, DB admin, application developer (Shimba, 2010). This cadre work varies according to business needs. With regards to technical side, every IT department has Information Systems and computing resources, such as (servers, networks, computers, operating systems, software, etc.) (Marston, 2010). These resources are controlled by the rules and regulations of directors. If the management of the IT department is delegated to a third party there must be a legal contract and penalty clauses that are subject to the government laws. The evolution of information technologies increased the complexity and became more expensive, as IT department has the largest share in these

expenses. In addition to maintenance, there are updates, development and cooling expenses. To meet business needs require resources with high specifications and sophistication, and high flexibility to keep up with market changes. In relation to the resources, cutting-edge technology has become very expensive, and flexibility that requires a relatively long time may cause the loss of opportunities available in the business world (Chang et al., 2010). The purpose of the short overview about information technology in organizations and their role in meeting the business needs is to clarify the cloud computing effects on the management structure and the opportunities offered by cloud computing to meet business needs, which will be explained in the following sections.

3.8.1 Cloud computing advantage

The cloud computing services technology provides many advantages, there are some features in common with other models of computing, but there are features offered by cloud computing only resulted from the five basic characteristics that have been mentioned previously and below are these benefits:

- **Cost effective**

  Cloud computing offers a great opportunity for medium-and small businessman, as it means the submission of the latest technologies and computing resources without the need to purchase expensive infrastructure (Chang et al., 2010). As for the success rate of any project, the factors of opaque and constituent expenses are always a great challenge, but the cloud computing concept and payment method pay-as-you-go and pay-per-use helped to remove many concerns in the case of a business slump and provided an opportunity for small and medium business that does not have the liquidity to enter the market (Marston, 2010). There is also no great loss in this option. Moreover, there are the companies with capital cloud computing services and innovation such as virtual companies and software industry companies. The cloud computing change capital expenses (CP EX) to operating expenses (OP EX). It is worth mentioning that, cloud computing exempts customers of maintenance expenses, updates, cooling and electrical energy and this leads to a reduction of IT staff and reduction of salary expenses. After all this, it is clear that cloud computing offers a great opportunity to reduce costs (Klems et al., 2009; Lokhande et al., 2013).

ility in business, the need for high flexibility in Information Systems and speed to meet the needs of the business are the most important key elements to a successful business. The world has become a small village, thanks to the Internet and the emergence of devices such as smart phones the ways of marketing and communicating with customers have been drastically changed and similar changes have occurred in commodities and products (Lokhande et al., 2013; Marston, 2010).

Therefore, the development of an information system should not take a long time. There are cases where high computing capabilities must be provided for the system in hours, which is difficult in traditional IT, so the cloud computing flexibility is its strong point. It allows customers to add any resource hardware or software in minutes and can be removed if there is no need to use it. Cloud computing, that is, high computing capacity that allows for their customers' opportunities to implement the ideas which need the high computing capabilities and it is very difficult to provide at the personal level. Modern technologies offered by cloud computing also gave an opportunity for the owners of small and medium-sized businesses to use systems and techniques if they want to use traditional IT which will cost them large sums (Saleem, 2011).

3.8.2 Cloud computing challenges

The cloud computing as a new technique, so it is natural that there are gaps and incomplete aspects. Among the most prominent of these negatives are the following points:

- **Data ownership**

  The idea of raising the data and applications to the cloud, as a new idea requires a study by the companies and organizations. Ignoring the location of the data and the absence of a copy of it in the corridors inside the company or organization requires high trust in the provider of cloud computing, as well as the provision of guarantees and commitments by the provider (Marston, 2010).

- **Quality service**

  The cloud computing performance services lacks the static measurements, and so far does not have a clear conditions in the service level agreement (SLA) on a scale of

performance. The customer cannot evaluate performance. The lack of information about applications or data, and how and where it is located is another shortcoming. In addition, the distance between the customer and the service provider increased the proportion of the delay (Wei et al., 2010). To get a consistent performance is currently difficult and the suppliers are working to develop and improve services. However, the current performance level is good for small and medium business (Dickmann et al., 2010). It is not much different from the performance of information technology in the house, but large organizations with mission-critical cloud computing services have not developed yet (Chuob et al., 2011) (Mikalsen, 2009) (Yuusuf & Tubb, 2013).

- **Security**

  Security has been the word that came up most frequently in any talk about the cloud computing. It is worth noting that all the weaknesses or drawbacks in cloud computing are under the umbrella of security for data in the cloud. It starts from the questions and concerns about the user authenticity access to cloud services, privacy that is guaranteed by the provider, a level of isolation and abstraction, and problems in the case of supplier malfunctioning which leads to the question about the fate of the data (Goyal & Supriya 2013; Saleem, 2011).

- **Legality**

  The cloud computing services are still new in the markets of Information Technology. At the stage of continuous development, many standards and measures of the service quality are lacking. All of this is reflected in the service level agreement between the supplier and the customer. It is worth mentioning that there are issues about cloud computing provider data centers in their own countries and customer in another country. There are differences between the two countries' laws, and this constitutes various problems. Cloud computing providers must work to find solutions to become more transparent and in the case of the customers, they should consult legal institutions before moving to cloud computing, which is also evident in the case of sensitive information which demands guarantees to secure data and dissuasive penalty clauses in case of non-compliance with the laws (Marston, 2010).

3.9 Decision Making

Humans in the daily life take many important decisions and unimportant, but made the right decision needs to be smarter and wiser and sufficient information before making the right decision. That the right decision is the one that achieves the best results and reduce the risk, so you must be prepared before any important decision, such as an environmental study that takes the decision, and the factors and alternatives (Janis et al., 1977; Buchanan et al., 2006). These preparations are the so-called decision-making process. One of the oldest methods of decision-making by using chance, such as flipping an unbiased coin and writing the pros and cons of the decision scenario, but after technological development in all fields has become a primitive methods do not suffice, so there has become an urgent need to develop policies and a new approach to make a decision. In the middle of the last century Chester Barnard, a retired executive and author of The Functions of the Executive book, used the term "decision making" (Buchanan et al., 2006). It is beyond many specialists have developed policies and methods of making the decision to live up the level of complex decisions. As a result of this movement emerged many decision models in addition to the means of applying a decision models, such as scorecard, decision tree and neural network.

3.9.1 Decision model

The decision-making process is always preceded by fears and concern over the appropriateness of the decision Does the decision improve the level of performance of the organization or company. So ,in recent years, many models have emerged trying to help in the decision-making process in the business sector and other sectors, through these models the situation of the organization or company are assessed in terms of a decision given by a risk analysis to determine the benefits. Decision-making models that rely on certain frames work, have a curriculum that incorporates steps depending on the type of decision and the work environment such as determining the scenario in this step is clarified IT and business context in addition to the constraints and requirements (Menzel et al., 2011).

In the next section, the most important types of decision-making approaches

1- **Multi- criteria decision making (MCDM):** This approach offers a broader understanding of the decision-makers by clarifying the different criteria in addition to clarifying the status

of the decision-making, in the form (MCDM) the objectives and conflicting and contradictory criteria can be used (Mendoza & Martins, 2006).

2- **Simple multi-attribute rating technique (SMART):** This approach is a more flexible one so it is the most dependent, and allows changing the criteria without affecting the final decision, and this property can update useful alternatives and factors during the process of comparison between existing standards and new alternatives. The SMART decision-making approach is based on balanced SCORE CARD (Menzel et al., 2011).

3.9.2 Decision model tools

- Scorecard: it is a table or mathematics model used to provide a mathematical expression for the performance analysis of the criteria the users given judgment by credit for each attribute in the organization or company and evaluate possible alternatives. Of the most important types of Scorecard such as balanced scorecard balanced scorecard is use to performance management in organizations or companies it has developed in 1992 by Robert Kaplan and David Norton 1992 (Kaplan & Norton, 1998).

  It helps the experts in the organization or company to develop plans for the future and by identifying weaknesses and evaluate alternatives. Balanced scorecard that has an approach that consists of several important steps which may vary in the details of the steps of one scenario to another. Here are the steps:

  1. Defining the aims of the organization or company and to identify the factors helping to achieve these goals the strategy work must be understood,
  2. Infinite performance measure,
  3. Determining key performance indicator are designed to let user know if results are on goal or off goal,
  4. Sharing goals with specialists in the organization or company (Kaplan & Norton, 2001).

- Decision tree whose graph is designed to predict the prospects of the decision results, the decision tree can be drawn by hand or by using a special software. Graph consists of more than one node or circles representing the issue of the decision, and every decision represents a branch (Safavian et al., 1991).

- Neural networks used for distributed decisions are often used by a group or a team of decision-makers, and through input by cells consultancy supported on the threshold for the nerve cell and outputs in the form of binary (Chowdhury,1993).

3.10 Summary

This chapter provides a theoretical framework for the next chapters, in addition to the attempt to answer the question what is cloud computing .The cloud computing model complex nested with more than one technique, and cloud computing concept was inspired by other computing models, so clarifies some of the techniques and computing models related to cloud computing. In addition to clarifying the impact of cloud computing in business as a good opportunity and where poses risks to business.

CHAPTER 4

DECISION MODEL

4.1 Overview

The lack of the clarity around the term cloud computing is one of the big challenges facing cloud computing, especially for the owners of small and medium business who have no experience in the field of computing. In this chapter, decision model which helps in the process of decision making to move from traditional computing to cloud computing by scorecard will be explained. Before entering into the details of the decision model there is a need to clarify some important points in the process of adopting cloud computing.

4.2 Stakeholders

The adoption of cloud computing involves participation of various specialists in information technology, business and law, and therefore, in this chapter, some of the roles of the people of stakeholders in cloud computing will be explained.

1. *Customers or users*

   They are the latest chain in stakeholders in cloud computing. The customers are a measure of the cloud computing performance, as depending on the customers' evaluation, cloud computing providers develop their services, In addition, customers pay for those services, and thus are the most important reasons for cloud computing provider to continue their work.

2. *Providers*

   Cloud computing service providers are companies that have clouds. In other words, these companies have the advanced technology resources and high level of expertise in the management of these resources, these companies are responsible for providing cloud computing services for customers.

3. *Mediators*

   Mediators are technical support companies. Their role is to bridge between providers and users. There is a clear contradiction with regards to this stakeholder. The most important characteristics of cloud computing is that, it does not have intermediaries between

providers and customers and does not need experts in Information technology. However brokerage firms are for an emergency and the reason they can be found is due to the lack of clarity about cloud computing. Their current role involves in the integration between the customers' systems and cloud computing services.

4. *Consultants and regulators*

The level of services agreement, a contract between cloud computing providers and customers, should be regulated by law experts in the world of information technology. This will ensure the rights of customers, especially in the contracts for cloud computing because it is a complex issue.

4.3 Decision Model

The development and keeping abreast of changes in any field is necessary and most important success factors, but making any decisions without planning may cause some risk so it is important to study any decision adequately before taking any step. The decision-making process has become more complicated after the development in information technology so that the decision-making process has become an important topic that has been met with interest from professionals in all areas. Many studies and researches are conducted on the prediction of the opportunities offered by the decision-making and the risks that may be caused by it. The decision models appeared in different areas with their approaches and certain steps including the scenario definition decision, evaluating status in the organization or company by identifying the most important performance criteria for the performance of the organization or company and evaluating alternatives that will be provided in the case of decision-making. Some decisions may have a significant effect and cause various changes in case of moving to cloud computing which is the subject of this thesis. The cloud computing is composed of several layers and has a variety of services and in spite of cloud computing benefits, there is a dangerous if the moving was careless. Therefore, there is a need to develop an approach whose steps will help in the process of making a decision to move to cloud computing. Within the theoretical framework in the chapter three, the related studies in chapter two and after interviews with specialists in the field of information technology and business in different countries in the Middle East, in addition to the questionnaire, which was published and included 119 samples from different countries and different specialties, formed a number of

criteria for the cloud computing adoption and factors that positively and negatively influence an organization or company wishing to move to cloud computing, These factors and criteria were used in developing the special decision model for organizations and companies in the Middle East. The decision model approach in this thesis depends on three perspectives: technical perspective, business perspective and the perspective of providers of cloud computing services.

Since the move to cloud computing has effects on the technical side and the business side this decision model should be a multi-criteria as well and has the possibility of changing the criteria.

4.3.1 Decision model approach

The first step in decision model approach is to define the case scenario, the decision model in this thesis is a private model to facilitate moving from the traditional computing to cloud computing. This is the constants in the decision model, while other important aspects in the definition of the scenario include the sector organization or company, business size and decision model user background.

The decision model approach is composed of five steps, in the scorecard where the technical side and the business side, on each side there are three steps. The aspects are evaluated by a scorecard user by give credit and weight for each aspect or point. This is accomplished through the scorecard. The steps are as follows:

1. Define the case scenario,
2. Assess the system attributes,
3. Assessment of alternatives,
4. Risk Assessment,

As for the cloud computing providers side the aspects include assessing the cloud computing providers offers relative to the criteria and the business needs of the system environment. Finally, the fifth step in decision model after the evaluation in scorecard is

5. Share and discuss the results.

The last step before making decision is discuss the results of the scorecard with specialists in the organization or company.

4.4 Scorecard

The scorecard used in the decision model is simple and flexible, consisting of 35 points or aspects to apply decision model steps. Scorecard user evaluates the thirty-five points which are distributed under threes umbrellas (technical, business and service provider). The purpose of the evaluation is to convert the information and ideas to the numbers to facilitate decision-making process, evaluation is done by scoring the points through giving credit from one to ten on each point, in addition to determining the priorities for each point by evaluating its importance through giving weight for each point, weight value for each point multiplies with points score credit then the total score for all points determines the readiness of the organization or company to move to cloud computing.

4.4.1 Guide to assessment

Each of the thirty five points represents a different aspect after careful reading and understanding aspect content, the assessment is done by giving credit from one to ten, the assessment investigates whether the aspect content is identical to the system specifications or not and whether the cloud computing services alternative meets the labor criteria or not and is suitable for the development and improvement of the work performance in the organization or company, the scoring increases to the upper limit of 10 and the minimum is 1. At the risk assessment step the sentence formulation must be taken into account, the sentences in the whole concept is that all the risks do not affect the organization or the company, and must be of high score, and vice versa, the more dangerous is whenever scoring is poor.

4.4.2 Weighting method

The business needs and performance criteria differ in each organization or company, so the aspects importance in the scorecard differ for the decision-makers, some aspects may be very important and others may not so weight to each aspect in scorecard must be given to perform more practical and accurate evaluation and the decision model results be more realistic.

Weight is represented in the scorecard for each point by number value. If the aspect has a high importance a high weight will be given for this point 2, but if it is not very important, or of limited importance, the weight will be 1, finally if it does not represent any importance it is given zero weight. Table 4.1 shows how to choose the weight.

Table 4.1: The weighting method

Classification	Important	Maybe important	Not important
Weight	2	1	0

A weight is used for each point by multiplying it with the score point to get the final score of this point.

4.4.3 Calculate the total score

The scorecard contains 35 points and each point is assessed by a scorecard user from 1 to 10 credit, for each point there is a weight either be (0, 1, and 2). Score credit point is multiplied to get the final evaluation of the point or aspect. Then the final evaluation is collected for 35 points to get the total scorecard credit. Figure 4.1 shows how to calculate the final score of the scorecard.

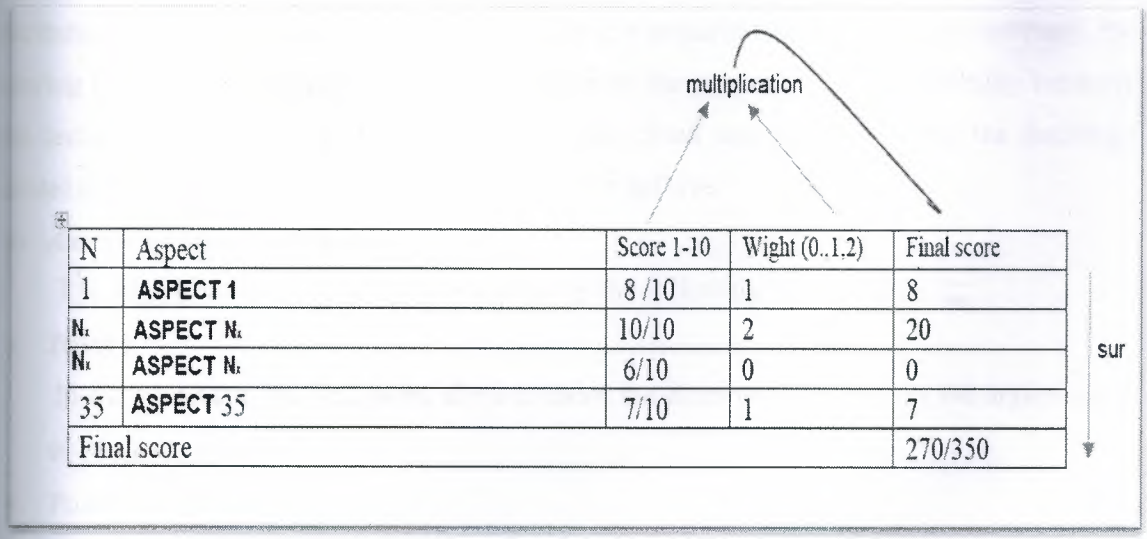


Figure 4.1: Calculate the final score

4.4.4 Architectural of scorecard

As mentioned above, the scorecard consists of 4 questions and 35 aspects distributed on three perspectives that are technical, business and cloud computing providers and all perspectives

represent a stage of decision-making. The next section will be to clarify all aspects according to their perspective:

- *Scenario define*

  Before entering the aspects of perspectives, four questions that define case scenario organization or company willing to move to cloud computing will be offered:

  1- The first question in the decision model is about the country of the organization or the company that wants use decision model.

  2- The second question is about the scorecard user job or title.

  3- The third question determines the number of employees in the organization or company and the purpose of that is to know the size of the business.

  4- The fourth question is about the sector of organization or company.

4.4.5 Technical perspective

Technical perspective is represented in a scorecard through 15 aspects describing the attributes, criteria and factors of the system in the organization or technical company, by scoring the aspects from scorecard user to determine the proportion of compatibility between the technical specifications of the system and the cloud computing services, the decision-model approach steps in technical perspective are as follows:

a- Assess the system attributes

The attributes of the system are evaluated by the following five points:

- Point 1

  In the scorecard, the first point about is about the distribution of data in the organization or company system

- Point 2, 3 and 4

  As previously stated the computing cloud consists of a set of techniques for this. There are three points in scorecard that will be assessed by scorecard user about the extent of the use of certain technologies that support cloud computing which are vitalization, SOA and web services whenever these techniques are supported in the organization or company. This will be good an indication for the success of the adoption of cloud computing technically.

- Point 5

  Since most of the cloud computing services are available through the Internet, the connection speed to the internet is one of the most important factors that will help in the success of the adoption of cloud computing, in the fifth point in the scorecard the connection speed to the internet is assessed.

b- Assessment of alternatives

The second stage in the technical perspective in the decision model scorecard, is the evaluation of the disadvantages of traditional IT system in organization or company, the advantages of cloud computing services alternatives. The following six points in the scorecard display the disadvantages of traditional information technology and the possible alternatives of cloud computing services.

- Point 6 and 7

  providing electrical power for the operation of the infrastructure of information technology in the Middle East is expensive in addition to that there is a difficulty in providing electric power continuously for 24 hours a day so cloud computing services is a good chance to get rid of this problem. A high score is given in the evaluation when it is more difficult and expensive to provide electricity.

- Point 8

  It's about developing computing capacity for the information technology system in the organization or company by cloud computing services in other words it's evaluating the need for the organization or company for this development capabilities.

- Point 9

  scalable computing capabilities and flexibility in the management of system resources is one of the most prominent problems of traditional information technology and at the same time is one of the most important advantages of cloud computing services, so at this point, evaluation will be over the need for scalability and flexibility in the organization or company.

- Point 10

  It about the diversity of systems and resources in the organization or company and the extent of its positive effect on the work performance.

- Point 11

  The costs of maintenance and cooling system resources are of the most prominent challenges faced by organizations and companies in the Middle East, while cloud computing offers an alternative opportunity to minimize the expenses of maintenance and cooling.

- ***Risk Assessment***

  In the latter part of the technical perspective from scorecard of decision model there are four points representing the risks that may have a negative effect in the case of a decision to adopt cloud computing.

- Point 12

  It's about the level of security of data and applications in the cloud, whether it is enough to maintain the security and privacy of data.

- Point 13

  It's about the problem of compatibility and integration of applications and systems in the organization or company with cloud computing services and what is the extent of the difficulties that the company has faced in the case of adoption of cloud computing.

- Point 14

  It's about the stability of the performance in cloud computing services and the problem of cloud off and the extent of its impact on the performance of the work in the organization or company.

- Point 15

  It's about the delay in responding to the instructions sent to the cloud. Whether these instructions outperform the proportion of the delay with the performance standards of the organization or company or not.

4.4.6 Business perspective

Business perspective of the decision model is represented in the scorecard through 15 aspects or points. Model approach in the business perspective in the decision consists of three stages or steps:

- ***Assess the system attributes***

The first step aims to evaluate the attributes of the organization or company from a business perspective through three points put in the scorecard to be assessed by scorecard user, in order to know the compatibility business attributes in organization or company and their compatibility with the cloud computing services, the following is a clarification of these points:

- Points 16

It's about the ratio of the sensitivity of the data and privacy, evaluating the level of data sensitivity is a very important aspect pre-loaded to the cloud, so as to ensure the security of the cloud computing services.

- Point 17 and 18

It's about the daily and seasonally rush hour, evaluating peak hours in other words, what are the hours of pressure on the system.

- Point 19

It's about the importance of continuous communication with the company's customers or organization's client by the simplest and less cost ways.

- ***Assessment of alternatives.***

The second step in the decision model in the business perspective represents some of the challenges that may face the organization or company, and solutions assumed in the case of adoption of cloud computing, this step is seen in nine points or aspects in the scorecard as follows:

- Point 20

It's about the opportunity offered by cloud computing services to reduce the need for IT professionals.

- Point 21

It's about the opportunity offered by cloud computing services to support the economics control of organization or the company, In other words, evaluating the property offered by cloud computing services in the payment on the amount of use and this reduces the waste in the organization or company.

- Point 22

  It's about alternative opportunities provided by the cloud adopting computing services to transfer capital expenditure to operation expenditure and whether this property is suitable for the organization or company.

- Point 23

  It's about the diversity of Information Technology systems and application offered by cloud computing services and its importance to customers or clients.

- Point 24

  It's about endless storage space offered by cloud computing and access to cloud computing services from any device via the Internet and the positive impact of these properties on the business.

- Point 25, 26, 27 and 28

  Are about assessing the usefulness to adopt cloud computing when using cloud services in customer relationship management (CRM), human resource (HR), sales and marketing, and research and development in organization or company.

c- ***Risk assessment***

The third and final step in the business perspective of the decision model approach consists of two sides or two points. It assesses the fears of risks that may be facing the organization or company, when adopting cloud computing as follows.

- Point 29

  This point is about losing control of the owner on the data and applications in the cloud, in other words, the existence of data and applications of geographical location outside the organization or company.

- Point 30

  It's about assessing concerns about losing complete control of the system resources and the lack of criteria for the performance of information technology in the organization or company.

4.4.7 Cloud computing provider perspective

The latter part of the decision model is the adoption of cloud computing from the perspective of a third party - cloud computing provider, so it is related to the assessment of the of service level agreement. This side consists of five points as explained below:

- Point 31

  It's about the assessment criteria for the security and protection of data and applications provided by the service provider.

- Point 32

  It's about assessing the service level agreement conditions. Are they under the legal umbrella of the country of the service provider organization or company?

- Point 33

  It is about the procedures and steps provided by the service provider in the event of a disaster affecting the data and client applications, in other words, what are the guarantees and compensations

- Point 34

  It's about assessing the level of guarantees to save data privacy provided by the service provider for the organization or the company in the case of bankrupt or lock-in provider.

- Point 35

  It's about the evaluation of plans and steps offered by of cloud computing provider during the moving to cloud computing in relation to the level of compatibility and integration.

4.4.8 Results scorecard

As previously mentioned, each point is evaluated with ranges from 1 to ten credits, taking into account the weight value, the sum of the thirty-five points credits is the final total credits for the scorecard user evaluation. After getting the final total credit assessment of the 35 points, the total is divided on 35 to get the average credit to analysis the result and the result expresses the readiness of the organization or company to move to cloud computing and whether the decision to move from traditional computing to cloud computing is a right decision or not. Analysis of the results will be as follows:

1. If credit average is from nine to ten and above this result means the scenario of this organization or company is perfect to move to cloud computing.
2. If credit average is from seven to nine, nine is not covered, this result means the scenario of this organization or company is appropriate to move to cloud computing.
3. If credit average is from five to seven, seven is not covered, this result means the scenario of this organization or company is possible to move to cloud computing.
4. If credit average is less than five, this result means the scenario of this organization or company is not appropriate to move to cloud computing.

These results are inclusive of for all technical, business and cloud computing perspectives. To obtain more accurate results, it is possible to know the extent of the readiness of the organization or company to move to cloud computing from the technical perspective or business perspective or cloud computing perspective, and that is done by calculating the credit average for each side separately, and this gives more accuracy in the results. It did not stop here, it is possible to diagnose the strengths and weaknesses of each perspective through the analysis of the results of the three steps in every perspective which assesses the system attributes, assessment of alternatives and risk assessment.

4.4.9 Software tool

It is a simple application facilitates scorecard using. Application inputs are entered by the scorecard user when the 35 points in scorecard are displayed by the application to the user, after the completion of the evaluation of all aspects in application, application makes the calculations to obtain the credit average (APPENDIX C). As for the output of the application, it is an analytical report of the results of the evaluation in addition to the result which is whether the organization or company is ready to move to cloud computing or not.

CHAPTER 5

METHODOLOGY

5.1 Overview

This chapter provides a clear description of the steps that have been taken to resolve the problem of the thesis and how they are applied in addition to explaining the techniques used to collect data.

5.2 Research Model

In this thesis a decision model is developed to help in the decision-making of moving from traditional computing to cloud computing, Simple Multi-Attribute Rating Technique (SMART) decision model approach has been selected to develop which suitable to the structure of the middle east countries and applied by a scorecard tool the developed decision model consisting of 35 aspect from three perspectives are technical, business and cloud computing service provider. Some of aspects taken form an earlier theses and another added by the author. This model has been chosen because it is a multi-criteria approach which fits the diversity of the decision elements of the move to cloud computing.

Table 5.1: The developed decision model

Aspects perspective	Perspective steps	Aspects number	Total aspects
Technical	Assess the system attributes	5	15
	Assessment of alternatives	6	
	Risk Assessment	4	
Business	Assess the system attributes	4	15
	Assessment of alternatives	9	
	Risk Assessment	2	
Cloud computing provider		5	5

5.3 Participants

One of the main steps to develop a decision model is that the study includes interviews and a survey which provides a more realistic model, specialists participants to answer questions as well as participants to apply the decision model have been chosen, and a detailed description of participants in this thesis will be presented as follows:

5.3.1 Interview participants

In cloud computing, there is more than one services layer, cloud computing provides infrastructure as a service and programming support services and application services, to take this into account, participants have been selected from different fields which interested and business by randomly. In more than one country:

Table 5.2 the characteristics of the interviews participants

Country	Responsibility	Special area
Cyprus	Mangers of IT department	Technical support
Iraq	Broadcast engineers	Satellite Channel
Turkey	Data base administrators	IT services
Syria	CEO	Marketing
Cyprus	Owners	Technical support
Iraq	Professors	University

5.3.2 Questionnaire participants

After the interviews with specialists and their answer to the open questions, in addition to the literary review. A good background about cloud computing is created on the basis of the questionnaire design.

After answering the published questionnaire for two months by 119 participants from different geographical regions, from Iraq 40% (48) of participants, Cyprus 7% (8) of participants, Turkey 5% (6) of participants, Egypt 3% (3) of participants, Syria 2% (3) of participants, Arabian Gulf 17% (20) participants, Europe 2%, (2) U.S.A 2% of (2) participants, East Asia 6% (7) of participants and North Africa 18% (20) of participants. Figure 5.1 shows the geographical distribution of participants.

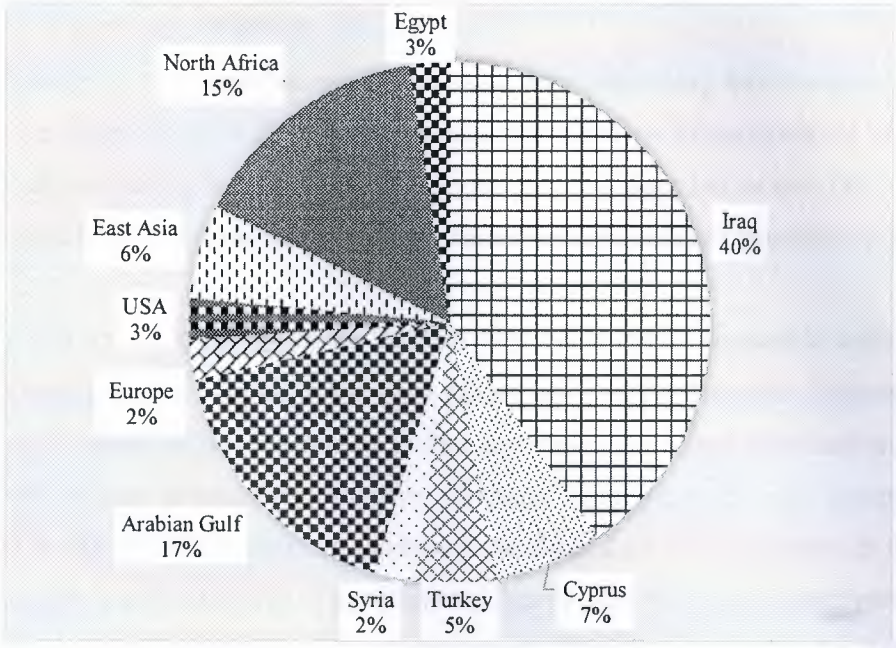


Figure 5.1: Geographic questionnaire participation

The participants were from different scientific area, and work in a variety of sectors. Under IT Management and Staff title there was a 24% (28) of participants, and Business Unit Management 9% (11) participants, Telecommunications Engineer 8% (10) of participants, Public users 24% (28) of participants, Programmer 19% (22) of participants, Owner & Executive Management 3% (4) of participants and Academy 13% (16) of participants. Figure 5.2 illustrates this:

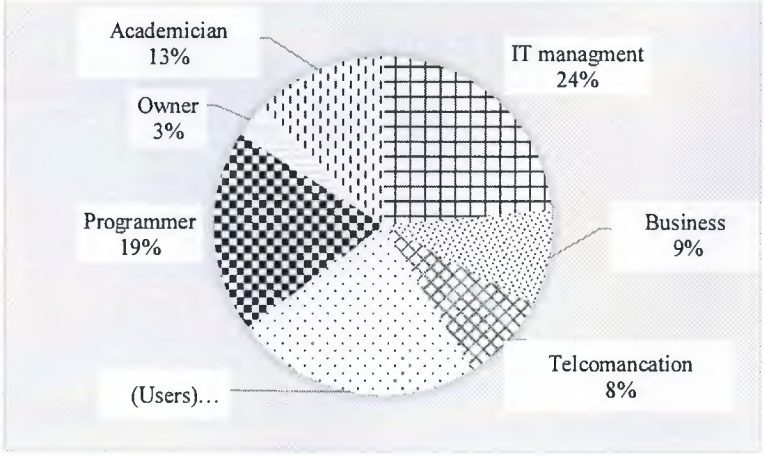


Figure 5.2: Background of questionnaire participants

5.3.3 Decision model participants

After conducting interviews and questionnaire mode then developing decision model approach depending on scorecard by which we can assess the situation of company or organization whether cloud computing is suitable for this organization or company or not. Decision model has been applied in 73 companies and organizations in eight deferent countries in the Middle East.

Companies and organizations from the Middle East exclusively compatible with the thesis topic have been selected. Emphasis has been placed on small and medium business, and the condition of the selection of case studies is that they have distributed information system on the network in one geographical location or more. Organizations and companies that participated in the test of the decision model are distributed on eight countries in the Middle East including Iraq with 25% (18) of participants, Cyprus with %12 (9) of participants, 21% of participants are from Turkey, 11% (15) of participants, from Syria 11% (8), the Arabian Gulf with 14% (10) of participants, Egypt with 6% (8) of participants, Jordan with 5% (4) of participants, and 4% (3) of participants are from Iran. Figure 5.3 illustrates the geographical distribution of participants.

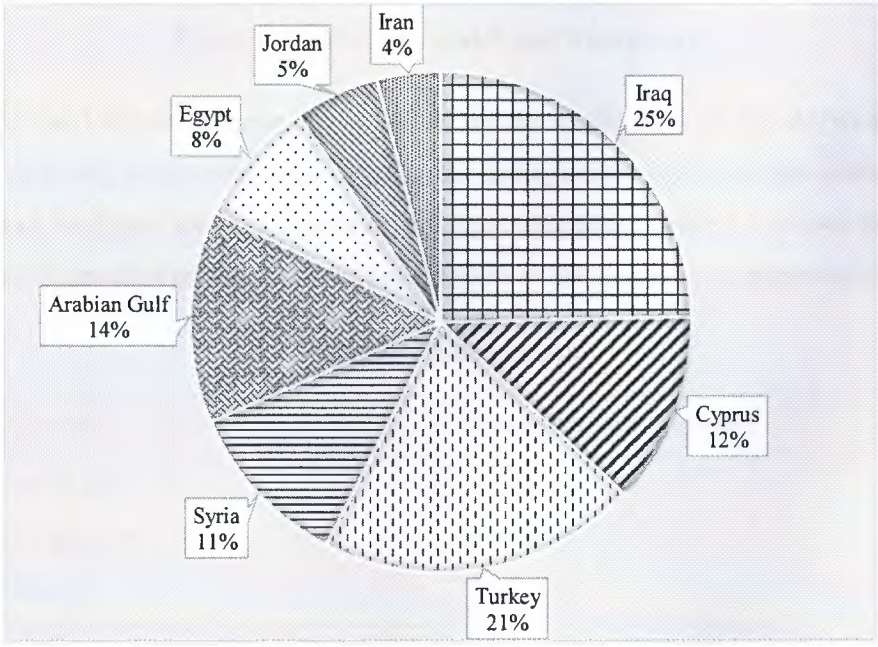


Figure 5.3: Geographical distribution of the decision model participants

As for the sectors in which they operate, eight different sectors are distributed as follows: Banking 11% (7) of participants, Education 12% (8) of participants, Military 2% (1) of participants, Communications 6% (4) of participants, information technologies 20% (13) of participants, Business and marketing 41% (26) of participants, Health 8% (5) of participants, and Media 7% (9) of participants. Figure 5.4 shows the sectors of the participants.

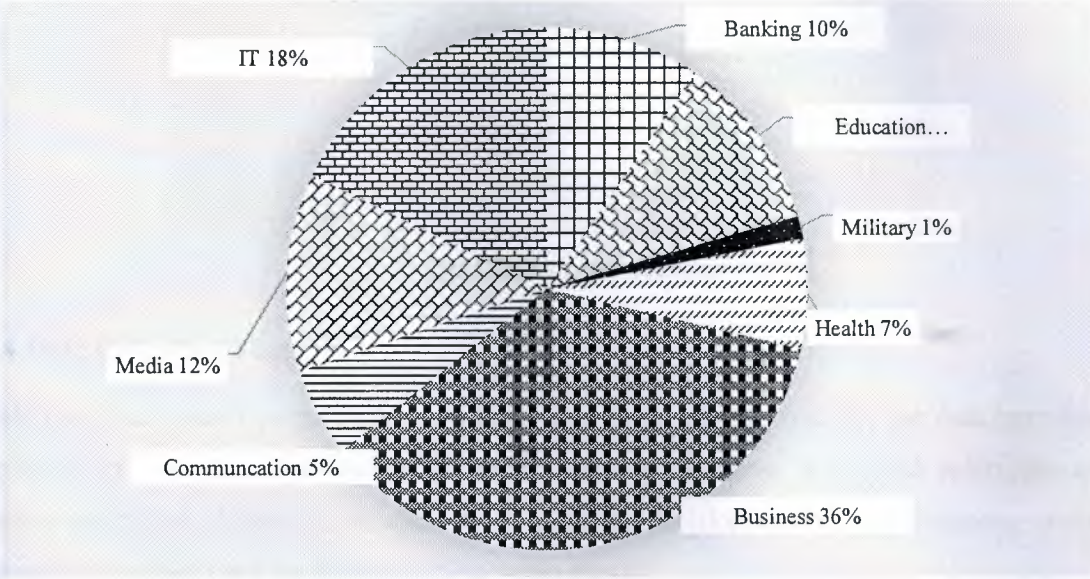


Figure 5.4: Decision model user background

The size of the business companies, involved in the application of the decision model is classified according to the principles of business management in region into three categories such as small business, medium business and large business. Table 5.3 shows the bases of classification depending on the number of employees in the company or organization.

Table 5.3: Business size

Classification	**Number of Employees**
Small business	1 to 50
Medium business	51 to 250
Big business	251 to 3000

In Figure 5.5 is to clarify the distribution of decision model participants with regard to size of the business.

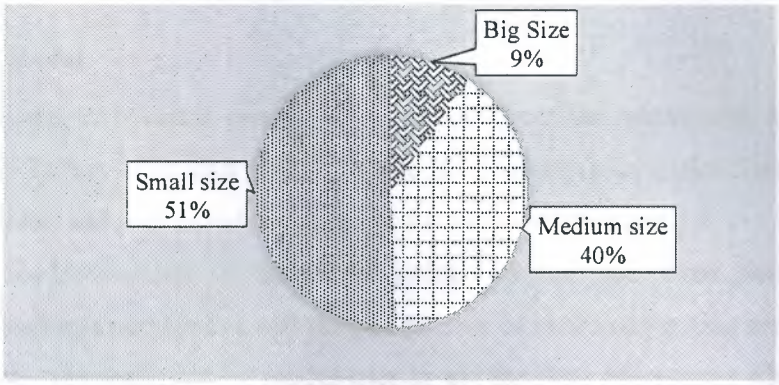


Figure 5.5: Business size in decision model

5.4 Data Collection Tools

Different Data collection methods have been used in this thesis, because the data have been collected in more than one country and three different ways have been used: interviews and online survey, in addition to the data of applying the decision model. The following section describes methods used for data collection in the thesis

5.4.1 Interview

In this thesis two types of questions have been edited, the first is a technical (TOP) the second is the business (BOB) based on the literature research and theoretical framework (Appendix A). Questions have been raised in interviews with experts, in meetings held in Cyprus and Turkey by meeting face to face with the participants in their offices during rest times answers have been recorded for the purpose of analyzing the answers, the time required to conduct the interviews ranged between 45 to 60 minutes. Interviews with specialists in Iraq and Syria conducted by telephone or Skype program, weekends have been selected to conduct interviews with specialists, so as to avoid affecting their time in working days.

5.4.2 Questionnaire

The questionnaire answering was easy, after clicking on the questionnaire link, questions with multiple answers for each question will appear, and the respondent selects the answers by clicks. The questionnaire consists of eight questions published on Google Drive-Google Forms

(Appendix B). Participants were selected in this questionnaire through sharing the questionnaire in scientific Facebook pages, as well as questionnaires link sent via email to people working in the field of information technology and business.

5.4.3 Decision model

The decision model distribution process was through direct interviews with the participants, by travelling to Turkey, Iraq and Cyprus, while the remaining countries Syria, the Arabian Gulf, Egypt, Jordan and Iran have been through the Skype application.

The decision model consists of thirty-five points divided into three parts: a technical perspective, a business perspective and the perspective of cloud computing services provider. Each perspective was evaluated by model user to get the final assessment which determines whether the company or organization is ready to move to cloud computing or not.

5.5 Data Analysis

Interviews, questionnaire and decision model include different data which need to analyze to get the factors that explain the success of the adoption of cloud computing or risk indicators facing cloud computing adoption. The following describes the analysis of the data in the thesis.

5.5.1 Interviews

Data collected during the interviews have been analyzed by the author.

5.5.2 Questionnaire

Qualitative statistics methods whose frequency, percentage and graphics where used to analyze the data collected by the questionnaire.

5.5.3 Decision model

The SMART decision model approach which is based on scorecard has been used to find out whether the company or organization is ready to move to cloud computing or not. As mentioned earlier, the purpose of the decision model is to assist in the decision to move from traditional computing to cloud computing, through the scenario evaluation of the organization or company through the decision model scorecard and according to the final score the readiness of the organization or company to move to cloud computing is determined. The

results of 73companies and organizations that have participated in the application of decision model, have varied in the four cases of the decision model Table 5.4 shows the scenarios and the basis of calculating results of the scorecard. Figure 5.6 illustrate the data collection steps:

Table 5.4: The scenarios

Scenario	**Description**	**Scorecard average result**
Perfect scenario	Excellent	Nine or above
Appropriate scenario	Ready	Seven or above until nine
Possible scenario	Ready but there is risk	Five or above until seven
Not appropriate	Not ready	Four or less

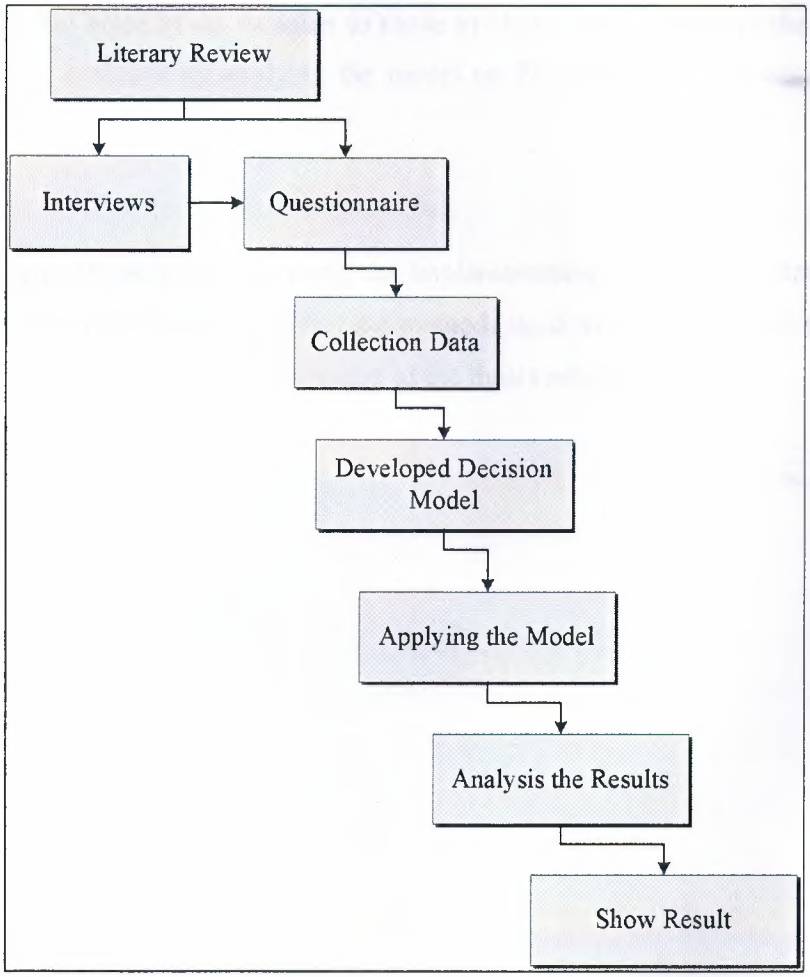


Figure 5.6: Data collection diagram

5.6 Implementation

After studying numerous articles, theses, books, studies and reports on cloud computing in the last period, a theoretical base about the subject has been formed. More debate about cloud computing is the process of moving from traditional computing to cloud computing. This topic has been the focus of research on previous studies. The Middle East has been chosen as the location of the study. Therefore, the researcher has to collect data over the region hence, interviews with specialists in information technology and business in the Middle East have been conducted as a stage to prepare for the design of the online questionnaire. The aim has been to get more accurate data about cloud computing in the Middle East. After that, data obtained from the questionnaire and interviews have been used in the development of a decision model that helps in the decision to move to cloud computing, then the results of the Model have been analyzed by applying the model on 73 organizations or companies in the Middle East.

5.7 Summary

The steps that have been followed during the implementation of this thesis have been taken with high accuracy and a prior study, and the methods used were different ways of collecting and analyzing data to blend in with the nature of the thesis subject.

CHAPTER 6

RESULTS & DISCUSSION

6.1 Overview

This chapter clarifies the results and analyzes of the steps performed in the previous chapters of the thesis. It also clarifies the results of preliminary interviews conducted with experts and the results of the questionnaire and finally the results of applying the decision model.

6.2 Interview Results

After conducting interviews with the participants the focus was on two main points which present the key answers to the research question, because the specialists interviewed will not add anything to what was published by cloud computing specialists, but they have experience in the Middle East market.

6.2.1 The reasons why Middle East countries not prefer to use the cloud computing

The participants from IT department in Cyprus think that the most important challenge facing cloud computing is the distance between cloud data centers and the Middle East region, as this causes delays while performing operations using the cloud. In other words, the performance of cloud computing in the Middle East may face difficulties.

Software developer participants and participants from the education sector in Iraq, in addition to the participants from Cyprus, all believe that there are no technical cadres, and think that the moving process from traditional computing to cloud computing is one of the main difficulties facing the spread of cloud in the Middle East. They noted that the reason for the lack of experiences is the major gap between the IT market needs and educational institutions.

Participants from Syria and network engineers in Iraq think that security and integration are the biggest obstacles to cloud computing in the Middle East. Security challenge faces the cloud computing in the Middle East and throughout the world. The integration problem is more influential on cloud computing in the Middle East, according to the participant's opinion.

6.2.2 The reasons why Middle East countries prefer to use the cloud computing

All participants agreed that cloud computing offers an opportunity to reduce costs, and they found this opportunity important especially for a few budgets in the medium and small business in the Middle East. All the participants think that the provision of electric power, cooling and maintenance for system infrastructure by cloud computing minimizes operating costs. In addition, they believe that, in cloud computing, there is great flexibility to increase computing capacity and minimize cost, therefore, it saves a lot of money spent on the purchase of the hardware. The geographical dimension between datacenters and Middle East countries, in addition to the problems of integration and security are the most important challenges facing cloud computing in Middle East from the opinion of specialists and there the similar previous difficulties with the US and Europe (Rehan, 2011).

6.3 Questionnaire Results

The following points explain the participants' answers to the questions in the questionnaire.

6.3.1The level of participants maturity in cloud computing

The level of understanding cloud computing is different among the participants. 17% (21) of participants comment that they do not know anything about cloud computing, 25% (35) of them have been interested in learning more about cloud computing, 15% (19) of participants said that they have knowledge about cloud computing, but do not use its services. 12% (15) of participants use cloud computing services without sufficient knowledge about it. 24% (29) of participants have good knowledge about cloud computing and use cloud services. Table 6.1 illustrates opinions of participants about cloud computing. It is worth mentioning that 71.5% (85) of the participants do not have enough understanding of cloud computing services even though some of them are using some cloud computing services. In addition to that, 25% (30) of participants who do not have enough understanding about cloud computing, are now interested in knowing more cloud computing services, and this is a good sign for the spread of the cloud computing in future.

Table 6.1: Cloud computing understanding level

Items	Percentage	Frequency
I do not know anything about cloud computing	17%	21
I am interested in knowing cloud computing now	25%	30
I know about cloud computing services but not used it	15%	19
I used it, but without enough understanding	12%	15
I have a clear understanding of cloud computing services and I use cloud services	24%	29
No responds	4%	5

6.3.2 Specifications important in cloud computing

The most interesting characteristics of cloud computing from the participants point of view is Broad network access. It has been selected by 56% (67) of participants. On demand self-service has been selected by 44% (53) of participants, support characteristics has been selected by 29% (35) of participants, and 27% (33) of participants for resource pooling and agility. Finally, measured service characteristics have been selected by 26% (32) of participants. Figure 6.1 illustrates these results.

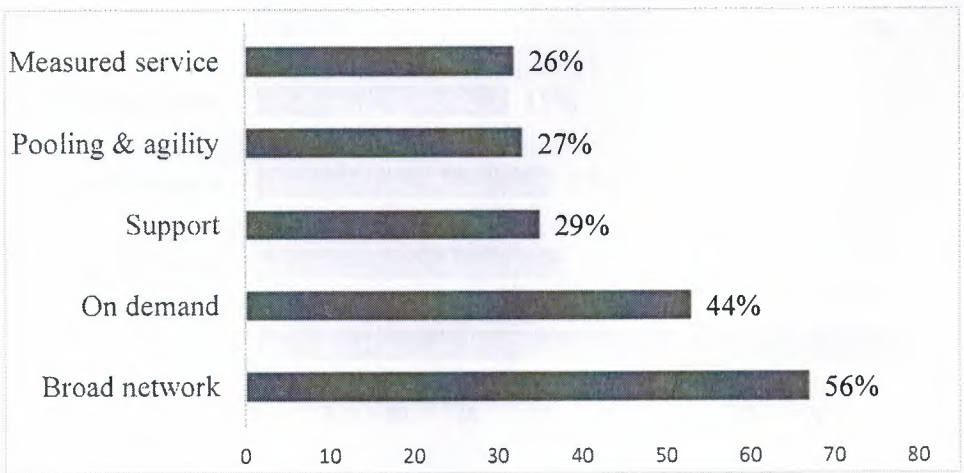


Figure 6.1: Opinions about cloud computing characteristics

On the positive side of cloud computing, 56.3 % (67) of participants found that access to cloud computing services from any device and from any place feature were attractive features. 44.5% (53) of participants found that demand in cloud computing was the second most important characteristics of cloud computing. The high percentage obtained by the previous two properties belonging to the strong need for these properties by users in the Middle East especially, therefore, to the deterioration of the security situation in most countries, which makes the idea of the possibility of doing the work from anywhere fantastic solution.

6.3.3 Cloud computing difficulties

Participants opinions about the difficulties faced by cloud computing in the Middle East were as follows: Most participants found that security is the biggest challenge facing cloud computing, through the choice of security by 39% (47) of participants. Integration between cloud computing services and existing systems, with legal challenges were selected each by 18% (22) of participants, problems which reduce the cloud computing service performance have been selected by 17% (21) of participants, lack of confidence in cloud computing service providers and insufficient understanding of cloud computing has been selected by 15% (18) of participants. Subscription difficulty with cloud computing services has been chosen by only 5% (7) of participants. Figure 6.2 illustrates these results.

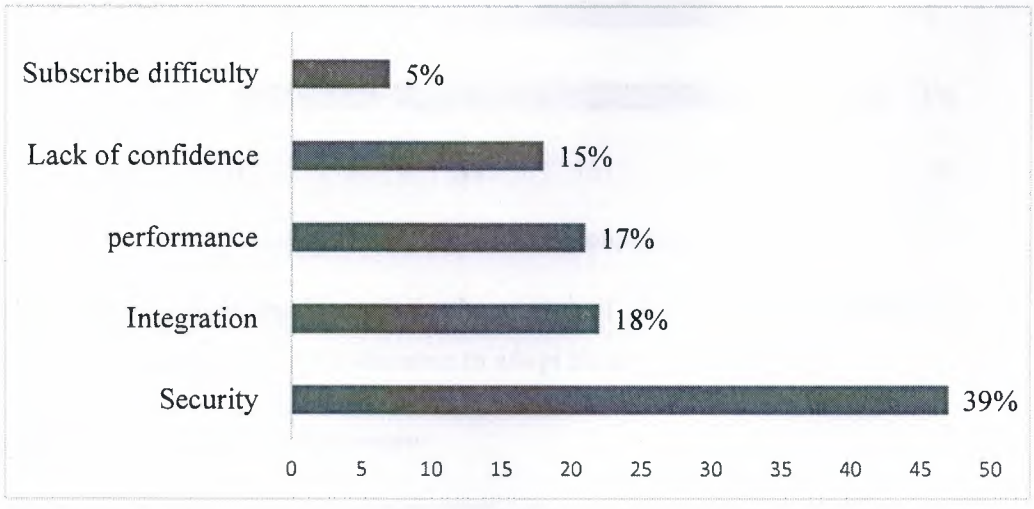


Figure 6.2: Opinions about cloud computing difficulties

39% (46) of participants think that security is the most important cloud computing problems, and then comes the lack of understanding of cloud computing by 15% (18) as one of cloud problem. These problems faced by cloud computing in the Middle East is not much different from the problems and difficulties in the U.S. and Europe (Mikalsen, 2009).

6.3.4 Group drives

As for the question about what is the most influential group in the cloud computing spread, 23% (28) of participants have chosen users group as the most influential in the spread of cloud computing, 22% (27) of participants have chosen business owners as the most influential in the cloud computing, programmers chosen by 18% (22) of participants, IT companies and IT Staff chosen by 17% (21) of participants and consultants and analyst centers & educational institutions chosen by 19% (23) participants. Figure 6.3 illustrates these results.

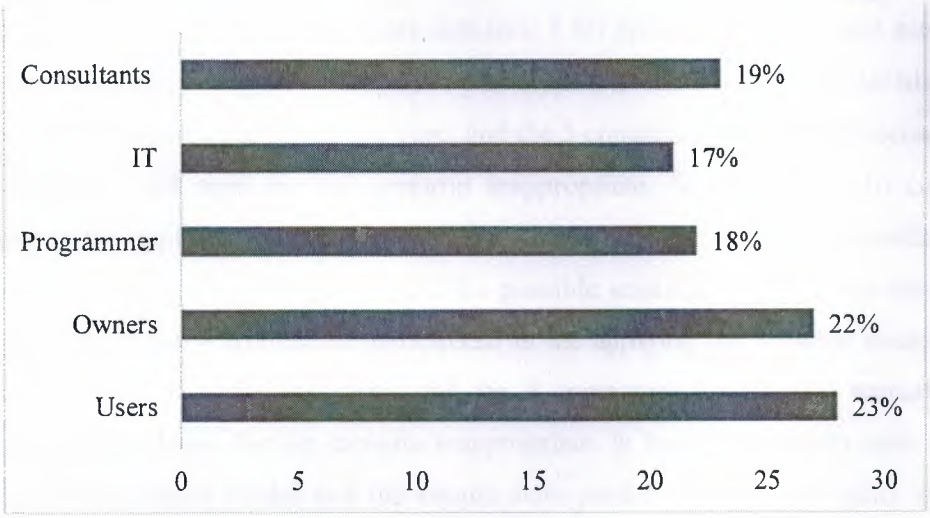


Figure 6.3: Influential groups opinions

Users and owners have the big role in the spread of cloud computing, that's because they represent the financial side in the decision to adopt cloud computing.

6.4 Decision Model Results Overview

The following sections of this chapter deals with the results of the decision model and the analysis and comparisons of the results accompanied by figures and tables explained in the results.

6.4.1 Geographical comparison of results

Decision model results differed, in each of the eight participating countries in accordance with the requirements of the business and the level of economic and business size. Table 6.2 shows the details of the results of the application of the decision model for each state. Results of applying the decision model in Iraq total of 18 companies participated, 18 Company results were a possible scenario is, the rest scenarios was zero. In Cyprus 9 companies participated in applying the decision model and the results for perfect scenario was zero, and for 3 companies the results was appropriate scenario, 6 for possible scenario, and zero for the inappropriate scenario. 15 companies participated in Turkey in applying the decision model and the results were perfect scenario was zero, and for 11 companies the result was appropriate scenario, 4 for possible scenario, and zero for the scenario inappropriate. In Syria 8 companies participated in applying the decision model and the results were perfect scenario was zero, and for 6 companies the result was appropriate scenario, 2 for possible scenario, and zero for the scenario inappropriate. In Egypt 6 companies participated in the applying the decision model and the results were perfect scenario was zero, and the 3 companies appropriate scenario, 3 for possible scenario, and zero for the scenario inappropriate. In Arab Gulf 10 companies participated in the applying the decision model and the results were perfect scenario is zero, and the 8 companies appropriate scenario, 2 for possible scenario, and zero for the scenario inappropriate. In Jordan 4 companies participated in the applying the decision model and the results were perfect scenario was zero, and the 3 companies appropriate scenario, 1 for possible scenario, and zero for the scenario inappropriate. In Iran 3 companies participated in the applying the decision model and the results were perfect scenario was zero, and the 1 companies appropriate scenario, 2 for possible scenario, and zero for the scenario inappropriate.

Table 6.2: Geographical distribution of results

Country	Number of perfect scenario	Number of appropriate scenario	Number of possible scenario	Number of not appropriate scenario
Iraq	0 out of 18	0 out of 18	18 out of 18	0 out of 18
Cyprus	0 out of 9	3 out of 9	6 out of 9	0 out of 9
Turkey	0 out of 15	11 out of 15	4 out of 15	0 out of 15
Syria	0 out of 8	6 out of 8	2 out of 8	0 out of 8

Arab gulf	0 out of 10	8 out of 10	2 out of 10	0 out of 10
Egypt	0 out of 6	3 out of 6	3 out of 6	0 out of 6
Jordan	0 out of 4	3 out of 4	1 out of 4	0 out of 4
Iran	0 out of 3	1 out of 3	2 out of 3	0 out of 3

Note that the results of the countries where there are laws and regulations of contracts and agreements in the field of information technology are the most preparation to move to cloud computing, in addition to the countries that have relatively high speed internet communication service, such as Turkey and Gulf countries.

6.4.2 Results according to business size

As was mentioned in the earlier part of the thesis, the companies have been classified according to their sizes: small businesses, medium businesses and large businesses. For the 37 Small business companies that participated in the decision model the results were as follows: perfect scenario 0, appropriate scenario 22, possible scenario15, not appropriate scenario 0. For the 29 medium size companies that participated in the decision model the results were as follows perfect scenario 0, appropriate scenario 13, and possible scenario16, not appropriate scenario 0. Table 6.3 shows the results of applying the model according to the business volume. For the 7 big size companies that participated in the decision model the results were as follows perfect scenario 0, appropriate scenario 0, and possible scenario 6, not appropriate scenario 1.

Table 6.3: Results according to business size

Business size	**Number of perfect scenario**	**Number of appropriate scenario**	**Number of possible scenario**	**Number of not appropriate scenario**
Small size	0 out of 37	22 out of 37	15 out of 37	0 out of 37
Medium size	0 out of 29	13 out of 29	16 out of 29	0 out of 29
Big size	0 out of 7	0 out of 7	6 out of 7	1 out of 7

The small and medium business in the Middle East are the most ready to move to cloud computing, and this is consistent with the United States and Europe, there is also small and medium businesses are most appropriate (Rehan, 2011).

6.4.3 Results according to sectors

The results in the decision model by the eight sectors were as follows: the 7 companies in banking sector were the perfect scenario 0, appropriate scenario 3, possible scenario 4, not appropriate scenario 0. The 8 organizations in education sector were the perfect scenario 0, appropriate scenario 4, possible scenario 3, and not appropriate scenario 1. The 4 companies in communications sector were the perfect scenario 0, appropriate scenario 2, possible scenario 2, and not appropriate scenario 0. The 4 companies in information technologies sector were the perfect scenario 0, appropriate scenario 8, possible scenario 5, and not appropriate scenario 0. The 26 companies in business and marketing sector were the perfect scenario 0, appropriate scenario 9, possible scenario 17, and not appropriate scenario 0. The 5 companies in healthy sector were the perfect scenario 0, appropriate scenario 2, possible scenario 3, and not appropriate scenario 0. The 9 companies in Media sector were the perfect scenario 0, appropriate scenario 7, possible scenario 2, and not appropriate scenario 0, In addition to one military organization, and result was the appropriate scenario. Table 6.4 shows the details of the results of the decision model according to the sectors.

Table 6.4: Results according to the sectors

Sectors	Number of perfect scenario	Number of appropriate scenario	Number of possible scenario	Number of not appropriate scenario
Banking	0 out of 7	3 out of 7	4 out of 7	0 out of 7
Education	0 out of 8	4 out of 8	3 out of 8	1 out of 8
Military	0 out of 1	0 out of 1	1 out of 1	0 out of 1
Communications	0 out of 4	2 out of 4	2 out of 4	0 out of 4
Information technologies	0 out of 13	8 out of 13	5 out of 13	0 out of 13
Business and marketing	0 out of 26	9 out of 26	17 out of 6	0 out of 6
Healthy	0 out of 5	2 out of 5	3 out of 5	0 out of 5
Media	0 out of 9	7 out of 9	2 out of 9	0 out of 9

Marketing and information technology and the media are the most ready to move to cloud computing and it is often because these areas close to the global technological market.

6.5 Results of the Developer Decision Model

The decision model approach as mentioned earlier includes three perspectives: technical, business, and cloud computing service provider. The results of each perspective will be discussed in the following sections. Then the final result that show if the companies/ organization in Middle East are ready to adopt cloud computing, and the results compered by business size, sectors and geographical were explained.

6.5.1 Technical perspective

The technical perspective was represented in 15 points in the scorecard and was evaluated by the decision model users. The results of the technical perspective were: inappropriate scenario 1% (1), appropriate scenario 55% (40) and possible scenario 44% (32). 6.4 Figure shows technical perspective results.

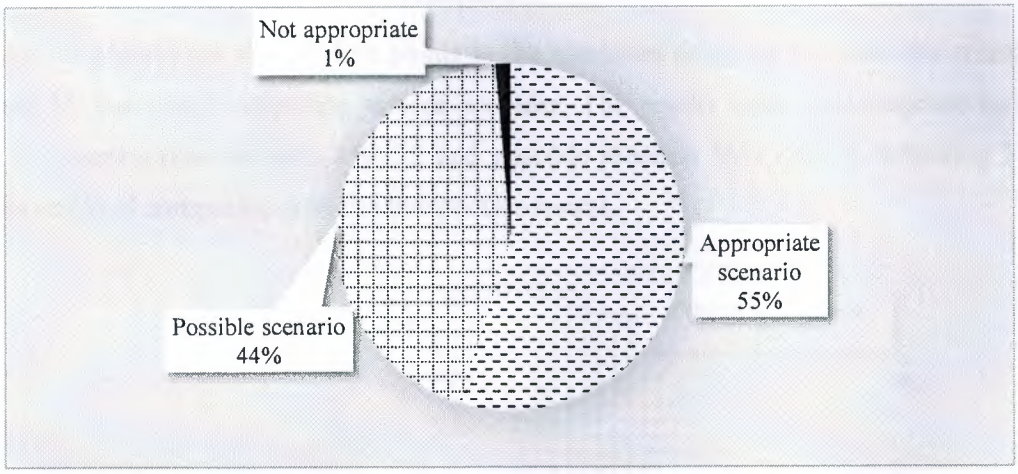


Figure 6.4: Technical perspective result

6.5.2 Business perspective

The business perspective was represented in 15 points in the scorecard and was evaluated by the decision model users. The results of the business perspective were: inappropriate scenario one, appropriate scenario 65% (48), perfect scenario 4% (3), and possible scenario 30% (22). Figure 6.5 shows Business perspective results.

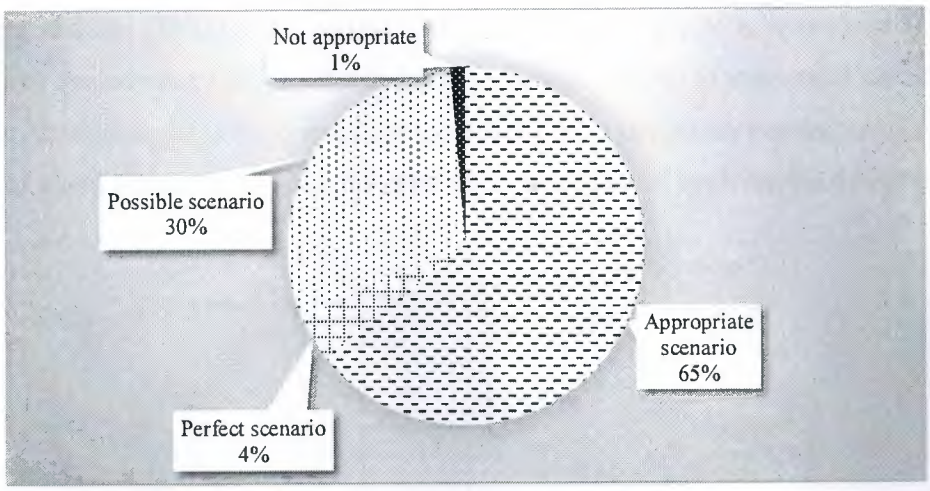


Figure 6.5: Business perspective result

6.5.3 Cloud computing provider perspective

This aspect was represented by five points in the scorecard designed to assess the criteria for services by the cloud computing service provider. The results were: inappropriate scenario 60% (44), appropriate scenario 4% (3), and possible scenario 36% (26). A following Figure 6.6 shows cloud computing provider perspective results.

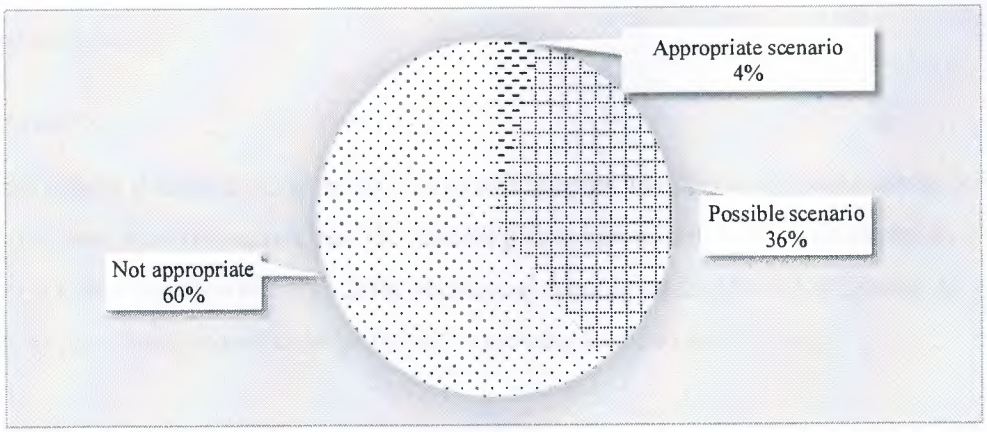


Figure 6.6: Cloud computing provider perspective result

6.6 General Results

After applying the decision model in 8 different countries in Middle East, the results were: for 51% (35) of companies or organizations the result was an appropriate scenario to adopt cloud

computing and for 48% (37) the results was a possible scenario to adopts cloud computing. But for only one company the result was not appropriate scenario to move to cloud computing. It is worth mentioning that there wasn't any company or organization that had perfect scenario to move to cloud computing. Figure 6.7 represents the results of applying the decision model.

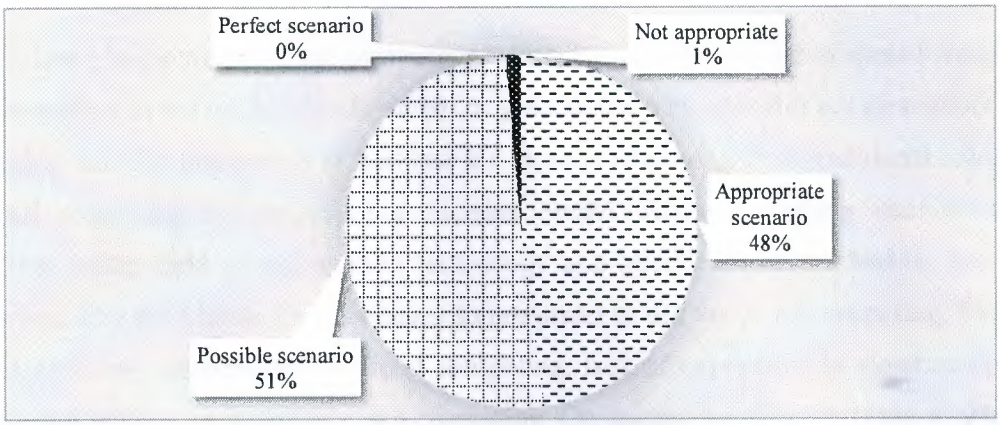


Figure 6.7: the result of the developed model

From the results one notes that the perspective of providers of cloud computing services has a negative effect on the readiness of companies and organizations to move to cloud computing, either technical perspective or business companies in the level of readiness allows one to move to cloud computing.

6.7 Summary

From the results that have been mentioned in this chapter, the following point can be raised: The interviews, questionnaires, and the resulting decision model have been useful in deciding whether a company should move from traditional computing to cloud computing. In general, the results have been shown to be positive for moving to cloud computing.

CHAPTER 7

CONCLUSIONS & RECOMMENDATIONS

7.1 Conclusions

As mentioned in the thesis, cloud computing, which has recently started to spread worldwide, is the new wave in the world of technology. In general, the picture is still not clear about cloud computing, and this thesis aims to facilitate the process of moving from traditional computing to cloud computing by proposing a decision model. After conducting interviews with specialists in the field of information technology and businesses in the Middle East, it is determined why the Middle East countries do not prefer to use the cloud computing. The main reasons are: slow performance of cloud computing, lack of experience in cloud computing, security and integration issues of cloud computing. On another hand, the reasons why Middle East countries prefer to use the cloud computing are: reduced overall costs, reduced operating costs, and great flexibility with increased computing capacity.

Questionnaires are prepared to get opinions of the participants from many sectors and different academic backgrounds about cloud computing in the Middle East. The decision model created by the author should help any organization or any business to make the correct decision in moving from the traditional computing to cloud computing. This decision model thus should help the organizations or the businesses to save money by not making the wrong decision.

The security and the lack of cloud computing understanding were the biggest difficulties faced by the participants before considering a move to cloud computing. Users and owners have the big role in the spread of cloud computing in a company or a business. After the interviews, questionnaires were developed and the created decision model has been applied in Middle East countries to find out the readiness of a company or an organization to move to cloud computing in the Middle East. The important conclusions of the thesis are summarized in the following items:

1- Small and medium businesses are more suitable for the adoption of cloud computing at this time.

2- Organizations and companies that do not have sensitive data are the closest to the adoption of cloud computing.
3- For newly established organizations or companies, the adoption of cloud computing will be much less complicated and less costly.
4- The greatest difficulty in the process of moving to cloud computing is service providers. The failure rate on the side of providers of cloud computing services in the scorecard is very high, because in the Middle East there is no a big companies provider of cloud computing does not have wide activities.
5- The technical aspects which received the highest evaluation by the organizations and companies participating in the decision model, is the cost of supplying electrical energy and freedom from the responsibility of providing electricity. In addition to reducing the costs of maintenance and updates.
6- Cloud computing brings flexibility to businesses and provide high computing power at reduced storage and processing costs. In general, small to medium sized companies will find it easier to move from traditional computing to cloud computing, especially during their expansion.

Since cloud computing is still fledgling in the IT market, it is natural that there are many difficulties and challenges facing cloud computing, security, consistent performance and integration are the most important challenges facing cloud computing services. To test the cloud computing service performance in the systems which host cloud computing services, and find solutions to problems such as latency and delay between the cloud and the customer, these challenges constitute a rich topic for research and future studies.

7. 2 Recommendations

The Information Technology field is one of the most rapidly evolving fields, since cloud computing is one of the results of the continuing evolution of the IT field. In order to keep pace with this evolution, scientific institutions in the Middle East must give more attention to cloud computing, starting from scientific conferences and research studies, in addition to providing new courses to form a good scientific basis about new technologies, especially for college students. These steps should help to reduce the gap between the market requirements and scientific institutions, and this actually happened when IBM and Google started a

cooperation initiative with universities to prepare unemployed graduates through long specialized courses at the university.

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Appendix A

OPEN – END QUESTIONS

Section 1: Technical (TOP)

1- What is your job title and responsibilities in the organization?

2- What are the main areas of work of your organization? Do you consider it as a large, medium or small enterprise?

3- Is there a network connecting computers in your organization? What is the number of computers in your organization? Is the network in your organization next ends in different geographical locations?

4- Are their servers in your organization? Is Virtualization, SOA, ASP, HOSTING, Gird computing technology used in your organization?

5- Does your organization use outside resources? Is Internet service available in your organization? What is the speed of the internet service?

6- Do your organization use cloud computing services? Are you planning to adopt cloud computing services in the future? Please provide a reason if yes or no?

7- Who is responsible for making the decision to adopt cloud computing in your organization?
(Please provide the title of the person and the relevant department)

8- From your point of view, what is needed in order to adopt cloud computing services in your organization?

9- What are the difficulties faced by your information technology department? Is the development and maintenance aspect of cloud computing expensive and time consuming for your organization?

10- Please comment on following points about the difference between the responsibility for on- premise and infrastructure as a service:
On – premise responsibility
APP, Run times, Security , Integration
Database

Servers

Virtualization

Storage and network

In IaaS responsibility

APP, Run times, Security, Integration

Database

11- From your view what are the reasons for latency in Network in cloud computing and in on- premise? What are the appropriate solutions?

12- Is Cloud computing scalability a better choice than upgrading and adding more computing power?

13- What are the bandwidth problems you have in Cloud computing and in on-premise?

Section 2: Business (BOP)

1- What is your job title and responsibilities in the organization?
2- What are the main areas of work of your organization? Do you consider it as a large, medium or small enterprise?
3- Is there a network connecting computers in your organization? What is the number of computers in your organization? Is the network in your organization extends in different geographical locations?
4- Are there servers in your organization? Are Virtualization, SOA, ASP, HOSTING, Gird computing technology used in your organization?
5- Does your organization use outside resources? Is Internet service available in your organization? What is the speed of the internet service?
6- Does your organization use cloud computing services? Are you planning to adopt cloud computing services in the future? Please provide a reason if yes or no?
7- Who is responsible for making the decision to adopt cloud computing in your organization?
   (Please provide title of the person and the relevant department)
8- From your point of view, what is needed in order to adopt cloud computing services?
9- What are the difficulties faced by your information technology department? Is the development and maintenance aspect of cloud computing expensive and time consuming for your organization?
10- In your opinion, is there any need to develop the IT department in your organization, which is deferred due to financial constraints?
11- Do vacations and holidays for the IT department staff pose a problem for the operations of your organization?
12- Do you think the maintenance and updating of systems and programs affect the work of your organisation as it consumes too much time?

APPENDIX B

THE OPINION OF COUNTRIES ON CLOUD COMPUTING

The aim of theses questionnaire is to find out about your opinions on cloud computing. This is an academic research about cloud computing adoption in the Middle East the case of the Near East University. This questionnaire will be anonymous and the result of question will be used for academic purpose only. It may take you no more 15 minutes to complete it, thank you for you for patience and cooperation.

1- Country (*Choose one only)*

- ◯ Iraq
- ◯ Cyprus
- ◯ Turkey
- ◯ Syria
- ◯ Egypt
- ◯ Arabian Gulf
- ◯ Europe
- ◯ USA
- ◯ East Asia
- ◯ North Africa

2. Job (*Choose one only)*

- ◯ IT Management and Staff
- ◯ Business Unit Management
- ◯ Telecommunications Engineer
- ◯ Public (Users)
- ◯ Programmer
- ◯ Owner & executive Management
- ◯ Academy

3. The number of employees in your organization (*Choose one only)*

- ◯ 1-20
- ◯ 20-100
- ◯ 100-1000
- ◯ 1000-3000

4. How well do you know what cloud-computing services are? (*Choose one only)*

- ◯ I do not know anything about cloud computing
- ◯ I am interested in knowing cloud computing now
- ◯ I know cloud computing services but not used it
- ◯ I used it, but without enough understanding
- ◯ I have a clear understanding of cloud computing services and I use cloud services

5. Choose from the following list of technologies and services that is used in your business or on a personal level

- ☐ Virtualization
- ☐ Service Oriented Architecture (SOA)
- ☐ Application Service Provider (ASP)
- ☐ Hosting
- ☐ Grid Computing

6. Which service from cloud computing services you use? (***Choose one only***)

- ☐ IaaS (Infrastructure as a Service) Customers rent CPU, storage, networking and other PaaS (Platform as a Service) rent infrastructure and programming tools
- ☐ SaaS (Software as a Service) Customers rent software hosted by the vendor

7. What are the characteristics of cloud computing that you find suitable for your use?

- ☐ On demand self-service (The use of services without the need to pro people)
- ☐ Broad Network access (Use of services from any device (mobile, desktop, laptop) from anywhere)
- ☐ Resource pooling (Infrastructure services such as storage, network processing, memory, Bandwidth)
- ☐ Rapidly elasticity (Increase and decrease capacity as needed automatically)
- ☐ Measure Service (Method of payment for the services will be depending on usage such as electric power and municipal water)
- ☐ Support (Get rid of the maintenance costs, cooling, software licenses and updates)

8. What are the challenges you face to adopt cloud computing

- ☐ Security and Privacy
- ☐ Integration (Incompatibility of systems and programs in your organization with cloud

computing services)

- ☐ Lack of confidence in the quality of cloud computing services
- ☐ Performance (Problems in the network, Internet and the lack of Bandwidth)
- ☐ Ambiguity (Lack of understanding of cloud services and the lack of educational institutions and IT supporting this technology)
- ☐ Legal problems (There are no laws in your country guarantee your right to use services like cloud)
- ☐ Subscribe (there is no cloud computing agencies and difficult to subscribe Online)

9. What is the cloud model you use, or find suitable for your business? (***Choose one only)***

- ◯ Public Cloud (Access it via the Internet is managed by the provider)
- ◯ Private Cloud (Accessible via the intranet, location is known)
- ◯ Hybrid Cloud (Is the union between the public and private cloud)

10. Who is the most influential in the decision to move to cloud computing in your organization? (***Choose one only)***

- ◯ Public and Users
- ◯ IT Organizations & IT Staff
- ◯ Programmers
- ◯ Owners & Executive Management
- ◯ Consultants and Analyst centers
- ◯ Educational institutions

Is this questionnaire encouraged you to search more about "Cloud Computing" (***Choose one only)***

- ◯ Yes
- ◯ Yes, but I do not know how to Start
- ◯ No

APPENDIXE C

SCORCARD SOFTWAER

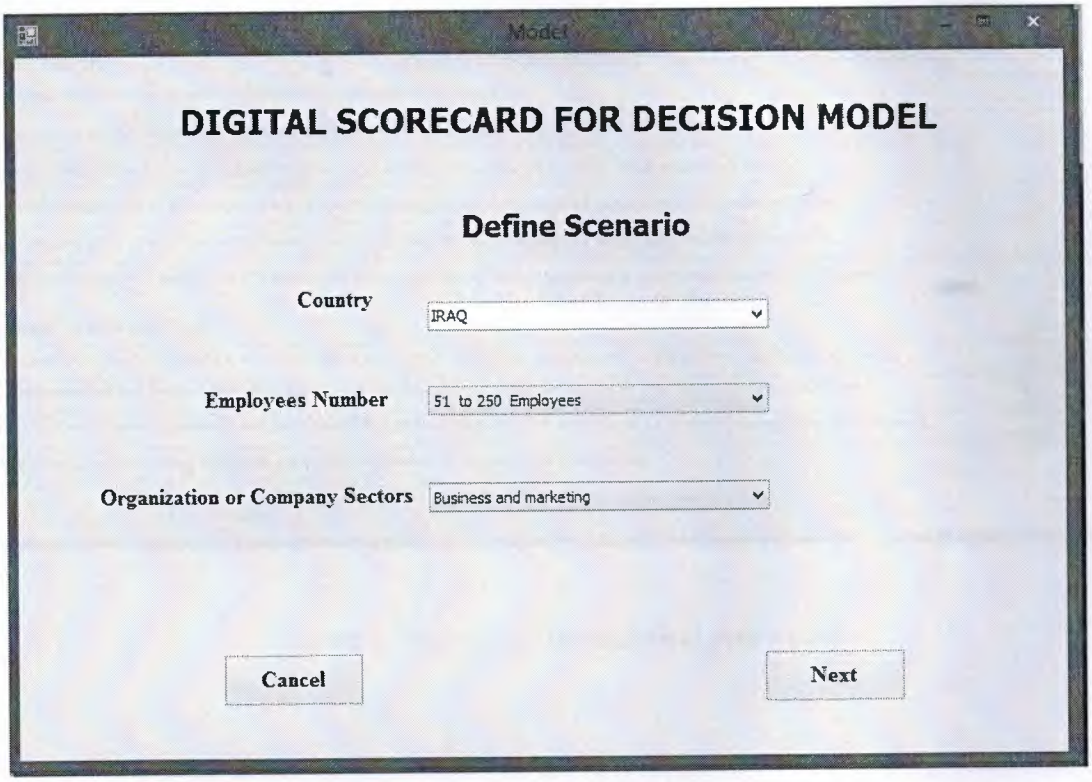

Figure 1: Snapshot of the define scenario

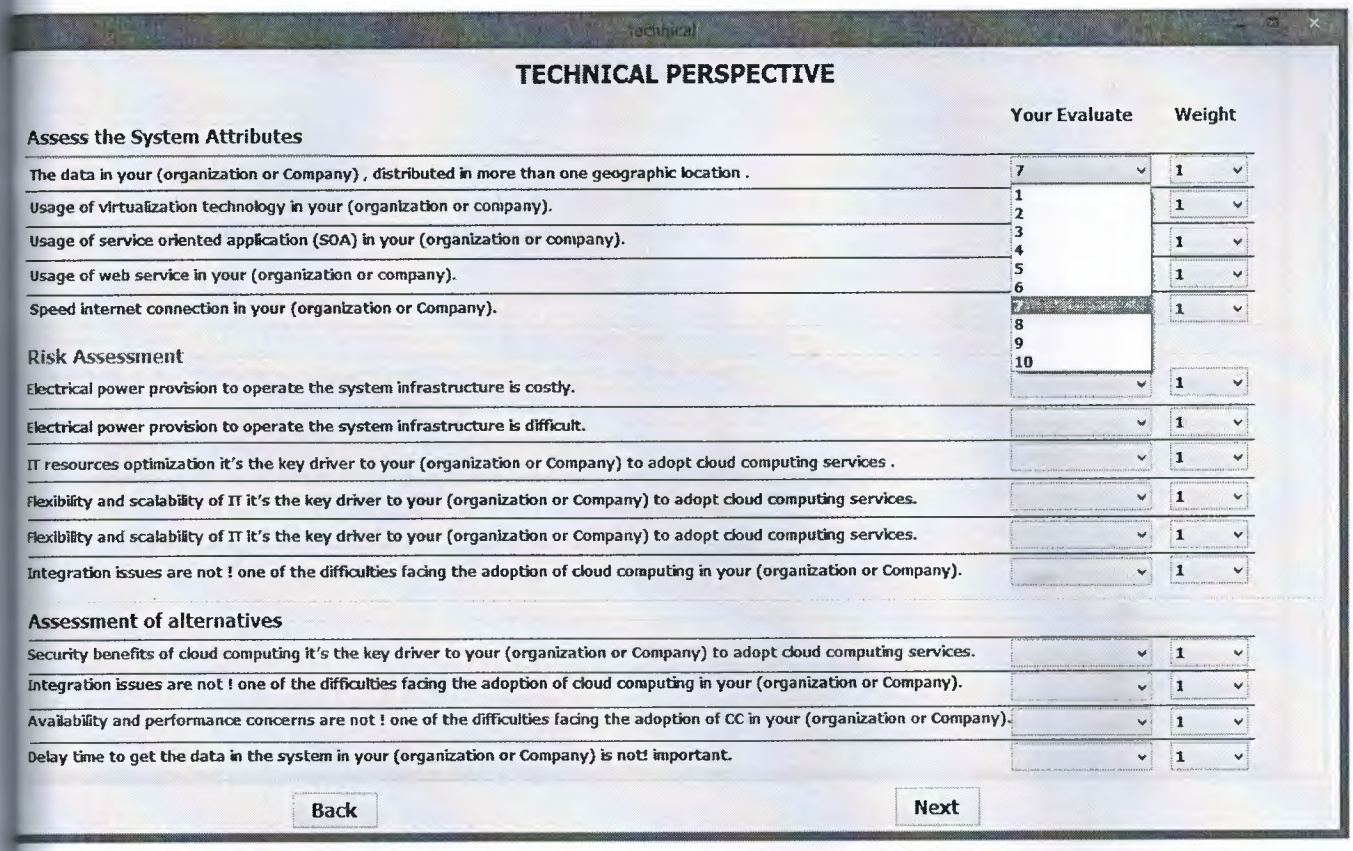

Figure 2: Snapshot of the technical perspective

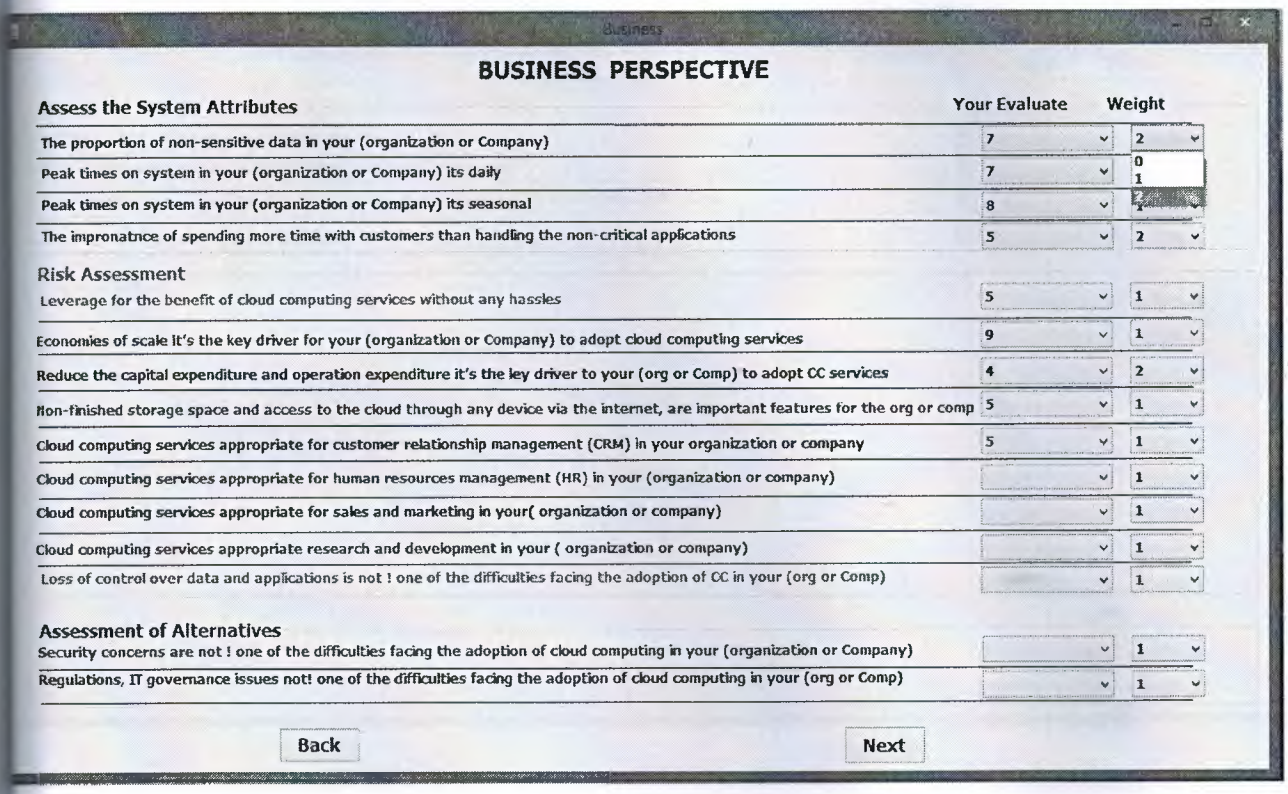

Figure 3: Snapshot of the business perspective

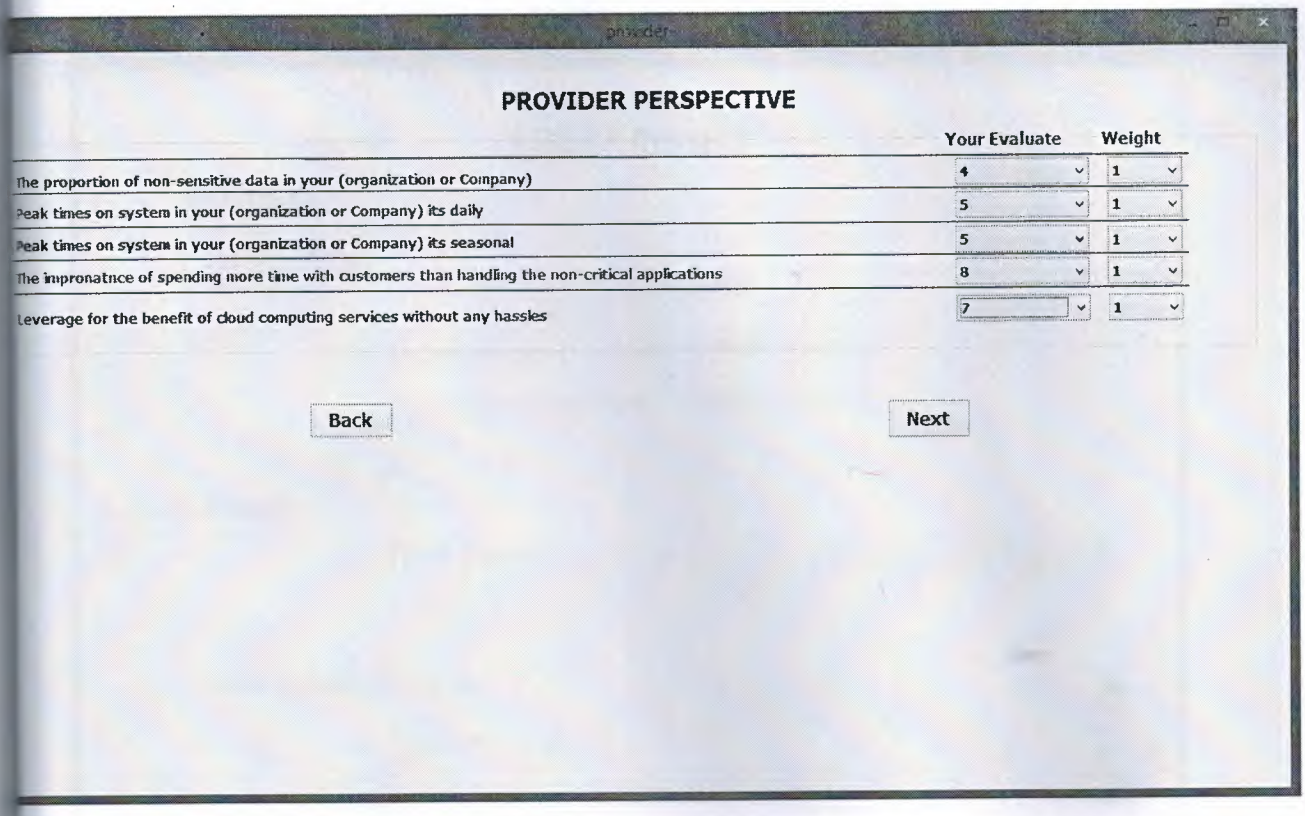

Figure 4: Snapshot of the provider perspective

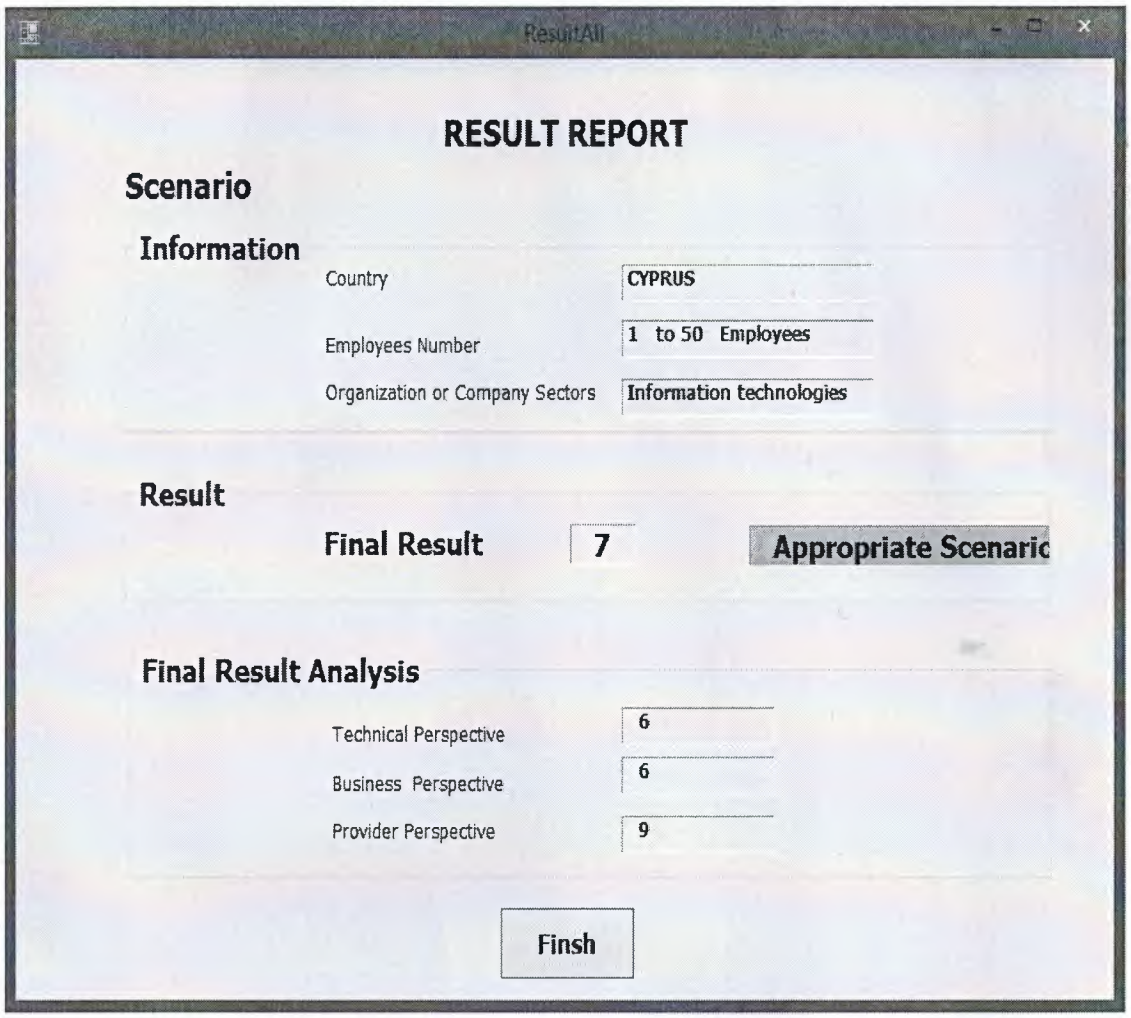

Figure 5: Snapshot of result