

ANALYZING FACTORS AFFECTING THE ADOPTION OF  
CLOUD COMPUTING: A STRUCTURAL EQUATION  
MODELING APPROACH

EZGİ ARI

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## Thesis Abstract

Ezgi Ari, “Analyzing Factors Affecting the Adoption of Cloud Computing: A Structural Equation Modeling Approach”

Cloud computing is a new and upcoming technology in Turkey. It is also a new business model for companies. Companies begin to invest in cloud computing with the expectation that this new technology will improve their business performance and operations. Cloud computing enables companies to buy their technological needs what if it is needed and they only pay for the amount that they used. However, many companies are not so much aware of its advantages and disadvantages clearly.

The aim of the study is analyzing factors affecting the adoption of cloud computing and applying structural equation modeling technique. There are many factors that affect the adoption of cloud computing. This study examines previous studies related to cloud computing adoption and presents a new model and new factors according to both literature and expert interviews. In addition, structural equation modeling is applied to analyze interrelationships between the factors in the proposed model.

According to study findings, *need, on demand service, legislation and regulations, other factors* (reliability, virtualization, maintenance, and performance) are have positive direct effects on cloud computing *adoption*. However, cost has negative direct effect on cloud computing adoption. *On demand service, other factors, and security* have positive direct effects on *cost*. Lastly, *other factors and legislation and regulations* have positive direct effects on *security*. According to results, the significance of *supplier availability* on cloud computing *adoption* and the significance of *security* on *cost* are not supported.

## Tez Özeti

### Ezgi Arı, “Bulut Bilişimin Benimsenmesini Etkileyen Faktörlerin Analizi: Yapısal Denklem Modelleme Yaklaşımı”

Bulut bilişim, Türkiye’de gelişmekte olan yeni bir teknolojidir. Bulut bilişim, aynı zamanda şirketler için yeni bir iş modeli olmuştur. Şirketler, bu yeni teknolojinin kendi iş performanslarını ve süreçlerini geliştireceği beklentisiyle bulut bilişim teknolojisine yatırım yapmaktadır. Bulut bilişim, şirketlere sadece ihtiyacı olanı olmasını ve bu ihtiyaçların kullandıkları kadarını ödemesi olanağı sağlamaktadır. Fakat, birçok şirket bulut bilişimin avantajlarının ve dezavantajlarının açıkça farkında değildir.

Bu çalışmanın amacı bulut bilişimin benimsenmesini etkileyen faktörlerin analizi ve yapısal denklem modelleme tekniğinin uygulanmasıdır. Bulut bilişimin benimsenmesine etki eden birçok faktör bulunmaktadır. Bu çalışma, bulut bilişimin benimsenmesi konusunda yapılmış geçmiş araştırmaları inceleyerek yapılan bu çalışmalara ve uzmanlarla yapılan görüşmelere göre literatüre yeni faktörler sunmaktadır. Ayrıca, önerilen modelde yer alan faktörler arasındaki ilişkilerin analizi için yapısal denklem modelleme tekniği uygulanmıştır.

Araştırma bulgularına göre, ihtiyaç duyma, talep üzerine satın alma, yasa ve yönetmelikler, diğer faktörler (güvenirlilik, sanallaştırma, bakım ve performans) bulut bilişimin benimsenmesine pozitif yönde direkt etkiye sahiptir. Fakat, maliyet bulut bilişimin benimsenmesinde negatif yönde direkt bir etkiye sahiptir. Talep üzerine satın alma, güvenlik ve diğer faktörlerin maliyet üzerinde pozitif yönde direkt etkisi bulunmaktadır. Son olarak, yasa ve yönetmeliklerin ve diğer faktörlerin güvenlik üzerinde pozitif yönde direkt etkisi bulunmaktadır. Analiz sonuçlarına göre, tedarikçi bulunabilirliğinin bulut bilişimin benimsenmesi üzerindeki ve güvenliğin maliyet üzerindeki etkileri analizler sonucunda anlamlı bulunmamıştır.

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## CHAPTER 1

### INTRODUCTION

Nowadays, cloud computing become very popular technology among companies. Companies begin to invest in cloud computing with the expectation that this new technology will improve their business performance and operations. Cloud computing is a very new technology in Turkey, so many companies are not aware of its advantages and disadvantages clearly. This indicates that many companies hesitate or cannot decide to adopt this new technology.

Cloud computing is a good option for companies, because it provides companies with many opportunities. Companies need this new technology to deal with new technology changes and gain a competitive advantage in a global environment. Companies become more business-oriented and they want to manage their businesses from anywhere and anytime. Companies do not want to be bothered with more technical issues anymore. Cloud computing provides companies with that they only buy their needs and they only pay for the amount used. Moreover, companies evaluate many issues in order to choose and adopt cloud computing technology. They prefer having more secure and reliable systems and paying fewer maintenance and up-front costs. In addition, integration of companies' legacy systems and new cloud computing systems is a very important concern for companies. Currently, legislation and regulations are very substantial factors for cloud computing adoption. Data are stored on service providers' servers. When a disaster or information leakage occurs, responsibility problem arises. Supplier

availability is also important to take cloud computing services and to get after service supports whenever companies need.

The aims of the study are explanation and evaluation of the interrelationships of the factors that affect the adoption of cloud computing services by applying Structural Equation Modeling (SEM) technique. In order to choose more important and suitable factors, a literature survey is made and expert interviews are arranged. Expert interviews are arranged with Anadolu Bilişim Hizmetleri A.Ş., Konsalt Bilgi Teknolojileri and Paydeg Bilgişlem Programlama Hizmetleri.

After completing interviews and literature survey, substantial factors are determined. These factors are *security, need, legislation and regulations, on demand, cost, supplier availability, reliability, maintenance, virtualization, integration, and performance*.

In this respect, a questionnaire is designed to study factors that may have an effect on cloud computing adoption. The questionnaire is sent to people that have knowledge about cloud computing and work at company which takes cloud computing service or services. After that, structural equation modeling approach is used to analyze interrelationships between the factors. AMOS 18.0 is used as analyzing tool.

In the literature, there are few studies about “Cloud Computing Adoption”. This study will be a good and leading resource about cloud computing adoption in Turkey. The originality of the study lies on conducting expert interviews and addressing the most important factors that are suitable for the structure of Turkish companies.

The remainder of this thesis is organized as follows. In Chapter 2 the literature review about cloud computing, its characteristics, advantages, and disadvantages; comparison of cluster, grid, and cloud computing; cloud computing service and deployment models, and technology acceptance models and cloud computing adoption are included. Chapter 3 introduces structural equation modeling (SEM) technique and points out path diagram and stages in SEM. Chapter 4 includes theoretical framework of the study and introduces factors in the study. Chapter 5 contains research methodology of the study. In Chapter 6, descriptive findings and SEM analysis results are presented. Lastly, in Chapter 7, the conclusions drawn from the study are expressed and suggestions for further research are given.

## CHAPTER 2

### LITERATURE SURVEY

#### Background of Cloud Computing

The Development of Web 2.0 leads to a change in World Wide Web (Tapscott and Williams, 2008). It enables many users to share information and stimulates the importance of collaboration among enterprises. These new technology trends and business models also lead to emergence of cloud computing (Armbrust *et al.*, 2009). Addition to these technology trends, development of cluster, grid, and virtualization technologies has an effect on the emergence of cloud computing (Butrico *et al.*, 2008). They also state that peer-to-peer computing, service oriented architecture and autonomic computing also lead to the emergence of cloud computing.

Mahmood (2011) declares that cloud computing is actually based on service oriented architecture and it works with service oriented architecture that integrates enterprises' internal services with outside such as public clouds. He also focuses that grid computing which consists of networking and hardware devices, is a very important underlying technology in providing integration of own and public or hybrid clouds.

Cloud computing was emerged at the fourth season of 2007 (Chen *et al.*, 2010). Prince (2011) makes an explanation of cloud computing basically and gives Google Docs as an example to make clear what the cloud computing is. Google Docs is a service of Google and this service is a “web-based office suite”. It enables the users to upload their own files from their computers and write and edit their

documents online. Users can access anywhere and anytime to their documents through the Internet connection. Users also share their works.

Chang, Dillon and Wu (2010) use the definition of National Institute of Standards and Technology to explain cloud computing.

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.

In addition, Carrol, Merwe and Kotze (2011) define cloud computing in more details.

Cloud computing provides a shared pool of configurable IT resources (e.g. processing, network, software, information and storage) on demand, as a scalable and elastic service, through a network infrastructure, on a measured (pay-per-use or subscription) basis, which needs minimal management effort, is based on service level agreements between the service provider and consumers, and often utilizes virtualization resources.

Moreover, Armbrust *et al.* (2009) explain cloud computing basically “both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that those services”. The term cloud also means datacenter including necessary hardware and software.

According to Armbrust *et al.* (2009), there are new aspects regarding to cloud computing. The first aspect is that computing resources are limitless and they are available on demand and it also enables enterprises to plan for ahead for supplying these computing resources. The second aspect is that enterprises do not need to pay large up-front costs, because they can increase their computing resources when their needs increase through cloud computing.

Carrol, Merwe and Kotze (2011) state that cloud computing architecture involves cloud service providers, cloud services, cloud consumers, and a network

infrastructure. Cloud service providers give cloud services to cloud consumers through a network infrastructure.

According to Jaradat *et al.* (2011), computational resources are stored in a pooled infrastructure and users access these resources which are “scalable and adjustable”, virtually. Figure 1 depicts the scheme of cloud computing.

Mahmood (2011) states that large and small organizations use cloud computing. He points out that individuals have been already using cloud computing services through many web sites such as Facebook (since 2006), YouTube (since 2005), Gmail (since 2006), and Hotmail (since 1996). Predictions show that cloud computing usage and investments for the development of cloud computing services will increase in the following years (Carroll *et al.*, 2011).

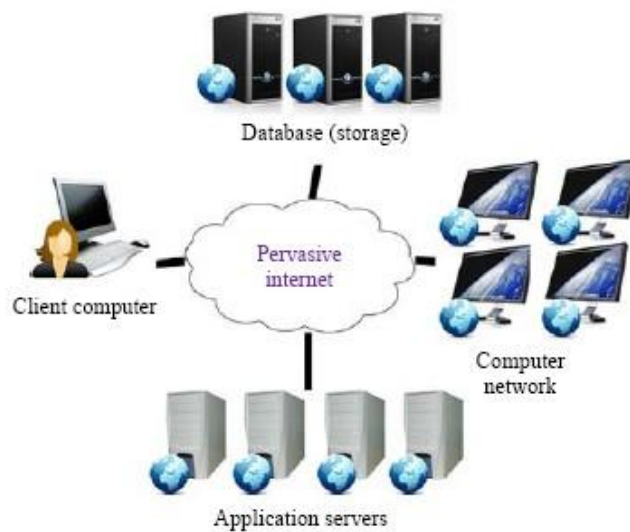


Fig. 1 Cloud Computing Scheme (Jaradat *et al.*, 2011)

## Comparison of Cluster, Grid, and Cloud Computing

Cluster and grid computing play an active role in the emergence of cloud computing; because cloud computing is based on these technologies. Addition to cluster and grid computing, cloud computing is also based on utility computing and distributed computing (Kumar and Sadashiv, 2010).

Kumar and Sadashiv (2010) make the definition of cluster as “A cluster is a collection of parallel or distributed computers which are interconnected among themselves using high-speed networks”. In a cluster, these computers work together to achieve a computational task which is not possible to achieve on a single computer. In other words, these all computers work as a single computer and all nodes in a cluster are homogenous and limited. The main advantage of cluster computing is that “if one node fails there is another standby node which will carry the task and eliminates single points of failure without any hindrance”. On the other hand, they point out that grid computing gathers heterogeneous nodes such as mobile phones and computers from different domains.

Chen *et al.* (2010) state that grid computing is a network, but nodes are not in the same place differently from cluster computing and in grid computing, resources are distributed such as switches, computers and other peripherals. They explain that the main aim of grid computing is supplying users with their resources when these users need the resources. According to them, the most disadvantage of grid computing is that “if one piece of the software on a node fails, other pieces of the software on other nodes may fail”.

Figure 2 explains the grid computing and cluster computing visually. The Internet enables different nodes such as laptops, personal computers, databases, supercomputers and clusters to work together.

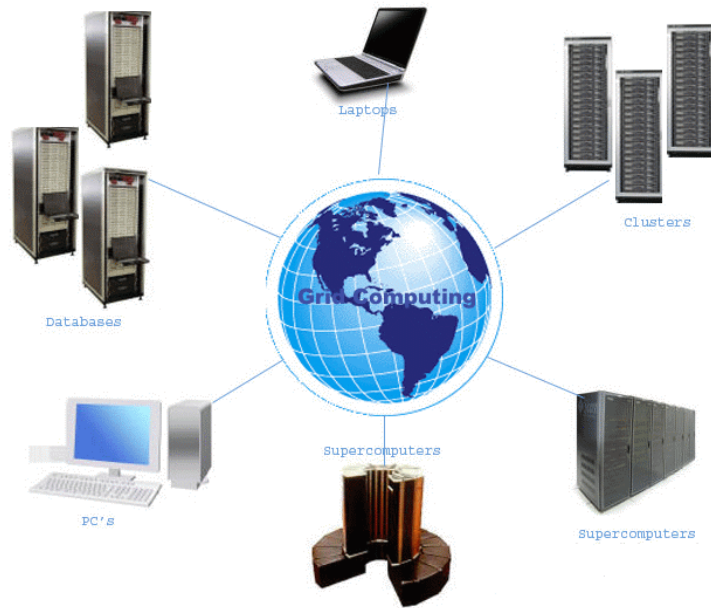


Fig. 2 Grid and Cluster Computing (Patil, 2010)

According to Chen *et al.* (2010) three things (thin clients, grid computing, and utility computing) are needed to form cloud computing. Thin client can be a computer or a computer program depending on other computers to execute its computational tasks like web browsers. According to Jaradat *et al.* (2011), utility computing means that “computing services and resources are available to the users whenever they need them and they will be charged based on the amount of used”. While the role of grid computing is linking distributed computers, the role of utility computing is paying for the amount that is used by the users (Chen *et al.*, 2010). They point out that in grid computing, there are resources and they can be either used or not used.

However, cloud computing moves one step further with on demand resource feature

and resources are used efficiently and effectively. Kumar and Sadashiv (2010) summarize the differences between these three technologies (Table 1).

Table 1 Comparison of Cluster, Grid, and Cloud Computing (Kumar and Sadashiv, 2010)

	Clusters	Grids	Clouds
SLA	Limited	Yes	Yes
Allocation	Centralized	Decentralized	Both
Resource Handling	Centralized	Distributed	Both
Loose Coupling	No	Both	Yes
Protocols/API	MPI, Parallel Virtual	MPI, MPICH-G, GIS, GRAM	TCP/IP, SOAP, REST, AJAX
Reliability	No	Half	Full
Security	Yes	Half	No
User Friendliness	No	Half	Yes
Virtualization	Half	Half	Yes
Interoperability	Yes	Yes	Half
Standardized	Yes	Yes	No
Business Model	No	No	Yes
Task Size	Single Large	Single Large	Small and Medium
SOA	No	Yes	Yes
Multitenancy	No	Yes	Yes
System Performance	Improves	Improves	Improves
Self Service	No	Yes	Yes
Computation Service	Computing	Maximum Computing	On demand
Heterogeneity	No	Yes	Yes
Scalable	No	Half	Yes
Inexpensive	No	No	Yes
Data Locality Exploited	No	No	Yes
Application	HPC, HTC	HPC, HTC, Batch	SME interactive applications
Switching Cost	Low	Low	High
Value Added Services	No	Half	Yes

## Characteristics of Cloud Computing

Cloud computing has various characteristics. In the literature many researchers mainly focus on the similar characteristics of cloud computing. Needs of users can change dynamically. Cloud computing enables these users to consume computing resources such as software and storage when they need and they are only charged by the amount that they used. This property is on demand service characteristics of cloud computing (Chang *et al.*, 2010; Chen *et al.*, 2010; Mahmood, 2011; Carroll *et al.*, 2011).

The second characteristic of cloud computing is broad access network. Computing resources that users consume reside over the network and these computing resources can be used with different platforms such as laptops, mobile phones, PDAs and personal computers at users' site (Chang *et al.*, 2010; Carroll *et al.*, 2011)

Resource pooling is another characteristics of cloud computing. Computing resources are “pooled” at cloud service providers' site. It means that cloud computing permits combination of these computing resources such as hardware, software and processing and to supply multiple users in a “multi-tenant model” (Mahmood, 2011; Chang *et al.*, 2010; Carroll *et al.*, 2011).

Cloud computing has a rapid elasticity and scalability and this feature of cloud computing enables that computing resources can be immediately supplied (Mahmood, 2011). In other words, consumers can increase and decrease the usage of computing resources at anytime they want without contract or “up-front commitment” and this indicates that consumption can immediately increase to meet

dynamic requirements of consumers at any time (Chang *et al.*, 2010; Carroll *et al.*, 2011).

It is mentioned that computing resources can be used by multiple consumers and meanwhile that each consumer is charged by the amount used, so cloud computing has a dynamic system which measures the usage of computing resources for each consumer and gives response to billing process. This feature of cloud computing is called a measured service (Chang *et al.*, 2010; Mahmood, 2011; Carroll *et al.*, 2011).

In addition to these five important characteristics of cloud computing, Chen *et al.* (2010) add further characteristics. They declare that a cloud can include million serves due to large scale feature of a cloud. Users can get service which is defined as virtualization feature of cloud computing anywhere and anytime by using their computers, laptops, notebooks or mobile phones. Cloud computing also has a reliable infrastructure meaning serving with minimal downtime and giving rapid response to consumers' requirements. Another characteristic of cloud computing is that various applications can work at the same time on a cloud because infrastructure of a cloud can support these diverse applications. They explain that consumers have benefit of low cost advantage of cloud computing because buying services over cloud computing is particularly inexpensive.

## Advantages of Cloud Computing

It is estimated that cloud computing adoption increases due to many benefits of cloud computing. The most important advantage of cloud computing is that it reduces the cost. Cloud computing enables companies to optimize their expenditures, because companies save in costs involving implementation, maintenance, hardware, software, power, cooling, storage, floor space (Carroll *et al.*, 2011; Mahmood, 2011).

Reducing power, cooling, and storage and floor space increase the sustainability of companies' facilities (Carroll *et al.*, 2011). IT staff in a company does not need to update software installed on each user's computers, because applications on a cloud exist in the site of cloud provider and the responsibility to update application belongs to cloud service provider (Prince, 2011). Therefore cloud computing decreases software upgrade costs of a company. In addition to this example; physical servers and storages reside in the site of cloud service providers and companies cannot only save in physical hardware costs but also they save in maintenance costs by reducing the number of both actual hardware and maintenance staff. Furthermore, when companies buy actual physical hardware, companies pay for both disk spaces they use for existing data and its unused part. However, cloud computing allows companies to only pay for the disk space for their existing data and for any additional needs, the company can purchase extra disk space and pays for it. It indicates that cloud computing prevents companies to pay for large up-front costs.

Study of Carroll *et al.* (2011) rank the cloud computing benefits through highest occurrence to lowest occurrence (Figure 3). Cost efficiency is the most important factor among cloud computing benefits and scalability follows it. Prince (2011) defines scalability as "the ability of a system to perform well under differing

load sizes”. According to this definition, cloud service providers give response to dynamically changing consumer requirements. According to Figure 3, flexibility, agility, and better IT resource management and business focus are other advantages of cloud computing. Mahmood (2011) declares that cloud computing allows companies’ personnel to become more business oriented. Thus, they produce “value and innovation for the business”.

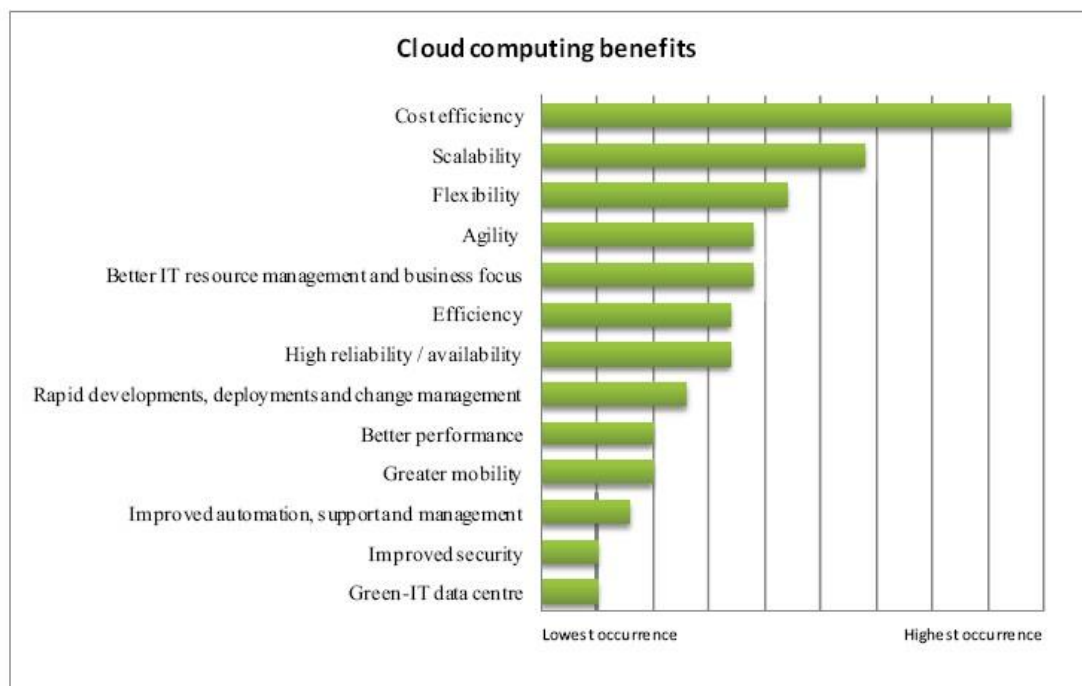


Fig. 3 Benefits of Cloud Computing (Carroll *et al.*, 2011)

Cloud computing increases efficiency and it has a reliable infrastructure with minimal downtime and rapid response to consumers’ requirements. The other advantages are rapid developments, deployments, change management, better performance, and greater mobility. Lastly, improved security and green – IT data centre are the benefits having the lowest occurrence in the list. In addition to these benefits, Prince (2011) points out that the world becomes more global and cloud

computing enables users to work remotely from any location and by any device through the Internet, and this increases the collaboration among users.

### Disadvantages of Cloud Computing

Even though cloud computing has many advantages, there are also disadvantages that companies hesitate to adopt cloud computing. Figure 4 shows the main concerns related to cloud computing. Carroll *et al.* (2011) list the risks of cloud computing through highest occurrence to lowest occurrence. The most important risk of cloud computing is the security, because many companies think that cloud infrastructure is not secure. Service providers, management and control, laws and regulations, portability and interoperability, disaster recovery, virtualization risks, lack of standards and auditing, maturity of technology and uncontrolled viable costs are other risks for companies after security. They examine the security concern as data security, administration and control, logical access, network security, physical security compliance and virtualization. They explain that companies hesitate to move their data especially their critical data to cloud due to data security risks and also state unauthorized access to data risks. Network security is also another concern and it is the risk of data hacking and also data centers are vulnerable to many security risks physically.

In addition to Carroll *et al.* (2011), many other researchers concentrate on the security issue. The first reason is that all the applications and data reside in the site of cloud service providers and companies do not have their data control. Therefore, the data are open to much vulnerability. This situation increases the concerns about the security of cloud computing platforms.

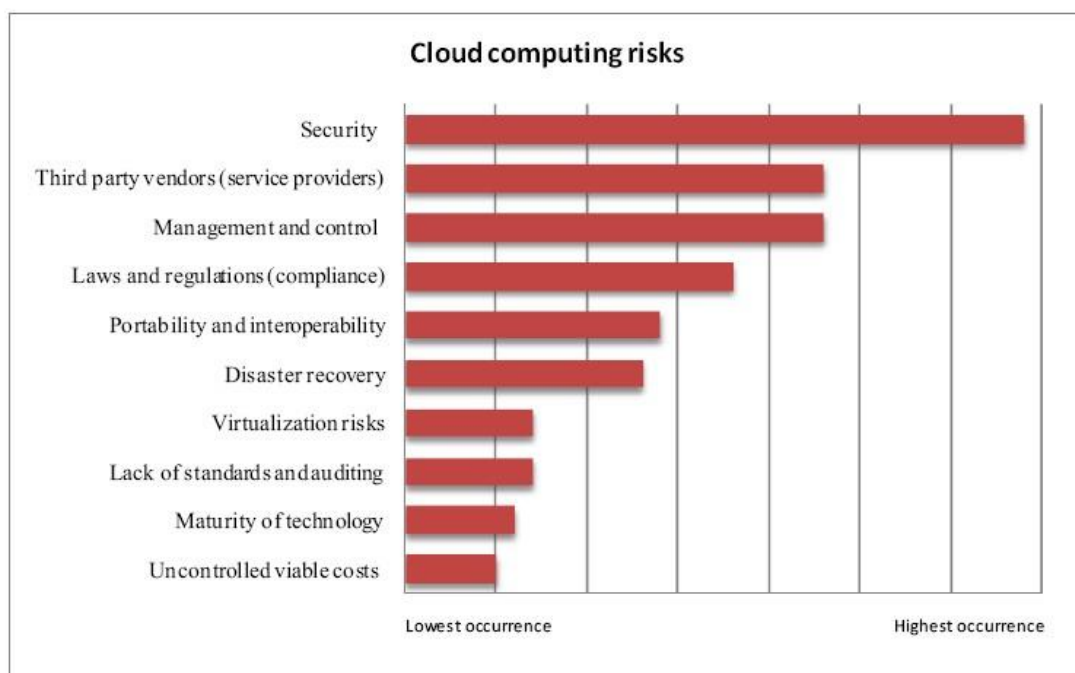


Fig. 4 Risks of Cloud Computing (Carroll *et al.*, 2011)

It raises the question that “how well protected is data in the cloud” (Chang *et al.*, 2010; Prince, 2011).

Cloud computing uses a multi-tenancy model which means that consumers share the same resources on a cloud. It is a risk concern for companies with regard to security issue (Chang *et al.*, 2010). This model also leads to another concern called ‘reputation fate-sharing’ which means that if a company’s reputation is bad and then this reputation damages the reputation of other good cloud users, because they share the same computing resources or the same network address.

Prince (2011) adds connectivity as another risk, because if you do not have a continuous Internet connection, you cannot have access to data and other applications. Reliability is also another risk; Prince (2011) explains that service provider’s cloud can be crashed or breakdown and consumers take the risk of data leakage. Chen and Yang (2010) state that there is a difference between having

servers on a cloud and in your own company when a downtime occurs. Since, the more servers are on a cloud, consumers are more dependent on cloud service provider. Prince (2011) also explains this situation as vendor lock-in. It is very hard for a company to migrate from its current vendor to another vendor due to differences between cloud computing platforms. In order to access data or other applications, the Internet is the essential element for cloud computing. In addition, cloud computing includes web-based activities and if there are not enough bandwidth, it can be a problem for large data packages.

Laws and regulations are other most important risks. There are many questions that companies seek for their answers; where the companies data are stored, if a problem occurs, what the place of jurisdiction will be, what if the data centre is hit by a disaster, whether their data is protected under intellectual property rights and how their trade secrets are secure (Agarwal, 2004).

Interoperability which means “links amongst different clouds and the connection between a cloud and an organization’s local systems” is also another risk and (Chang *et al.*, 2010). Vendor lock-in problem plays an active role in interoperability issue. It can be very problematic for companies to link servers reside on different clouds due to different cloud platform infrastructures. It is obvious that consumers do not have any control on computing resources. They only take the service given by cloud service provider. It raises the problem that consumers can not be sure about the quality, availability, reliability and performance of these computing resources. In order to take guarantees from cloud service providers, companies prefer signing service level agreements.

## Cloud Computing Service Models

Cloud computing includes various service models and Butrico and Da Silva and Youseff (2008) focus on these main service models through a cloud computing ontology consisting five layers. Figure 5 shows these five layers: cloud application, cloud software environment, cloud software infrastructure, software kernel and firmware/hardware layers. Actually, each layer corresponds to one of the cloud computing service models.

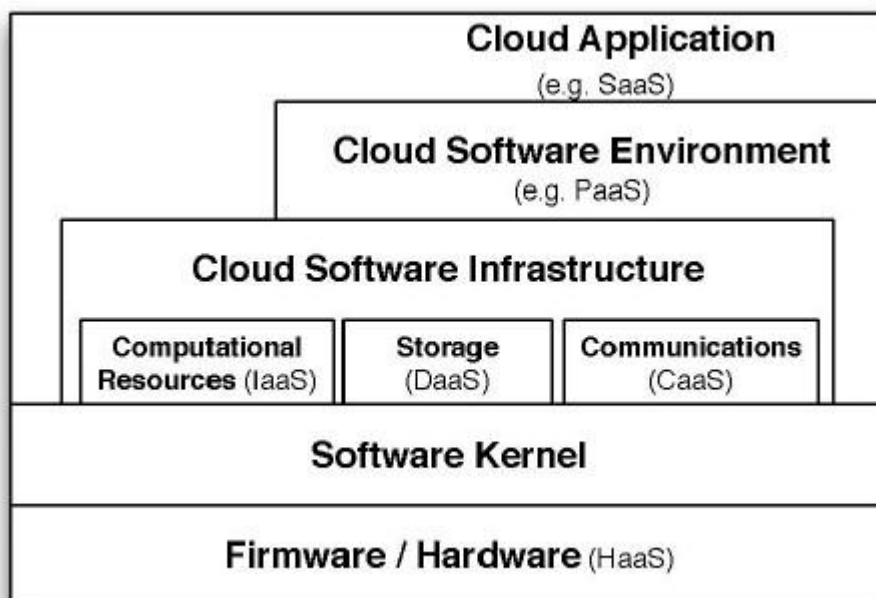


Fig. 5 Cloud Computing Ontology (Butrico *et al.*, 2008)

The first layer is the cloud application layer and it corresponds to Software as a Service (SaaS) service model. Butrico *et al.* (2008) state that end users access cloud services provided by this layer. An e-mail system, human resources management, payroll processing, database processing can be one of the examples as SaaS (Mahmood, 2011). Consumers only buy these user friendly applications. The advantage of SaaS model is that consumers do not need install or run special software on their computers but, they have the advantage of paying per use model

instead of purchasing software at a higher price (Chen *et al.*, 2010). These services reside on a hosting environment and consumer can easily access these services through diverse clients such as web browsers and personal digital assistants. On the other hand, they point out that if a delay occurs on the network, this can be very problematic for end users. Gmail, Hotmail, IBM Websphere, SalesForce and Google Docs are examples as SaaS.

The second layer is the cloud software environment and in this layer, users are not end users anymore, instead cloud application developers are the users. This layer corresponds to Platform as a Service (PaaS) model. PaaS provides cloud application developers to develop their own cloud applications and services by a “programming-language-level” environment (Butrico *et al.*, 2008). Mahmood (2011) gives application servers, database servers, portal servers and middleware as an example development tools as PaaS and declares that offerings can be runtime environment for application coding, cloud services, computing resources, networking and storage. Briefly, PaaS provides a platform that supports the whole software lifecycle (Chang *et al.*, 2010). Instead of pay per use model as in SaaS, pricing strategy is different for PaaS and pricing strategy can be computing usage per hour, data transfer per gigabyte, storage per gigabyte or Input/Output requests per million (Mahmood, 2011). Google App Engine and Windows Azure are examples of PaaS.

Third layer is cloud software infrastructure layer providing essential resources to other layers. It is divided into sub three layers (Butrico *et al.*, 2008). Computational resources are referred to Infrastructure as a Service (IaaS). They are virtual machines including visualized servers, storage and network devices that enable cloud platforms and applications to run (Butrico *et al.*, 2008; Mahmmod, 2011). Consumers only buy computing resources and they avoid large up-front costs.

The pricing strategy is “pay-for-what-you-use” and it can sometimes be called as utility computing (Mahmmod, 2011). For instance, if a company buys storage service, the company only pays for the amount used instead of buying whole storage disk. The main idea is that companies buy virtualized services, they do not buy actual storage disks or servers. Amazon EC2 and VMWare are examples of IaaS. They explain storage service as another layer and this service is called as Data Storage as Service (DaaS) and this service gives response to companies’ requirements to manage, maintain and store their data and information. The last layer under cloud software infrastructure layer is communications. They point out that communication is an important part of a cloud infrastructure, so cloud infrastructures must support some communicational capabilities such as service oriented, configurable, schedulable, predictable and reliable. Communication as a Service (CaaS) provides these requirements and network security, communication encryption, network monitoring and bandwidth.

Fourth layer is software kernel and this layer basically supports physical servers in the cloud by providing software management. The last layer hardware and firmware includes the actual physical hardware and switches which form the backbone of a cloud. Hardware as a Service (HaaS) is an example of hardware service. Service providers have the responsibilities to operate, manage and upgrade hardware bought by companies.

These are the main service models for cloud computing and there are also other types of service models such as Database as a Service, Security as a Service, Integration as a Service, Testing as a Service, Business Process as a Service, Management/Governance as a Service (Mahmood, 2011).

## Cloud Computing Deployment Models

There are mainly four types of cloud computing deployment models: public, private, community and hybrid cloud deployment models.

Public clouds are hosted and managed by cloud service providers and responsibilities of maintenance, installation, support and supply belong to cloud service providers (Mahmood, 2011). Public cloud is the main deployment model in comparison with other deployment models and cloud service providers have their own policies to govern public clouds, because they are the owner of clouds (Chang *et al.*, 2010). Different customers share the same cloud and thus the same computing resources (Chen and Yang, 2010). Consumers are charged by pay-as-you-go model, that is, they only pay for the amount used (Mahmood, 2011). On the other hand, security and reliability can be one of the problems for companies using public clouds.

The second deployment is private clouds and private clouds belong to an enterprise and they are mainly located in datacenter in the company (Mahmood, 2011). In addition, computing resources are not shared by other cloud consumers (Chen and Yang, 2010). Enterprise has the full ownership and uses all computing resources. Responsibilities of maintenance, installation, support and supply belong to internal personnel of the enterprise or a cloud service provider. Enterprises can prefer private clouds due to security, reliability and quality issues especially for critical tasks (Mahmood, 2011).

If several enterprises forms and share the same cloud infrastructure together, this is the type of community deployment model (Chen and Yang, 2010). A community cloud can be hosted and managed by a cloud service provider or one of

the enterprises in the community (Chang *et al.*, 2010). Responsibilities of maintenance, installation, support and supply belong to a cloud service provider or the members of community.

The last deployment model is the hybrid model and enterprises can use a combination of public and private and community clouds. Both cloud service providers and enterprises share the responsibilities. Enterprises can prefer hybrid models in order to optimize their resources and for their sensitive data and core competencies they can prefer using private clouds (Mahmood, 2011; Chang *et al.*, 2010). However, hybrid clouds can cause standardization and interoperability problems within the enterprise.

#### Technology Acceptance Models and Adoption of Cloud Computing

Technology acceptance model (TAM) shown in Figure 6, is one of the most fundamental research models in the literature to predict information technology acceptance. TAM is developed by Davis in 1989. The main constructs of TAM are: perceived usefulness and perceived ease of use. Davis (1989) defines perceived usefulness as “the degree to which a person believes that using a particular system would enhance his or her job performance”. Additionally, perceived ease of use points to “the degree to which a person believes that using a particular system would be free of effort”. He implies that perceived usefulness has an effect on intention to use and perceived ease of use affects both perceived usefulness and intention to use.

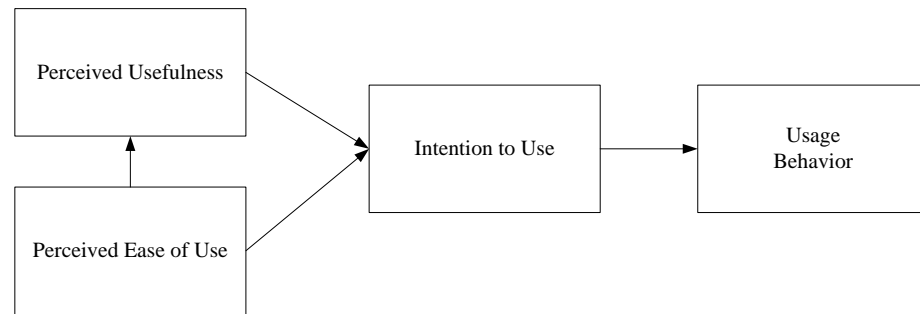


Fig. 6 Technology Acceptance Model (Davis, 1989)

Davis and Venkatesh (2000) extend technology acceptance model and they develop Technology Acceptance Model 2 (TAM2). They include new determinants to predict perceived usefulness: subjective norm, image, job relevance, output quality, result demonstrability. In addition, they use experience and voluntariness as moderating variables. In 2008, Bala and Venkatesh develop Technology Acceptance Model 3 (TAM3). In this instance, they extend model by adding six determinants to predict perceived ease of use: computer self-efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment and objective usability (Figure 7).

Cloud computing is an upcoming technology and a new research area in the literature, so academic research is very scarce in cloud computing field. On the other hand, Ross (2010) studies factors influencing the adoption of cloud computing by decision making managers. His study focuses on the organizations that want to maximize their resources and minimize their costs. Organizations think cloud computing is a new approach which is serving their needs. He takes perceived cost effectiveness, need, reliability, and security as study factors in order to predict cloud computing adoption by Technology Acceptance Model (TAM).

The data are collected from thirty eight information technologies managers (Ross, 2010). Factor and correlation analyses are used in the study to analyze cloud computing adoption. Results indicate that there is a positive relationship between dependent and independent factors: perceived cost effectiveness, need, reliability, security, and decision to adopt cloud computing.

In addition, Chen and Low and Wu (2011) study the determinants of cloud computing adoption. They use technology, organization, environment (TOE) framework and focus on eight factors to predict cloud computing adoption: relative advantage, complexity, compatibility, top management support, firm size, technology readiness, competitive pressure and trading partner pressure. Results imply that only five of these factors, relative advantage, top management support, firm size, competitive pressure and trading partner power have an effect on cloud computing adoption.

Behrend *et al.* (2011) study cloud computing adoption and usage in community colleges. They use Technology Acceptance Model 3 (TAM3) to predict cloud computing adoption. Behrend *et al.* (2011) measure access to software, ease of travel, personal innovativeness, technology anxiety, instructor support, reliability, usefulness, and ease of use to predict actual usage, intentions for future use, and future usefulness of cloud computing. They collect data from 760 students from two community colleges in USA. Results show that ease of use factor is stronger predictor than usefulness for the adoption of cloud computing. In other words, students accept the advantage of a tool, but they are not motivated to use it unless it is user friendly.

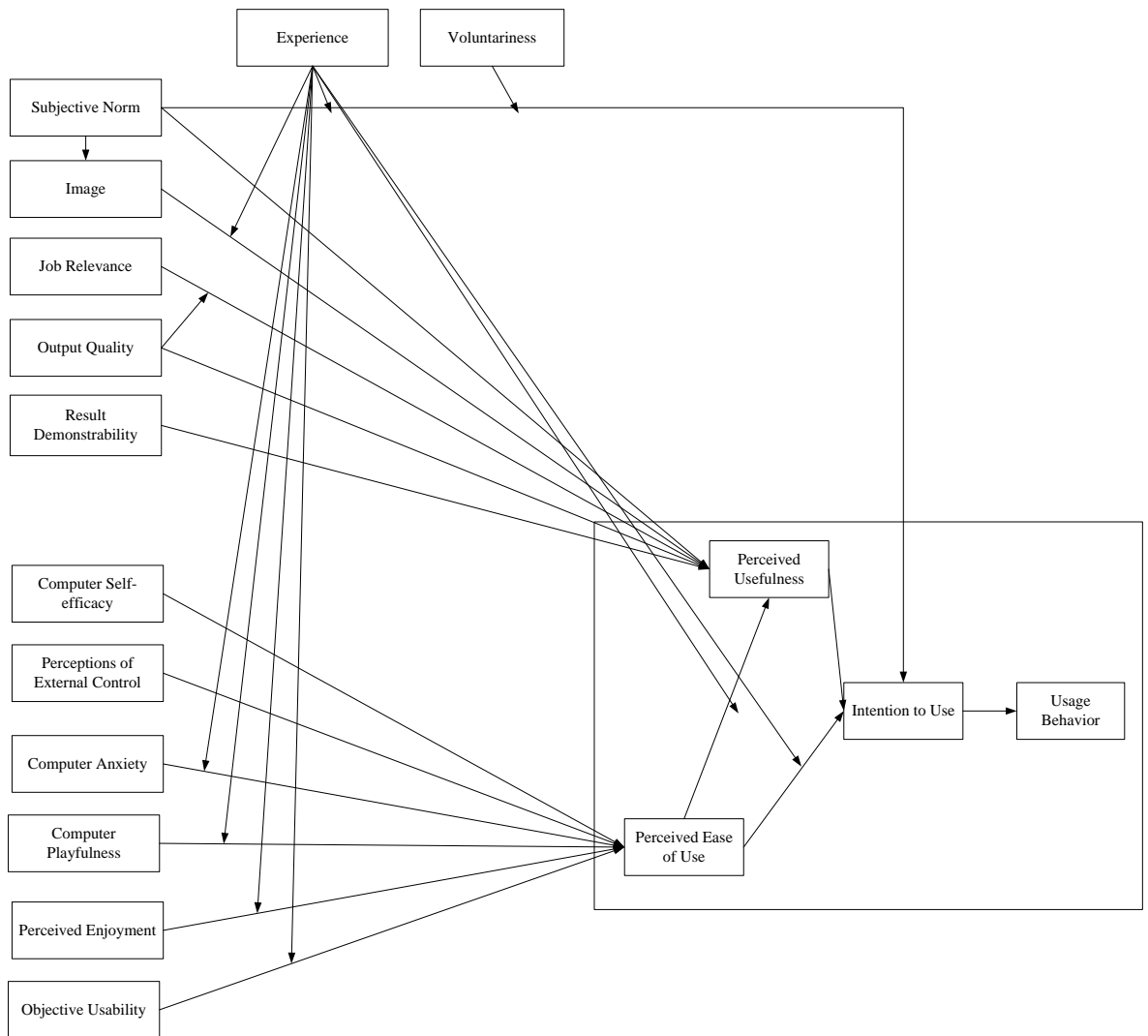


Fig. 7 Technology Acceptance Model 3 (Bala and Venkatesh, 2008)

Cegielski, Farmer, Wu, and Hazen (2012) conduct a study about adoption of cloud computing technologies in supply chains. They use organizational information processing theory to determine the effect of the company's organizational processing requirements and capabilities on cloud computing adoption. They use both quantitative and qualitative methods including Delphi, survey and interview. They hypothesize that information processing requirements (environmental uncertainty, task uncertainty, and inter-organizational uncertainty) have effect on adoption of cloud computing. They collect data from 357 individuals. Their findings support that

information processing capability affect the intention to adopt cloud computing.

They suggest that decision to adopt cloud computing depends on multiple conditions.

## CHAPTER 3

### STRUCTURAL EQUATION MODELING

Structural equation modeling (SEM) is a statistical model that analyzes and explains the relationships among multiple determinants. In other words, hypotheses about how sets of variables determine factors and how these factors are related to each other are tested with different theoretical models in SEM (Schumacker and Lomax, 2010). For example; basic models which include regression, path and confirmatory factor models.

History of SEM is based on the development of regression, path, and confirmatory factor analyses. The prediction of dependent observed variable is permitted by a given linear weighting of a set of independent observed variables in the regression model. According to Pearson (1938), Karl Pearson developed the formula for correlation coefficient in 1896 and made regression models possible (as cited in Schumacker and Lomax, 2010). After years, Spearman (1904, 1927) created factor model and he used factor analysis term firstly (as cited in Schumacker and Lomax, 2010). The main idea underlying the factors analysis is that whether a set of items are correlated or not. In the 1960s, Karl Jöreskog developed confirmatory factor analysis completely in order to test whether a set of items defines a construct. Sewell Wright who was a biologist developed the path model based on box and arrow diagrams (Wright, 1918, 1921, 1934, as cited in Blunch, 2007; Schumacker and Lomax, 2010). Path model combines correlation coefficients and regression analysis to test more complex relationships among factors. Finally, SEM which integrates path and confirmatory factor analyses was developed by Karl Jöreskog, Ward Keesling and David Wiley (Jöreskog, 1969, 1973; Keesling 1972; Wiley,

1973, as cited in Schumacker and Lomax, 2010). Their JKW model becomes well known after the development of linear structural relations model (LISREL) which is also the first software program to test SEM.

SEM includes two common multivariate statistical techniques: factor analysis and multiple regression analysis (Hair, Black, Babin and Anderson, 2010). According to Hair *et al.* (2010) structural equation models have three different characteristics: multiple and interrelated dependence relationships are estimated, it is able to show unobserved concepts and clarify measurement error and lastly a model explaining whole relationships is defined.

These differences can be explained in more detail. Firstly, SEM differs from other multivariate techniques by making separate and interconnected multiple regression equations simultaneously. Secondly, unobserved variables referred to as latent construct cannot be measured directly. These variables are represented by observable referred to as manifest variables or indicators. SEM measures these latent variables by analyzing consistency among multiple indicators. The last difference states that theory including set of relationships and hypotheses are represented in a model. SEM is made up of two models: measurement model and structural model. While measurement model represents how indicators or manifest variables are combined to represent latent variables, structural model depicts interdependency among these latent variables.

## Path Diagram

Path diagram visually depicts both measurement and structural model. Path diagram includes notations and shows constructs and measured variables and relationships between them. Before representation of these notations, it is beneficial to give some definitions take part in the structural equation models.

Latent construct is an unobserved variable, so “latent construct cannot be measured directly but can be represented or measured by one or more variables” (Hair *et al.*, 2010). The researcher should define the latent behavior in terms of “behavior believed to represent it” (Byrne, 2010). Indicators are observed variables which are also referred to as manifest variable and “indicators are used as a measure of a latent construct that cannot be measured directly” (Hair *et al.*, 2010).

Endogenous constructs are also latent constructs and “an endogenous construct is represented by a variety of dependent variables”. In other words, endogenous constructs are influenced constructs by exogenous constructs directly or indirectly (Byrne, 2010). Exogenous constructs are also latent constructs but these constructs are controlled by factors that are outside of the model (Hair *et al.*, 2010). Exogenous latent constructs are causal independent variables (Byrne, 2010).

Another notation used in path diagram is measurement error and it is “degree to which the variables we can measure do not perfectly describe the latent construct(s)” (Hair *et al.*, 2010). Measurement errors or residuals show the difference between the observed data and hypothesized model (Byrne, 2010).

Figure 8 shows path diagram notations. Measured variables or indicators are represented by squares or rectangles. Constructs or unobserved variables are

represented by ovals or circles. Measurement errors or residuals for both constructs and indicators are represented by ovals or circles.

There are two types of relationships: measurement and structural relationships. Measurement relationship is a dependence relationship between indicators and constructs. This relationship is depicted by a straight arrow from the construct to indicator (Figure 8). Structural relationships are between latent constructs and they can be a dependence relationship or correlational relationship. If a relationship exists between two latent constructs, an arrow is drawn. In a dependence relationship, an arrow goes from an independent variable to a dependent variable. Additionally, dependence relationship determines whether a latent construct is endogenous or exogenous (Hair *et al.*, 2010). Although the construct which is pointed by an arrow and acts like a dependent variable is endogenous construct, exogenous constructs act like independent variables and they can have correlational relationships with other latent constructs.

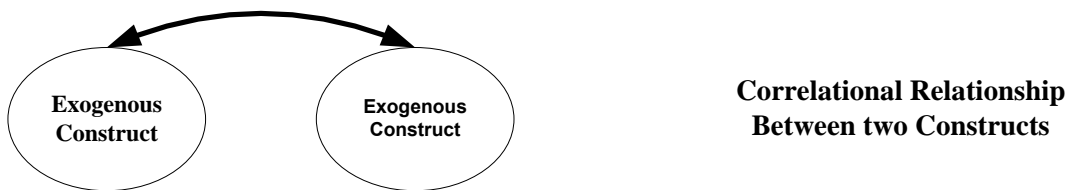
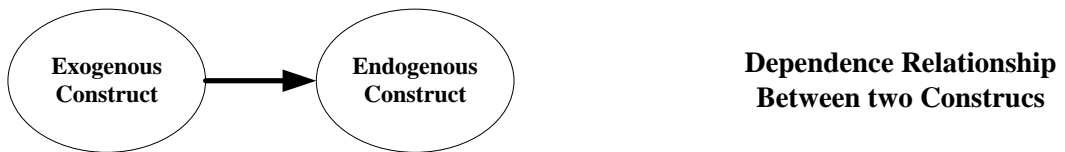
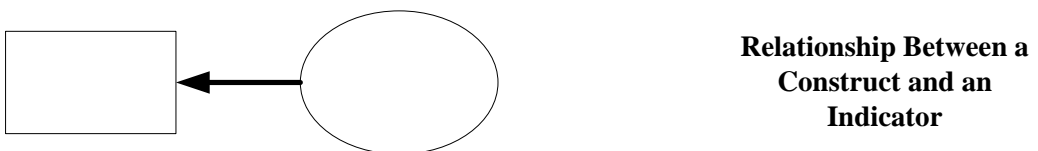
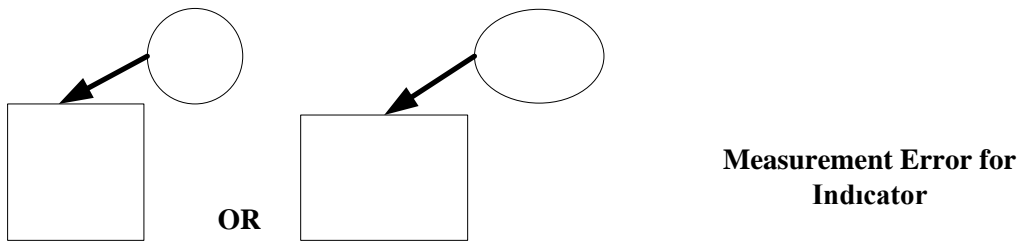
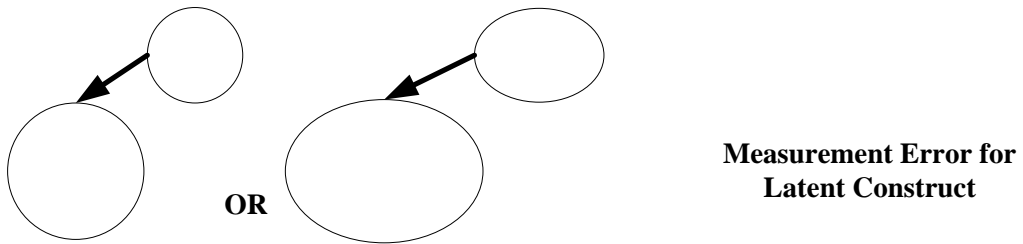
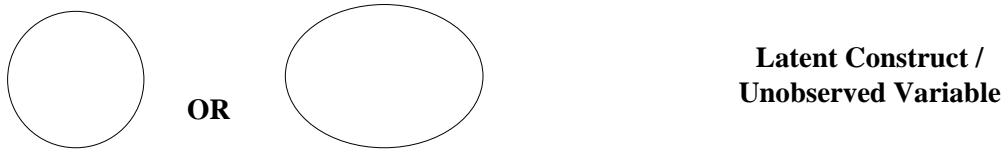
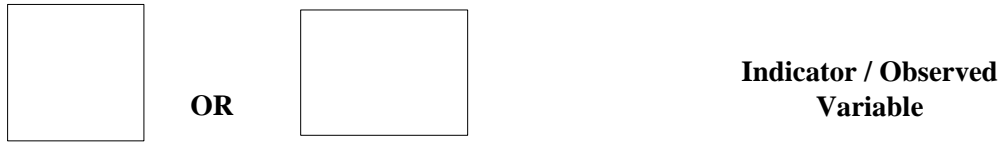


Fig. 8 Path Diagram Notations

## Stages in Structural Equation Modeling

According to Hair *et.al* (2010), there are six stages in structural equation modeling.

Figure 9 depicts the six-stage decision process for structural equation modeling.

In order to test hypotheses in the structural model more reliable, a good and well designed measurement model is very important. At the first stage, a good measurement scale is needed to start with SEM. In the second stage, a path diagram is designed to show latent constructs, indicators and relationships.

Next step is important to decide sample size and estimation method. If model contains five or fewer constructs and highest (0.60) communalities, sample size should be at least 100. Each construct should be measured more than three indicators. Communalities refer to average error variance of indicators and they are calculated as the square of the standardized construct loadings. If there are seven or fewer constructs with modest (0.50) communalities, sample size should be at least 150. If model includes seven or fewer constructs with lower (below 0.45) communalities and has fewer than three indicators, minimum sample size should be at least 300. Models including large numbers of constructs require at least 500 sample size.

Selection of estimation technique is another issue. There are five estimation models: ordinary least squares, maximum likelihood estimation, weighted least squares and generalized least squares and asymptotically distribution free. Maximum likelihood estimation is the most preferred method and is more efficient and unbiased.

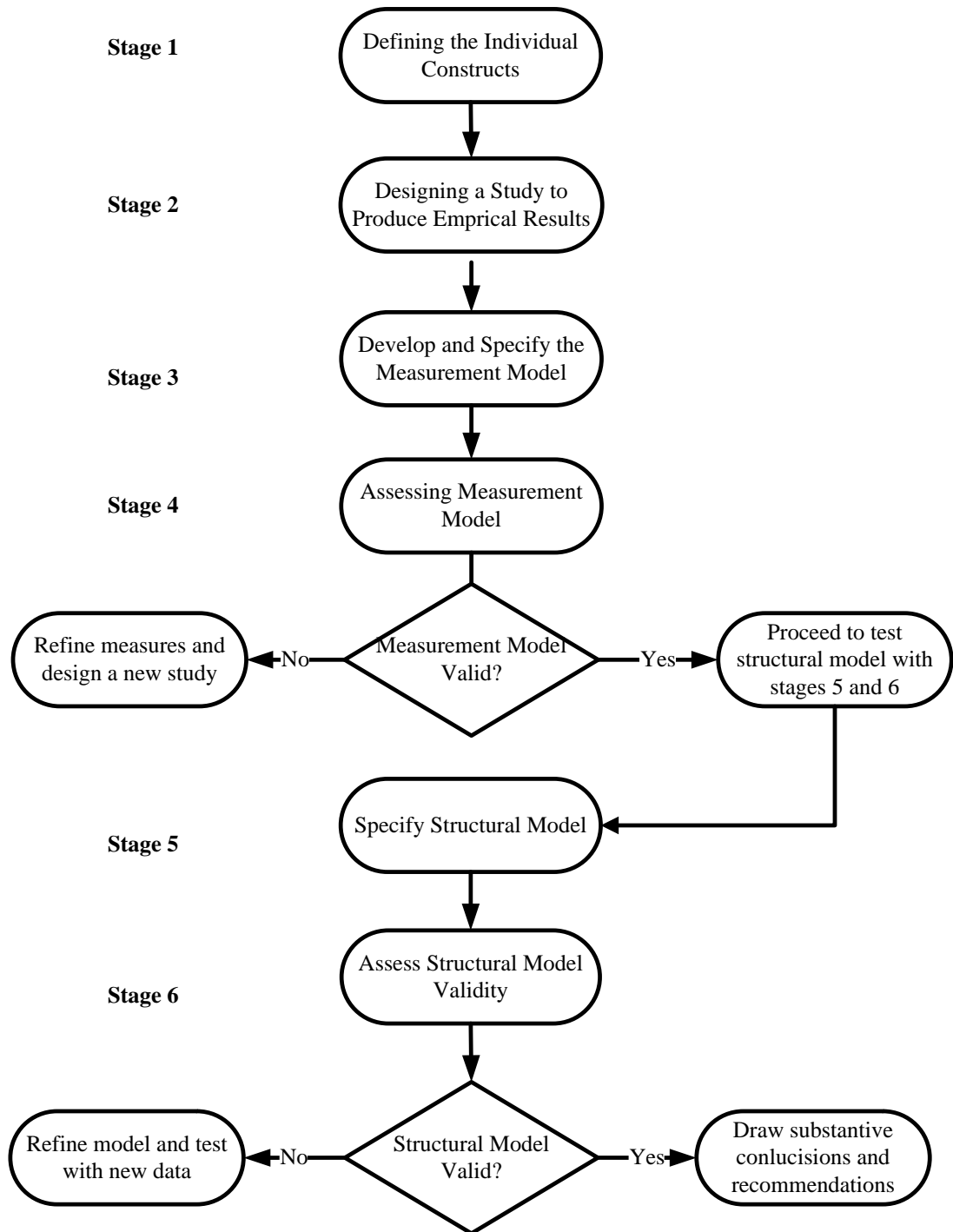


Fig. 9 Six-stage Decision Process of Structural Equation Modeling (Hair et. al, 2010)

Fourth stage includes measurement model validity by assessing fit indices and path estimates. “Goodness-of-fit (GOF) indicates how well the specified model reproduces the observed covariance matrix among the indicator items (i.e, the similarity of the observed and estimated covariance matrix).”

There are four types of fit indices: the basics of goodness of fit, absolute fit indices, incremental fit indices and parsimony fit indices. The basics of goodness of fit indices are Chi-Square and Degrees of Freedom.

1. Chi-Square( $X^2$ ): it is difference in the observed and estimated covariance matrices. The equation of Chi-Square is  $X^2 = (N-1) * (S - \sum_k)$  where S is observed sample covariance matrix and  $\sum_k$  is SEM estimated covariance matrix and N is the overall sample size.
2. Degrees of freedom “represent the amount of mathematical information available to estimate model parameters.” Degrees of freedom is found by the equation of  $df = \frac{1}{2}[(p)(p+1)] - k$  where p is the total number of observed variables and k is the number of estimated parameters.

Absolute fit indices show how well proposed model fits the sample data. Mostly used absolute fit indices are goodness of fit index (GFI), root mean square error of approximation (RMSEA), root mean square residual (RMR) and standardized root mean residual (SRMR).

1. GFI: The possible range of GFI values is 0 to 1 and if it is .90 and greater then it indicates a good model.
2. RMSEA: Lower RMSEA values indicate a good fit and the value between .05 and 0.80 is acceptable for a good model.

3. RMR and SRMR: RMR is the square root of the mean which means the average of the residuals and SRMR represents the average standardized residuals. Lower RMR and SRMR represent a good fit.

Incremental fit indices provide that “how well the estimated model fits relative to some alternative baseline model”. Normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI) and relative noncentrality index (RNI) are incremental fit indices.

1. NFI: “It is the ratio of the difference in the  $X^2$  value of fitted model and a null model divided by the  $X^2$  value for the null model” and it is between 0 and 1 and 1 represents a perfect model fit.
2. TLI: “It is actually a comparison of the normed chi-square values for the null and specified model” and it is between 0 and 1 and 1 represents a perfect model fit.
3. CFI: Values 0.90 and greater are considered with acceptable model fit.
4. RNI: It also analyzes estimated model and alternative null models and Values 0.90 and greater are considered with acceptable model fit.

The last group is parsimony fit indices and these indices give information about which model among alternative models is the best by analyzing “its fit relative to complexity”. Adjusted goodness of fit index (AGFI) and parsimony normed fit index (PNFI) are in this group of fit indices.

1. AGFI: It takes different degrees of model complexity and it is less used.
2. PNFI: It adjusts NFI and high values indicate a good model.

According to Hair *et al.* (2010), three to four fit indices are adequate to show model fit and at least one incremental index and one absolute index besides chi-square and degrees of freedom should be reported.

In addition to Hair *et al.* (2010), the study by Engel, Moosbrugger and Müller (2003) also focuses on goodness of fit measures and summarize good and acceptable fits (Table 2).

Table 2 Summary of Goodness of Fit Indices (Engel, Moosbrugger and Müller, 2003)

Fit Measure	Good Fit	Acceptable Fit
$\chi^2$	$0 \leq \chi^2 \leq 2df$	$2df \leq \chi^2 \leq 3df$
P value	$.05 \leq p \leq 1.00$	$0.01 \leq p \leq 0.05$
$\chi^2/df$	$0 \leq \chi^2/df \leq 2$	$2 < \chi^2/df \leq 3$
GFI	$.95 \leq GFI \leq 1.00$	$.90 \leq GFI \leq .95$
RMSEA	$0 \leq RMSEA \leq 0.05$	$.05 \leq RMSEA \leq .08$
SRMR	$0 \leq SRMR \leq 0.05$	$.05 \leq SRMR \leq .10$
NFI	$.95 \leq NFI \leq 1.00$	$.90 \leq NFI \leq .95$
CFI	$.95 \leq CFI \leq 1.00$	$.90 \leq CFI \leq .95$
AGFI	$.90 \leq AGFI \leq 1.00$	$.85 \leq AGFI \leq .90$

Second part of the stage four covers testing measurement validity. There are two analyzes: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

#### 1. Exploratory Factor Analysis

“Exploratory Factor Analysis provides the tools for analyzing the structure of interrelationships (correlations) among a large number of variables by defining sets of variables that are highly interrelated, known as factors” (Hair *et al.*, 2010).

Exploratory factor analysis (EFA) should be done to find whether indicators

represent the unobserved variable well. Variables in the measurement model must have high loadings on a single factor and rule of thumb; variables generally should have communalities of greater than 0.50 and Cronbach's Alpha with 0.70 or greater value provides a good reliability (Hair *et al.*, 2010).

## 2. Confirmatory Factor Analysis

In confirmatory factor analyses (CFA) the researcher finds whether the sample data validate the model (Schumaker and Lomax, 2010). CFA tests whether measured variables represent a smaller number of constructs well or not (Hair *et al.*, 2010).

There is a distinction between EFA and CFA. In EFA, a model is found that fits the data (Schumaker and Lomax, 2010). Researcher finds how many factors there are in the proposed model and how they are correlated. The important point is that which observed variables measure each factor well. The main distinction is that while in EFA there is not any proposed model, in CFA there is a proposed theoretical model. EFA is just determined from statistical results while CFA is derived from the theory (Hair *et al.*, 2010). They reveal that while conducting EFA the numbers of factors existing and which variable belongs to which constructs are not really known.

As rules of thumb, they declare that standardized loading estimates must be 0.50 or higher and ideally 0.70 or higher, however square of a standardized factor loading shows "how much variation in an item is explained by the latent factor". It is referred to as variance extracted and it is stated that loadings less than 0.70 can be significant but their variance extracted decreases. For example; a loading of 0.71 squared equals 0.50 and it explains half the variation in the item.

Another criterion is average variance extracted and it should be 0.50 or greater suggesting enough convergent validity and average variance extracted is

calculated as:  $AVE = \frac{\sum_{i=1}^n L_i^2}{n}$  where  $L_i$  is the standardized factor loading and  $i$  is the number of items.

Construct reliability is also an important indicator and it should be 0.70 or higher indicating enough convergence or internal consistency. Construct reliability is

calculated as:  $CR = \frac{(\sum_{i=1}^n L_i)^2}{(\sum_{i=1}^n L_i)^2 + (\sum_{i=1}^n e_i)^2}$  where  $L_i$  is the standardized factor loadings

and  $e_i$  is the error variance terms for a construct. Additionally, measurement error is calculated as  $1 - (L_i)^2$  (Hair *et. al*, 1998, as cited in Bolat, 2010).

If measurement model is valid, structural model testing can be proceeded. At the fifth stage, structural relationships and research hypotheses are determined. Lastly, sixth stage includes structural model validity. In order to validate structural model, goodness of fit indices mentioned in the fourth stage are used. If structural model is valid, conclusions and recommendations can be drawn from the proposed model.

## CHAPTER 4

### THEORETICAL FRAMEWORK

The main goal of the study is to explain and evaluate the factors having an effect on the adoption of cloud computing and to predict causal relationships between these factors. In this study, fifteen factors are considered as determinants and they are adapted from literature review. These factors are *reliability, maintenance, virtualization, integration, performance, cost, on demand service, legislation and regulations, security, supplier availability, adoption, need, customization, user friendliness, and managerial support* factors. They are considered as the key factors affecting the adoption of cloud computing and described in a model (Arı and Mardikyan, 2013).

After literature survey, interviews are arranged with cloud computing experts who work at leading companies in Turkey. During interviews, the most important factors are determined and the number of variables is decreased. *Customization, user friendliness, and managerial support* factors, which are mostly measurable for a specific cloud service rather than general cloud computing adoption, are removed from the model. As a result of these interviews, *security, need, supplier availability, on demand service, cost, security, and legislation and regulations* are determined as the most important factors. In addition to interviews, to create a smooth and measurable model that can be analyzed with SEM, *reliability, maintenance, virtualization, integration, and performance* which are mostly related with each other are grouped under *other factors*.

## The Factors of the Proposed Model

The first factor is *security*. It is added to the study model as an important determinant for adoption of cloud computing. *Security* is evaluated a cloud computing risk by organizations. Customers or cloud users must be sure that their organizational data is more secure in a cloud (Chen and Yang, 2010; Carroll *et al.*, 2011).

Ross (2010) says that companies need cloud computing due to changing technological improvements and to satisfy their technological needs. Moreover, competitive pressure and trading partner pressure are other factors that increase the need for cloud computing (Chen *et al.*, 2011). In this respect, *need* is added as a determinant in the study model.

The third determinant is *on demand service*. It is a feature of cloud computing and it allows organizations to buy according to their needs and to pay just for the amount that they used. It is like paying for electricity and water (Chen *et al.*, 2010).

*Cost* is also one of the most important constructs in the model. It consists of both purchasing cost and long term usage costs. Purchasing cost of cloud computing is very inexpensive compared to traditional computer technologies. Companies can save in the long term costs by preferring cloud computing technologies. In this way, they save in energy, space and staff costs (Chen *et al.* 2010; Ross, 2010). Besides, responsibility to update applications and software belongs to cloud service provider. Therefore, software upgrade costs are decreased in the organizations (Prince, 2011). Physical servers and storages reside in the site of cloud service providers and companies cannot only save in physical hardware costs but also they save in

maintenance costs by reducing the number of both actual hardware and maintenance staff.

The fifth determinant is *other factors*. It includes five sub-factors: *integration, maintenance, virtualization, reliability, and performance*. The first sub-factor is integration. *Integration* of cloud services with existing legacy systems are hard (Chang *et al.*, 2010). On the other hand, according to interviews it is said that there are integration operations resulted smoothly. The second sub-factor is *maintenance*. It is very easier in an organization, because updating and other maintenance processes are held on the cloud rather than on each user's computers (Prince, 2011). The third sub-factor is *virtualization*. Cloud computing allows cloud users to use cloud services anywhere and anytime through various devices such as notebook, personal computers and mobile phones (Chen *et al.*, 2010). *Reliability* is the fourth sub-factor. Cloud computing has a reliable infrastructure serving with minimal downtime and giving rapid response to consumers' requirements and organizations expect minimal downtime and rapid response (Chen *et al.* 2010; Ross, 2010). The last sub-factor, *performance*, is added to the model according to interviews. It is declared that cloud computing technology increases both companies' and especially users' performances.

*Legislation and regulations* is the sixth factor and added through interviews. It predicts whether there are enough legal protections to solve conflicts between cloud users and cloud providers when a problem such as a disaster or a hack occurs.

*Supplier availability* is the last factor and added in accordance with interviews. It includes two aspects. The first one is that there must be enough suppliers to purchase cloud services when they are needed any time. Second aspect is that there must be enough suppliers to give after sale support.

The proposed model is given in Figure 10. It shows that there are also interrelationships between factors. Firstly, *security* may have an effect on *cost*. In accordance with interviews, companies can prefer private clouds to public clouds for data security. In this respect, private cloud costs much than public cloud. Secondly, *legal issues* may have an effect on *security*. As stated in interviews, inadequate legal protections for safety of organizational data affect the security. Thirdly, *on demand service* may have an effect on *cost*. This feature of cloud computing decreases cost, because organizations pay only for the amount used rather than paying for all amount. (Carroll *et al.*, 2011). Lastly, *other factors* may have effects on both *security* and *cost*.

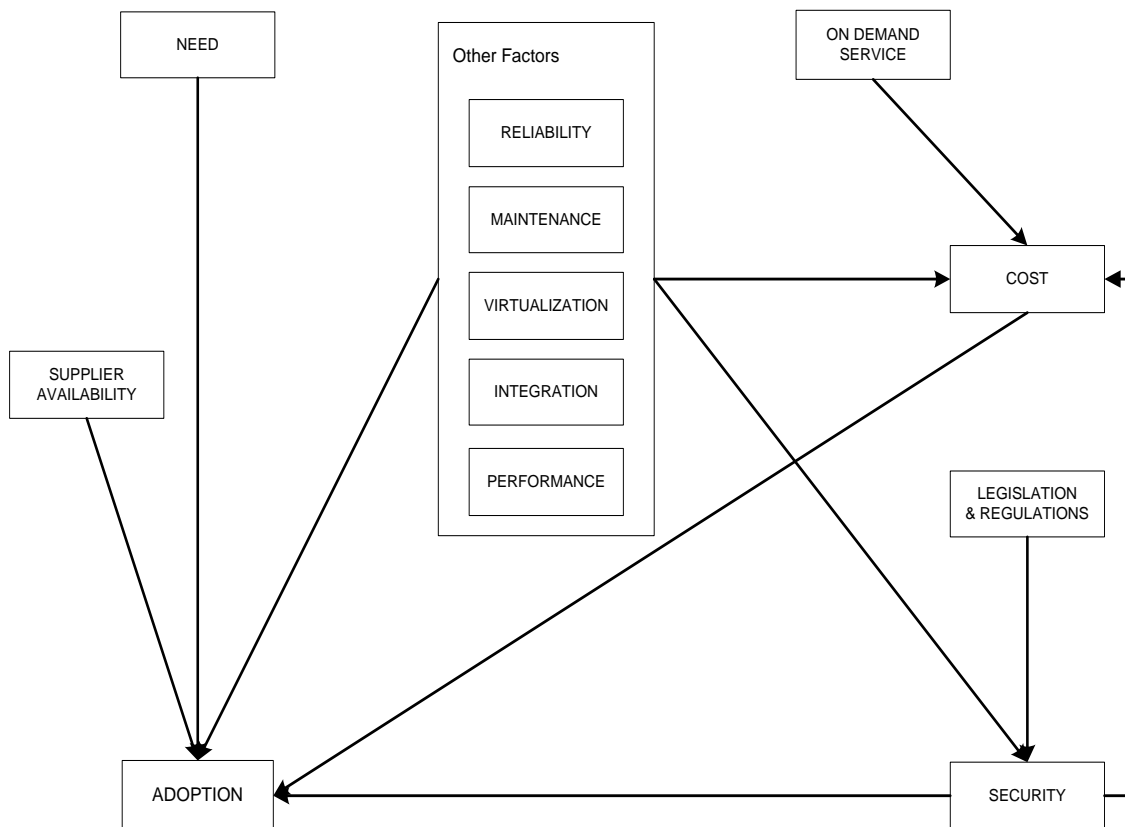


Fig. 10 Theoretical Framework of the Study

According to the proposed model, *adoption* which is the target variable of the study is affected from *supplier availability, need, other factors, security, and cost* directly and *on demand service, legislation and regulations, and other factors* indirectly.

## CHAPTER 5

### RESEARCH METHODOLOGY

In the study, a survey methodology is used to collect data and verify our model hypotheses. A questionnaire is prepared to measure the factors of the study based on literature reviews and interviews.

The questionnaire (Appendix A) is prepared in Turkish and includes seven questions. The first question is a control question to check whether the related organization is taking any cloud computing services or not. The second question asks for organizations' sectors. It includes thirteen sector options and an open-ended option for sectors which are not on the list. The third question is added to collect organizations' active years in the related sector. The fourth question asks for whether the organization operates internationally or nationally in the sector. The fifth and sixth questions are designed to collect descriptive data about cloud computing. The former asks which cloud computing services the organization takes: SaaS, PaaS, IaaS, and DaaS. More than one answer can be chosen. The latter asks from which cloud service providers the organization takes services. It includes seventeen options and an open-ended option for cloud service providers which are not included in the list.

The last question includes sub- twenty two items and measures the factors of the study. 7-point Likert-Scale is used for each item. The questions related to security, cost, need, reliability, and adoption are adapted from Ross (2010). Security (V1, V2), need (V3, V4), cost (V6, V7), legislations and regulations (V9, V10), on demand service (V11, V12), supplier availability (V22, V23), and adoption (V24, V25) are measured with two questions for each. Other factors which includes

reliability (V5), maintenance (V8), virtualization (V14, V15, and V16), performance (V19, V20), and integration (V13) are measured with eight questions. The explanations of each factor and indicators are given in Table 3.

Data is collected using an online questionnaire service. Targeted sample is IT personnel who are well-versed in cloud computing. At the first stage, online questionnaire was distributed to main cloud service providers such as Cloudfurk, Hayat Bilgi Teknolojileri, Inspark, and Turkcell. After that, these cloud service providers are shared questionnaire with their customers.

At the second stage, online questionnaire was shared on LinkedIn platform and this online questionnaire is posted on groups: Bulut Bilişim Türkiye – Cloud Computing Turkey, Bulut Bilişim (CloudComputing), Bulut Bilişim Paylaşımları, Türkiye Bilişim Derneği, Turk IT, Turkish Telecom Professionals, Telekom Sektörü Çalışanları, Turkish Business Network, IEEE Türkiye, Türkiye Bilişim, .NET Türkiye (.NET Turkey), Turkish Telecom / IT Contractors, ICT Club, [YBS] Yönetim Bilişim Sistemleri (MIS-TR), Network in Turkey, IT & Telekoms Türkiye, BThaber.

At the third stage, online questionnaire was sent as personal messages to potential IT personnel. Online questionnaire was sent to 838 IT personnel. As a result, 388 replies were returned and 82 of them were from IT personnel who stated that they do not have enough knowledge about cloud. Therefore, the sample of the study includes 306 replies.

Table 3 Factors and Indicators

Factors	Sub-Factors	Indicators (Observed Variable)	Explanation
Security		V1	I feel that cloud computing technology is secure.
		V2	I feel that cloud computing technology is more secure than traditional computing methods.
Need		V3	My organization needs cloud computing technology to meet its IT needs.
		V4	Cloud computing technology provides a significant benefit to my organization.
Cost		V6	I consider cloud computing technology to have considerable cost savings over traditional computing methods in the long run.
		V7	I consider cloud computing technology to have considerable low purchasing cost advantage over traditional computing methods.
Legislation & Regulations		V9	I feel that there are enough legislation and regulations regarded cloud computing technology.
		V10	I feel comfortable that there are enough legislation and regulations to store organizational data safely regarded cloud computing technology.
On Demand Service		V11	Cloud computing technology enables my organization to only buy its' needs over traditional computing methods.
		V12	My organization is only charged by the amount that is used through cloud computing technology over traditional computing methods.
Other Factors	Reliability	V5	Cloud computing technology is more reliable with minimal downtime and rapid responses than traditional computing methods.
	Maintenance	V8	I consider cloud computing technology to have easier maintenance over traditional computing methods.
	Virtualization	V14	I consider that cloud computing technology increases business agility through faster application deployment and updates with no user interruptions.
		V15	I consider that cloud computing technology enables the personnel to complete their tasks at any time and from anywhere easily.
		V16	I consider that cloud computing technology reduces the number of physical servers through hardware virtualization.
	Performance	V19	I feel that cloud computing technology increase organizational performance.
V20		I think that it is easier to monitor organizational performance with cloud computing technology over traditional computing methods.	
	Integration	V13	I consider cloud computing technology to have easy integration with my organization's existing legacy systems.
Adoption		V24	I feel comfortable recommending cloud computing technology in my organization.
		V25	I am willing to use cloud computing technology in my organization.

## CHAPTER 6

### FINDINGS OF THE STUDY

This chapter includes descriptive findings, exploratory factor analyses and confirmatory factor analyses, and SEM analysis results. AMOS 18.0 is used as SEM analysis tool and SPSS 16.0 is used to analyze descriptive findings and exploratory factor analysis.

#### Descriptive Findings

Table 4 shows the sectors of the companies in the study. Companies that are taking cloud computing services are mainly from Information and Telecommunication sectors. While 60.5% of the companies are in information sector, 20.6% of the companies are in telecommunication sector. The companies in trade, food, energy, health, and construction sectors have the least proportion in the list.

Table 4 Descriptive data for Company Sector

Company Sector	Frequency	Percentage
Information	185	60.5%
Telecommunication	63	20.6%
Other	13	4.2%
Finance	11	3.6%
Service	8	2.6%
Education	6	2.0%
Trade	4	1.3%
Food	4	1.3%
Energy	4	1.3%
Health	4	1.3%
Construction	4	1.3%

Table 5 describes more detailed information about companies. 48% of the respondents work at a company that operates for more than 21 years. It is an indication that long-established companies mostly prefer taking cloud computing services. Whereas 58.2% of the respondents work at an international company, 41.8% of them work for a national company. Moreover, 75.8% of the respondents' companies take SaaS and 61.4% take IaaS. Almost half of them make use of PaaS and DaaS of cloud computing.

Table 5 Descriptive Data for Companies

	0-5	6-10	11-15	16-20	>= 21
Company Age	43	39	52	25	147
	14.1%	12.7%	17.0%	8.2%	48.0%
	International	National			
Company Structure	178	128			
	58.2%	41.8%			
	SaaS	PaaS	IaaS	DaaS	
Cloud Computing Services	232	163	188	153	
	75.8%	53.3%	61.4%	50%	

Table 6 includes data about cloud computing service providers. 24.5% of the respondents' companies prefer Microsoft as cloud computing service provider. VMware that has 19.3% proportion follows Microsoft. 18.6% of the respondents' companies prefer other service providers such as Salesforce, Cloudshare, Superonline, Cloudshare, and PlusClouds. HP (16.3%), IBM (14.7%), Google (13.4%), and Oracle (12.1%) are also preferable cloud service providers, respectively.

Table 6 Cloud Computing Service Providers

Cloud Service Provider	Frequency	Percentage
Microsoft	75	24.5%
VMware	59	19.3%
Other	57	18.6%
HP	50	16.3%
IBM	45	14.7%
Google	41	13.4%
Oracle	37	12.1%
Amazon	25	8.2%
Koç Sistem	25	8.2%
Türk Telekom	24	7.8%
Turkcell	19	6.2%
Cisco	18	5.9%
TTNET	15	4.9%
Inspark	13	4.2%
Doruk Cloud	11	3.6%
Sun	10	3.3%
Salesforce.com	10	3.3%
Cloudturk	6	2%
Anadolu Bilişim Hizmetleri	5	1.6%

### Structural Equation Modeling Analysis

This part of the chapter includes SEM analysis. SEM analysis consists of two parts: measurement model validity and structural model validity. Results are obtained by using AMOS 18.0 and maximum likelihood estimation method.

#### Measurement Model Validity

In the proposed model, there are eight latent constructs: *need, on demand service, cost, legislation and regulations, security, adoption, service provider, and other factors* including virtualization, reliability, maintenance, integration, and performance. Measurement model validity includes two analyses: Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The followings show EFA results for each latent construct.

1. *Need*: It includes two indicators. Table 7 shows the results of latent construct and its indicator. It is shown that indicators (V3 and V4) determine the latent variable. Factor loadings of V3 and V4 are 0.93 and both above 0.50. Total variance explained is 87.09%.

Table 7 EFA Results of Need

Unobserved Variable	Observed Variable	Factor Loading
Need	V3	0.93
	V4	0.93
Eigen Value		1.74
Total Variance Explained		87.09%

2. *On demand service*: Table 8 depicts that indicators (V11 and V12) of the latent variable explain it 85.99%. Factor loadings of the indicators are 0.93 and they are greater than 0.50.

Table 8 EFA Results of On Demand Service

Unobserved Variable	Observed Variable	Factor Loading
On Demand Service	V11	0.93
	V12	0.93
Eigen Value		1.72
Total Variance Explained		85.99%

3. *Cost*: It has two indicators (V6 and V7). Factor loadings of each indicator are 0.88 which are greater than 0.50 and acceptable. These two indicators explain 77.59% of *cost* totally (Table 9).

Table 9 EFA Results of Cost

Unobserved Variable	Observed Variable	Factor Loading
Cost	V7	0.88
	V6	0.88
Eigen Value		1.55
Total Variance Explained		77.59%

4. *Legislation and Regulations*: Table 10 shows EFA result. The latent variable has two indicators. Each indicator has 0.96 factor loading. Factor loadings are greater than 0.50. Lastly, total variance explained is 91.64%.

Table 10 EFA Results of Legislation and Regulations

Unobserved Variable	Observed Variable	Factor Loading
Legislation & Regulations	V9	0.96
	V10	0.96
Eigen Value		1.88
Total Variance Explained		91.64%

5. *Security*: Table 11 depicts that *security* has two indicators (V1 and V2). Both of two indicators have 0.92 factor loading which are greater than 0.50 and acceptable. They explain 84.92% of *security*.

Table 11 EFA Results of Security

Unobserved Variable	Observed Variable	Factor Loading
Security	V1	0.92
	V2	0.92
Eigen Value		1.70
Total Variance Explained		84.92%

6. *Adoption*: It has two indicators (V24 and V25). Factor loadings of indicators are 0.95. According to Table 12, these indicators explain 90.00% of this latent construct together.

Table 12 EFA Results of Adoption

Unobserved Variable	Observed Variable	Factor Loading
Adoption	V24	0.95
	V25	0.95
Eigen Value		1.80
Total Variance Explained		90.00%

7. *Service Provider*: This latent variable has two indicators. Factor loadings of them are 0.94 and are above 0.50. They explain 89.19% of *service provider* together (Table 13).

Table 13 EFA Results of Service Provider

Unobserved Variable	Observed Variable	Factor Loading
Service Provider	V22	0.94
	V23	0.94
Eigen Value		1.78
Total Variance Explained		89.19%

8. *Other Factors*: This latent construct includes eight indicators: virtualization (V14, V15, and V16), performance (V19 and V20), maintenance (V8), reliability (V5), and integration (V13). According to Table 14, V14, V15 and V16 have 0.80 and 0.74 and 0.61 factor loadings respectively. V19 and V20 have factor loadings of 0.79 and 0.75. V5 and V8 have 0.73 and 0.66 factor loadings. The last indicator has 0.54 factor loading. All factor loadings are

above 0.50 and acceptable. They explain 49.98% of the factor. It is very close to 50 %.

Table 14 EFA Results of Other Factors

Unobserved Variable	Observed Variable	Factor Loading
Other Factors	V14	0.80
	V15	0.74
	V16	0.61
	V19	0.79
	V20	0.75
	V5	0.73
	V8	0.66
	V13	0.54
	Eigen Value	
Total Variance Explained		49.98%

The second part is the CFA analysis. According to Hair *et al.* (2010) factor loadings should be ideally 0.70 or greater. However, values which are at least 0.50 are also acceptable. In addition, Hair *et al.* (2010) state that squared of factor loadings should explain half of the variable even if at least 0.50 factor loadings are significant. In this respect, V16 and V13 related to *other factors* have factor loadings 0.56 and 0.50 respectively. Their squared of factor loadings are 0.32 and 0.25 which are very lower than 0.50 (Table 15). In order to represent the latent variable well and increase the goodness of fit of the measurement model, these two indicators are removed from the measurement model.

Table 15 CFA Results of Measurement Model

Unobserved Variable	Observed Variable	Factor Loading	Factor Loading Squared	Measurement Error	p-Value
Need	V3	0.77	0.59	0.41	.*
	V4	0.96	0.93	0.07	0.001
On Demand Service	V11	0.88	0.77	0.23	0.001
	V12	0.82	0.67	0.33	.*
Cost	V7	0.74	0.55	0.45	.*
	V6	0.75	0.56	0.44	0.001
Legislation & Regulations	V9	0.90	0.80	0.20	.*
	V10	0.93	0.86	0.14	0.001
Security	V1	0.83	0.70	0.30	0.001
	V2	0.84	0.70	0.30	.*
Adoption	V24	0.87	0.75	0.25	0.001
	V25	0.92	0.85	0.15	.*
Other Factors	V14	0.76	0.58	0.42	0.001
	V15	0.70	0.48	0.52	0.001
	V16	0.56	0.32	0.68	0.001
	V19	0.75	0.56	0.44	.*
	V20	0.68	0.46	0.54	0.001
	V5	0.67	0.45	0.55	0.001
	V8	0.61	0.37	0.63	0.001
Service Provider	V13	0.50	0.25	0.75	0.001
	V22	0.78	0.61	0.39	0.001
	V23	1.00	1.00	0.00	.*

\*not estimated when loading set to fixed value of 1.0

The new CFA results are shown in Table 16. Factor loadings of the indicators should be 0.70 and greater. However, V20, V5, and V8 have 0.67, 0.68 and 0.62 factor loadings respectively. These values are very close to 0.70 and do not violate the construct integrity. All values are significant with p value 0.001 (Table 16).

Table 16 New CFA Results of Measurement Model

Unobserved Variable	Observed Variable	Factor Loading	Factor Loading Squared	Measurement Error	p- Value
Need	V3	0.77	0.60	0.40	-*
	V4	0.96	0.92	0.08	0.001
On Demand Service	V11	0.88	0.78	0.22	0.001
	V12	0.82	0.66	0.34	-*
Cost	V7	0.74	0.55	0.45	0.001
	V6	0.75	0.56	0.44	-*
Legislation & Regulations	V9	0.90	0.81	0.19	-*
	V10	0.93	0.86	0.14	0.001
Security	V1	0.83	0.70	0.30	0.001
	V2	0.84	0.70	0.30	-*
Adoption	V24	0.87	0.75	0.25	0.001
	V25	0.93	0.86	0.14	-*
Other Factors	V14	0.77	0.59	0.41	0.001
	V15	0.71	0.50	0.50	0.001
	V19	0.74	0.54	0.46	-*
	V20	0.68	0.47	0.53	0.001
	V5	0.68	0.47	0.53	0.001
	V8	0.62	0.39	0.61	0.001
Service Provider	V22	0.78	0.61	0.39	0.001
	V23	1.01	1.01	-0.01	-*

\*not estimated when loading set to fixed value of 1.0

Table 17 shows construct reliability and average variance explained (AVE) results.

Construct reliabilities and average variance explained results are calculated by using formulas mentioned at confirmatory factor analysis section. Whole constructs have at least 0.70 or greater construct reliability value. Their average variance explained values are greater than 0.50. However, *other factors* construct has 0.49 AVE value which is very close to 0.50 and acceptable.

Table 17 Construct Reliability and Average Variance Explained

Unobserved Variable	Construct Reliability	Average Variance Extracted
Need	0.86	0.76
On Demand Service	0.84	0.72
Cost	0.71	0.55
Legislation & Regulations	0.91	0.83
Security	0.82	0.70
Adoption	0.89	0.80
Other Factors	0.85	0.49
Service Provider	0.89	0.81

Table 18 shows goodness of fit indices of measurement model. According to Hair *et al.* (2010) at least three or four indices are adequate in order to show how the measurement model well. Normed Chi-Square, GFI, RMSEA, RMR, NFI, and AGFI values are acceptable and indicate a good fit for the measurement model (Table 2).

Table 18 Goodness of Fit Indices of Measurement Model

Chi-Square	285.441
Degrees of Freedom	142
<b>Absolute Fit Measures</b>	
GFI	0.91
RMSEA	0.058
RMR	0.087
Normed Chi-Square	2.010
<b>Incremental Fit Indices</b>	
NFI	0.92
CFI	0.96
<b>Parsimony Fit Indices</b>	
AGFI	0.87

Figure 11 also depicts the measurement model of the study and factor loadings of each latent variable.

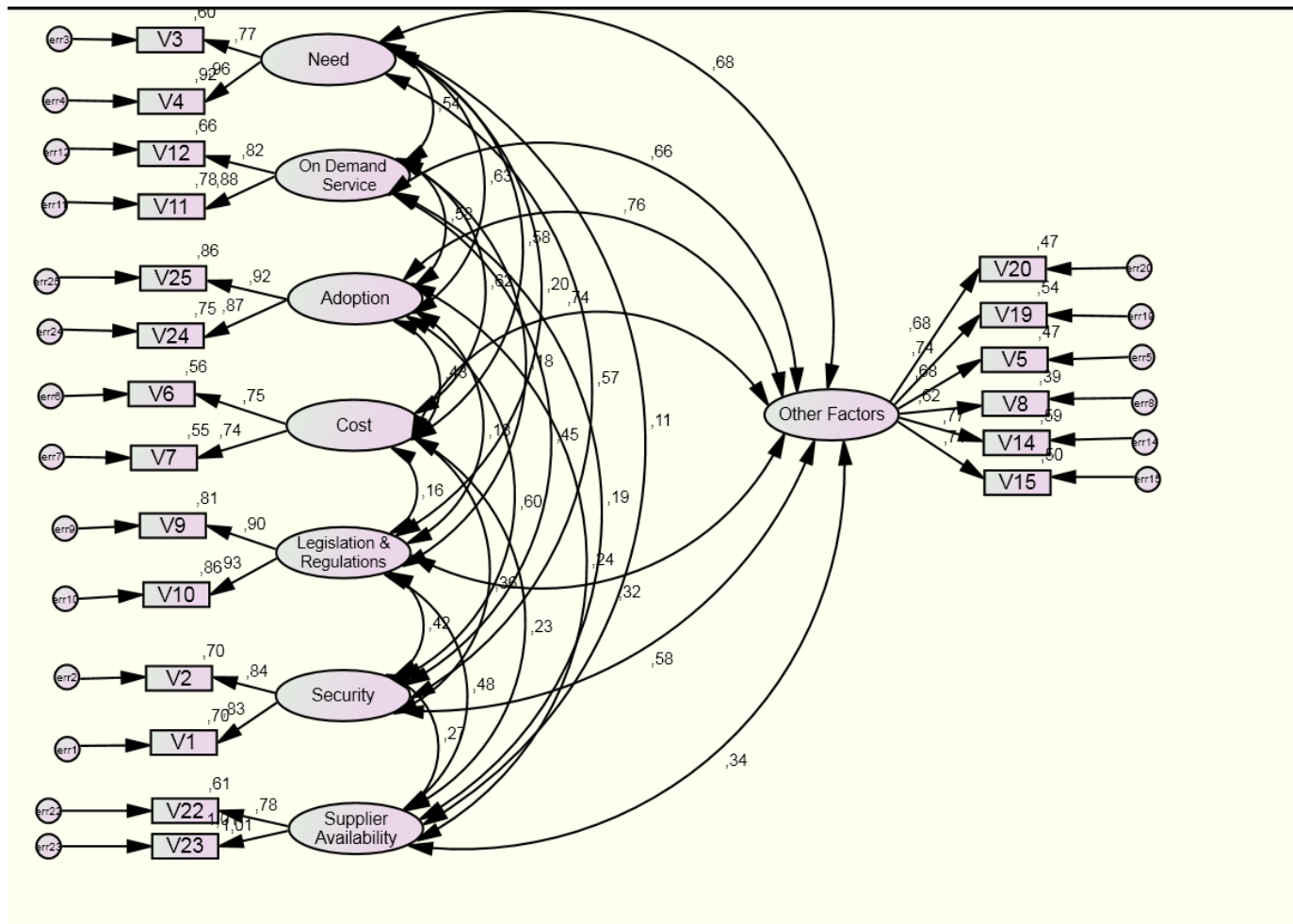


Fig. 11 Measurement Model

## Structural Model Validity

Structural model of the study shows the relationships between factors affecting the adoption of cloud computing. In the structural model, *cost*, *security*, and *adoption* are endogenous variables. On the other hand, *need*, *on demand service*, *legislation and regulations*, and *supplier availability* are exogenous variables.

Figure 12 shows the structural model and hypotheses. In the model, hypotheses are grouped into two categories. First category includes hypotheses between endogenous and exogenous variables. These hypotheses are:

*Hypothesis 1 (H1):* Need has a direct effect on adoption.

*Hypothesis 2 (H2):* Supplier availability has a direct effect on adoption.

*Hypothesis 3 (H3):* On demand service has a direct effect on cost.

*Hypothesis 4 (H4):* Legislation and regulations have a direct effect on security.

*Hypothesis 5 (H5):* Other factors have a direct effect on adoption.

*Hypothesis 6 (H6):* Other factors have a direct effect on security.

*Hypothesis 7 (H7):* Other factors have a direct effect on cost.

Second category includes hypotheses between endogenous variables. These hypotheses are:

*Hypothesis 8 (H8):* Cost is negatively related to adoption.

*Hypothesis 9 (H9):* Security is positively related to cost.

*Hypothesis 10 (H10):* Security is positively related to adoption.

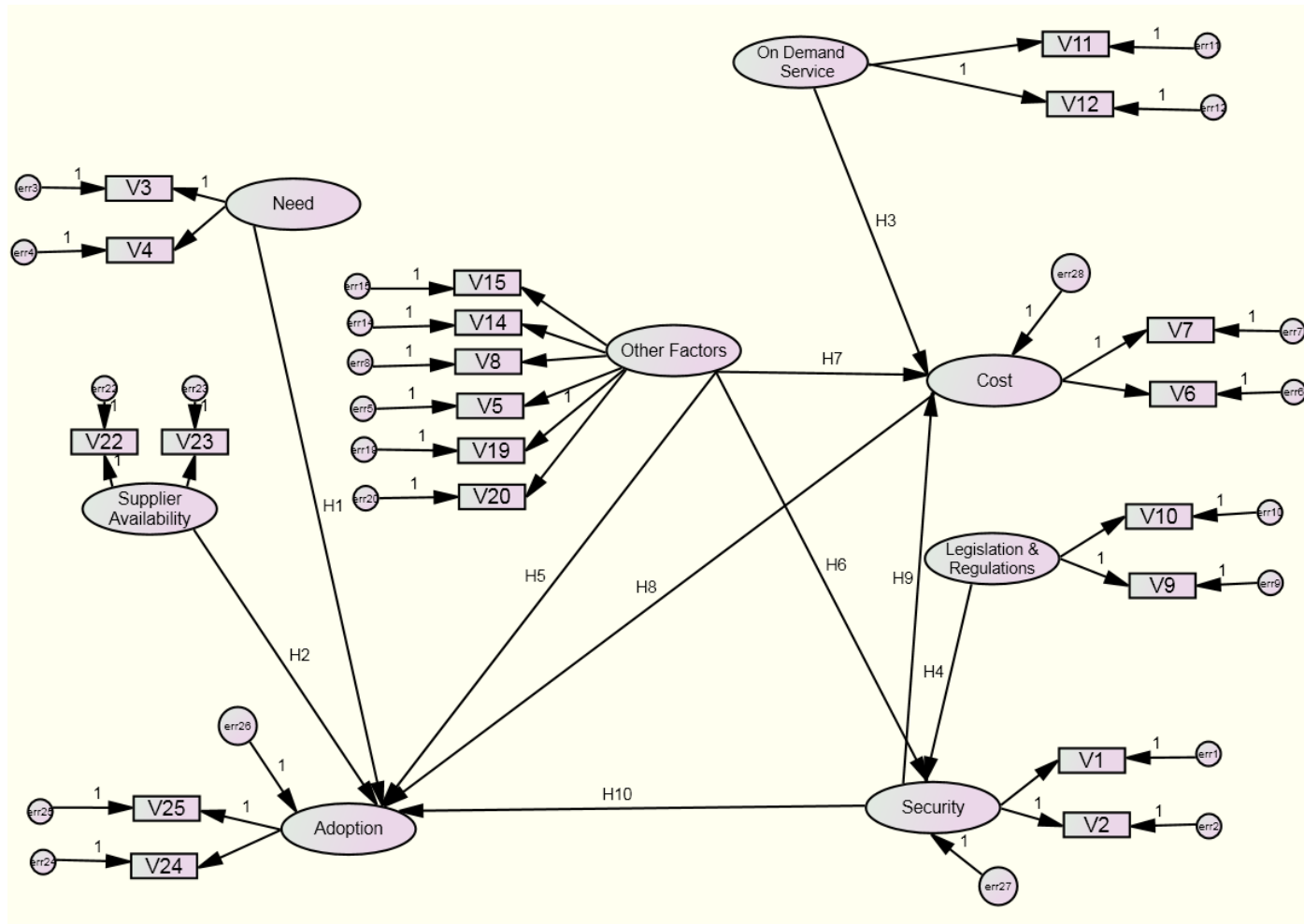


Fig. 12 Structural Model of the Study and Hypotheses

According to results of SEM, Table 19 shows regression weights and p values of hypotheses between endogenous and exogenous variables. p values of all hypotheses except hypothesis 2, are 0.001 and significant. In other words, direct effect of supplier availability on adoption is not significant.

Table 19 p Value Results for Hypotheses in the First Category

Hypothesis	Regression Weight	p Value
1	0.29	0.001
2	<i>0.05</i>	<i>0.467</i>
3	0.28	0.001
4	0.28	0.001
5	0.70	0.001
6	0.53	0.001
7	0.70	0.001

Table 20 shows regression weights and p values of hypotheses between endogenous variables. Significance of hypothesis 9 is greater than 0.050. It is not acceptable in the model. In addition, hypothesis 8 indicates a negative relationship.

Table 20 p Value Results for Hypotheses in the Second Category

Hypothesis	Regression Weight	p Value
8	-0.20	0.019
9	<i>-0.12</i>	<i>0.133</i>
10	0.17	0.012

Table 21 depicts goodness of fit indices of the structural model. GFI, RMR, NFI, CFI, AGFI, Normed Chi-Square, and RMSEA values indicate a poor model. These values are below for an acceptable model. GFI, NFI, and CFI are lower than 0.90.

RMSEA value is greater than 0.080. Normed Chi-Square is greater than 3 and AGFI value is less than 0.85.

Table 21 Goodness of Fit Indices of the Structural Model

Chi-Square	733.336
Degrees of Freedom	160
Absolute Fit Measures	
GFI	0.81
RMSEA	0.11
RMR	0.43
Normed Chi-Square	4.583
Incremental Fit Indices	
NFI	0.80
CFI	0.83
Parsimony Fit Indices	
AGFI	0.74

In order to redesign the structural model, hypotheses that are not accepted should be removed from the model. In addition, modification indices show how the model fit can be increased. Modification indices (See Table B.1 in Appendix B) indicate that a relationship between *on demand service* and *other factors*, *need* and *other factors*, and *need* and *on demand service* increases the model fit. Figure 13 shows the new proposed structural model.

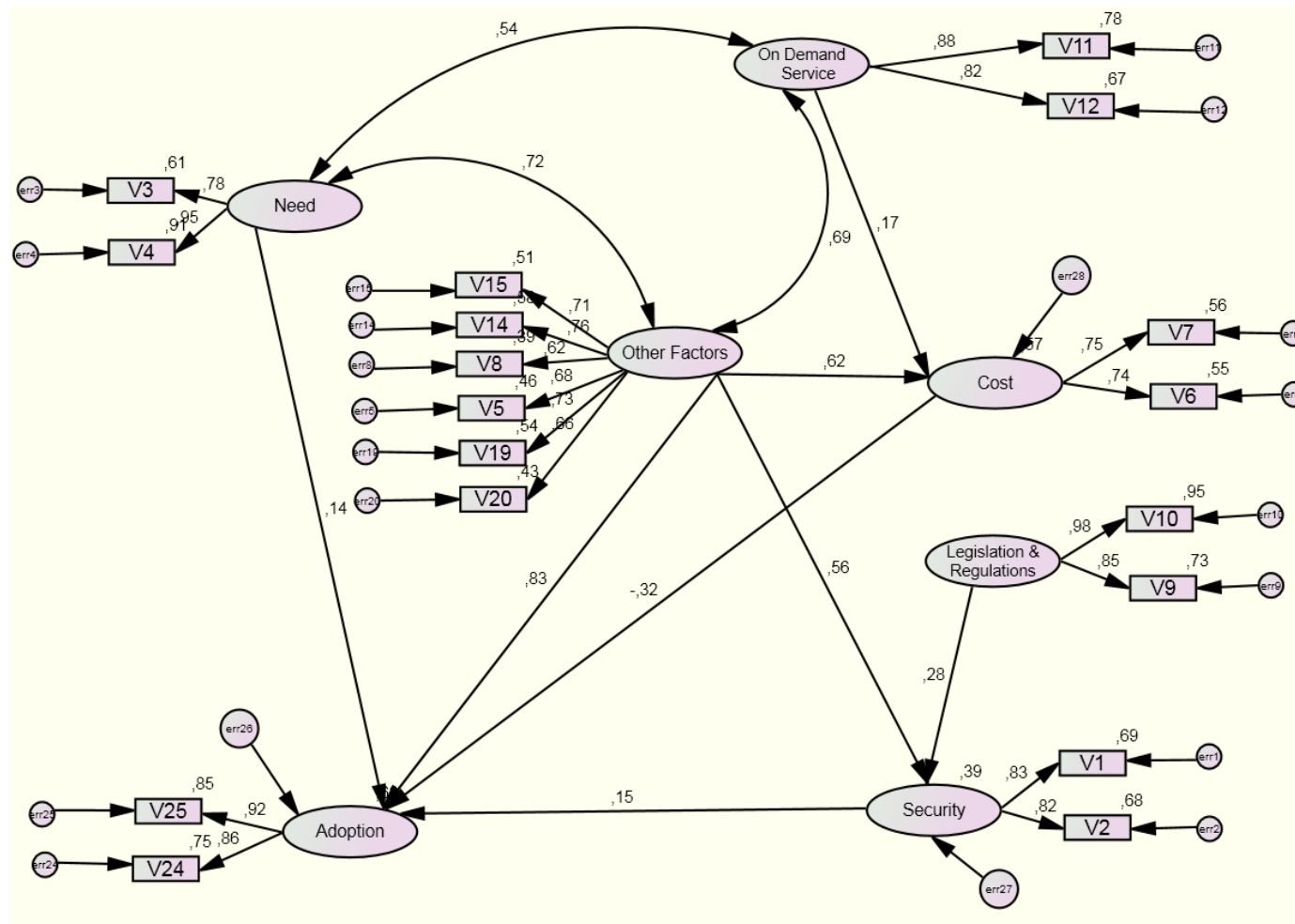


Fig. 13 Path Diagram of New Structural Model

According to Table 22, p values of hypotheses are significant and less than 0.050 (See Table C.1 and Table C.2 in Appendix C). In other words, all hypotheses are accepted in the model.

Table 22 Regression Weights and p Values of New Structural Model

Hypothesis	Regression Weights	p Value
1	0.141	0.048
3	0.174	0.050
4	0.278	0.001
5	0.835	0.001
6	0.556	0.001
7	0.624	0.001
8	-0.318	0.002
10	0.150	0.012

Table 23 Goodness of Fit Indices for the New Structural Model

<b>Chi-Square</b>	
Chi-Square	293.468
Degrees of Freedom	124
<b>Absolute Fit Measures</b>	
GFI	0.91
RMSEA	0.067
RMR	0.18
Normed Chi-Square	2.367
<b>Incremental Fit Indices</b>	
NFI	0.91
CFI	0.94
<b>Parsimony Fit Indices</b>	
AGFI	0.87

In addition, GFI, RMSEA, Normed Chi-Square, CFI, NFI, and AGFI results except RMR, indicate acceptable model fit (Table 23 and Appendix D). RMR is 0.18 and it is not acceptable. However, Hair *et al.* (2010) state that three to four acceptable fit indices are enough to show that model is adequate.

According to Figure 13 and Table 22, structural equations are:

$$Adoption = 0.835*Other\ Factors + 0.141*Need - 0.318*Cost + 0.150*Security\ and\ R^2 = 0.682$$

(6.1)

$$Cost = 0.624*Other\ Factors + 0.174*On\ Demand\ Service\ and\ R^2 = 0.569$$

(6.2)

$$Security = 0.556*Other\ Factors + 0.278*Legislation\ and\ Regulations\ and\ R^2 = 0.386$$

(6.3)

According to equations, *adoption* has positive relationships with *other factors*, *need*, and *security*. However, there is a negative relationship between *adoption* and *cost*. While *cost* increases, *adoption* decreases.  $R^2(0.682)$  indicate that 68.2% of the variance in adoption is significantly explained by these independent factors.

*Cost* is positively related to *other factors* and *on demand service*.  $R^2 (0.569)$  shows that 56.9 % of the variance in cost is significantly explained by *other factors* and *on demand service*.

The last equation shows that *security* is positively related to *other factors*, and *legislation and regulations*.  $R^2 (0.386)$  indicates that 38.6% of the variance in security is significantly explained by these independent variables.

In addition, Table 24 shows correlational relationship results. All p values are 0.001 and significant . It is seen that variables are positively and highly correlated with each other.

Table 24 Correlational Relationships

	Correlational Weight	p-Value
On Demand Service - Other Factors	0.689	0.001
Need - Other Factors	0.715	0.001
Need - On Demand Service	0.545	0.001

Table 25 shows factor loadings of indicators related to endogenous variables. Contribution of V25 (0.92) to *adoption* is greater than V24 (0.86). The greatest factor loadings related to *cost* are V7 (0.75) and V6 (0.74) respectively. V1 (0.83) has higher factor loading than V2 (0.82) and contributes more than V1 to *security*.

Table 26 shows factor loadings results of indicators related to exogenous variables. Indicators of *need* have 0.95 (V4) and 0.78 (V3) factor loadings. V11 (0.88) has greater factor loading than V12 (0.82) regarding *on demand service*. V14 (0.76), V19 (0.73), V15 (0.71), V5 (0.68), V20 (0.66), and V8 (0.62) have greater factor loadings respectively regarding *other factors*.

Table 25 Factor Loadings of Endogenous Variables

	Adoption	Cost	Security
V24	0.86		
V25	0.92		
V6		0.74	
V7		0.75	
V1			0.83
V2			0.82

Lastly, V10 (0.98) indicates *legislation and regulations* variable more than V9 (0.85).

Table 26 Factor Loadings of Exogenous Variables

	Need	On Demand Service	Other Factors	Legislation & Regulations
V3	0.78			
V4	0.95			
V11		0.88		
V12		0.82		
V5			0.68	
V8			0.62	
V14			0.76	
V15			0.71	
V19			0.73	
V20			0.66	
V9				0.85
V10				0.98

In structural equation modeling, there are two types of relationships: direct and indirect relationships. Exogenous variables can have indirect effects on endogenous variables. Sum of direct and indirect effects of exogenous variables on endogenous variables show the total effect. Table 27 shows indirect effects of exogenous variables on endogenous variables. Indirect effects of on demand service, other factors, and legislation and regulations are calculated (Equations 6.1, 6.2., and 6.3). *On demand service* has a negative indirect effect (-0.055), *other factors* has a negative indirect effect (-0.115), and *legislation and regulations* has a positive indirect effect (0.042) on *adoption*.

Table 27 Indirect Effects of Exogenous Variables on Endogenous Variables

	Need	On Demand Service	Other Factors	Legislation & Regulations
Adoption	-	-0.055	-0.115	0.042
Cost	-	-	-	-
Security	-	-	-	-

Table 28 shows total effects of exogenous variables on endogenous variables. Total effects include both direct and indirect effects. According to results, total effects of *other factors* on *adoption* are 0.72. According to Equation 6.1, it includes positive direct effect (0.835) and negative indirect effect (-0.115) on *adoption*.

*Need* has only direct effect on *adoption* and they have a positive relationship (Equation 6.1). *On demand service*, and *legislation and regulations* variables have only indirect effects on *adoption*.

According to Equation 6.2, *on demand service* (0.174) and *other factors* (0.624) have only direct effects on *cost*. They both have positive relationships with *cost*. *Other factors* (0.556), and *legislation and regulations* (0.278) have also only direct effects on *security* and they have positive relationships with *security* (Equation 6.3).

Table 28 Total Effects of Exogenous Variables on Endogenous Variables

	Need	On Demand Service	Other Factors	Legislation & Regulations
Adoption	0.141	-0.055	0.720	0.042
Cost	-	0.174	0.624	-
Security	-	-	0.556	0.278

In addition, endogenous variables can have direct and indirect effects on other endogenous variables. In the proposed model, there are not any indirect effects of endogenous factors on other ones. Table 29 shows total effects. While *cost* has negative direct effect (-0.318) on *adoption*, *security* has a positive direct effect (0.150) on it (Equation 6.1).

Table 29 Total Effects between Endogenous Variables

	Adoption	Cost	Security
Adoption	-	-0.318	0.150
Cost	-	-	-
Security	-	-	-

## CHAPTER 7

### CONCLUSION

Cloud computing provides companies with various opportunities and companies consider lots of factors in order to adopt this new technology. According to both literature and expert interviews, these factors are evaluated delicately. *Security, need, legislation and regulations, on demand, cost, supplier availability, and other factors* (reliability, maintenance, virtualization, integration, and performance) are added to the proposed model. Structural Equation Modeling (SEM) technique is applied to a sample of 306 respondents who have knowledge about cloud computing and work at company which benefits from cloud computing. The estimation method is Maximum Likelihood and the analysis tool is AMOS 18.0.

SEM includes two models: measurement model and structural model. In order to test measurement model validity, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are applied. EFA results point out that indicators represent their related unobserved variables well. According to CFA results, integration and one of the indicators of virtualization under *other factors* are extracted from the model. Factor loadings of them are not significant. Finally, a new model is proposed and goodness of fit indices of the model (Normed Chi-Square, GFI, RMSEA, NFI, CFI, and AGFI) shows a good and acceptable measurement model.

After these analyses, two structural models are constructed. The first model does not support the effect of *supplier availability* on *adoption* and the effect of *security* on *cost*. These relationships are extracted from the model. In addition, modification indices show that there may be strong correlational relationships

between *need* and *on demand service*, *on demand service* and *other factors*, and *need* and *other factors*. These relationships are added to new model. Goodness of fit indices indicates a good and acceptable new structural model.

As a result of analysis carried out, *need*, *on demand service*, *legislation and regulations*, *other factors* (reliability, virtualization, maintenance, and performance) and *security* have positive direct effects on cloud computing *adoption*. Especially, *other factors* and *security* have the strongest direct impacts on the *adoption*.

*Need*, *on demand service*, *legislation and regulations*, *other factors* (reliability, virtualization, maintenance, and performance) increase cloud computing adoption. However, *cost* has negative direct effect on cloud computing *adoption*. It indicates that companies are open to adopt cloud computing, if they pay less.

Additionally, *on demand service* and *other factors* have negative indirect impacts and *legislation and regulations* has positive indirect impact on *adoption*.

*On demand service* and *other factors* have only positive direct effects on *cost*. *Other factors* particularly have the strongest positive direct impact on *cost*. In other words, more reliable systems and more performance, virtualization, and maintenance needs increase *cost*.

Lastly, *other factors* and *legislation and regulations* have only positive direct effects on *security*. *Legislation and regulations* are very important to increase *security* in cloud computing systems.

Briefly, study results point out that adoption is affected more by *cost* and *other factors*. *Other factors* including reliability, maintenance, virtualization, integration, and performance have a great impact on *adoption*. This indicates that companies want to have reliable systems, to increase their business performance, and to be more business-oriented by lightening their technical burdens. In addition, *cost*

plays a key role in the adoption of cloud computing. *Cost* increase leads to decrease in cloud computing adoption. It points out that companies prefer less expensive technologies. *Need* and *security* increases cloud computing adoption. Companies' technological needs arise with the emergence of a competitive global environment. In this respect, companies' needs change dynamically and they prefer more secure systems.

This study is a primary study for following studies to analyze the factors having effects on cloud computing adoption. It contributes the literature by presenting new factors and a model. The study can be extended in a few directions as a future work. One direction is increasing the sample size. Another direction is adding new factors to the study.

## APPENDICES

### A. Questionnaire

Değerli Katılımcı,

Bu anket Boğaziçi Üniversitesi Yönetim Bilişim Sistemleri Yüksek Lisans programı öğrencisi Ezgi Arı'nın yüksek lisans tezi kapsamında gerçekleştirilen "Bulut Bilişim Teknolojisinin Benimsenmesini Etkileyen Faktörler" konulu araştırmanın bir parçasıdır.

Anketimizi çalışmakta olduğu şirketinde bulut bilişim servisi kullanılan ilgili katılımcıların doldurması gerekmektedir. Anketi yanıtlamak için herhangi bir kimlik belgesi gerekmemektedir. Çalışmamıza vereceğiniz destek tezin başarısı için önem taşımaktadır. Katkınız ve ayırdığınız zaman için teşekkür ederiz.

Soru ve görüşleriniz için:

[sona.mardikyan@boun.edu.tr](mailto:sona.mardikyan@boun.edu.tr)

[ezgi.ari@boun.edu.tr](mailto:ezgi.ari@boun.edu.tr)

Soru 1: Şirketinizin bulut bilişim hizmeti ve hizmetlerini kullanıp kullanmadığını lütfen belirtiniz:

Evet	
Hayır	

Soru 2: Şirketiniz hangi sektörde faaliyet gösterdiği lütfen seçiniz:

Bilişim	
Ticaret	
Hizmet	
Gıda	
Enerji	
Telekom	
Sağlık	
Tekstil	
Otomotiv	
Turizm	
Finans	
Eğitim	
İnşaat	
Diğer	

Soru 3: Şirketinizin ilgili sektörde kaç yıldır faaliyet gösterdiğini lütfen seçiniz:

0-5	
6-10	
11-15	
16-20	
21 ve daha fazla	

Soru 4: Şirketinizin yapısını lütfen seçiniz:

Uluslararası	
Ulusal	

Soru 5: Şirketinizin kullanmakta olduğu bulut bilişim servislerini lütfen seçiniz:

\*Birden fazla seçenek işaretleyebilirsiniz.

SaaS	
PaaS	
IaaS	
DaaS	

Soru 6: Şirketinizin kullanmakta olduğu bulut bilişim servislerini, hangi bulut servis sağlayıcısından aldığınızı belirtiniz:

\*Birden fazla seçenek işaretleyebilirsiniz.

Microsoft	
HP	
IBM	
Google	
Oracle	
Anadolu Bilişim Hizmetleri	
Amazon	
VMware	
Sun	
Doruk Cloud	
TTNET	
Turkcell	
Koç Sistem	
Inspark	
Cloudturk	
Cisco	
Türk Telekom	
Diğer	

Soru 7: Bulut bilişim teknolojisi ile ilgili aşağıda yer alan görüşlere ne kadar katıldığınızı lütfen belirtiniz

\* Aşağıda yer alan görüşlerde geçen "diğer bilgi teknolojileri" ile anlatılmak istenen bulut bilişim teknolojisi kullanmayan bilgisayar sistemleridir.

		Kesinlikle Katılmıyorum (1)	(2)	(3)	(4)	(5)	(7)	Kesinlikle Katılıyorum (7)
1	Bulut bilişim teknolojisinin güvenli olduğunu düşünüyorum.							
2	Bulut bilişim teknolojisinin diğer bilgisayar teknolojilerine göre daha güvenli olduğunu düşünüyorum.							
3	Şirketim, bilgi teknolojileri ihtiyaçlarını karşılamak için bulut bilişim teknolojisine ihtiyaç duymaktadır.							
4	Bulut bilişim teknolojisi şirketime önemli derecede yarar sağlamaktadır.							
5	Bulut bilişim teknolojisi diğer bilgisayar teknolojilerine göre, iş isteklerine daha hızlı cevap verebilen ve daha az sistemsel sorunun yaşandığı bir yapı içerir.							
6	Bulut bilişim teknolojisinin, diğer bilgisayar teknolojilerine göre uzun vadede oldukça daha fazla maliyet tasarrufu sağladığını düşünüyorum.							
7	Bulut bilişim teknolojisinin, diğer bilgisayar teknolojilerine göre oldukça daha az satın alma maliyetine sahip olduğunu düşünüyorum.							
8	Bulut bilişim teknolojisi ile bakım ve güncelleme işlemlerinin diğer bilgisayar teknolojilerine göre daha kolay olduğunu düşünüyorum.							
9	Bulut bilişim ile ilgili yasal ve hukuksal düzenlemelerin yeterli oranda olduğunu düşünüyorum.							
10	Şirket bilgilerinin bulut bilişim ortamında güvenli şekilde saklanmasını sağlamak için ilgili yasal ve hukuksal düzenlemelerin yeterli olduğunu düşünüyorum.							

		Kesinlikle Katılmıyorum (1)	(2)	(3)	(4)	(5)	(7)	Kesinlikle Katılıyorum (7)
11	Bulut bilişim teknolojisi diğer bilgisayar teknolojilerine göre, şirketimizin sadece ihtiyacı kadarını satın alabilmesine olanak sağlayan dinamik bir yapıdır.							
12	Bulut bilişim teknolojisi şirketimizin, kullandığı hizmetlerin tam maliyetlerini ödemek yerine kullandığı kadarını ödemesine olanak sağlamaktadır.							
13	Bulut bilişim teknolojisinin, şirketimizin var olan eski sistemleri ile kolaylıkla entegre olacağını düşünüyorum.							
14	Bulut bilişim teknolojisinin, daha hızlı uygulama kurulumu ve kullanıcı kesintisi olmadan kolay güncelleme işlemleri sayesinde iş süreçlerini hızlandırdığını düşünüyorum.							
15	Bulut bilişim teknolojisinin, personelimizin işlerini istedikleri zaman istedikleri yerden yapabilmesini sağladığını düşünüyorum.							
16	Bulut bilişim teknolojisinin yapısı gereği kullanmakta olduğu donanımsal sanallaştırma özelliği sayesinde şirketimiz, daha az fiziksel alt yapı barındarmaya gereksinim duyacaktır.							
17	Bulut bilişim teknolojisinin şirketimizin ihtiyaçlarına göre özelleştirilebileceğini düşünüyorum.							
18	Bulut bilişim teknolojisinin kullanımının ve anlaşılmasının kolay olduğunu düşünüyorum.							
19	Bulut bilişim teknolojisi kullanımının şirketimizin performansını arttırdığını düşünüyorum.							
20	Bulut bilişim teknolojisini kullanarak şirketimizin performansını gözlemlmek diğer bilgisayar teknolojilerine göre daha kolaydır.							

		Kesinlikle Katılmıyorum (1)	(2)	(3)	(4)	(5)	(7)	Kesinlikle Katılıyorum (7)
21	Bulut bilişim teknolojisinin kullanımının şirketimizde benimsenmesi için yönetimin desteği de önemlidir.							
22	Bulut bilişim teknolojisi servislerini verebilecek yeterli sayıda bulut servis sağlayıcısı olduğunu düşünüyorum.							
23	Satış sonrası destek için yeterli bulut servis sağlayıcısı olduğunu düşünüyorum.							
24	Bulut bilişim teknolojisini rahatlıkla kendi şirketimde kullanılmasını önerebilirim.							
25	Bulut bilişim teknolojisini kendi şirketimde kullanmaya istekliyimdir.							

## B. Modification Indices

Table B.1 Modification Indices

			M.I.	Par Change
Other Factors	<-->	Supplier_Availability	11,575	,286
On Demand_ Service	<-->	Supplier_Availability	5,141	,205
On Demand_ Service	<-->	Other Factors	102,441	,502
Legislation &_Regulations	<-->	Supplier_Availability	11,571	,450
Legislation &_Regulations	<-->	Other Factors	19,020	,317
Legislation &_Regulations	<-->	On Demand_ Service	9,415	,240
Need	<-->	Other Factors	120,199	,709
Need	<-->	On Demand_ Service	70,550	,584
Need	<-->	Legislation &_Regulations	9,611	,315
err27	<-->	Need	15,426	,352
err28	<-->	Need	4,366	,141
err26	<-->	On Demand_ Service	7,411	,101
err8	<-->	On Demand_ Service	9,900	,190
err8	<-->	err28	22,222	,276
err23	<-->	Other Factors	7,086	,148
err23	<-->	Legislation &_Regulations	28,861	,471
err25	<-->	Legislation &_Regulations	10,200	-,144
err15	<-->	err25	16,741	,116
err15	<-->	err24	12,968	-,124
err14	<-->	Supplier_Availability	4,367	,162
err14	<-->	err22	5,560	,122
err14	<-->	err15	5,587	,099

		M.I.	Par Change
err11	<--> Other Factors	21,986	,191
err11	<--> Legislation &_Regulations	6,782	,167
err11	<--> Need	9,881	,179
err12	<--> Other Factors	8,159	,120
err12	<--> Need	7,552	,161
err12	<--> err14	6,461	,098
err20	<--> Legislation &_Regulations	12,390	,309
err20	<--> err23	10,391	,217
err20	<--> err25	5,240	-,079
err20	<--> err24	5,449	,098
err6	<--> Need	7,264	,196
err6	<--> err8	5,334	,146
err7	<--> err8	7,132	,172
err3	<--> err6	5,517	,135
err4	<--> Other Factors	42,968	,290
err4	<--> On Demand_ Service	15,503	,187
err4	<--> Legislation &_Regulations	4,415	,146
err4	<--> err12	4,615	,086
err9	<--> err3	5,840	,125
err10	<--> err4	4,232	,095
err5	<--> err28	9,955	,177
err5	<--> err26	7,076	-,107
err5	<--> err8	14,757	,251
err5	<--> err25	4,473	-,071
err5	<--> err15	6,444	-,135

		M.I.	Par Change
err5	<--> err6	6,743	,157
err19	<--> Supplier_Availability	4,368	,170
err19	<--> Need	18,946	,273
err19	<--> err28	5,059	-,105
err19	<--> err8	10,157	-,173
err19	<--> err20	12,929	,193
err19	<--> err4	5,392	,100

## C. Regression Weights

Table C.1 Unstandardized Regression Weights

	Estimate	S.E.	C.R.	P	Label
Security <--- Other Factors	,844	,105	8,016	***	par_15
Security <--- Legislation &_Regulations	,259	,053	4,852	***	par_16
Cost <--- Other Factors	,721	,115	6,261	***	par_17
Cost <--- On Demand_ Service	,180	,092	1,959	,050	par_18
Adoption <--- Other Factors	,895	,141	6,336	***	par_11
Adoption <--- Need	,112	,057	1,975	,048	par_12
Adoption <--- Cost	-,295	,096	-3,073	,002	par_13
Adoption <--- Security	,106	,042	2,518	,012	par_14
V4 <--- Need	1,075	,076	14,182	***	par_1
V3 <--- Need	1,000				
V7 <--- Cost	1,000				
V6 <--- Cost	,962	,095	10,071	***	par_2
V9 <--- Legislation &_Regulations	1,000				
V10 <--- Legislation &_Regulations	1,192	,156	7,630	***	par_3
V1 <--- Security	,857	,076	11,318	***	par_4
V2 <--- Security	1,000				
V12 <--- On Demand_ Service	1,000				
V11 <--- On Demand_ Service	1,062	,080	13,302	***	par_5
V20 <--- Other Factors	1,074	,096	11,142	***	par_6
V19 <--- Other Factors	1,000				
V5 <--- Other Factors	1,072	,093	11,479	***	par_7

			Estimate	S.E.	C.R.	P	Label
V14	<---	Other Factors	1,059	,082	12,923	***	par_8
V15	<---	Other Factors	,995	,082	12,070	***	par_9
V24	<---	Adoption	1,079	,058	18,690	***	par_10
V25	<---	Adoption	1,000				
V8	<---	Other Factors	,981	,093	10,534	***	par_19

Table C.2 Standardized Regression Weights

			Estimate
Security	<---	Other Factors	,556
Security	<---	Legislation &_Regulations	,278
Cost	<---	Other Factors	,624
Cost	<---	On Demand_ Service	,174
Adoption	<---	Other Factors	,835
Adoption	<---	Need	,141
Adoption	<---	Cost	-,318
Adoption	<---	Security	,150
V4	<---	Need	,953
V3	<---	Need	,778
V7	<---	Cost	,748
V6	<---	Cost	,744
V9	<---	Legislation &_Regulations	,853
V10	<---	Legislation &_Regulations	,977
V1	<---	Security	,833
V2	<---	Security	,822

		Estimate
V12	<--- On Demand_ Service	,815
V11	<--- On Demand_ Service	,882
V20	<--- Other Factors	,659
V19	<--- Other Factors	,732
V5	<--- Other Factors	,678
V14	<--- Other Factors	,760
V15	<--- Other Factors	,712
V24	<--- Adoption	,863
V25	<--- Adoption	,923
V8	<--- Other Factors	,624

## D. Goodness of Fit Indices

Table D.1 CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	47	293,468	124	,000	2,367
Saturated model	171	,000	0		
Independence model	18	3177,221	153	,000	20,766

Table D.2 RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	,179	,905	,869	,656
Saturated model	,000	1,000		
Independence model	,647	,270	,184	,242

Table D. 3 Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	,908	,886	,944	,931	,944
Saturated model	1,000		1,000		1,000
Independence model	,000	,000	,000	,000	,000

Table D.4 Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	,810	,736	,765
Saturated model	,000	,000	,000
Independence model	1,000	,000	,000

Table D.5 RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	,067	,057	,077	,003
Independence model	,255	,247	,262	,000

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