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Cloud Growth and Challenges

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Abstract

The purpose of this thesis is to probe more into how users are influenced to use cloud computing amidst the various cloud challenges and risks. Cloud computing is a new and advanced way of handling services, applications, resources, infrastructures and as any other Information Technologies, is composed of challenges and as well as possibilities. But like other technologies that die along with its challenges, cloud computing usage is increasing by each year. Thus the risks, challenges and the factors that influence users were the motivation for our research.

But our interest on this matter also showed the limited amount of resources available about the issue. Though it was difficult for us to do enough literature analysis, it was also another motivation for us to contribute our knowledge and findings to the limited resources available.

We designed a literature model based on our literature reviews, and compared it to our empirical framework that we designed from our interview analysis.

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- Farhana Kabir

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- Zeba Shamshad Chowdhury

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1 Introduction

As business continues to grow, business tends to depend more on IT for better efficiency. And as the dependency grows, the resources required running the business grows as well. Thus organizations build complex and massive infrastructures that are generally underused. The complex IT infrastructures made are expensive and time consuming. Hence organizations are forced to take service from other external IT services or providers who offer cloud computing services.

Cloud computing has its benefits such as elasticity and easily scalable, it can be used when it is needed, charged according to service usage, multi-tenancy, virtualization and better resource management etc. but it also has disadvantages such as poor service agreements, inflexible, inability to manage risks, vendor lock-in etc (Table 1.1).

Table 1.1 Benefits and drawbacks overview for growth of cloud computing. (Armburst et al., 2009, p.54)

Obstacle	Opportunity
Availability of Service	Use Multiple Cloud Providers
Data Lock-In	Standardize APIs
Data Confidentiality and Auditability	Deploy Encryption, VLANs, firewalls; Geographical Data Storage
Data Transfer Bottlenecks	Data Backup/Archival
Performance Unpredictability	Improved VM Support; Flash Memory
Scalable Storage	Invent Scalable Store
Bugs in Large Distributed Systems	Invent Debugger that relies on Distributed VMs
Software Licensing	Pay-for-use licenses

A business having sensitive data and using cloud services might be unaware where its data is located and in which country; the country could have different data security rules. The president of servers and tools at Microsoft, admitted in one interview published on the internet, that Microsoft Cloud Service would have to hand over their data in the cloud to the US authorities if they are asked to, since they have no right or agreements to keep sensitive information away from them.

A recent cloud research by International Data Corporation (IDC, n.d) showed that world revenue from public cloud services have risen from $21.5 billion in 2010 and will rise to $72.9 billion in 2015. The cloud is happening and will rise even though it has many disadvantages and dangers embedded with it. Business organizations are confused and unclear about their rules and

drawbacks, many cloud vendors have limited transparency and are not honest with their users. As a result organizations are providing sensitive information to the internet with security that a third party service controls and as the organization uses the cloud services it falls into vendor lock-in where it is difficult to escape.

1.1 Research Motivation and Objectives

In 2011 Amazon's Cloud service crashed while it was performing a system upgrade, as a result, their customers where off-line for several days. Also, in the same month, Sony Play Station Network was hacked leaking the information of millions of users around the world (Cachin and Schunter, 2011). And after two months, in June, due to an error in the cloud storage provider Dropbox, any guest was allowed to log in and view the contents of any of their millions of customers (Cachin and Schunter, 2011). This is an alarming and important issue in today's world where virtualization is at its peak. Most of the people are now putting up their private information in places they have no information about. Since resource is an important factor nowadays, the people need to store more data, hence they are forced to use services that take their personal photos, information, emails, etc. and store it somewhere other than their personal computer or storage. The service providers are also promising security and trust to guard that personal information.

Organizations do not want to deploy an in-house IT infrastructure anymore; it is more convenient and efficient for them to use resources (from cloud providers) that can scale according to their usage and needs and also eliminates IT infrastructure costs (Molony and Kirchheimer, 2011). As a result, more and more organizations are moving to the cloud as cloud providers tend to offer better services in terms of cost, security, resources, etc. Kevin Crowe, Director of Cloud Services at Longview Systems, said "in 2012, 20% of businesses will own no IT assets, and Cloud will account for 25% of IT budgets.**"** Cloud computing has become a major issue in today´s phenomena. It is growing very rapidly. It has increased 65% from 2010 and almost 45% of the Multi-National Companies have adopted cloud computing. (Molony and Kirchheimer, 2011)

Small and medium sized companies were the initial focus of cloud computing but now large companies are also adopting cloud at some extent for IT services. Mostly they use it for taking backup and storage of data in the cloud. According to the research made by Molony and Kirchheimer (2011), it was found that "matching capacity to user demand" and "scalability of capacity" and "increased speed of provisioning" attracts Multi-National Companies the most. However, there was also mentioned that though most of the cloud providers are using "pay as you go" approach, so small or medium sized companies get certain benefits as: the start up cost is low, risk is low, easy to add new services from cloud portfolio and elasticity of up and down

services when needed (Molony and Kirchheimer, 2011). On the other hand, Molony and Kirchheimer (2011) found that companies are worried about certain issues to adopt cloud computing, as security, data governance, public internet infrastructure and loss of control.

Consequently, the increase of cloud computing is becoming a problem in recent time. There was a report published in the Newspaper "The Local" of Sweden on the risks of cloud computing. The headline was, "Sweden warns firms of cloud computing risks" and the sub- heading was, "Hundreds of Swedish companies have lost out on large international contracts after their secrets were leaked to competitors due to security breaches as a result of the explosion in cloud computing"(The Local, 2011)

For the above reasons, according to many researchers, cloud is now evolving from cloud 1.0 to cloud 2.0. Cloud 2.0 is believed to use web 2.0 functionalities into cloud applications (Pallis, 2010). Cloud 2.0 would be focused on providing value to their customers, and would be more user-centric. This new model would be specifically designed for enterprise expectations and will not address compliant or compatibility issues (Durkee, 2010).

1.2 Research Question

We have used the above issues and motivations to design our research question on how cloud users are influenced by different providers. The research would be aimed at finding out what kinds of services are being offered now that is influencing organizations to move to the cloud.
This is why we formulated our research question: *"how are customers influenced by cloud providers amidst cloud challenges?"*

We think, for systems to exist users are important and the number of users a system will have depends on the user experience and acceptance for that particular system or technology. And in a system where security, sensitive data, data location etc. are involved, it is very important to have *trust*. In this research, both user-experience and trust go hand in hand with each other resulting in the development and deployment of more cloud. This is why we formulated some research issues to guide our research, which were:

1. What are the main challenges of Cloud services?
   Here we wanted to find out the main challenges in cloud services that cloud service users experience; this was also designed to probe more into user experience in the cloud.

2. What are the factors that influence customers to use cloud?

This helped us to find out why cloud service users select a particular cloud provider and how are they influenced to use cloud computing.

3. How do cloud providers influence more customers?
   This issue addressed our interest in knowing in what ways a cloud service provider is gaining customers, how they are influencing customers to use their cloud service and in what ways they are providing more user experience.

1.3 Research Purpose

Since cloud computing is gaining market share at a fast rate, some researcher think that it poses a worldwide danger having its challenges and risks involved. The purpose of our thesis is to find out how organizations are influenced by cloud providers to use their products.

1.4 Delimitations

Since the area of cloud computing is very broad, the research focused only on some of the challenges of cloud computing that companies and researchers think is important considerations. The research delimits to the companies perception on cloud services, not individual's perception of using different cloud services. As cloud challenges are more of an issue among organizations and companies due to their sensitive data and business logics, our thesis was also delimited within company usage of cloud computing and not individual or personal usage.

In addition, the study will not cover an in depth analysis on the technical aspect of cloud computing.

2 Literature Review

This chapter covers the theoretical concepts in our research. The concepts we decided to theorize were cloud computing, how it evolved, various definitions proposed by vendors and experts, service and deployment models. These theories would help to understand more about cloud computing. In order to know more about cloud computing and to have a clear idea, we concluded a survey of a literature. It is important to understand how the cloud evolved, what problems gave rise to the cloud services that is so widely used nowadays. We have also discussed literatures on trust and user experience from other researchers' point of view and other research surveys.

2.1 Cloud Evolution

Experts and cloud providers have their own definition for cloud computing, there is no standard definition for what cloud computing might really mean. Some quotes from existing definitions are –

Table 2.1: Cloud Definitions

	Authors	**Definition**
U.S. National Institute of Standards and Technology	Mell and Grance (2011, p.2)	"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"
Forrester Research	Staten (2010)	"A pool of abstracted, highly scalable, and managed compute infrastructure capable of hosting end-customer applications and billed by consumption"
Gartner	Plummer, Bittman, .Austin, Clearley and Smith (2009)	"A style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using Internet technologies."
	Buyya, Yeo and Venugopal (2008, p.601)	"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"

Cloud computing is not a new idea, early in 1961; John McCarthy said that "computer someday may be organized as a public utility". Most experts believe that cloud computing evolved from two technologies – grid computing and virtualization. Grid computing is the sharing of resources

from various computers and using them to solve a particular problem. It was introduced by Foster and Kesselman in the 1990s (Foster and Kesselman, 1999), later on, this idea was developed further by researchers and concepts such as, Open Science Grid, TeraGrid, EGEE evolved, which provides computing power, software or data on demand (Ian Foster et al., 2001).

Cluster computing - *"A cluster, is a type of parallel and distributed system, which consists of a collection of inter-connected stand-alone computers working together as a single integrated computing resource"* (Buyya et al., 2009, p.601). In simple words, clustering is a technique of using several computes together to perform a particular task to lessen the workload on a single computer and to become a more powerful computing device. Figure 2.1 shows the basic processes in cluster computing.

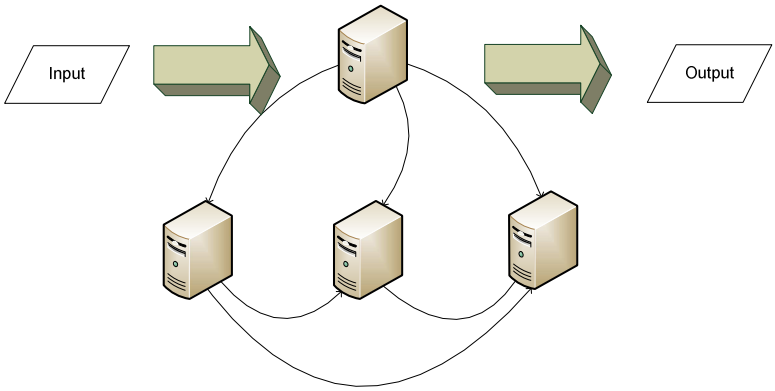

Fig 2.1: Cluster computing

Grid computing - *"is a type of parallel and distributed system that enables the sharing, selection, and aggregation of geographically distributed `autonomous' resources dynamically at runtime depending on their availability, capability, performance, cost, and users' quality-of-service requirements"*(Buyya et al., 2009, p.601). The difference between cluster computing and grid is that grid is heterogeneous, loosely coupled and resource is distributed (see Fig 2.2) (Buyya et al.,2009).

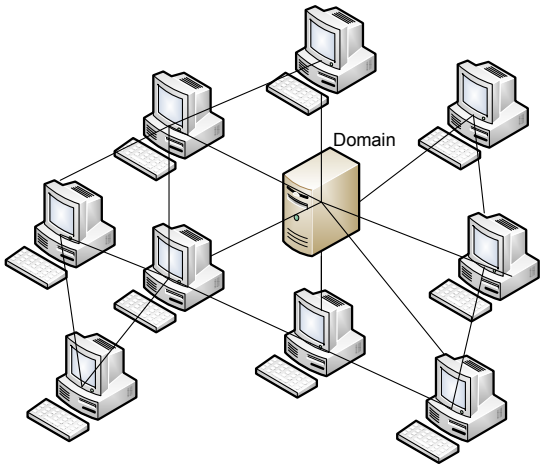

Fig 2.2: Grid computing (Strickland, n.d.)

Cloud Computing – As shown in Table 2.1, cloud computing provides on-demand network access, grid computing only solves computational problems while cloud computing has different services such as SaaS(Software as a Service), IaaS(Infrastructure as a Service), PaaS(Platform as a Service), which will be discussed later on.

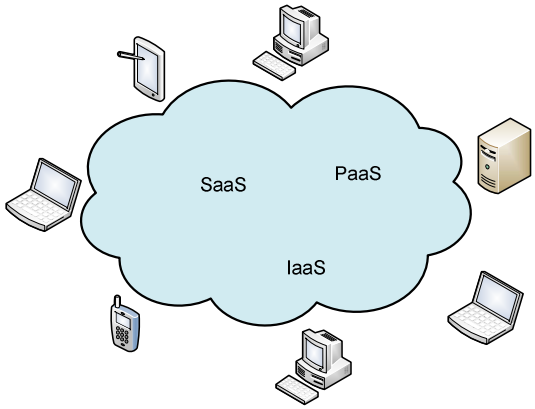

Fig 2.3: Cloud computing

Some of the differences of cluster, grid and cloud computing has been discussed below (Table 2.2).

Table 2.2 Comparison among clusters, grids and clouds (Buyya et al.,2009, p.603)

Characteristics	Clusters	Grids	Clouds
Population	Commodity computers	High-end computers	Commodity computers and high-end servers and network attached storage
Ownership	Single	Multiple	Single
Interconnection	Dedicated	Internet	Dedicated
Security/privacy	Traditional login/password-based. Medium level of privacy – depends on user privileges.	Public/private key pair based authentication and mapping a user to an account. Limited support for privacy.	Each user is provided with a virtual machine. High security/privacy is guaranteed.
User management	Centralized	Decentralized and also virtual organization (VO)-based	Centralized or can be delegated to third party
Resource management	Centralized	Distributed	Centralized/distributed
Standards	Virtual interface architecture	Some open grid forum standards	Web services (SOAP and REST)
Capacity	Stable and guaranteed	Varies, but high	On demand
Failure management	Limited (failed tasks are restarted)	Limited (failed tasks are restarted)	Strong support for failover and content replication. VMs can be easily migrated from one node to other.
Pricing of services	Limited	Dominated by public good or privately assigned	Utility pricing, discounted for larger customers
Potential for building 3rd party or value-added solutions	Limited due to rigid architecture	Limited due to strong orientation for scientific computing	High potential — can create new services by dynamically provisioning of compute, storage, and application services and offer as their own isolated or composite Cloud services to users

In order to bring value to enterprises by cloud providers, some people believe that cloud is evolving from cloud 1.0 to cloud 2.0 (see Fig 2.4). A value based service is suggested to bring good relation among vendors and consumers and thus maintaining strong trust relations. Cloud 2.0 evolution is believed to use web 2.0 networking functionalities into cloud applications (Pallis, 2010). This social cloud will use existing trust relations to share or trade resources (storage) or services in an online network (Pallis, 2010). Durkee(2010) believes that cloud 2.0 would belong to small, medium, as well as large enterprises. "*This second-generation value-based cloud is focused on delivering a high-performance, highly available, and secure*

computing infrastructure for business-critical production applications, much like the mission of today's corporate IT departments." (Durkee, 2010, p.6). This new model is believed to be designed for enterprise expectations. This value-based cloud model was proposed after industry surveys on enterprises that were not adopting the available cloud offerings. It was also thought of based on the knowledge that enterprises do not value cost per CPU only (Durkee, 2010). Cloud 2.0 is believed to provide solutions to current cloud challenges rather than focusing on cost (Durkee, 2010).

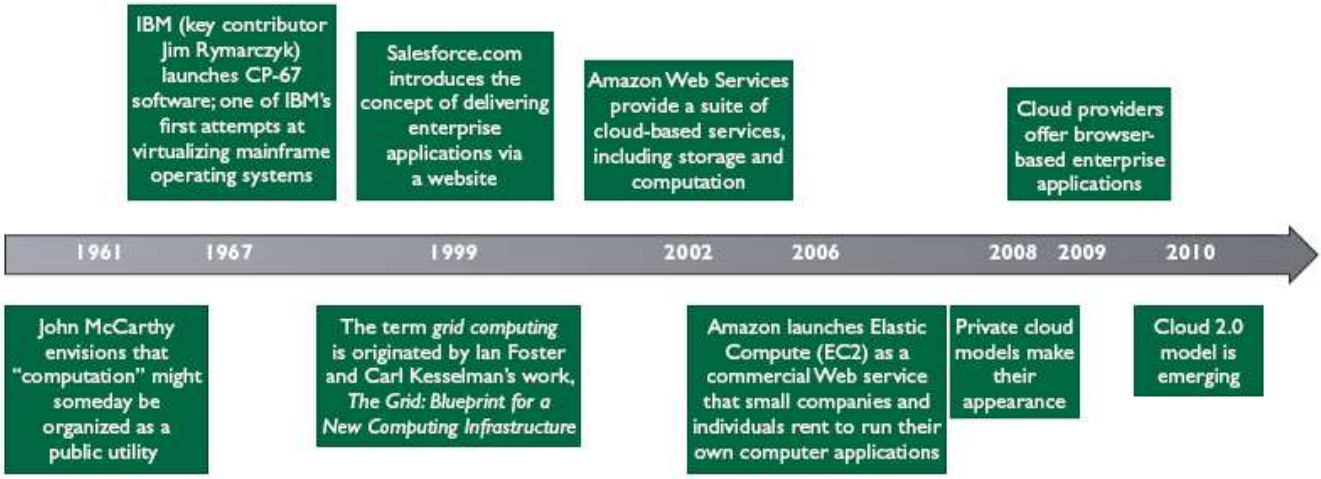

Fig 2.4: Cloud computing timeline (Pallis, 2010, p.72)

Transparency is an important issue among cloud users in establishing trust. Cloud 2.0 is believed to be transparent, allowing cloud providers to provide a non-disclosure agreement if necessary of the inner architecture of the cloud provider's environment, thus maintaining a close relation with the cloud customer.

According Durkee(2010), Cloud 2.0 is believed to contain the following factors –

- Not cost-based, rather value-based to meet enterprise expectations (thus might have competitive disadvantage among cloud providers with low cost models)
- Transparent allowing users to know internal infrastructures
- Improved Service Level Agreements (SLA)
- Automation

2.2 Cloud Properties

The NIST definition for cloud computing which states that – *"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"* (Mell and Grance, 2011, p.2) would be the foundation to advance our thesis since it supports five cloud properties, three delivery models and four deployment models.

Cloud Computing Characteristics-

1) On-demand **–** cloud providers are required to provide any amount of resources that the user demands, in the user's point of view, the resources are infinite. Cloud computing allows consumers to use and dispose any amount of resources without any interaction with cloud service providers (NIST, 2009).

2) Resource pooling – virtualization in cloud computing allows the cloud provider to pool his resources. Resource pooling is the ability to share physical and virtual resources with other consumers by "dynamically assigning and releasing resources according to consumer demand" (NIST, 2009).

3) Broad network access – the services offered can be accessed through the network from personal computers to smart phones.

4) Rapid elasticity – cloud computing allows resources to be compared with actual demands and rapidly increases the properties of it if a demand rises and also releases the particular capabilities if a demand is dropped (NIST, 2009).

5) Measured service – cloud computing has another important property which is the usage based billing system. The amount of resources used can be measured and thus provides payment information to consumers and cloud providers (NIST, 2009)

6) Economic Benefit – The economic model of cloud computing is converting capital expense (CAPEX) to operating expense (OPEX).

There are different cost model for cloud computing but short term billing model is the most used model. (Armburst et al., 2009)

Pay per use basis is a short term billing process. The model has been designed by Armbrust (2009). It is the most convenient payment method. Here customers pay for a short period of time as long they would in need of using the service but after that they would leave the storage and machines. Armbrust et al. (2009) named the costing method as "Pay as you go". Customers only need to buy hours from cloud providers and need to pay according to that. For example, if one uses a certain number of server-hours today, then, using any kind of services tomorrow would only need to pay for the used server-hour. This payment method could be more expensive but the consumer gets more benefit of elasticity and transference of risks which overweighs cost. (Armbrust et al., 2009, p10). Here it is very flexible to include or remove resources. (Armbrust 2009). For example, it takes few minutes to up or remove resources in AWS rather than hours or weeks (Amazon EC2).

Tiered pricing: Some cloud providers like Amazon offers payment per tier basis. It provides several tiers and different tiers provide different computing specifications like, memory allocation, CPU type and speed etc. and SLA (Service Level Agreement) at a certain price per unit time. (Yousef et al., 2008, p7)

Per unit pricing: Go Grid uses *per unit pricing* model. They offer "RAM/hour" as usage unit for their system (GoGrid). It is more flexible payment method than tiered pricing model. This kind of method is mostly used for data and memory usage (Yousef et al., 2008)

Subscription-Based Model: Using subscription based payment model users can forecast the periodic expenses of using cloud computing. This kind of model mostly used in SaaS. (Yousef, et al., 2008).

There are different services offered by cloud providers, NIST cloud model supports three delivery models or cloud services, which are:

Software as a Service (SaaS): in this delivery model, the consumer is allowed to use applications located in the cloud provider's infrastructures (NIST, 2009). The consumers can access this application from a web browser or by program interface, but cannot control or manage the operating systems, network, storage or servers (NIST, 2009).

Platform as a Service (PaaS): PaaS allow consumers to deploy their own applications that comply with the programming language, tools, libraries, services of the cloud provider. The consumer would only have control over his application but not over operating systems, servers or storage (NIST, 2009).

Infrastructure as a Service (IaaS): here, the consumer is supplied with storage, networks where he is allowed to deploy his own software- operating systems, applications etc. but the consumer cannot manage the underlying infrastructure of the cloud provider (NIST, 2009).

The NIST model also involves four deployment models, that is, four types of cloud that can be selected by organizations see Table 2.3.

Table 2.3 Deployment models (NIST, 2011)

	Deployment model	Provisioned for	Used by	Location
1.	Public cloud	Open use, General public	Business, academic, government organization, combinations of above	Premises of cloud provider
2.	Private cloud	Exclusive use, Single organization	Organization, third party or combination of them	On or off premises
3.	Community cloud	Exclusive use, Community of consumers who share common interest	Community of different organizations, or third party	On or off premises
4.	Hybrid cloud	Combination of two or more clouds	depends	depends

2.3 Challenges in cloud computing

As part of the main focus of our research this sub-chapter would represent some cloud challenges that we have identified in our literature review. The purpose of this sub-chapter is to provide a clear view of cloud challenges.

2.3.1 Security Risks

Confidentiality of Corporate data: Placing and processing sensitive data outside the organization or by non- employees is risky as there is lack of control of data security by the organizational managers and they are not immediately aware about the nature or level of risks (Heiser & Nicolett, 2008). In addition, Heiser & Nicolett (2008) mentioned that,

"Any externally sourced IT service bypasses the physical, logical and personnel controls that IT normally provides for in-house applications." (Heiser & Nicolett, 20008, p. 2)

As there is lack of long term commitment between user and provider than that an employee usually has with the organization, therefore, the trend of fraud is more within cloud than with

employees. Though employees could also entrust with the organization but the tendency is lower than the outsiders. As a result,

"……experienced security specialists are highly aware of the inverse relationship between loyalty and risk". (Heiser & Nicolett, 2008, p. 2)

On the other hand, Zissis & Lekkas (2012) argued that trust in cloud is depended on the chosen deployment model, though the data, information and applications are outsourced and organized by the cloud providers. Here the owner has little control over their own data. In traditional IT architecture the company itself provided highest security to guard their data and information but in the cloud deployment model this perception is totally obscured (Zissis & Lekkas, 2012). In case of public cloud control and security is provided by the infrastructure owner, therefore, the user needs to highly depended on the cloud owner and there exists certain risks. On the contrary, private cloud deployment model is operated and managed by a private organization and does not require additional security challenges. Therefore, trust remains within the organization and infrastructure owns data and process. (Zissis & Lekkas, 2012)

Data Security and leakage: Many companies outsource their payroll, some use external services to keep sensitive information but face problem with data leakage. Data leakage or unauthorized access is one of the major problem in cloud computing. It occurs in different ways as, XML Signature element wrapping attack, Null Prefix Attack, Malware Injection Attack and Flooding Attacks (Jamil & Zaki, 2011) due the *"fact that clients are typically able to connect to cloud computing via a web browser or web service"* (Jamil & Zaki, 2011, p. 2674).

Company "know how" or patent is very secret and confidential for a company. It is the heart of product development, manufacture and services of a business. Though cloud services are maintained and provided by the provider or the third party, therefore, there is a high risk of security and confidentiality. (Chandran & Angepat, 2010) Moreover, lots of companies use cloud services for maintaining their financial documents and email services. Since email services hold sensitive information, there is always a chance of leakage of sensitive information.

Data Location: In most cases the data storage of cloud is unknown to the customers. This makes a great problem to retrieve data and moreover, creates risks for putting confidential data into an unsecured geographical region. Therefore, the need for knowing the data location is very important before putting data into cloud.

"A unique ramification of the cloud-computing model is that you probably cannot know where your data is hosted. Indeed, in an increasingly globalized infrastructure, you might not even know in which country your data is stored, which should be of concern to anyone needing to meet national privacy regulations." (Heiser & Nicolett , p. 3)

Regulatory compliance: Information security and integrity is a very sensitive issue, which means protecting data from unauthorized deletion, modification or fabrication (Zissis & Lekkas, 2010). Armbrust, Fox, Griffith, Joseph, Katz, Konwinsk, Lee, Patterson, Rabkin, Stoica and Zaharia, (2009) mentioned that Cloud customers face different security threats from both inside and outside clouds. He also argues that maintaining the security in the cloud is divided among cloud users, cloud vendors and any third-party vendors that users rely on for security-sensitive software or configuration (Armburst et al., 2009). Usually cloud users are accountable for application-level security; cloud providers are accountable for physical security, and implementing external firewall policies configuration (Armburst et al., 2009) and software owners or administrators are accountable for software integrity (Zissis & Lekkas, 2010).

2.3.2 Availability of a Service

Service availability is also a great challenge for cloud adopters. Many companies are very concern about the adequate availability of the "Utility Computing Services". (Armbrust et al., 2009). Usually cloud adopters only use one cloud provider's service; as a result if the provider fail to provide services for any reasons or market failure happens then the cloud user would face a great problem. They would not get their "Utility computing services" when they are in need of that. Even if they use a cloud provider's service, which have data centers in different geographical locations, using various network providers' service may face same problem as the cloud provider might use common software infrastructure and accounting systems for providing the service (Armbrust et al., 2009). Armburst et al. (2009) mentioned that though existing SaaS providers like Google provide high standard services but a small disruption became a key new source. Table2.3 illustrates documented outages for Amazon Simple Storage Service (S3), App Engine and Gmail in 2008 and justification for the outages (Armburst et al., 2009). Even though Amazon, App Engine and Google have disruption for few hours, it became news for the whole world (see table 2.3). Customers' expectation from the cloud providers is similar like the Google´s but it is very difficult for cloud users to maintain. Therefore, Armburst et al. (2009) suggested that cloud adopters should use services from multiple cloud providers.

Table 2.4.: Outages in Amazon Web Services (AWS), AppEngine, and Gmail (Source: Armbrust et al, p.14)

Service and Outage	Duration	Date
S3 outage: authentication service overload leading to unavailability	2 hours	2/15/08
S3 outage: Single bit error leading to gossip protocol blowup	6-8 hours	7/20/08
AppEngine partial outage: programming error	5 hours	6/17/08
Gmail: site unavailable due to outage in contacts system	1.5 hours	8/11/08

2.3.3 Integrity

Integrity is a very important aspect in information security. It refers to maintaining the data accuracy in the information system (Chandran & Angepat, 2010) and could only be customized by the authorized parties or in authorized ways (Zissis & Lekkas, 2010). Zissis and Lekkas (2010) referred that

"*Data Integrity refers to protecting data from unauthorized deletion, modification or fabrication.*" (Zissis & Lekkas, 2010, p. 586)

Since cloud provides multitenancy, there is always a risk of unauthorized interference of the data. In addition, as there is more than one entity can access the same cloud location, it is hard to assure authorization only to the authorized entities (Zissis & Lekkas, 2010). Cloud providers can gain consumers confidence and trust by preventing unauthorized access in data and system integrity as well providing a mechanism through which data or system modification can be visible (Zissis & Lekkas, 2010).

2.3.4 Data Lock in

Integration of software among different platforms has been improved, but APIs for cloud computing are still platform specific and has not yet been standardized. Though there is no standardization on providing cloud services and difficult to shift data and program from one site to another, so cloud users do not have the flexibility to change the providers. It is good for the cloud providers but cloud users face problem with data lock in. Since cloud computing users are sensitive to price increases, reliability problems or even risk of providers going out of business. (Armburst et al., 2009)

2.3.5 Costs

Cloud computing costs more than in-house data center, Forrest and Barthold (2009) argue that *"Current cloud computing offerings are not cost effective compared to large enterprise data centers"* (Forrest and Barthold, 2009, p. 21). Yet it is more applicable for large companies; small and medium companies are profitable by using cloud. Lublinsky and Boris (2009) mentioned that most of the customers of cloud are small and medium sized enterprises as developing a data center is most costly and inefficient. In addition Qamar et al. (2010) mentioned that cost

efficiency is main reason for adopting cloud computing; moreover, transparency of cost, scalability are also reasons for adopting cloud computing for small companies

2.3.6 Summary

From the above literature reviews, we could summarize that *cloud security* is one of the main challenges for using cloud computing. In 2008 a survey was conducted by Gens, F. on behalf of IDC exchange and figured out that security was the number one concern for using cloud services (see fig 2.5). As the customers need to put their valuable business information and critical IT resources outside the firewall, they feel a threat of attack. Therefore, from the analysis we can say that security is the major risk factor of using cloud.

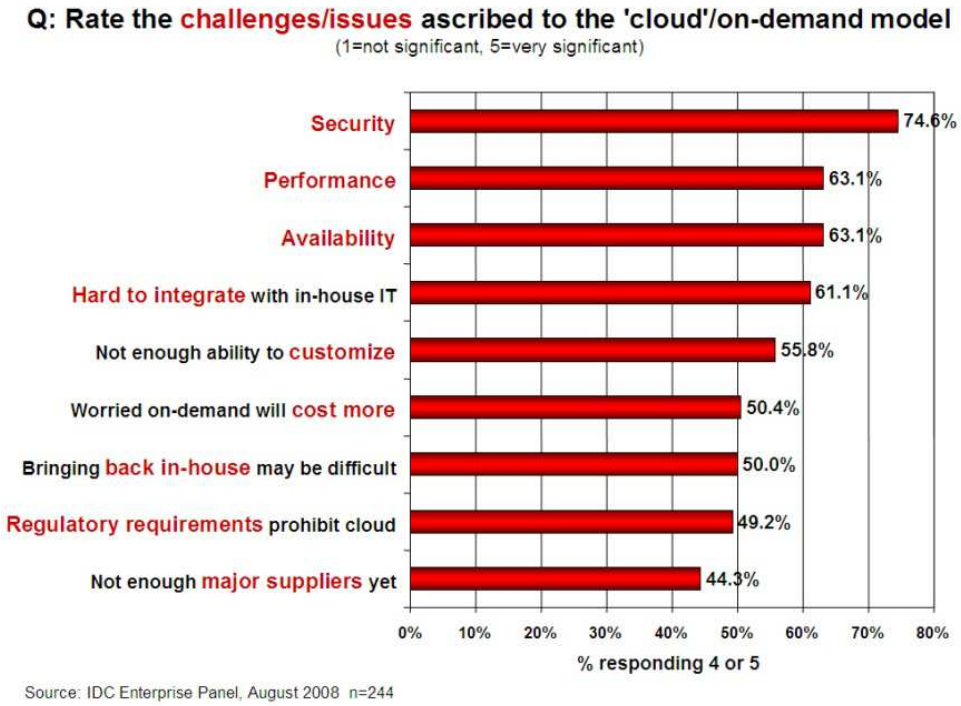

Fig 2.5 Survey results (IDC, 2008)

According to IDC (2008) survey the next two challenges were performance and *availability* (fig 2.5), in broader aspects which are basically termed as dependability of cloud services. As cloud adopters need to totally depend on the cloud providers or services for their business from the availability and performance of network to the cloud service provider´s system. Moreover, they also need to depend on the "supply chain" of the service provider who can offer better transparency and reliable service level assertion. Also *integrity* is an important concern for cloud computing. Lack of integrity could create a great trouble for cloud users, as there is a threat of unauthorized interference in the cloud environment.

From the bar chart of IDC (2008) (Fig 2.5) we can elaborate that 50.4 % of the respondents paid concern on "*cost more*". As cloud costs "pay as you go" approach, therefore heavy usage of cloud costs more than in house IT support.

Furthermore, the survey of IDC (2008) indicates that 50% of the respondents said that "bringing back in house" or "*data lock in*" are potential a challenges, as there is no standardization for APIs. Therefore, customers struggle a lot for using cloud services.

2.4 What influences?

Cloud services have several benefits, such as on-demand resource, and flexible, rapid elasticity and also have challenges and risks. And according to several sources cloud computing usage has increased considerably and is still increasing with very high predictions for forthcoming years. Since it has lot of challenges, trust among cloud users and providers is of utmost importance and plays an important role in the growth of cloud computing. Cloud computing is a great concern among privacy supporters and demands a "high degree of trust" (Weiss, 2007, p25.).

AppNexus chief technology officer, Mike Nolet thinks that the current crisis in economic change will aid in adopting cloud computing by companies who have limited money on IT infrastructures (Leavitt, 2009, p20.). He added, "*The core competency for most companies is not designing and building IT architecture. They don't want to deal with middle-of-the-night emergencies, vendor management, the procurement cycle, estimating future needs, hiring and managing large IT staffs, and everything else needed for in-house infrastructure. If clients can trust the uptime, speed, and security of a cloud, we can't see any reason not to use it.*" (Leavitt, 2009, p20.) So, one of the influencing factors that customer take into account is *trust.* They do not want to worry about IT infrastructures when they have important decisions to make and other business processes to handle. They decide to use cloud computing because they have trust on the cloud provider to keep their business logic and information safe and secured. And cloud providers influence customers by gaining that trust.

2.4.1 Trust

"Trust is letting other persons (natural or artificial, such as firms, nations, etc.) take care of something the trustor cares about, where such 'caring for' involves some exercise of discretionary powers." (Baier, 1986, p.234)

Storage of critical business information in the cloud relates to a new level of trust (Oza et al., 2010). The cloud service users must be able to feel trust in order to hand over their valuable and

sensitive business information. That is, they must trust cloud service providers to keep their information secured and safe (Jaeger et al., 2008). Frost and Sullivan (2009) mentioned that all cloud providers should work together to maintain a shared goal of ensuring trust in the cloud.

Trust is an important consideration to a successful strategic alliance (Sherman, 1992) and most of the times, trust is necessary to maintain for strategic partnerships (Spekman, 1988). Sherman (1992) believes that most strategic alliances disrupts for lacking trust. Trust between organizations provides more efficiency, effective and productivity in supply chain relations (Morgan and Hunt, 1994).

It is more difficult to trust online services than offline services and can be easily lost but very difficult to gain (Best, et. al, 2005). There are also issues of hard trust, that deals with transaction security, authenticity and encryption and soft trust that deals with human psychology, user friendly products and brand (Singh and Morley, 2009).

Oza, et al. (2010) in a study of user experiences in the cloud, found that most interviewees mentioned trust as the most important aspect of user experiences (see Table 2.5).

Table 2.5: User experience affectors (Oza et al., 2010, p.4)

UX affectors in the cloud	Mentioned by % of interviewees
Trust	100 %
Liability between cloud user and provider	63 %
Users' comprehension of cloud	45 %
Security awareness	36 %

Uusitalo et. al (2010) performed 33 interviews on different types of organizations as well as different types of people. The study was done to find out the factors customers consider to trust a cloud provider. From their research, they came up with two kinds of trust affectors, functional trust affectors and non-functional trust affectors.

The majority of the interviewees mentioned the non-functional aspects that affect trust, such as, (Fig 2.6) *Brand name*, *reputation*, *history* and *image* were found out to be most important (Uusitalo et al., 2010). In their research, the interviewees mentioned that in order to maintain trust, a well-known company, country of origin, political situation is also important (Uusitalo et al., 2010).

Service Level Agreements (SLA) was mentioned by 18%, they thought clear, straightforward service agreements between cloud service providers and cloud customers increase trust (Uusitalo et al., 2010). Some 12% also mentioned *popularity* as a trust affector. But 6% referred *price* as an aspect of trust, low price was appealing but expensive services where mentioned as being more trustworthy (Uusitalo et al., 2010). The other trust affectors mentioned by the interviewees were 6% for *customer care* and another 6% for *search engine hits.*

The other interviewees mentioned *security or privacy, transparency, user experience, availability and resources* as the functional trust affectors (Uusitalo et al., 2010). Some 30% thought more privacy and security in cloud computing would strengthen their trust, some also mentioned that positive experiences do not matter much but a *negative experience* can lower the trust level. Some of them stated that "The trust will develop, provided that the promise of relatively unlimited capacity will be kept and the promise of availability will be fulfilled," (Uusitalo et al., 2010). Figure 2.6 shows the factors mentioned that affect trust.

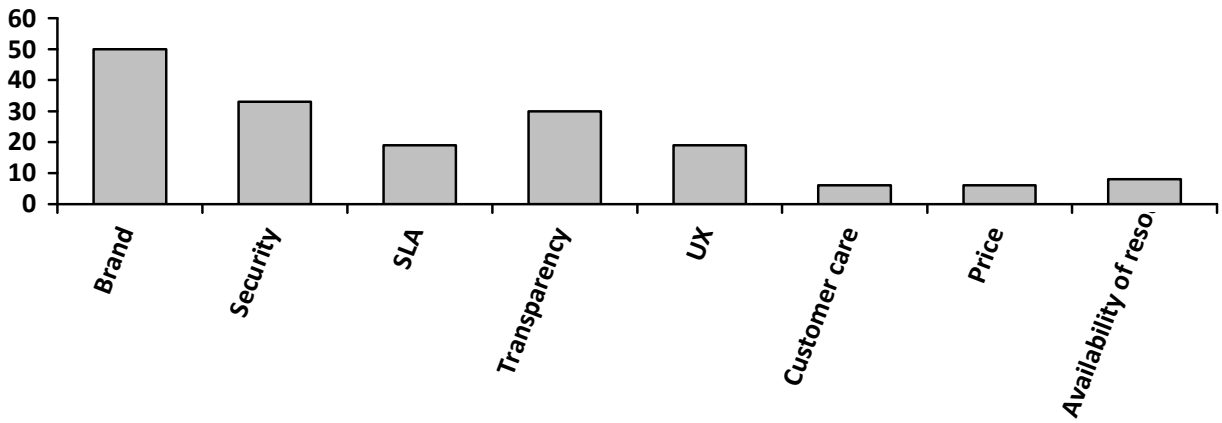

Fig 2.6 Trust affectors (Uusitalo, 2010, p.6)

Cloud computing is still new but to attain more maturity and to be more widely used, trust is an important factor, but when we looked for research papers regarding how trust can be gained or any research paper regarding trust, it was very difficult to find. We found a report made by the European Network and Information Security Agency (ENISA), which mentioned some factors by which trust can be built in cloud system, some of them were, certification or standards for cloud services, measurement for security in cloud services, transparency, data confidentiality, and assurance.

Warrior (2009), CTO of Cisco, also mentioned in her blog that user experience and trust is very important in cloud computing. She also recommended that Security, control of data by cloud

service users, Service-Level Agreements, compliance with enterprise affects in strengthening trust.

2.4.2 Technological Initiatives

The top cloud providers such as Amazon cloud services, Microsoft Azure, RackSpace etc. are offering different services that would provide a good user experience for the cloud customers. They are taking technological initiatives that would ease their usability while providing the necessary products to run their business and securing customer information. The competition is increasing and the rise in this competitive environment is allowing more and more providers to produce more innovative services. We have studied some of the technologies being offered by the top providers to form our literature framework on how cloud provider tends to influence customers.

After observing the current market of cloud providers, we deduced the list of some top cloud providers which have been discussed below to know about what kind of initiatives they have taken to influence their customers.

Amazon Simple Storage Service (S3) offers a storage service with *high scalability*; suitable for end users and at a *reasonable price*. Amazon Simple DB is a web service which can be easily used by the customers without being concerned about the internal processing. (Amazon EC2) Amazon EC2 also has 99.95% of guaranteed uptime service in their S*ervice Level Agreements (SLA)*. However, Amazon Simple Storage Service (S3) does not have any SLA guarantee.

Another well-known cloud provider, rackspace acquired companies like Slicehost, which is an *on-demand virtualization server* solution, Jungle Disk which is an online storage service, Cloudkick which supports auto system administration. Rackspace also has partnership with Dell and Equinix in developing OpenStack which is an open source cloud platform (Oriel, 2012).

SalesForce's main product revolves around Customer Relationship Management (CRM) platforms. SalesForce integrates SalesCloud, Data.com, ServicesCloud, Chatter, Heroku and many other cloud services which are used for Sales, Marketing, Social Enterprising, social network for business and social and mobile apps in Ruby and Java (SalesForce). Salesforce is trying to influence customers who do not want to be *locked in with a single cloud provider* (Oriel, 2012)

The cloud service provider GoGrid has three major packages on Cloud Hosting; Windows *Secure Scalable* Website and Scalable Website Solution offers multiple internet properties, supports web2.0 and application, ecommerce and gaming application. Whereas the other

package, Data Center Expansion Solution has free F5 hardware load balancing, web servers, database servers, cloud storage and *off-site back up* (GoGrid).

Another well-known cloud provider, Joyent, supports collaboration among teams through emails, contact or file sharing. One of the customers of Joyent is LinkedIn, which is an online social networking site and popular among small and medium sized enterprises (Oriel, 2012). Joyent uses '*on-demand computing provider'* as its cloud property. Joyent and Dell also has a joint effort to provide *preconfigured cloud IaaS packages*. It has also formed a partnership with Nexenta Systems which provides *unlimited scalability, data protection, inherent virtualization, deduplication* (Oriel, 2012).

Micorosoft Windows Azure is a very innovative *on demand* cloud platform, where developers provide and manage on demand web applications, compute, scale and host data storage using Microsoft´s data center. Basically Microsoft´s PaaS service is entitled as Windows Azure (Microsoft Windows Azure).

The initiatives on *open source cloud computing* was also widely accepted by experienced cloud service users, who can edit their cloud services according to their needs. Eucalyptus is an open source cloud computing. It is quite different from other cloud computing. It was formed as a substitute of Amazon EC2 by the University of California at Santa Barbara to perform academic research on cloud computing. But it is also used as a private cloud computing. The major advantage of Eucalyptus is to provide scope for open development with easy to install and maintain. Moreover, it is also compatible with Amazon´s EC2 for its IaaS model and also it uses the similar API as Amazon´s AWS. (Eucalyptus Cloud Platform)

Linode gained its image by offering custom virtual server, Xen-virtualization which allows users to have full control of their virtual server, ability to monitor resource usage, cloning own data, *on-demand* resources. Linode also offers virtualization that eliminates shared web-hosting (which is restrictive and gives more control to cloud provider) and thus offer more flexibility for customer (Linode).

Table 2.6 shows a brief summary on the above study of cloud providers. As we have said earlier in our delimitation, we did not go deep into technical aspects such as Xen-virtualization, cloning data, inherent virtualization etc.; we considered some of the factors that were offered by most of the providers and literature reviews.

Table 2.6 Analysis on how cloud providers influence customers

Technology offered	**Examples**	**Advantages**
Price	Tiered pricing(amazon EC2), per unit pricing	Cost-effective traditional IT-infrastructures
On-demand	Virtualization of resources (Linode, Rackspace), on-demand applications (Microsoft azure)	Expense of dedicated servers, better for environment
Service Level Agreements	99.95% uptime guarantee (Amazon EC2)	Customer needs are mentioned, provides a guarantee of what was decided.
Open Source	Eucalyptus cloud, OpenStack (Rackspace in joint venture with Dell and Equinix)	Open development, easy to maintain and install, eliminates vendor lock-in
Pre-configured cloud packages	Joyent as infrastructure as a service	Easier to select by customers
Off-site backup	GoGrid	Duplication of data in case of data loss
Multiple-cloud providers	Salesforce together with Salescloud, data.com, Servicescloud, Chatter, Heroku offers this service for interested organizations	Organization is not locked in with a single vendor (Vendor Lock-in)
Elastic Compute Cloud	Amazon EC2	full access to the software stack control, freedom to higher or lower the number of server instances
Automation	Rackspace allows automatic administration	Power saving, automatic scalable infrastructure, automatic disaster recovery

As we have shown in the table, price is an important factor in this current cost-driven cloud model. The cloud providers are at competitive struggle to provide a low cost model than the other. Some providers also use this approach to show their contribution to the environment and how it is helping in *Green-IT* initiatives.

Open source is offered by some providers and attracts customers who want to change or develop the cloud services to meet their needs and eliminates vendor lock-in. some cloud providers also offering pre-configured services which customers can choose from according to their expectations. In our opinion, all these factors play some important role in influencing customers to adopt cloud computing.

2.5 Summary

From our literature reviews we found that *cloud security* is the major challenge among all the cloud challenges. The survey of IDC exchange (2008) (see fig 2.5) also found that 74.6 % of the respondents experienced security as the major challenges of using cloud services. Also from our literature reviews we found that *service availability, integrity, costs* and *data lock in* are the significant challenges of cloud.

Also, *trust* is an important issue between cloud users and cloud providers. Trust influences customer to adopt any new technology, that is having a trusted relationship influences a user to adopt that service. Since cloud computing involves security of business information, trust between cloud users and providers is very important. The factors that influenced customers to have trust on cloud providers were mentioned as,

Brand. The image, reputation and history of the cloud provider were mentioned by most of the interviewees on the survey conducted by Uusitalo and others (2010). A well known popular service was seen as more trustworthy. They thought the more popular the brand; users would be more influenced in adopting it.

Privacy and Security. Though the main challenge in cloud computing is the issue about security, security also plays an important part in user trust. The cloud provider or cloud services that are more secured are eventually more trusted. Thus the more secured cloud product influences users to use it.

Transparency and Reliability. Transparency between cloud users and providers produces a more clear understanding of privacy statement, security policies, and assessments. Customers are more influenced by providers who share who are allowed to access company's data and how the sensitive data would be handled.

Service level Agreements, SLA. Service level agreements aid in influencing users towards cloud computing. The SLA addresses the expectations that arise from both user and provider, and a good understanding of service availability, service loss etc. (Pauley, 2010), and helps to attain more trust.

User experience, Functionality. A positive user experience also plays an important role in maintaining trust thus, influencing customers to use cloud. Some also argues that, a negative experience is more important since little positive experience would not matter much but a negative experience would weaken trust and influence.

Price. The survey mentioned in 2.4.1, stated price as being another factor for trust gain. The interviewees on that survey mentioned that an expensive product gains more trust. But from 2.4.3 Technological Initiatives, we see that cloud providers are providing several means of pricing and offering a low cost model to influence more customers.

Customer Care. Customer care and support for cloud customers enhances cloud adoption and a positive user experience.

In 2.4.2 we discussed how top cloud providers are taking new technological initiatives to influence customers and to provide a good user experience.

We have used the above factors and the technological offers shown in Table 2.6 to revise our literature framework.

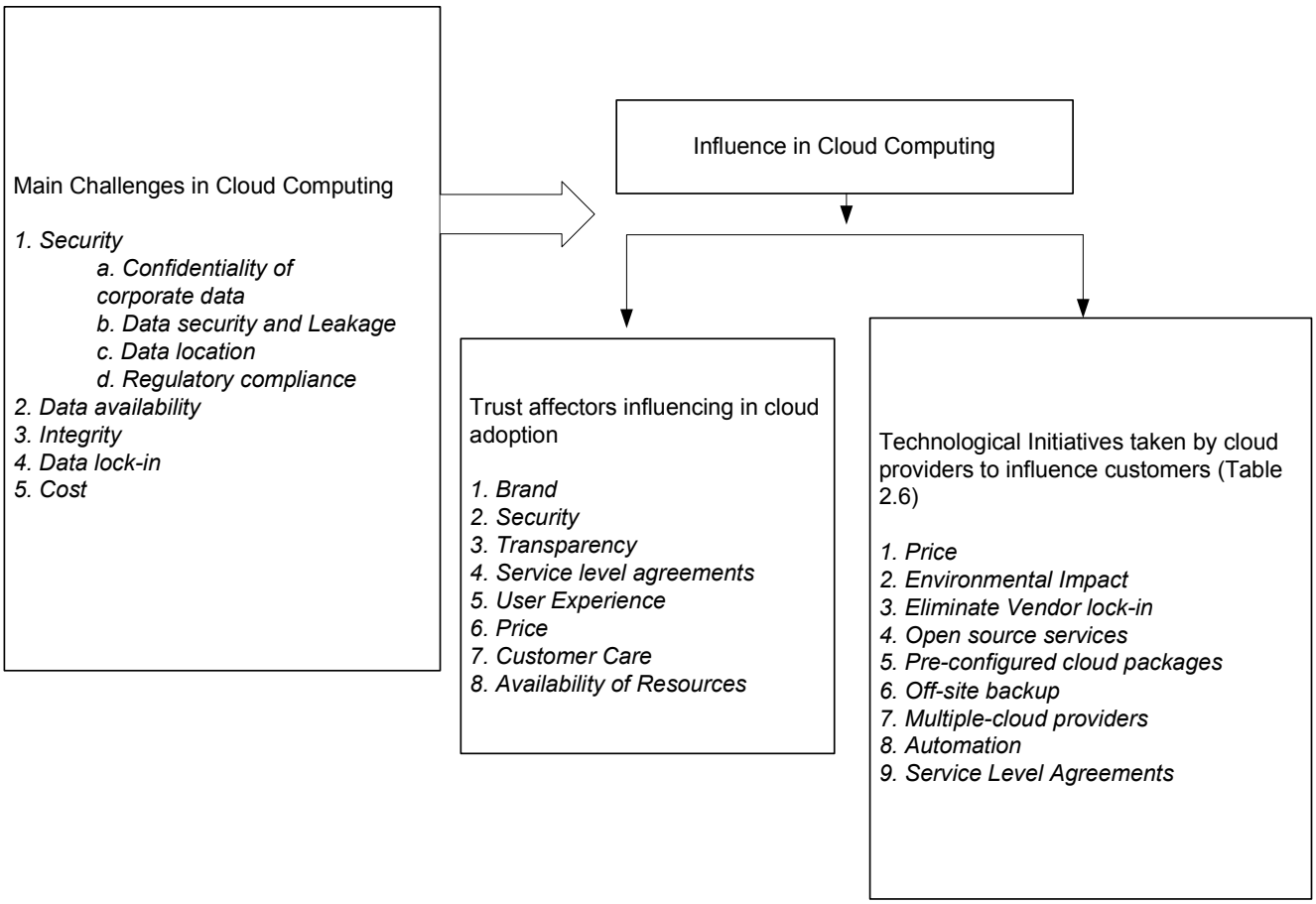

Fig 2.7 : Research Model

3 Research Methodology

In this chapter, we mentioned what methods we have used for our research; a brief explanation on it, data analysis techniques and the issues of validity, reliability and ethics was discussed.

3.1 Research Approach

There are several research strategies that are different in their characteristics of inquiring and analyzing empirical evidence (Yin, 2003; Creswell, 2007). Therefore, the selection of an appropriate research strategy that was useful for carrying out the research was a critical decision and required considerable attention. Yin (2003) discussed three different conditions that help social researchers determine what and when to use a particular research strategy. The three conditions were, the types of research questions, the ability of the researcher to control events and access available resources and the degree of focus on contemporary as opposed to historical events. Based on our research questions and according to our needs, we decided to use qualitative research techniques so that we can analyze the issue in detail by interviewing various companies and their opinion relevant to our research questions. As our main purpose is to analyze how providers are gaining trust and which are the main trust factors from consumers´ perspective, so it is not possible through quantitative study. Therefore, qualitative study is most suitable for our research.

The qualitative approach we used was in- depth semi-structured interviews. We used in- depth semi-structured interviews as it was more flexible and provides an open discussion between the interviewer and interviewee, also, new questions could be added to the ongoing conversation providing a broader perspective on the research questions. As we have shown on chapter-1, we sub divided our research issues according to cloud users, how they are influence and cloud providers, how they influence users. Therefore, our interview participants were from two areas, cloud service users and cloud service providers.

Cloud Service Users: The interview was conducted on companies that are already partially or totally using cloud computing. This was conducted to find out what kind of cloud services were used by organizations, what kind of problems they experienced, what kind of benefits they were getting from their provider, their thoughts, suggestions and their perception of using cloud computing. The main goal was to find the challenges they experienced and what kind of trust

affectors were involved in using the cloud services. We interviewed three cloud users and the reason for more than one interview was to figure out a pattern by comparing them and to have a wider perspective.

Cloud service providers: The semi structured interview was also conducted on two service providers. And the goal for those interviews were to find out what kind of risks or challenges they experienced while providing cloud services and also to probe into in what they provide more user experience in order to enhance more trust with their customers.

3.2 Data collection

We designed our interview questions based on our research questions, since we had limited time, we could not design the interview questions after literature analysis. But later on, we compared the literature model with our empirical findings to find out any similarities or differences.

We tried to select our interviewees from all over the world since cloud computing in Sweden is not so widely used yet. We could not get the opportunity to acquire participants from different countries but only US and Sweden. We conducted our interview through skype, face to face meeting and phone. And before every interview we took permission to record the conversation in our mobile phones and as well as a tool used in skype to record voice calls. We used that recorded conversation to transcribe our data. We transcribed the interview data as soon as we finished it so that we do not forget any important issues. The transcribed interview was checked, typed and coded later on.

The interview guide serves as a driving vehicle for the interviewer as it contains the purpose and themes of the study as well as a sequential description of questions (Yin, 2003).

We planned our interview questions according to our research questions and tried to map them with the theoretical themes we have used earlier in chapter-2.

We interviewed four organizations and we sent our interview questions in advanced before interviewing them. We also mentioned some important points that address their privacy and provided a brief summary of what we were trying to achieve. We conducted one interview face to face, one interview through skype and two interviews through email. Two of the interviews were done through e-mail as not having the opportunity of an appointment for face to face or phone interview. We sent out interview questions and the interviewees mailed back their answers. For further clarification or probing any questions we emailed them again and they provided us adequate answers. Other than the two emailed interviews, we used a semi-structured

interview process with the help of skype voice chat. We took permission to record our interview with the help of a tool that records the whole skype voice chat.

3.2.1 Interview Guide

As we have decided to conduct a semi structured interview for our research there is a scope to modify questions depending on the interviewees' response. The purpose of the semi structured interview is to have a proper guideline to support the structure of the interview and covering the areas that is needed for our research. Also we could leave the questions from the interview guide if we feel that the interviewee had already answered the questions or the topic has been already discussed.

For our research we prepared two interview guides one for the cloud adopters (Table 3.1) and another for the cloud service providers (Table 3.2) according to our research purpose. Though our intention from this research is to extract different challenges of cloud and the customer´s view on trust factors and analyze that with how providers are gaining trust, therefore, the interview guide for cloud customers would not be same as the interview guide for cloud providers. So we made two interview guides.

However, there are some similarities in both of the interview guides. At first we have general introduction to make the interviewee comfortable and also we asked them whether they want their name to be appear in the thesis or not.

Table 3.1: Interview guide for cloud service users

Research Model	Interview Questions	Purpose
	Why did you decide to choose that particular service and model?	To find out the reasons behind adopting the particular services
Challenges in Cloud computing, what influenced customer knowing a challenge exists.	Were you aware about any security problem before going for cloud?	To find out user awareness on cloud challenges
User experiences and functionalities	Are you satisfied with the services?	To analyze user satisfaction level on the services they are using
To know more about user perception on cloud challenges.	Did you take any security precautions before going for the cloud? What were they?	To investigate whether cloud users are taking any security precautions before using cloud services
Challenges involved in cloud computing, user experience, functionalities	What advantages or disadvantages have you faced while using that service?	To examine the experiences of cloud users about the advantages and disadvantages of using cloud services. Also we want to analyze whether customers´ perception on

		cloud is positive or negative.
Previous user experiences, comparison with other services, understand what influenced the customer to change, better service?	Have you used other cloud services before? If yes, why did you choose to change it?	The purpose of this question is to find out whether the customers have any previous experience of using other services or providers of cloud and the reason behind the change.
Data location challenge, transparency of cloud provider	Have you been notified where your data would be located?	Though Data location is one of the vital challenges that cloud adopters face, therefore, we asked these two questions to know their views and awareness of data location to mitigate challenges.
Transparency between user and provider, any Service Level Agreements (SLA) made prior to cloud deployment.	Do you have the right to select where your data will be located?	
SLA	Could you tell us what kind of agreement you made with your cloud service provider (some terms and conditions)?	This question was asked to comprehend what kind of services the customers are getting to ease the challenges.
User recommendation	What would you suggest for companies who want to use cloud services?	To understand customers´ expectation regarding cloud providers.
	Can you tell us about any differences among the cloud providers from your past experience?	To have clear view about customers perception on cloud providers from their experience
	Are you satisfied with your cloud provider? What would you suggest for them to change?	The purpose of these two questions were to know about customers satisfaction and trust on cloud providers
	Would you continue using the cloud on the long run?	

Table 3.2: Interview guide for cloud providers

Research Model	Interview Questions	Purpose
	Can you tell us a little about yourself and your company	Interviewee Introduction
	How big is your organization?	
	Would it be alright to show your name or your organization's name on our thesis paper?	
	Would you like us to e-mail you our transcribed data on this interview?	
	Can you define cloud computing in your own words?	To analyze cloud providers´ view on cloud computing
Services offered, technological initiatives taken	What kind of products and services do you offer to your customers?	The purpose of this question was to understand the services that the cloud providers are providing to the cloud users and the category of the cloud adopters.
	Who are your customers (For example, small/medium/large enterprises)?	
	Why do you think an enterprise should adopt cloud computing?	To have clear knowledge about their attitude towards the importance of adopting cloud services and to know the level of services they are providing to the customers.
Which services make them unique and influential	What do you think is your organization's competitive advantage from other providers?	The purpose of these questions were to examine the cloud providers service specialty and to comprehend the key issues of gaining trust of cloud users
	Why do you think enterprises would adopt your services and not other providers or deploy their own data centers?	
Customer influence	How do you attract customers for using your services?	
	How would you differentiate your services from other cloud providers?	
Customer care, user experience, transparency of risks involved.	What kind of questions do you normally get from your customers regarding the risks of cloud computing? How do you handle the risks/problems?	This question was asked to identify the main challenges of cloud computing and how they minimize the risk
Trust	What are the initiatives do you take to gain customer trust?	To investigate what they do for gaining trust of cloud users.
	Do you think there are any risks from adopting cloud services? If yes, what are they and how do you handle them?	Again this was asked to probe them whether there are more risks of adopting cloud services or not and do they take any further steps to minimize the risks and gaining customers trust.
	Do you maintain transparency with your customers? If yes, what kind of information do you share and how?	The intention of asking this question was to understand the level of transparency the cloud providers

		maintain with their customers to gain trust
SLA	Do you provide any kind of agreement regarding security, data availability, data lock in, etc to your customers? Could you please explain elaborately?	The idea of this question was to probe the interviewee for understanding the level of transparency
	Do you think the current market regarding cloud computing is competitive for the providers?	To gain clear idea about the current market condition of the cloud computing,

3.2.2 Company and Informants overview

According to our research question and purpose we required to take interviews of cloud customers and providers. Therefore, we searched for companies who are totally or partially user of cloud computing and cloud service provider. The overviews of the selected interviewees are provided below:

Cloud Users

Interviewee – 1: Bertil Samfors of Best of Jobs in Sweden AB. Best of Jobs (BOJ) is a privately held Limited Company working with brooking specialist consultants within IT industry. We got in contact with Bertil Sämfors who is self-employed at BOJ which has ten subcontracted consultants working. BOJ uses cloud mainly for Web based accounting, mail and office products. We emailed our research questions before meeting him in person.

Interviewee – 2: Jahid James Hossain of Maxim Litigation Support Services. Maxim Navigation Support Services (Maxim Legal) specializes in legal support services in US and all over the world; they have 22 employees, three branches in NY, California and Texas. They have been using cloud services for the last 5 years and currently using the cloud service provider called RackSpace.The person we interviewed was James Hossain, who is the owner of the company. We first emailed him our questions and he decided to give us an interview on Skype.

Interviewee – 3: Sam Khan from SK Consultants. Sam Khan is the president of SK Consulting. They are based in New York, USA, and provide personalized “A to Z” legal related services for small corporations, Attorneys and their Law Firms. They use Microsoft Sky Drive for block storage and shared database and also use other cloud software service as well.

Cloud Provider

Interviewee – 4: Robert Wiberg of Excellent Hosting AB. Excellent Hosting supplies IT-solutions and cloud services to their customers. Their cloud services today are hosting of dedicated servers, co-location, virtual servers, and web space and game servers. The company is located in Malmö but they have locations for hosting in Malmö, Stockholm and Frankfurt. The number of employees is three, who are mainly running the company with a turnover of 1.2 million.

3.2.3 Interview and transcription

The face- to- face and skype interview were conducted at the interviewees´ office to maintain certain comfortable and formal setting. Before starting the interview we asked permission for recording the interview. Then we started the interview with general introduction and told them about our research purpose of taking the interview and tried to make them feel comfortable with the interview. After that we tried to conduct open ended questions for getting more information from the interview. We paid full attention to the interviewee´s response and checked that whether we covered all questions or not. Time to time we asked the interviewees some follow-up questions, direct questions and probed them as well. Also we stayed silent sometime to allow the interviewee talk. At the end we interpret the questions to get more information from them about the research and also clarify the understanding. After completing each interview we sent our transcription for validating the collected data and to get feedback. (Kvale & Brinkmann, 2009).

3.2.4 Interview Analysis

We transcribed the interviews right after completing the interviews. The purpose of this was to ease the transcription process and make it more accurate. The process of transcription was carried by both of us and then cross checked it for getting more accuracy (Kvale & Brinkmann, 2009). After we transcribed our interviews, we performed interview coding and categorized our data.

Here we used open coding for the analysis as it is appropriate for data categorizing method for qualitative interviews (Creswell, 2007). Kvale & Brinkmann (2009) mentioned that Glaser and Strauss (1967)stated that open coding refers to “The process of breaking down, examining, comparing, conceptualizing and categorizing data” The coding was conducted using themes and categories. Since we have used in depth interview for collecting the empirical data, there exists lots of unnecessary discussion. Therefore, to ease the analysis and to make the category of the data we have used coding. At first both of us read the transcripts very well and then according to the research topic, literature review and informant´s response we made the codes of the relevant

themes of our research and we included it to the transcript. As every interview starts with a common introduction, therefore we coded it as “I”. Then we asked the definition of cloud to our respondents which was coded as “D”. Each theme has a unique code to find out the discussion. The list of the codes and themes are provided in table 3.3.

Table 3.3 Codes for interview analysis

Codes	Theme
I	Introduction
D	Definition
CA	Concurrent Access
DS	Dedicated Server
SLA	Service Level Agreements
T	Transparency
DL	Data Location
UX	User Expectation
B	Brand
T	Trust
DI	Dependent on optimal Internet connection
DLI	Data Lock-In
DG	Data Leakage
M	Maturity
DA	Data Availability
S	Data Security
CC	Customer Care/support
OB	Offsite Backup
C	Cost

3.3 Research Quality

The main two points in quality is validity and reliability. Lincoln & Guba (1985) discussed the issue of establishing validity and reliability with respect to the notion of trustworthiness. In our research we tried to maintain the quality of the research.

The concept "Internal Validity" is related to the truth and confidence of the research findings in the sense that was described by Lincoln & Guba (1985) of how to persuade readers that these findings are related to the reality and expressions of participants. For better quality, we send our transcripts to the respondents and according to the feedback we changed wherever it was required. Moreover, we also included the company and interviewer details to validate our research.

Also we tried to keep up transferability in our research. Transferability refers to the ability to apply the results from a particular context into another similar one (Lincoln & Guba, 1985). We interviewed different types of companies who are totally or partially involved with cloud services and analyzed the results in detailed to find out the relationship from one context to the other. According to our research theme we took one interview of cloud provider and three interviews of cloud users from different companies.

In addition, Reliability means that the use of the same methods should produce the same results and findings (Lincoln & Guba, 1985). To maintain reliability of our research, both of us transcribed each interviews just after completing the interview and crossed checked the transcripts (Kvale and Brinkmann, 2009).

Moreover, throughout the research we ensured that our perception would not influence the research finding and interpretation of the research. Therefore, we asked our supervisors and friends to criticize our research and provide feedback on the research. According to their feedback we tried to modify wherever it is necessary.

3.4 Research Ethics

"*Ethics is a generic term for various ways of understanding and examining the moral life*" (Beauchamp and Childress, 1994, p.4).

Confidentiality of participants was assured by us by securing their information gathered and not to reveal them. We aimed to assure and to trust as we consider the subject we are discussing tends to be important and might be sensitive too. We did not intend on doing research on other people's lives or use their sensitive personal data for the public views. Before each interview, we asked for the interviewee's consent on what media we could use (recorder, voice recorder tool for skype), we also asked if they would want their name or organization name to be published and also offered to send our transcribed data on the interviews if they are interested. So we think we behaved ethically during our research and tried to gain our trust of the people we worked with.

4 Empirical Data

In this chapter, we presented the empirical data that we obtained from our interviews. Since we had separate interview questions for cloud providers and customers, we have provided the data separately as well.

4.1 Cloud Service Provider

4.1.1 Excellent Hosting AB

The board member of Excellent Hosting Sweden AB, Robert Wiberg´s view on cloud computing is *"limitless of resources"*. He also mentioned that, "when company `A` needs to have more cores on a machine the cloud solves it without disturbing the service." Moreover, his view on the purpose of adoption of cloud is "when an enterprise is not sure about the resources to use for their services, they adopt cloud´s service." Also he mentioned that customers would adopt cloud services because to have own IT infrastructure they need to employ employees to get support, which is of lot of work.

Wiberg declared that Excellent Hosting provides dedicated servers, co-location, virtual servers, web space and game servers to its customers. He also mentioned that they are mostly like *"an internal IT-department"* and working closely with customers to provide them the best services. He also revealed that they attract customers through applying "Word of Mouth" technique and they have reseller, who is responsible for bringing customers for their business. They do not use any commercial advertising technique for attracting customers. Mostly small, medium enterprises and individuals are the customers of Excellent Hosting.

In addition, he mentioned in the interview that the current market condition is the combination between "the old hosting market and the new cloud business model." Also he stated that "It's not easy to compete with the big companies on per hour price for services but you can make up for it in *support and service to customers."*

Wiberg mentioned that his customers usually concern about backup issue and Excellent Hosting solve the problem "by using commercial software doing *backups daily offsite.* Offsite means that we do not keep the backups on the same location as the actual hosting for the servers." He also stated that "If something breaks in the virtual environment the software solves this for us by *HA*

modules that moves the virtual servers from broken servers to working servers so we can fix the broken hardware without interrupting the customer service."

Also he pointed out that to gain customers´ trust they meet with the customers and explain the way of solving problems. In addition to that to be *transparent* enough with customers they provide the information about "what software and hardware manufacturer we use but not exactly what hardware we use."

"We have to have *better customer care and support* to have more advantage from other bigger providers."

"When you use cloud services you do not have total control of the resources as when you are purchasing a dedicated server or virtual machine. Problems have occurred that other customers could gain access to other customer's information in the big clouds (I think it was amazon that had problems)."

4.2 Cloud service user

4.2.1 Maxim Legal

Jahid Hossain from Maxim Legal defined cloud computing as "I see Cloud computing as a service. Cost efficient way of doing computing in this environment. Use cloud a lot share data, put all the data in the servers, I can access the data anywhere in the world. " If we analyze the above definition, it also shows why he decided to use cloud computing, which is, cost efficient, to share data and to access the data from anywhere in the world. Jahid hossain also mentioned several times that he trust his cloud service provider completely. He has very much satisfied with his provider and has no obligations regarding their security or data location. He also praised the cloud provider's service level agreements and mentioned several times in what ways they agreed to provide special features since Jahid Hossain's company dealt with legal issues.

"Well we, security wise, we have to deal with legal issues but our cloud provider has very *secured servers* and only *dedicated* for us, it is *not shared or linked with any other servers* so there is no security breaches on that. It depends on clients to clients; some clients do not have problems with shared servers."

"Yes, we have *agreement* with our cloud provider, that they use a separate server for us." As shown in our interview transcript in appendix 4, service agreements were mentioned several times.

But if we look at the challenges of cloud computing, having a separate dedicated server does not mitigate chances of an attack on security. If the data is connected to the internet, it might be risky but in the case of cloud computing, the data is kept under someone else's custody and the factor that connects the provider and customer is trust. Jahid Hossain also mentioned that he knew about the challenges in cloud computing which is why he went to a well-established or popular vendor. He also mentioned the issue about *dependency on fast internet connection* when having no internet connection or a slow connection would be devastating for business. Another aspect that he stated was the transfer of service provider which he said was very smooth and only took two hours. As a summary, Jahid Hossain from Maxim Legal, confronted that cloud computing is the new direction in this current environment where the internet access is quite fast. He thinks the cloud providers are spending their time and money to provide valuable products to their customers that are secured and trustworthy. And the cloud services are a lot better than the in-house IT solutions he used before which required more money and was comparatively slow. He also said that "they knew our expectations before we even told them", that is, knowing *user expectations*, which is very important to maintain trust in business.

Jahid hossain also talked about another useful feature, which is the *concurrent user access*, "or if you want to change something, or update something, two or more people can simultaneously do that."

4.2.2 Best of Jobs AB

The owner of Best of Jobs AB Bertil Samfors describes cloud computing as "cloud computing is replacing local servers with internet based services" After analyzing his view we found that he basically use cloud computing for taking backups and also used to use it for using book keeping software. He is no longer using book keeping software as he faced some problems by using that particular cloud service. He mentioned that "This software company who were providing the book keeping software as a service, they were become matured enough and was forming *bugs and errors*. Typically in accounting software you cannot have errors. So I choose to old model." After that when we asked him whether he tried any other cloud provider´s services for bookkeeping, his reply was "No I do not have that much *time* for doing the experiments. I have my *running business*."

Moreover, from the discussion of cloud challenges we identified that there is a problem of *data lock in*. Consequently we asked him whether he faced any problem like that and reply to that he said that he has to face a great challenge for *bringing the data back into in-house*. He needed to do it manually. He took the print out of the screen and asked his accountant to insert the data manually.

Furthermore he mentioned that though he is an engineer, so he *does not trust* software and also takes backup by himself through USB and hard disk. In addition, he mentioned that he is basically using cloud´s services as he is self employed and only he needs to get access to the cloud from any parts of the world. However, he does not store all the data in the cloud. He stores only a part of the data in the cloud which he could share with other people like, "calculations, work-files, excel files, etc". From the interview we revealed that he *does not have any trust* on cloud services and he really concern about *security risk*.

Also he is concern about *availability of cloud services*. He stated that "all technology has its limitations; cloud technology has huge number of hard-drives, servers, hard-discs and lot of communication channels, which are bound to fail, as everything fails. How I think is what will happen if it fails. If I cannot connect to my work, what will happen to my business? In my case, I can't do anything. I can't guarantee access to my data. I have everything on the cloud but I cannot access it, therefore, my business fails. I think that is the reason for people not wanting to use the cloud. I think there are two reasons why people stay away from cloud – a *secure access of data every time* and the other thing is *business secrets*, I *don't trust* them that's why I don't put all my business secrets there."

Finally, he mentioned that he thinks modern way, which is two types: "…. go into cloud as a backup, so that I can access my data from anywhere through my mobile phone or laptop and the other way is old way for accounting back in 90s." Therefore, his summary is "It is a new way of thinking but for some aspect we need to use old things."

4.2.3 SK Consulting

Sam Khan, who is the president of SK Consulting, saw cloud computing as a virtual space that can be accessible from anywhere in the world. His company uses Microsoft's SkyDrive, for block storage and as a shared database. He took that particular service because it was more *cost efficient*, though he does not use it exclusively due to security issues, "we are not sure on *how safe our* cloud based data is protected. This is why we still are local based with our data, and have not moved to cloud exclusively." He also mentioned that he sees *dependence on internet* as a problem, since the data would not be locally saved. He stated that he does not trust the cloud completely which is why he mirrors his data in case of *data unavailability*. He also thought *assurance on data protection* or *backup*, *transparency* on security and *better service* would allow him to use the cloud even more.

5 Analysis and Discussion

In this chapter, we performed a preliminary analysis and discussion and then a further analysis later on. According to our research issues, our preliminary analysis was according to cloud challenges and how customers are influenced by providers.

5.1 Cloud Challenges

We have presented some cloud challenges in our literature review and also we got some cloud challenges from our empirical data. As we have conducted three interviews of cloud users, which are not that large companies, their perception of cloud is more positive than negative. Also they have mentioned some challenges which were not found in the literature review.

5.1.1 Trust and Data Security

Trust was mentioned by two of the interviewees. They mentioned they do not trust the cloud to keep business secrets and data. But another interviewee, Jahid Hossain stated several times that he trusts the cloud and his provider completely. And also, there is no assurance regarding how, when, where and by whom the data would be stored and manipulated. Table 5.1 shows what was mentioned by our interviewees.

Table 5.1: Trust comparison

Challenge	Code	Best of Jobs (Bertil Samfors)	Maxim Legal (Jahid Hossain)	SK Consulting (Sam Khan)
Trust	TT	"I do not trust cloud with my business logics and backups."		"We are not fully confident on the security of cloud just yet. Also any files or data we save to cloud is password encrypted"
Security	S	". I think there are two reasons why people stay away from cloud – a secure access of data every time and the other thing is business secrets"		"There are no assurances for data protection or backup."

5.1.2 Dependent on optimal internet connection and Data availability

Jahid Hossain from Maxim Legal commented that if the cloud user does not have fast internet connection then it would not be benefitted from cloud services. Moreover, Bertil Sämfors of Best of Jobs stated that if some Catastrophic happens then there would be no connection to the cloud. Therefore, it would cause a great problem. However, he has not faced that kind of problem with the cloud yet.

Sam Khan from SK Consulting also mentioned(Table 5.2) that being completely reliable on internet connectivity is a problem since the speed is not always optimal to use the cloud services.

Table 5.2: Dependent on optimal internet connection and Data availability comparison

Challenge	Code	Best of Jobs (Bertil Samfors)	Maxim Legal (Jahid Hossain)	SK Consulting (Sam Khan)
Dependent on fast internet connection	DI		"If you don't have a good internet connection you might not get your files easily."	"Depending on internet reliability, there are times connectivity is not always optimal for software computing."
Data availability	DA	"All technology has its limitations; cloud technology has huge number of hard-drives, servers, hard-discs and lot of communication channels, which are bound to fail, as everything fails. How I think is what will happen if it fails."		

5.1.3 Data Leakage and Data Assurance

Sam Khan and Bertil Samfors stated that(Table 5.3) security is a problem and they do not trust the cloud because of that. And also, there is no assurance regarding how, when, where and by whom the data would be stored and manipulated.

Furthermore, Data leakage as a problem was only mentioned by Bertil Samfors, who fears that data leakage may occur anytime and since all technology has its limitations and as well as limitations in security (Table 5.3).

Table 5.3: Data Leakage comparison

Challenge	Code	Best of Jobs (Bertil Samfors)	Maxim Legal (Jahid Hossain)	SK Consulting (Sam Khan)
Data leakage	DG	"So you are afraid of data leakage?" "Yes of course. "		
Data Assurance and Data Security	S	". I think there are two reasons why people stay away from cloud – a secure access of data every time and the other thing is business secrets"		"There are no assurances for data protection or backup."

5.1.4 Service Maturity and Data Lock In

Bertil Samfors mentioned that he also experienced service maturity and data lock in problems (Table 5.4). He stated that provider did not have enough experience or maturity level to fix bugs and errors and thus it was a problem for him to maintain his accounting software.

Table 5.4: Service maturity and Data Lock in comparison

Challenge	Code	Best of Jobs (Bertil Samfors)	Maxim Legal (Jahid Hossain)	SK Consulting (Sam Khan)
Maturity	M	"This cloud service provider who was providing the book keeping software as a service, they were not matured enough and was forming bugs and errors. Typically in accounting software you cannot have errors. So I changed to the traditional way"		
Data relocation/data lock in	DLI	"Actually there was huge problem. Because of this immaturity of the software. There were no possibility of people want to export things from their company to other system. So I need to do it manually. "		

Moreover, Bertil Samfors pointed out (Table 5.4) that he experienced huge problems when tried to come out of his cloud service. The transfer was almost impossible and he has to take screen shots of his data and entered them manually in his own system.

In addition, James Hossain also suggested that a large company, who needs to deal with huge amount of data; should have its own data center, rather using cloud services. For large company it would be expensive to use cloud services. As we have stated previously in 2.3 that computation through cloud is more expensive rather than having in- house data center.

Therefore, having in- house data center is more suitable for large companies than small or medium sized companies.

From our interviews, Bertil Samfors mentioned that, his company makes a local backup of all data continuously. Since his company is using cloud services for web based accounting and mail, it requires a storage option at all times, as he also mentioned, it would be catastrophic if their connection is lost, so using a local backup continuously requires additional storage and resources. Though, two of the interviewees mentioned that they are using cloud services because it was more cost effective. But we have also seen from analyzing other company documents and interview, that some cloud providers have the services of duplicating data for backup and also offer separate backup servers.

Bertil Samfors also mentioned that he has no idea of where his data is located and cannot provide information to cloud providers about where he would want his data to be located. This kind of control from cloud provider might be not influence prospective customers. On the other hand, James Hossain mentioned that he can select where his data would be located and he was allocated a different server for his storage purposes.

5.2 Cloud influence

To probe more into how customers are influenced to use cloud services, we analyzed our interviews to find some factors that influence customers to choose a particular provider or cloud service.

Even though *security* was mentioned as a challenge in cloud computing by the interviewees, it was also seen as a trust affector. Jahid Hossain from Maxim Legal stated that security was the reason he trusts his cloud service provider. According to him (Table 5.5), his service provider has the experience and ability to handle any kind of security problem. Sam khan also said that, though he does not know about the security level of his service provider, he would trust the cloud more if they the provider can protect his data securely. On the other hand, Bertil Samfors from Best of Jobs mentioned that he does not trust the cloud, which is why he backs up his data and does not share all business information.

Table 5.5: Security

Influence Factor		Best of Jobs	Maxim Legal	SK Consulting	Excellent Hosting
Security	S	“I don’t trust the cloud”	“The cloud security is better than ours. They have a lot of	“Data protection and security is important and the reputation of	

			professional people who are regularly making sure the client data is safe and backup is done properly. “	the provider” “The type of firewall used is also important to how secure our data is protected.”	

When Jahid Hossain was asked about trust in his cloud provider, he also talked about his allocation for a dedicated server by his cloud provider (Table 5.6). Thus influencing more trust from him providing a secured environment for his data, though this factor changes the definition of cloud computing, as having shared resources with other companies.

Table 5.6: Dedicated server

Influence Factor		Best of Jobs	Maxim Legal	SK Consulting	Excellent Hosting
Dedicated server	DS		“our cloud provider has very secured servers and only dedicated for us, it is not shared or linked with any other servers”		

Another important trust affector was the *Service Level Agreements* made by cloud service providers and cloud service users and was mentioned several times by interviewees. Jahid Hossain mentioned (Table 5.7) how his cloud provider offers service agreements at start about the use of dedicated servers, transparency about data storage, agreements on where data will be located, and also if data will be deleted in case the service is stopped.

Table 5.7: SLA

Influence Factor		Best of Jobs	Maxim Legal	SK Consulting	Excellent Hosting
Service Agreements	SLA		“Yes, we have agreement with our cloud provider, that they use a separate server for us.” “Yes, that was in our agreement, that they will delete all data if we change or stop using the service.”		
(1)Transparency	T		“Yes, they tell us how they are going to store the data”		
(2)Data location	DL		“We made sure that it stays in United States, because we are dealing with laws		

			and legal matters, so it must stay in the US.”		

We listed some features as user experiences since user experience is related to trust; user experience included, knowing user expectations, offsite backup, data lock-in.

The *user experiences* our cloud service users went through were also discussed by the interviewees, Jahid Hossain mentioned (Table 5.8) that his provider knew his expectations before they even told them, understanding what the user needs is one of the factors for trusting cloud. The cloud provider, Excellent Hosting, stated that they work closely with customers to provide them with better service. Another feature that Excellent Hosting talked about was offsite backup which was also discussed in cloud challenges as being a problem. But in this case, Excellent Hosting provides this feature for a higher user experience. Jahid Hossain also said that when he changed his cloud provider, it was very smooth and only took two hours, thus giving him a good user experience.

Table 5.8: User experiences

Influence factor		Best of Jobs	Maxim Legal	SK Consulting	Excellent Hosting
(1)User expectations	UX		“There are lots of cloud providers in the US who has to deal with these litigation issues so they understand what needs to be done and they do it that way.” “They knew our expectations before we even told them.”		“We are more like an internal IT-department; working closely with our customers to give them the best services.”
(2)Offsite Backup	OB				“Backup we solve by using commercial software doing backups daily offsite.”
(3)Data lock in/data relocation	DLI		“And that was very smooth as well; the transfer was done in a few hours.”		

Brand or reputation was mentioned by two of the cloud users as being an important factor of trust. They mentioned (Table 5.9) that a well-established and a provider with good reputation will be more reliable. *Customer Care* (Table 5.9) was another important aspect. The cloud

provider we interviewed said that it is hard to compete against the big providers but it can be overcome by providing a better service to cloud users.

Table 5.9: Brand and Customer Care

Influence factor		Best of Jobs	Maxim Legal	SK Consulting	Excellent Hosting
Brand/Reputation	B		"Yes, this is why we went to a well established vendor." "I believe all the big providers are very competitive and service wise all of them are excellent."	"Data protection and security is important and the reputation of the provider" "Use a reputable service that guarantees data security and backup of cloud"	
Customer Care and support	CC				"It's not easy to compete with the big companies on per hour price for services but you can make up for it in support and service to customers" We have to have better customer care and support to have more advantage from other bigger providers"

Cost (Table 5.10) was mentioned by two of the interviewees, one of them mentioned that he changed his cloud provider because his new provider gave him a better offer on the price. And another interview mentioned that they used cloud services because it was cost efficient.

Table 5.10: Cost comparison

Influence Factor		Best of Jobs	Maxim Legal	SK Consulting	Excellent Hosting
Cost	C		"The new cloud service provider gave us a better price, the service was almost the same." "I see Cloud computing as a service. Cost efficient way of doing computing in this environment. Use cloud a lot to share data, put all the data in the servers, I can access the data anywhere in the world."	"It was cost effective and fit our need at that moment."	

5.3 Summary

5.3.1 What are the challenges experienced in cloud services?

From our research we can elaborate that trust is one of the major challenges in cloud computing as security remains the main problem in cloud computing. However, there are some mixed opinions on trust. According to our empirical research we found that Bertil Samfors and Sam Khan do not have trust on cloud, even though they are using cloud services. As they think that there is a threat of security risk, so they do not keep confidential data into cloud. Also in our literature review we have analyzed that as sensitive data is placed and processed outside the organization and managed by non- employees, so there is a lack of control of data security (Heiser & Nicolett, 2008).

On the other hand, our respondent Jahid Hossain has complete trust in cloud services. He mentioned that as his company is using private cloud and has agreement with cloud providers, therefore, there is no threat for security risk. Also Zissis and Lekkas (2012) have similar view. He talked about that trust in cloud is more attached to the deployment model, although everything is handled by cloud providers. He also mentioned that as private cloud is maintained by the private organizations there remains trust. (Zissis & Lekkas, 2012)

Therefore, we could summarize that private cloud is more trustworthy than others and trust mainly depends on cloud deployment model and also depends on cloud providers.

Depending on fast internet connection was a concern for our interviewees. They mentioned that to use cloud´s services fast internet connection is very important otherwise it is not possible to get appropriate cloud´s services. Also the empirical study shows that data availability is also a

major challenge for using cloud´s services, which is also analyzed in our literature review and marked as one of the key challenges for using cloud´s services.

The risk of data leakage was also concerned by the cloud adopters. It also has been discussed in the literature review. The threat of data leakage has given one of the highest priorities in the security risk as well.

Our respondents mentioned service maturity as one of the challenges for using cloud computing. Though it was not mentioned in the literature review, but it really becomes a challenge when it creates problems towards using sensitive software.

According to our discussion on literature review 2.3 data lock-in is also one of the main challenges for cloud users. Armbrust et al. (2009) declared that as there is no standardized API for providing cloud services, it is difficult to change providers or sites. Our respondent Bertil Samfors faced the data relocation problem. He stated that "Actually there was huge problem, because of this immaturity of the software. There were no possibility of people want to export things from their company to other system. So I need to do it manually." Therefore, data relocation or data lock in is a great challenge for cloud adopters

5.3.2 What are the factors that influence customers?

It is a common believe that well-established and popular organizations are more trustworthy. From our interviews we saw that *brand* was mentioned several times and was advised for other organizations for using cloud provider. *Trust* was an important factor that was mentioned by two of our interviewees, one who does not use cloud computing for his trust, and another interviewee who uses cloud computing for his trust towards it.

Security is challenge for cloud providers. Most of the providers are trying to overcome or mitigate this issue to gain for user trust. Security was also one of the trust affectors we found from literature reviews. Assurance of security would also increase the trust level as discussed by the interviewees.

Transparency was also one of the challenges in cloud computing, some cloud providers are very transparent about their infrastructures, security while others are not. As shown in our literature review and interview analysis, transparency between cloud providers and cloud users is very important and binds them with higher trust levels.

Service Level Agreements could be made about data location, data transfer, server type etc., it depends on the provider how they will make their product more user centric so that the cloud

customer has a positive experience. As we have seen in our interview analysis, our interviewee was very content and completely trusted his provider who offered him several flexibilities while signing the agreement.

In the literature an expensive product was considered as more trustworthy. While in our empirical data, we see that *cost* has a different meaning. A low cost offer influenced our interviewees more than an expensive service.

Another important initiative most cloud providers have is *customer care* and, knowing what the customer wants, might want, and supporting the customer with any problems he faces. The cloud providers we interviewed and from literature analysis we saw that cloud providers offer numerous features for customers like offsite backup, showing they care for customer data, preconfigured packages, showing they know what the customer wants and easier for customers to choose from.

From our interview analysis, we studied the challenges our interviewees experienced and the factors that influenced them to or not to use cloud computing. And finally, we deduced the following empirical framework (Fig 5.1).

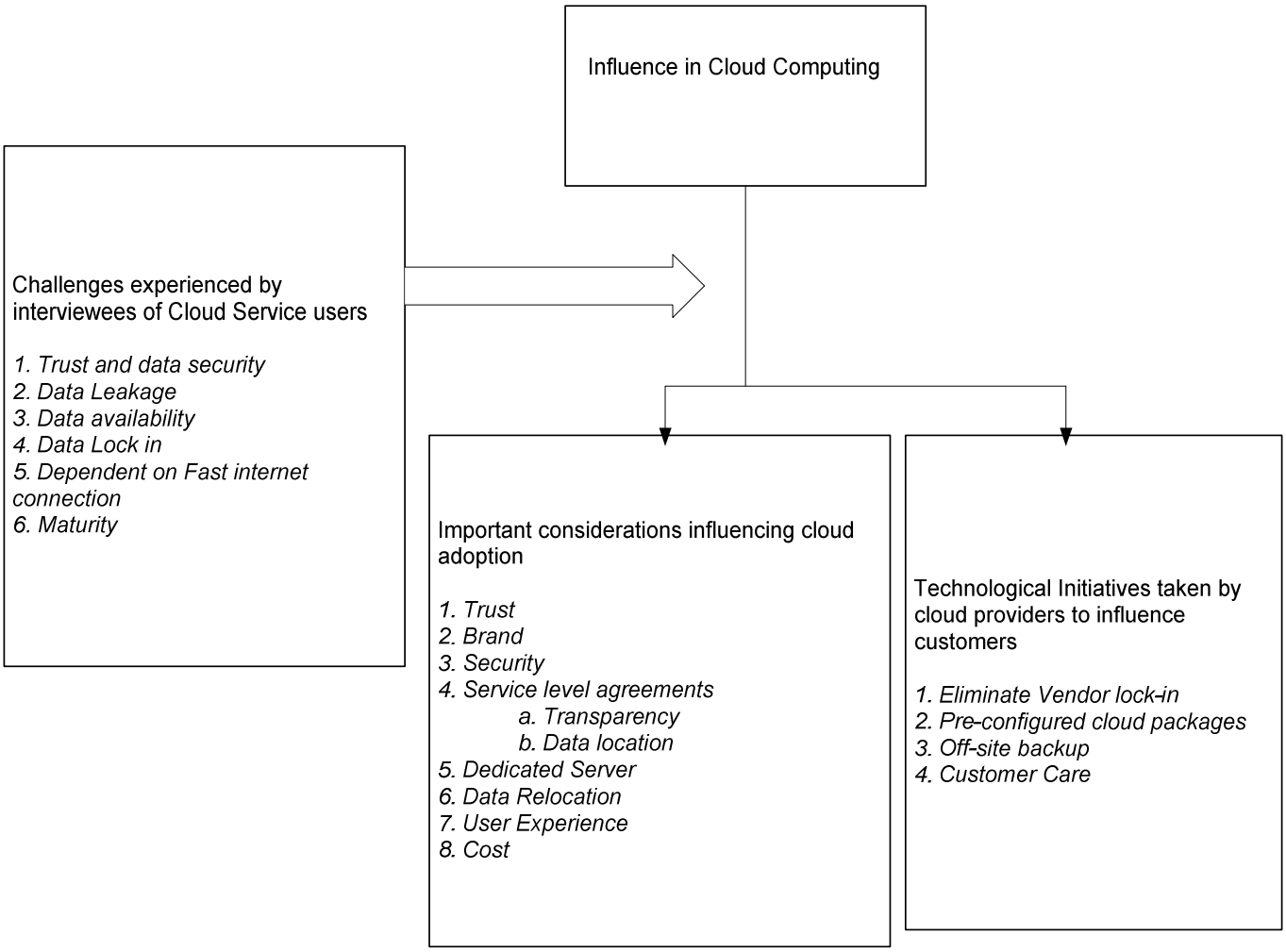

Fig 5.1 Empirical Framework

6 Findings and Conclusion

Even though there are lots of challenges in cloud computing, cloud providers are still influencing customers to use their services, how are they doing that?

The cloud provider market is very competitive, from our literature review on evolution, we saw that, at first cloud services were cost-based, and the provider with the better cost-effective model was more used than the others. But as the market is evolving, customer expectations are changing and enterprises now need value-based services that will provide what the enterprises expects or services that will provide a solution to the cloud problems. This evolution is giving rise to mitigation of the challenges discussed in cloud computing, and to keep a place in the market. Thus more and more cloud providers are offering solutions that try to eliminate the challenges of cloud computing and thus giving more value to enterprise expectations.

6.1 Research Question – how are customers are influenced by cloud providers amidst the cloud challenges?

The interview analysis showed how cloud users are being provided different features to gain more trust and user experience, thus more growth in cloud service usage. From our interview analysis, we see that user experience, knowing what the user wants, user expectations, trust and price some of the important factors in assisting growth of cloud computing.

Cloud providers are offering more and more technology that would benefit user experience and trust for users. As cloud computing is growing, there is more competition among the providers thus, the race to acquire more customers rises for business existence. And also, cloud users are trusting the cloud providers that is influencing them to use cloud computing. The main reason to trust some providers was the brand name or image of the provider. As we have seen from our interview, one of the interviewees used cloud computing because he trusts the provider and another interviewee suggested to use a reputable cloud provider.

Another important consideration was security; the cloud customers (interviewee) suggested to use a cloud provider that will provide more data security, another interviewee was using cloud computing due to good security his provider offered.

All the cloud users we interviewed used cloud services for *cost efficiencies*. Since it needs huge investment as well as extra effort to build own IT infrastructure, therefore, one of the purposes of using cloud was cost effectiveness and hassle free. Moreover, as mentioned by our interviewees, they do not need to pay more attention to install or upgrade software by using cloud and also

storage is an easy way of taking backups. In addition to that, one of the interviewees said that another important reason for using cloud is because it provides much secured servers and that was only dedicated for them. And we saw that cloud service providers are gaining users by providing better *user experience*, *customer care*, *agreements* regarding the risks in cloud computing and also through *transparency*.

Important considerations for cloud adoption

1. Brand
2. Security
3. Transparency
4. Service level agreements
5. User Experience
6. Cost
~~7. Customer Care~~
~~8. Availability of Resources~~ } Not so important according to empirical analysis
9. Trust
10. Data Location
11. Dedicated Server
12. Data Relocation
} further additions from empirical analysis

Technological Initiatives taken by cloud providers to influence customers

~~1. Price~~
~~2. Environmental Impact~~
3. Eliminate Vendor lock-in
~~4. Open source services~~
5. Pre-configured cloud packages
6. Off-site backup
~~7. Multiple-cloud providers~~
~~8. Automation~~
~~9. Service Level Agreements~~
10. Customer care

Fig 6.1: Framework comparison – Influence factors

From Fig 6.1, we can see that there are some differences between Empirical framework and literature framework regarding the factors that influence adoption of cloud computing.

As we can see from both the frameworks, *trust* is very important, one of the interviewees mentioned several times that he uses cloud computing and his provider because he trusts them.

While another interviewee does not provide all his business logics since he does not trust cloud computing.

Offsite backup was also mentioned by the interviewees and also was revised from our literature. This factor is important for customers to have a backup of their data out of the cloud in case the cloud servers fail. And we can see from our framework that cloud providers are also offering it to influence customers.

Customer care was a trust affector mentioned by literature survey. From our empirical framework we can compare and see that providers are providing customer care which the users expect from them thus maintaining a good relationship, trust and influence.

Empirical and Literature framework compared for challenges

1. Security
2. Data availability
3. Data lock-in
4. ~~Integrity~~ } Not so important according to empirical analysis
5. ~~Cost~~
6. Data Leakage
7. *Dependent on fast internet* } further additions from empirical analysis
8. *Maturity*

Fig 6.2 Framework comparison - challenges

From both our literature review and empirical data we found that *data security, data leakage, data availability* and *data lock in* were the challenges of cloud computing. However, our Interviewees also included *Dependent on Fast internet connection* and *Maturity* (Fig 6.2) as the challenges of using cloud services. They mentioned that if one does not have fast internet connection then it is not possible to use cloud services. It is definitely an important challenge for cloud users but it was not found in the literature review. The reason for this could be as literatures are mostly based on the advancement of cloud computing and they are more academic. Moreover, one of our respondents Bertil Samfors mentioned maturity as a challenge. From analyzing his perception we could say that at some aspect cloud services has not received at its maturity phase yet. As mentioned previously, the literature reviews are more concentrated on the advancement of cloud services; therefore, “maturity” has not been discussed.

On the contrary, the literature reviews paid attention to “Integrity” and “Costs more” as challenges of cloud computing. But the empirical findings did not emphasize more on those. The reason could be as they are not very large companies, so they did not feel “integrity” and “costs more” as important considerations. One of our interviewees mentioned he changed his provider because they offered fewer prices, which is contradictory to the literature reviews from cloud challenge and influence in the cloud. The literature survey on 2.3.1 mentioned that expensive products influence more customers as it involves more trust. Though on 2.3.2 technological initiatives, we have seen that the top providers are trying to offer low cost models to get more customers.

6.2 Conclusion

We have learned that, in spite of all the challenges regarding cloud computing, small and medium size enterprises are using cloud services mainly due to the fact that cloud providers offer a low cost model than traditional data centers and internal IT infrastructures. But due to the competitive and evolutionary nature of cloud services, cloud providers are trying to eliminate some challenges involved in cloud computing so that more enterprises, even large ones, join in. For that reason, and to gain customer value and trust, some providers are offering strategically competitive products. Thus the some factors for gaining customer trust would be higher user experiences, mitigation of cloud challenges, and assurance of security, which has several similarities with the literature model we designed earlier.

Appendix A - Interview of Jahid Hossain of Maxim Legal, US)

S: Student

R: Respondent

S: Can you tell us a little about yourself and your company?

R: I am Jahid Hossain, my organization is called Maxim Litigation Support Services in short Maxim Legal. We provide litigation consulting in US and all over the world. Our main goal is litigation services. (I)

S: How big is your organization?

R: I have 22 employees and have offices in 3 places, New York, California and Texas (I)

S: Would it be alright to show your name or your organization's name on our thesis paper?

R: Yes

S: Would you like us to e-mail you our transcribed data on this interview?

R: Yes please

S: Can you define cloud computing in your own words?

R: I see Cloud computing as a service. Cost efficient way of doing computing in this environment. Use cloud a lot to share data, put all the data in the servers, I can access the data anywhere in the world. (D) (C)

S: What kind of cloud service and deployment model do you use for your company?

R: We use the private cloud for Contract management, email, task management, Databases Finances and to store data.

S: What kind of data do you normally store in your cloud?

R: Lots of Client's data which are in pdf format. So we have millions and billions of pdf documents. So those documents are always on the cloud so that everyone can look into the documents. The application can be on the servers but the documents are on the cloud so that anyone from the office can look at them from anywhere in the world. We also have power-point presentations, so everything we put on the cloud so other people can look at them, or if you want to change something, or update something, two or more people can simultaneously do that. (CA)

S: Do you face any problems regarding confidentiality?

R: Well we, security wise, we have to deal with legal issues but our cloud provider has very secured servers and only dedicated for us, it is not shared or linked with any other servers so there is no security breaches on that. It depends on clients to clients; some clients do not have problems with shared servers. (DS)

S: Did you sign any agreements with your cloud provider about data leakage?

R: Yes, we have agreement with our cloud provider, that they use a separate server for us. (SLA)

S: Do your provider informs you your server location or about any changes made to it?

R: Yes, they tell us how they are going to store the data, because they have to do backups too so depending upon how they are going to, not only they are going to provide us the server, secure server, but also how they are backing up our data, that is also very important. And also, that our data is backed up in each media or each tape and they cannot just save two company's' data in one media or one tape, so we agreed with all these. (T)

S: Do you have any idea about the physical location of your data?

R: Yes, we made sure that it stays in United States, because we are dealing with laws and legal matters, so it must stay in the US. And if somebody wants to access from outside the US, we understand that the process might be little bit slow but we take that chance because we do litigation and it is defined by the US law. (DL)

S: So, are these the precautions that you took by yourself or they were provided by your cloud service provider?

R: There are lots of cloud providers in the US who has to deal with these litigation issues so they understand what needs to be done and they do it that way. (UX)

S: Do you also take backups of your data?

R: Yes, what happens is, maybe 20% of the data we need all the time, that 20% of the data might stay in our server and we will back them up by ourselves in our own tape drives and there are providers like Iron Mountain who will take the tapes and will keep them in a secured place. But we have the 20%-30% data we always use; we keep that in our servers.

S: Are you satisfied with your cloud provider?

R: Yes.

S: Did you know about the various risks or challenges before going to the cloud?

R: Yes, which is why we went to a well established vendor and they know what they are doing and they know what we are asking for. They knew our expectations before we even told them. (UX) (B)

S: If you need to keep very important data or information, which if stolen or leaked could destroy your business; would you keep that kind of information in the cloud?

R: Yes, I will keep that information in the cloud. (TT)

S: What advantages and disadvantages did you experience by using the cloud?

R: Let me tell you about the advantages first, advantage is that, by using cloud computing I am not spending money on people, depending on the business. I can expand the cloud services. And also it is not my headache anymore, it is up to the cloud provides to ensure backups, updates, security etc.. The bad part would be, if you don't have a good internet connection you might not get your files easily. But even if your files are in your own server, if you don't have good internet, you won't get your files easily. Also if you are saving a lot of data, it is better to use own server for that. But cloud computing is very favorable to us. (DI)

S: Have you used any other cloud services before?

R: Yes I used another service provider but we changed our whole computer system, the new provider gave us a better deal so we took it. And that was very smooth as well; the transfer was done in a few hours. (DLI)

S: Why did you change that Cloud provider?

R: The new cloud service provider gave us a better price, the service was almost the same. (P) (C)

S: Did your old service provider delete your company data after the transfer?

R: Yes, that was in our agreement, that they will delete all data if we change or stop using the service. (SLA)

S: Can you tell us any difference among the service providers from your experience?

R: I believe all the big providers are very competitive and service wise all of them are excellent. (B)

S: How long have you been using cloud services?

R: For the last five years, but I am using cloud for the last 3 years extensively.

S: Why extensively for the last 3 years?

R: I think the internet usage and speed is higher right now and so we can use cloud services more efficiently now.

S: What did you use for your company before using the cloud?

R: Before using cloud services, we had our own servers, but it was slow and more expensive than the cloud services we are using now. It was much hassle before but those days are over and we are moving to the new direction.

S: Did you experience any security breaches?

R: No my cloud provider has lot of securities and everything. They have so many people working on security issues that I am confident that there will be no such problem. They will do their best and I trust them. (TT)

S: Why do you trust cloud?

R: The cloud security is better than ours. They have a lot of professional people who are regularly making sure the client data is safe and backup is done properly. This is their business and they have vested interest on keeping the customer confidence. (S)

Appendix B – Interview with Bertil Samfors

S: Student or Moderator

R: Respondent

S: Can you tell us more about yourself and your company?

R: I am a broker; I arrange transactions for IT consultants. So I have customers looking for technical specialists with 10 years of experience and they do not normally find them in consultant houses. So they come to me and I look around find experienced specialists and I connect them. (I)

S: How would you define cloud computing in your own words?
R: For me, cloud computing is replacing local servers with internet based services. (D)

S: What kind of cloud service and model do you use for your company: like public cloud or private cloud?
R: I have been using the cloud before it became the name as cloud. I have been using the internet everywhere I could. And the most formal thing I bought from the cloud was my book keeping software. I just using the webpage and what happens behind the cloud I do not know. And in addition to that I also used the cloud to backup my data. And recently I have been using drop box, which is a great thing.
S: W are also using the dropbox regarding our thesis work.

S: Are you only using software as a cloud or any platform or any cloud services?
R: I am mainly using for taking backup of my files.

S: Do you take back up by yourself or with cloud?
R: I do not trust cloud. I also take by myself. I am an engineer. I do not trust software. I use my USB for taking backup. (TT)

S: Why you do not trust cloud?
R: Because I am an engineer. I have developed software. I know all the problems. Also I do not trust Google, Apple, which are having secret agendas for having my files. My secret business files I keep separate from cloud. (TT)

S: So you are afraid of data leakage?
R: Yes of course.

S: Do you put all the data in the cloud?
R: No, just part of it that I am willing to sacrifice and willing to expose to other people. It can be used without my permission and without my knowledge. Google has recently handling huge amount of data. They had an engine that can access huge amount of data and find out things and sell to other companies.

S: Are you a victim of data leakage?
R: No, I am not. But I have seen several cases. Like divorce situation of several cases. Also I use facebook, google account and spotify. When I use spotify all the web knows what I am playing. May be I have clicked yes some where. I use google account, facebook and spotify and all they are hooked up together. But I want to play at spotify but do not want to publish that at the website. That was a technical peoblem. But later I solved it. I am using cloud because there are lots of functions that I need but also I am afraid of this situation. They are not legal here. (DG)

S: Why did you decide to choose that particular service?
R: For number of reasons. I used software for accounting. It was offered by cloud. It was convenient and I do not care about others.

S: Which cloud providers service are you using?
R: I do not care and I do not know about the providers. It was bought with a software company, which provided software as service. (B)

S. So you are using cloud for book keeping and data storage?
R: yes I am using for data storage and also for saving pictures and videos I am using drop box. So whenever anyone asks me to send that picture or anything then I do not need to take hassle to send them just add them to the drop box.

S: So you are using cloud for book keeping and data storage regarding your professional work.
R: I am not using cloud for book keeping any more. I am using old ways for accounting. This software company who were providing the book keeping software as a service, they were not matured enough and was forming bugs and errors. Typically in accounting software you cannot have errors. So I choose to old model.
I started to think modern way. Modern way thinking were to go into cloud as a backup. So that I can access my data from anywhere through my mobile phone or laptop… and the other way was to old way for accounting back in 90s. I decided to use accounting 20 years back in from now. I have my own people for doing accounting. (M)

S: Did you try any other provider´s service?
R: No I do not have that much time for doing the experiments. I have my running business.

S: Was it easy to come back out of cloud?
R: Actually there was huge problem. Because of this immaturity of the software. There has not possibility of people want to export things from their company to other system. So I need to do it manually. Need to take print out of the screen and have to go to someone else to help me with that. (DLI)
So my summary is it is a good way of technique. It is a new way of thinking but for some aspect we need to use old things.

S: Can you tell more specifically which cloud services are you using currently for your professional work?
R: mainly backups. You know you are using cloud a lot but you are not thinking it as a cloud. Like of course the linked in and facebook. I use it one way. I have my small profile, which is anonymous.
But mostly I think I am using for back up.
More importantly I am self employed. I need to see things by myself. I do not need to distribute my stuffs to lots of companies. I need to access my stuffs from different places. So it is not a problem for me. That's why I use cloud for backups.
I work with lot of people, but I am the only employee of my company. So, I don't have the problem of employees looking at the company from different parts of the world. So that is why I am using it only for backups.

S: what kind of software are you using for your backups?

R: day to day routines like calculations, work-files, excel files, that kind of thing. I have my data in my hard-drive and some of that data is used to publish my website in the cloud. This gives me to have more control over it. I don't trust the cloud.

S: so are you satisfied with using the cloud?

R: it's another way. I don't have to buy discs for storage anymore, like CDs and DVDs, I can use the cloud.

S: Did you take any other precautions before using the cloud except for backup?
R: No.

S: What would you suggest for other companies who want to use the cloud?
R: I would say, know your own business, what is important and what is not. For instance, when I opened my own company, the first thing that came to my mind, was that, I need a website. But one day I realized, why do I need a website, will my consultants look at it or my customers? so my advice for companies trying to use the cloud techniques would be to go back to basics and then decide why do you need it and look for possible solutions.

S: are you also the accountant of your company?

R: No, I buy that hour by hour from another company.

S: The cloud providers are using various kinds of security encryptions, firewalls etc. but still, some organizations do not trust the cloud, why do you think that is the case?

R: all technology has its limitations; cloud technology has huge number of hard-drives, servers, hard-discs and lot of communication channels, which are bound to fail, as everything fails. How I think is what will happen if it fails. If I cannot connect to my work, what will happen to my business? In my case, I can't do anything. I can't guarantee access to my data. I have everything on the cloud but I cannot access it, therefore, my business fails. I think that is the reason for people not wanting to use the cloud. I think there are two reasons why people stay away from cloud – a secure access of data every time and the other thing is business secrets, I don't trust them that's why I don't put all my business secrets there. (DA) (T)

Appendix C – Interview with Sam Khan of SK Consulting

S: Student

R: Respondent

S: Can you tell us a little about yourself and your company?

R: I am Sam Khan, President of SK Consulting. We are based in New York, USA. We provide personalized "A to Z" legal related services for small corporations, Attorneys and their Law Firms. (I)

S: How big is your organization?

R: It is a small localized organization.

S: Would it be alright to show your name or your organization's name on our thesis paper?

R: Yes

S: Would you like us to e-mail you our transcribed data on this interview?

R: Yes

S: Can you define cloud computing in your own words?

R: Virtual computing not based locally in our space, accessible from anywhere. (D)

S: What kind of cloud service and deployment model do you use for your company?

R: Microsoft's SkyDrive, we use it mostly as a block storage and database to share amongst others and rare software computing is done as well.

S: Why did you decide to choose that particular service and model?

R: It was cost effective and fit our need at that moment. (C)

S: Were you aware about any security problem before going for cloud? What are they?

R: Data protection and security is important and the reputation of the provider. The type of firewall used is also important to how secure our data is protected. (S)(B)

S: Are you satisfied with the services? Why or why not?

R: No, we are not sure on how safe our cloud based data is protected. This is why we still are local based with our data, and have not moved to cloud exclusively. (S)

S: Did you take any security precautions before going for the cloud? What were they?

R: We keep a mirror of all data storage saved locally, as we are not fully confident on the security of cloud just yet. Also any files or data we save to cloud is password encrypted. (T)

S: What advantages or disadvantages have you faced while using that service?

R: Depending on internet reliability, there are times connectivity is not always optimal for software computing. (DI)

S: Have you used other cloud services before? If yes, why did you choose to change it?

R: No other for business purposes.

S: Have you been notified where your data would be located?

R: No.

S: Do you have the right to select where your data will be located?

R: Not that I am aware of.

S: Could you tell us what kind of agreement you made with your cloud service provider (some terms and conditions)?

R: The basic Terms and Conditions provided at sign up.

S: What would you suggest for companies who want to use cloud services?

R: Use a reputable service that guarantees data security and backup of cloud. (S)(B)

S: Can you tell us about any differences among the cloud providers from your past experience?

R: No past experience.

S: Are you satisfied with your cloud provider? What would you suggest for them to change?

R: There are no assurances for data protection or backup. (S)

S: Would you continue using the cloud in the long run?

R: I would, if services and security are worked on and improved.

Appendix D - Interview with Robert Wiberg of Excellent Hosting AB

S: Student

R: Respondent

S: Can you tell us a little about yourself and your company?

R: My name is Robert Wiberg and imboardmember of the company Excellent Hosting Sweden AB. What we do on Excellent Hosting is supplying IT-solutions and services to our customers. Our services today are hosting of dedicated servers, co-location, virtual servers, webspace and game servers. The company is located in Malmö but we have locations for hosting in Malmö, Stockholm and Frankfurt. (I)

S: How big is your organization?

R: We are three people running the company. No employes. Our turnover is about 1.2 million sek.

S: Would it be alright to show your name or your organization's name on our thesis paper?

R: Yes

S: Would you like us to e-mail you our transcribed data on this interview?

R: Yes please.

S: Can you define cloud computing in your own words?

R: Cloud computing for me is to have limitless of resources. For example when company A needs to have more cores on a machine the cloud solves it without disturbing the service. (D)

S: What kind of products and services do you offer to your customers?

R: Hosting of dedicated servers, co-location, virtual servers, and web space and game servers. (DS)

S: Who are your customers (For example, small/medium/large enterprises)?
R: Small or medium enterprises and individuals.

S: Why do you think an enterprise should adopt cloud computing?
R: When an enterprise is not sure about the resources to use for their services.

S: Do you think the current market regarding cloud computing is competitive for the providers?
R: Yes. It's a mix between the old hosting market and the new cloud business model. It's not easy to compete with the big companies on per hour price for services but you can make up for it in support and service to customers. (CC)(P)

S: What do you think is your organization's competitive advantage from other providers?
R: We have to have better customer care and support to have more advantage from other bigger providers. (CC)

S: Why do you think enterprises would adopt your services and not other providers or deploy their own data centers?
R: To deploy their infrastructure in their own data center they need to have people employed to support their services. We can do this for them.

S: How do you attract customers for using your services?
R: Through customers talking to other customers. We also have some resellers getting customers for us. We have not done any commercials or anything like that.

S: How would you differentiate your services with other cloud providers?
R: We are more like an internal IT-department; working closely with our customers to give them the best services. (UX)(CC)

S: What kind of questions do you normally get from your customers regarding the risks of cloud computing? How do you handle the risks/problems?

R: We always get the backup question and what happens is something goes wrong with the hardware. Backup we solve by using commercial software doing backups daily offsite. Offsite means that we do not keep the backups on the same location as the actual hosting for the servers.

If something breaks in the virtual environment the softwares solves this for us by HA modules that moves the virtual servers from broken servers to working servers so we can fix the broken hardware without interrupting the customer service. (OB)

S: What kind of initiatives do you use to gain customer trust?
R: Meeting the customer and explain what we do to solve certain problems. Show them how we solved solutions for other companies. (CC)

S: Do you think there are any risksfrom adopting cloud services? If yes, what are they and how do you handle them?
R: When you use cloud services you do not have total control of the resources as when you are purchasing a dedicated server or virtual machine. Problems have occurred that other customers could gain access to other customer's information in the big clouds (I think it was amazon that had problems). (S)

S: Do you maintain transparency with your customers? If yes, what kind of information do you share and how?
R: We use need to know basis for the underlying infrastructure. But we are open about what software and hardware manufacturer we use but not exactly what hardware we use. (T)

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