THE UNIVERSITY of York

UNIVERSITY OF YORK
DEPARTMENT OF COMPUTER SCIENCE

AN ANALYSIS OF THE SOCIO-TECHNICAL FACTORS INFLUENCING THE UPTAKE OF CLOUD COMPUTING

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SUBMITTED IN SUPPORT OF THE DEGREE OF
MASTER OF SCIENCE IN INFORMATION TECHNOLOGY

Academic Year
2009 - 2010

Word count: 16,803 as counted by the Apple iWork's Pages info. This includes the full body of the report.

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ABSTRACT

Cloud computing has emerged as a significant technology trend. This new computing paradigm aims to provide Information Technology services easily accessible via the Internet. Adopting such a delivery model can be both advantageous and risky for an organisation. This project considers the significant factors, both social and technical, that influence an organisation's decision making with regard to the use of Cloud Computing. By Interviewing technology experts in the field and opinion formers/decision makers within organizations, we try to understand the perception of these benefits and issues. Moreover, the interviews are then analyzed using Grounded Theory as qualitative research technique, to identify the factors currently considered the most important.

ACKNOWLEDGMENTS

I would like to express my deep and sincere gratitude to my supervisor Simon Poulding for his support, guidance and advice throughout the process of writing this project.

I am also greatly indebted to Dr. Paul Cairns for providing me valuable assistance with the methodology and analysis of my research.

My sincere thanks are due to all the participants for taking the time out of their busy schedules to talk to me. Without them this project would have not been possible.

I would like to thank my parents for their constant unconditional support and encouragement. A warm thanks is due to my sister for her moral and emotional support.

I owe my love and gratitude to the person who believed in me and influenced me in pursuing my dreams and aspirations. Tania, thank you for being by my side.

STATEMENT OF ETHICS

In compliance with the departmental guidelines [1], all activities of the project were designed within the following ethical principles:

- Do no harm
- Informed Consent
- Confidentiality of data

Do no Harm

The project tries to identify Cloud computing benefits and issues, particularly the factors that affect the use of Cloud technologies and services by organisations deploying information systems. The research method used includes interviewing technology experts in the field, and opinion formers/decision makers within organisations, to understand the perception of these benefits and issues. The participants that agreed to take part on the interviews, were not asked to give out information that would be against their own or company/organisation interests.

Informed Consent

The participants recruited for this project were all experienced professionals in the Information Technology field. Each participant agreed to take part by signing a written informed consent form setting out the nature and purpose of the study, voluntary participation and confidentiality.

Confidentiality of Data

All data gathered during this project was stored only by the author and referred to anonymously. Treatment and use of the data were explained to the participants both in the consent form and orally. The quotes presented from the data gathering procedure are used in a way that the participants can not be identified.

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1 INTRODUCTION

Cloud computing has been in existence in one form or the other since the beginning of computing. Over the last few years it has evolved into a new delivery model that can provide infrastructure, storage, software applications and computing platforms easily accessible via computer networks. Various corporations like Amazon, Google, Microsoft, IBM and many more are already providing such services.

The use of Cloud computing can be beneficial for an organization as it may offer lower capital expenditure costs, pay-as-you-use and on-demand services and reduces the management costs within an organization. Other advantages of the model include scalability and availability of resources, platform independence and easily accessible software services over the Internet.

However, an organisation considering the adoption of services provided via Cloud can come across various challenges. Issues include security, data protection and legislation, availability and performance of services, loss of control over the existing information technologies used within the organisation and lack of service standardization.

This project aims to provide an up-to-date analysis of the factors, both social and technical, that influence an orgisation's decision making with regard to the use of Cloud computing. This will be achieved by interviewing technology experts in the field and opinion formers/decision makers within organisations, to understand the perception of these benefits and issues.

In the following chapters, we first present a literature review that considers the technology of Cloud computing and related work on benefits and issues. Next, we compose our research question by identifying the gaps found in the related literature and state the reasons that make this project worthy of our attention. In Chapter 4, we explain the methodology used in order to provide answers for our research questions. Chapter 5 gives details on how we carried out the data collection and analysis procedure described in our selected methodology. The results are presented and analyzed in Chapter 6. Finally, in Chapter 7 we summarize and evaluate our work.

2 LITERATURE REVIEW

Several articles have been written for Cloud computing over the last years. In this chapter we will make an effort to present some of the most influential. The chapter is deviled in three major sections providing information about Cloud computing, the technology involved in Cloud computing and the adoption of the services offered by the model.

2.1 CLOUD COMPUTING

In an effort to present the related literature, we will start with the evolution of the concept from the early days of computing all the way to the most recent developments in the field.

2.1.1 Evolution

Turing-Award winning computer scientist John McCarthy, now a Professor Emeritus at Stanford, was the first that suggested the idea of utility computing in 1961. In a celebrated speech, for MIT's hundredth birthday, he foresaw the future of computer time-sharing technology. He had a strong belief that in the years to come, computer power or applications will be delivered as utilities like electricity or water [2]. Other scientist took his ideas even further, like J.C.R. Licklider in 1963, a key man at ARPANET, that predicted an *"intergalactic computer network"* from which users could access data or programs anytime, anywhere [3].

The idea of utility computing, having as an example the developments in electricity, was very popular in the early days of computer revolution at the late 1960s. Companies like IBM and General Electric were offering time-sharing systems. The IBM mainframe for instance, was the first commercially viable system that could deliver resources to multiple users at the same time [4]. IBM had created services where the data centre could be located elsewhere from where the client was and the mainframe could process multiple tasks at the same time.

During the 1970s we find a company delivering services to that direction. Tymeshare was a small firm that provided remote dial-in access to its infrastructure. This way the company was able to rent out mainframe space and computing power [5].

In the 1980s numerous companies were investing in hosting large mainframes and minicomputer clusters. As part of their business, they were renting out computational power and data storage. In exchange corporations were paying them on a monthly or yearly ba-

sis. The corporations where connected to their providers via dedicated Integrated Services Digital Network (ISDN) lines. It was during that period that the cost of service provided was based on a Service Level Agreement (SLA) between the client and the provider [6].

Advances in hardware, software and computer networking brought the rise of Application Service Providers (ASPs) in the 1990s. The idea was, to deliver software-based services for hosting, managing, and providing access to an application from a centrally managed facility [7]. Small, medium-sized and larger companies would be under contract for their services on a rental basis. They would be able, through their local area network (LAN), to have remote access to their applications across a wide area network (WAN). Over time the internetwork of all of these WANs and LANs would create the Internet [7].

It was also during the same period that the term 'cloud' was first introduced. Gillet & Kapor [8] use this term in order to describe all the intermediate networks between the originating and the receiving end of a network in the Internet (**Figure 1**). The MIT researchers were the first to outline foundational elements of today's movement.

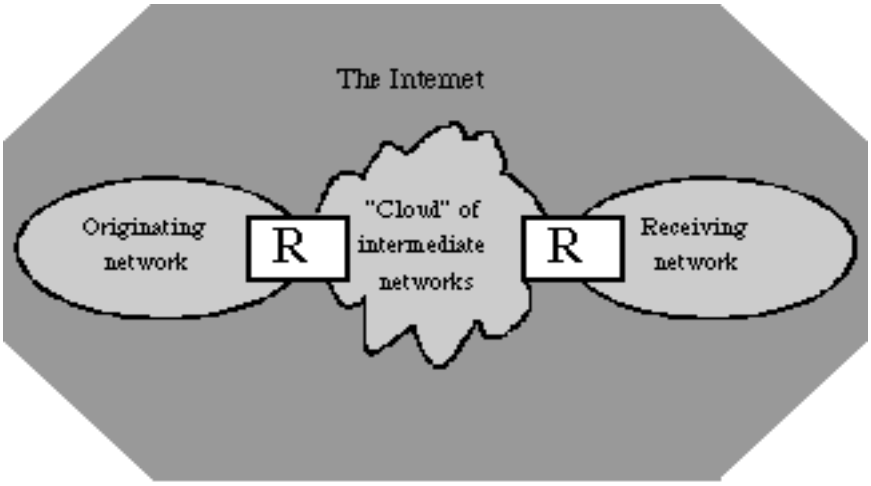

Figure 1. 'Cloud' in 1996, taken from [8]

Over the same decade, and more specifically in 1997, numerous corporations like NetCentric and Dell tried to trademark the term 'cloud computing' but gave up the effort a few years later [9]. According to an article about the history of Cloud computing, the first milestone for this new type of technology consumption was in 1999. The arrival of Saleforce.com[1], a company that offers enterprise applications on demand through their website, truly changed the way software specialist firms provide their services over the Internet [10].

[1]Salesforce.com, http://www.salesforce.com

According to the same article, with the start of the new century companies like Amazon and Google provided similar services. Since the early 2000s Amazon Web Services[2] provide infrastructure web services platforms. One of them, which was launched in 2006, is the Amazon Elastic Compute cloud (EC2)[3], a web service that allows users to rent computing capacity according to their needs [10]. Furthermore, the author states that in 2009 Google introduced Google Apps[4], a customizable version of traditional office suite software like email, calendar or documents, accessible from a browser, introducing new type of service that could be offered in the Cloud [10].

As for the most recent developments in the Cloud services, the Windows Azure Platform[5] , launched in January 2010, offers a set of services and technologies that can be consumed over the Interenet [11].

2.1.2 Trend / Hype

Used mostly by individuals with little understanding of its actual meaning, Cloud computing has become a 'buzzword' for the IT industry. In an overview of the term by Qian et al. [12], Cloud computing like e-commerce in the past, is described as one of the most ambiguous technical terminologies in history.

Excitement and over-enthusiasm for the term, transformed Cloud computing into hype. Gartner coined the word 'hype' in 1995 in order to describe the zest and the subsequent disappointment that usually happens in an introduction of a new technology [13]. In Gartner's hype cycle, that is used to graphically represent those changes, there are five distinguished phases that capture the expectations of the specific technology trough a limited period of time. The first phase is the *"Technology Trigger"* or breakthrough, the second is the *"Peak of Inflated Expectations"*, the third is the *"Trough of Disillusionment"*, the fourth is the *"Slope of Enlightenment"* and the fifth is the *"Plateau of Productivity"* [13].

Gartner produces and release the graph once a year, most of the time during the end of the business season. In the Emerging Technologies edition for 2009, Cloud computing was characterized as the most hyped technology (**Figure 2**). Currently, the technology is going through one of the most critical phases of the cycle. It has reached the peak point of the *"Inflated Expectations"* phase and most of the time technologies that reach that point rarely

[2]Amazon Web Service, http://aws.amazon.com

[3]Amazon EC2, http://aws.amazon.com/ec2

[4]Google App. Engine, http://appengine.google.com

[5]Microsoft Azure Platform, http://www.microsoft.com/windowsazure/

fulfill their expectations. What is also interesting from studying the specific graph, is that Cloud computing is predicted to reach its mainstream adoption in 2 to 5 years [14].

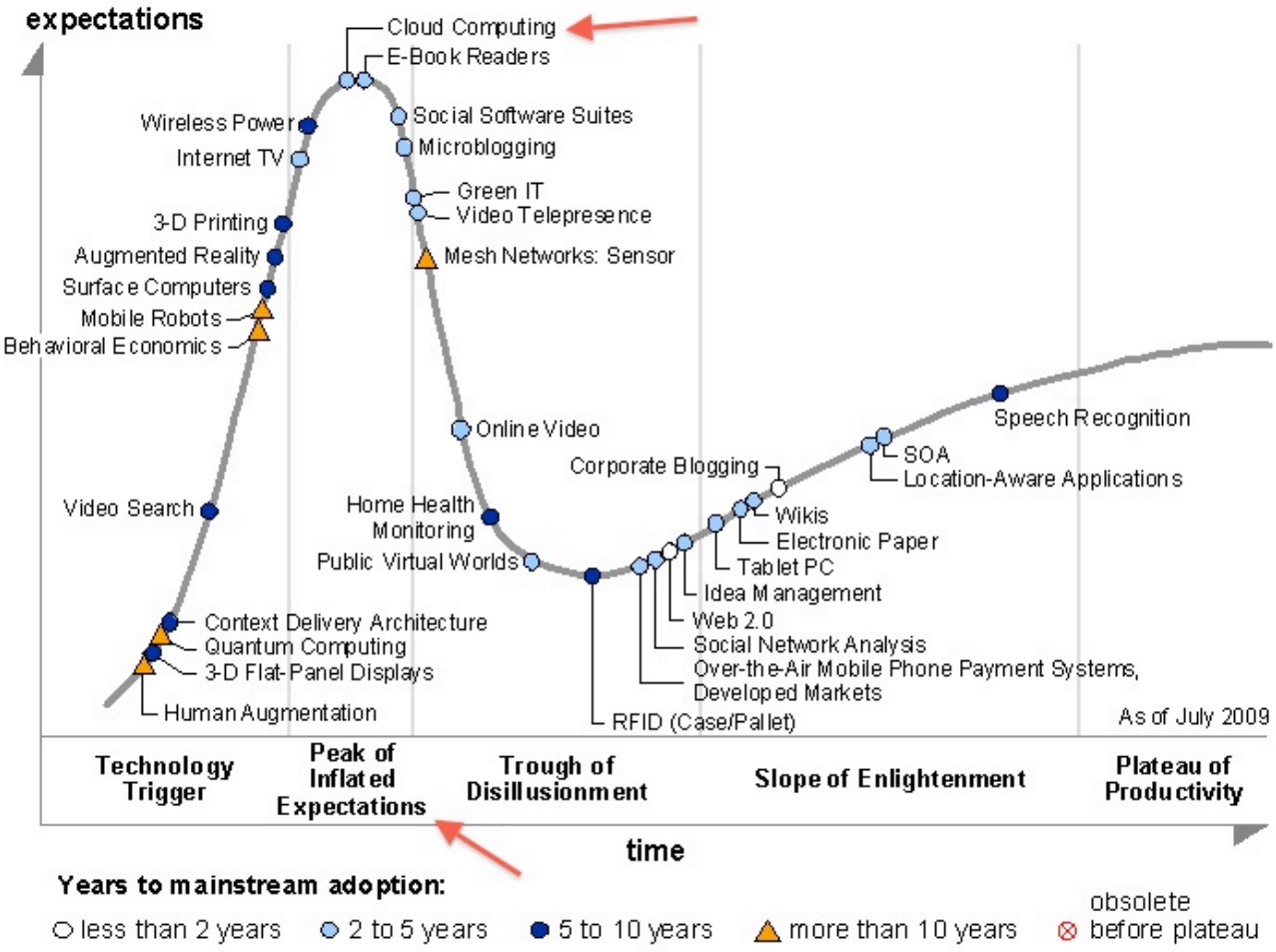

Figure 2. Cloud Computing Hype Cycle, taken from [14]

Emerging as a new technology over the last years, Cloud computing has been also labeled as a trend. Google Trends[6] is web-tool that shows the volume of searches, news, articles and events for a specific term. It has emerged as an anlytinc tool for researchers in order to capture the developments of a tehnology over a certain period of time [15]. Wang et al. [16] use the particullar web-tool in their study to compare Cloud computing with an other familiar technology that has same characteristics, Grid computing. Based on the idea found in their paper, we took a snapshot in August 2010, compering the same two technologies. As a result, **Figure 3** shows that Cloud computing (blue line) has already outaken Grid computing (red line), in terms of web search volume and articles published over the last years.

[6]Google Trends, http://www.google.com/trends/

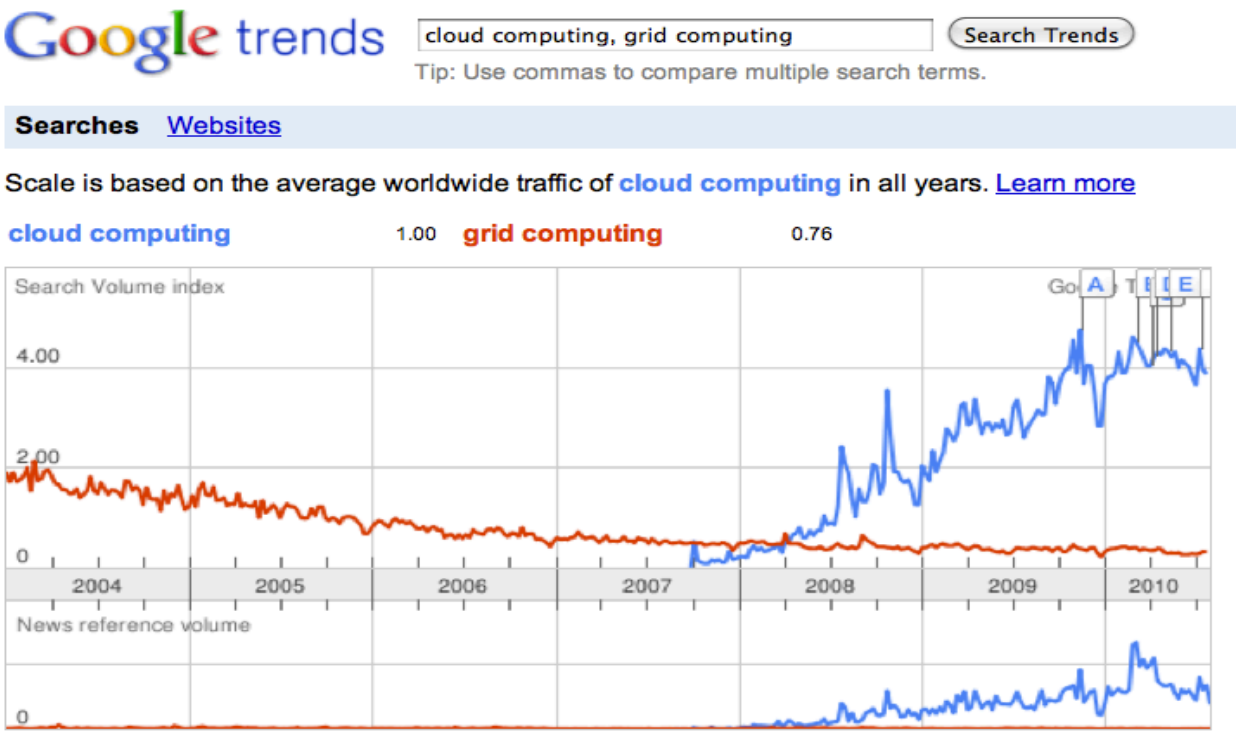

Figure 3. Cloud Computing Vs Grid Computing Trends

In an effort to expain the phenomenon, the authors state that the involvement of various leading companies like IBM, Amazon, HP, Intel, Yahoo and projects like OpenNEbula[7] or Stratus[8] from the academia, has attracted reasonably attention for the new technology. Moreover, Wang et al. [16] argue that the incrementing web search popularity of the term is showing that the IT community is acknowledging Cloud computing as something more than just a technology trend. Finally according to the authors, Cloud computing has caused a constructive confusion among IT people and the only thing that remains is to see if it lives up to its expectations [16].

2.1.3 Enabling Technologies

All of this progress mentioned in the sections above, could not have happened without some key technological advances. Bhattacharjee [17] in his analysis of the Cloud computing platform, states that there are three major technological developments that pushed towards Cloud computing: virtualization, provisioning and Application Programming Interfaces (API's).

[7]OpenNEbula, http://www.opennebula.org

[8]Status Project, http://www.acis.ufl.edu/vws/

Virtualization is one of the key components of computer science and has existed since the early days of computer technology. It represents the fictional (virtual) version of something like an operating system (OS) or hard drive. One of its basic implementations is the ability to run multiple OS images over the same hardware at the same time with just the use of a software [18]. Over the last years virtualization software has grown rapidly making available the production of highly usable network, storage and server virtualization. For example companies like VMWare[9] are able to run Linux OS or Microsoft OS over the same single computer. Using this kind of tools Cloud providers can meet the needs of different OS requirements over the same hardware in a data-centre enabling them to reduce their management costs [17].

Provisioning makes data and technology resources available to users. More specifically, it can be seen as the process of preparing and equipping an information system in order to provide services [19]. Bhattacharjee [17] argues that server and resource provisioning brought big changes to the IT enterprise model and affected the development of Cloud computing. As result of those changes, companies are able to remotely prepare and equip the network in order to provide services to the users. He also states that Cloud providers nowadays, like IBM, HP, VMWare and others, are able to build automated software for these type of functions.

APIs specify a set of functions, routines and protocols that are implemented by a software program and enable it to interact with other software. Protocols like Universal Description Discovery and Integration (UDDI), SOAP (Simple Object Access Protocol), Web Services Description Language (WSDL) and Extensible Markup Language (XML) helped in order to interconnect machines on large medium [20].

Other technical concepts like, Service Oriented Architecture (SOA), that helps creating accessible web services over standard Internet protocols without the need of specific platforms or programming languages [21], also pushed towards the same direction.

2.1.4 Definition

It is very difficult to go through any technical web site or blog and not come across a mention about Cloud computing. Most of the times the comments or articles include a proposed explanation of the technology. Researchers and engineers from different backgrounds, all involved in one way or the other in the Information and Telecommunication Technology (ICT) society, have came up with various definitions comparing Cloud computing with established technologies like Grid computing for instance.

[9]VMWare, http://www.vmware.com

In an article by Geelan [22], the author has collected 21 different definitions for Cloud computing from experts of the ICT industry and academia. Couple of the most interesting ones come from Thorsten Von Eicken, founder of cloud management platform RightScale[10] and Trevor Doerksen, development consultant for the cloud services provider Cybera[11]. Their definitions, quoted within [22], appear below.

> *"Most computer savvy folks actually have a pretty good idea of what the term 'cloud computing' means: outsourced, pay-as-you-go, on-demand, somewhere in the Internet, etc."*
>
> *Thorsten von Eickein*

> *"Cloud computing is ... the user-friendly version of grid computing."*
>
> *Trevor Doerksen*

Trying to extract a consensus definition from all of these, Vaquero [23] reports in his paper that there is a need for a minimum definition with the predominant characteristics of the technology. He argues that all previous definitions focus on specific aspects of the technology and he proposes the following definition.

> *"Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs."*

What is more interesting in one of the previous definitions, more specifically from Trevor Doerksen, is the definition of Cloud computing as an evolution of Grid computing. Foster [24] in his comparison of the two terms argues that the 'Cloud Computing' is a new name for 'Grid computing'. The author agrees that they need to share the same vision but he disagrees as far as the demand and benefits are concerned. Undoubtedly, Cloud computing has some of the characteristics of Grid computing but the second one is a technology that is almost twenty years old and lacks of operating scale, he adds. His definition of the term is presented below.

> *"A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing*

[10]RightScale, http://www.rightscale.com

[11]Cybera, http://www.cybera.com

power, storage, platforms, and services are delivered on demand to external customers over the Internet."

Another comparison done between two technology concepts brings us again to utility computing that was first mentioned in the early 1960s by John McCarthy [2]. In an article by Perry [25], CMO at GigaSpaces[12], for the differences between Cloud and utility computing, the author argues that utility computing is more of business model in which customers receive computing services from a provider and they *"pay the drink"* in the end. On the contrary, she states that Cloud computing is a broader concept that includes all the underlying architecture of the utility services provided.

Even if Cloud computing is a new term for an old technology and even if is has common features or characteristics with previous defined technologies one thing is certain: it does not lack attention from ICT community nor academia.

2.1.5 Characteristics

Many articles and papers are written around the terminology, definition, underlying technology and issues of Cloud computing. Even though Cloud computing is an evolving technology paradigm, the ICT community has clearly defined its characteristics. Using an article by Mell & Grace [26] as a wireframe and additional arguments from other authors we will next present the five essential characteristics of Cloud computing.

Self-service

Users must be capable of selecting, configuring and modifying resources and services themselves. In addition, all of the previous ones have to be done without having to go directly to any of the service's provider [26]. Furthermore, Surgient [27] suggests that users should be a able to access their services on-demand.

Ubiquitous Network Access

Applications must be developed having in mind primarily the platform independence of the model. Services have to be delivered over a broad network enabling mobility and flexibility [26, 27]. Furthermore, Armbrust et al. [28] suggest, that these days the alignment with how businesses operate is crucial. Users using various media, like laptops, PDA, mobile phones and other, must be able to access the wider network through standard mechanisms.

[12]GigaSpaces, http://www.gigaspaces.com

Resource Pooling

Computer resources must be able to serve multiple users adapting accordingly to the demand. These virtual or physical resources must be available over the network [26]. Additionally, Fox et all. [29] suggest, that recourses must be location independent, in a way that the consumer will not know from where they are provided. According to the authors, examples of those resources include storage, CPU power, memory and even virtual machines.

Elasticity of Resources

Resource allocation must be able to grow or shrink accordingly to the user demand and more importantly in fast pace. This way, resources will be capable to scale when the number of users gets higher or even when the application requirements change [26].

Billing and Service Usage Metering

The billing and service usage metering is a key function for both the consumer and the provider. The consumer is being charged according to a pay-per-usage model over a pre-agreed rate and the provider has the capability to monitor the resource usage [26, 28, 29, 30]. From a business perspective, this is unarguably one of the most important features of the upcoming technology [27].

2.2 Cloud Computing - The Technology

Having presented the evolution of the model along with its definitions and characteristics, in this part we will describe the structure of Cloud computing by presenting its architecture. Moreover, we will also present its delivery models mainly adopted by large corporations in the IT field.

2.2.1 Architecture

There are many white papers, research articles and publications suggesting an architecture model for Cloud computing. It consists of many different technologies and its main attribute is that it is a service model. For that reason it widely acclaimed to use 'X-as-a-service' in order to describe, by replacing X, all the available levels of services [23]. Cloud computing can basically provide services in three different layers: Infrastructure layer, Platform layer and Software layer. Additionally, under and over those three layers are: the servers (fabric) layer and the clients (actors) layer (**Figure 4**) [23, 24, 31].

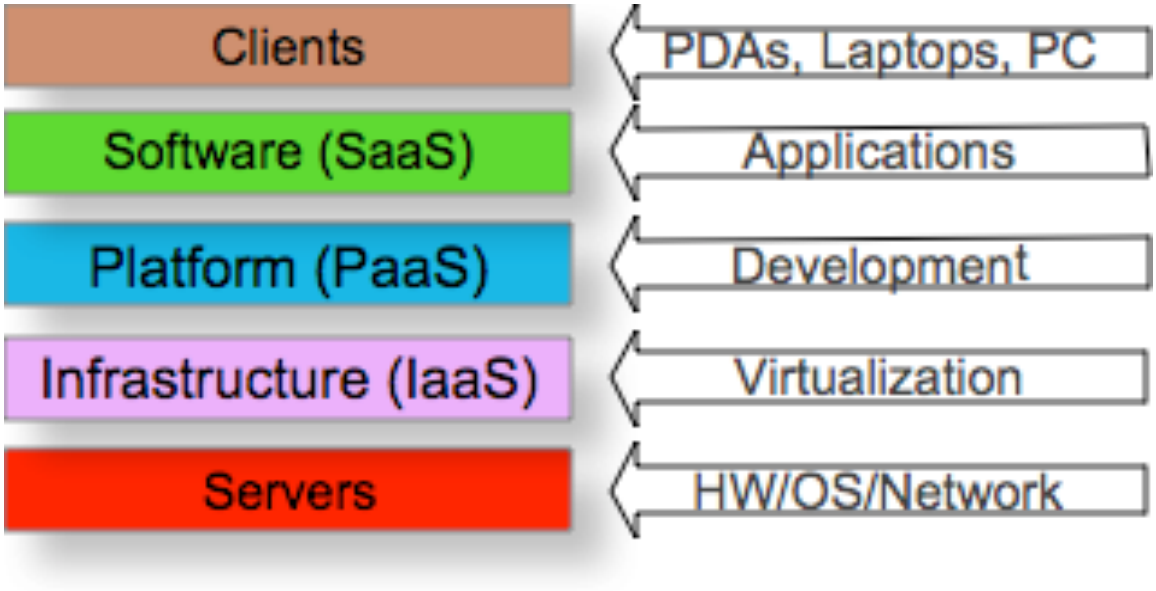

Figure 4. Cloud Computing Layers, based on the figures in [23, 24, 31]

Servers Layer

The Servers layer consists of the computer hardware and software needed to produce those services. Hardware is more and more designed having in mind the demanding needs of that type of service. Intel for example unveiled in 2009, a 48-core processor labeling it as a 'Single-chip Cloud Computer' [32]. In addition, CISCO lunched the same year its 'Unified Computing System' allowing providers to build data-centres, optimized in virtualization resources, a key element in Cloud computing technology [33]. All these types of specialized multi-core processors, virtualized switches and the lower level operating systems are becoming the integral parts of Cloud computing's Servers layer [31, 34].

Infrastructure Layer

The Infrastructure layer is characterized typically from its virtualization capabilities. The physical hardware is divided into virtual machines creating a pool of resources. This way the providers are able provide elasticity to the customers by dynamically changing their resources according to demand. This ability allows vendors to deliver Infrastructure-as-a-Service (IaaS) usually over online systems [23, 24, 31]. Solutions like the Amazon Elastic Compute Cloud (EC2) or the Amazon Simple Storage Service (S3)[13] are able to provide online web storage services. Additionally, open-source models like the Nimbus[14] and the

[13]Amazon Simple Storage Service (S3), http://aws.amazon.com/s3/

[14]Nimbus Project, http://workspace.globus.org/clouds/nimbus.html/

OpenStack[15] are able to offer various computer infrastructure resources. Clients are able to choose between CPU power, storage and networking facilities, using any type of operating system platform [23].

Platform Layer

The Platform layer is an extension of the Infrastructure layer. This layer provides a level of abstraction that is able to deal with the difficulty and complexity of developing an application to a Cloud platform. This way the developers can easily deploy web-based applications using both computer infrastructure along with APIs and programming languages delivered by the providers [23, 24, 31]. Examples of the Platform-as-a-Service Layer (PaaS) are the Google's App Engine and Saleforce.com's Force.com platform. The first one can provide a platform were developers can built and host web applications using Python or Java. The second one can serve as a platform for creating custom collaborative applications using the Saleforce.com's API [31].

Software Layer

The Software layer will be probably the most widely accepted service for this new type of technology [24]. The recent adoption by users of services, like Google Docs[16] and Google Apps, is pointing towards the potential popularity of the service [31]. Software-as-a-Service (SaaS) is the layer were any user or company that does not want to develop their own applications are able to rent fully usable web applications like email, calendar and word processors [23]. This layer has attracted the biggest attention from the public and several vendors are providing customizable, configurable, scalable solutions for any type of services [24]. Further examples are, Oracle's Customer Relations Management (CRM) solution CRM-On-Demand[17] or IBM's Lotus Live[18] enterprise collaboration tool.

Client Layer

The Client layer consists the most important part of the whole service. Without the technology needed to access those services all of the previous layers are worthless. Examples of this layer are the laptops, the PCs, the smart-phones but also the delivery mechanisms of the Cloud services, like to browsers and operating systems [31]. Examples are Micro-

[15]OpenStack, http://openstack.org

[16]Google Docs., http://docs.google.com

[17]Oracle CRM-On-Demand, http://crmondemand.oracle.com

[18]IBM Lotus Live, http://www.lotuslive.com

soft's Windows Azure OS[19] or the open source Linux-based OS Jolicloud[20]. Furthermore, Google is developing and planning to release shortly, a fully based Cloud based operating system titled Chrome OS[21]. All of the previous ones have embraced some of the main characteristics of Cloud computing like platform and location independency [34].

Overall, the Cloud computing architecture involves multiple components communicating mostly over the network using specific and documented APIs. One of the biggest challenges of this type of architecture is the standardization of the whole process. Some progress towards to that direction comes from the Open Grid Forum (OGF) with the development of the Open Cloud Computing Interface[22] and from the works of the Open Cloud Consortium (OCC)[23] [34].

2.2.2 Delivery Models

The delivery models are mainly directed at large enterprises. The corporations are able to employ their applications on three different models choosing from a public, private or a hybrid Cloud model [16, 35].

Public Cloud

The public model is the most often and is run by a third party labeled as the Cloud provider. Services are dynamically provisioned over the Internet and the customer is billed on a pay-per-use basis. The model is based away from customer's premises and usually acts as an extension to the in-house infrastructure [35].

Private Cloud

The private model has a very distinctive characteristic. It is build exclusively for the client and the client holds the control of the whole infrastructure. The provider offers the possibility to construct and deliver the model on client's premises or to collocate it with the provider's infrastructure. It is addressed to huge corporations that are not interested in a low initial expense for their IT infrastructure but are more concerned about the control over it [35, 36].

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[19]Microsoft Azure, http://www.microsoft.com/windowsazure/windowsazure/

[20]Jolicloud, http://www.jolicloud.com

[21]Google Chrome OS, http://sites.google.com/a/chromium.org/dev/chromium-os/

[22]Open Grid Forum, http://www.ogf.org

[23] Open Cloud Consortium, http://opencloudconsortium.org

Hybrid Cloud

Somewhere in the middle lies the hybrid model. This model has characteristics from both the private and the public ones. It allows the customer to keep the in-house infrastructure but also benefit from the public model Cloud services. The biggest challenge for this solution lies on the complexity of the distribution of services or applications between the two models [35, 37].

2.3 Cloud Computing - The Service

The last section is dedicated in describing the potential adoption of the Cloud service and the unique changes it might evoke. Moreover, we provide information about the economic aspect of the service and we briefly present some of the benefits and concerns regarding the embracing of the upcoming model.

2.3.1 Adoption

A lot of people argue that the services provided in the Cloud have been already used over the last decades and that Cloud computing is just a new commercial term for them. Either way the uniqueness of the service lies in that is able to provide the whole IT-as-a-service (ITaaS) [38]. The wide spectrum of services, from infrastructure, to distributed data-centres, to web-based applications, all have become an integral part of the way we work. Moreover, according to Buyya [39] IT tends to become the 5th utility after water, electricity, gas and telephony for our western societies.

Nickolas Carr in his book 'The Big Switch' acknowledges the importance of IT and argues that it is transforming into a general purpose technology. He suggests that through standardization, like it has happened before with electricity, the new form of IT will be able to reduce costs and maximize offerings. Carr is clearly picturing Cloud computing as a new utility and constantly compares it with electricity, which has become a necessity for the western society. This way he tries to emphasize the socio-economical changes that will happen if its widely adopted [40].

Overall, according to Roller & Waverman [41] other changes in the past like the revolutionary developments in telecommunications or the breakthrough of the Internet had a quite huge socio-economic impact . It is only a matter of time to see if the same changes will take place with the wider adoption of Cloud computing.

2.3.2 Economics

One of the key factors for the adoption of Cloud computing services is cost. The model has the ability to reduce IT capital expenses for a company. In contrast with the traditional IT model, Cloud computing is able to offer pay-per-usage and on-demand services. This way the company will not have to invest in infrastructure (hardware, servers, network) or services (software). They will be able to use the provider's utilities and be billed for the consumption [42]. Additional economic benefits are the lower entry barriers for start-up companies and the wide range of offerings and applications from the providers [43].

However, a significant factor of this cost saving switch is the operating costs. Paul [44], argues that you cannot only concentrate on the hard figures and that there has to be balance between the capital and the operating costs. He also states that the switching costs between Cloud providers are, at the moment, extremely high and that the selection of the appropriate provider is crucial. In addition, Golden [45] argues that the perception of IT as a cash consumption department leads companies to think only of the initial cost reduction benefits of Cloud computing. By thinking this way they forget the operational expenditure issues of their investment.

2.3.3 Benefits

Apart from the economics benefits mentioned above Cloud computing has other additional advantages. Wang et al. [15] state, that Cloud computing has some distinctive beneficial capabilities like user-centric interfaces, resource scalability and platform flexibility that make it attractive for organisations. Moreover, Qian et al. [12] identify cost efficiency and low energy consumption as additional benefits for the upcoming technology. Bhattacharjee [17] states easier installing and test of new software, IT processes improvement and better utilization of resources as additional benefits for the Cloud computing model. Lastly, among other benefits that were mentioned by various authors include reliability, lower maintenance costs and resources metering [28, 31].

2.3.4 Concerns

An organization considering the use of Cloud services has to examine further challenges than the economic ones. Qian et al. [12] state, privacy and security issues, service migration and continuity of services as some of the most important ones. Buyya [34] mentions issues regarding performance unpredictability of the service and process complexity of hind-end computing systems like Clouds. Moreover, Vaquero [23] argues that there are issues regarding scalability and self-management, standardization of services and software

workload coordination for programmers in the Cloud. Finally, in an article by Armrest et al. [28] for the obstacles in the adoption of Cloud computing, the authors identify data lock-in and software licensing as some of most crucial.

2.3.5 Conclusion

As result, it is not difficult to understand that the Cloud computing has a number of potential benefits for the organisations that are ready to adopt it. However, the issues that need be addressed create a skepticism and concern about the maturity of the service. This raises the question of whether Cloud computing is ready for 'prime time'?

3 RESEARCH QUESTION

The number of articles, journals and papers presented in the previous chapter prove that Cloud computing is emerging as a hot topic in not only in the IT community but also in the academia. Unarguably, both of them have identified challenges regarding the adoption of the upcoming technology model.

The aim of this project is to investigate the significant factors, both social and technical that influence an organisation's decision making with regard to the use of Cloud computing. More specifically, we need to understand the current perceptions of people influencing such a decision. Furthermore, we try to understand the reason that keep companies away from widely adopting Cloud computing as a core delivery model for their needs or services.

We strongly believe that a project tackling those questions is worthwhile doing for reasons connected with the material presented in the literature review and with the nature of the Cloud computing model itself. The papers and articles presented in the previous chapter mostly come from people in the academia and professionals who have a commercial relationship with the model. Authors from the academia have not necessarily directly faced the issues of Cloud computing in their line of work and professionals offering Cloud services are not necessarily objective about the challenges and concerns regarding its adoption. Additionally, due to the nature of the IT market, the services deployed via a Cloud are evolving rapidly, the offerings provided change constantly and so the perceptions of people involved change continually as well.

As a result, we believe our project will be capable of providing a 'snapshot' of the most important factors influencing the use of the Cloud computing model within organisations. To achieve that we will be interviewing people from the industry who are either technology experts or have considered moving some of their services in the Cloud. This way, we will have the opportunity to currently identify the potential benefits and risks for organisations adopting Cloud services.

4 METHODOLOGY

In order to provide sufficient answers to our research question we had to consider a methodology that would allow us to understand people's attitudes and beliefs towards the adoption of Cloud computing. Additionally, our proposed methodology should be scalable to the size of the research and respect the time restrictions of this project.

In this chapter we present our selected methodology initially by identifying the connection between social sciences and study of Information Systems (IS). Moreover, we explain the qualitative research technique that enabled us to search and analyze the factors influencing the uptake of Cloud computing from the IT industry. As part of this technique, we describe the data collection method that we used in order to gather opinions and perceptions regarding the selected research subject.

4.1 INFORMATION SYSTEMS RESEARCH

The social effect of IT is not a new concept. Some of the first to do research in the field were Kling & Dutton. In their book 'Computer and Politics', published in 1982, they carried out a five year project in order to identify the political, economical and social effects of computer technology at the time [46]. This wider notion of IT was later on labeled in what we call today Information Systems.

In a more recent study, Kroenke [47] identifies data, software, hardware, processes and people as the most important elements that interact within an IS (**Figure 5**). The author argues that the relationships between those elements, produce the social, economical and technical changes wthin an organisation.

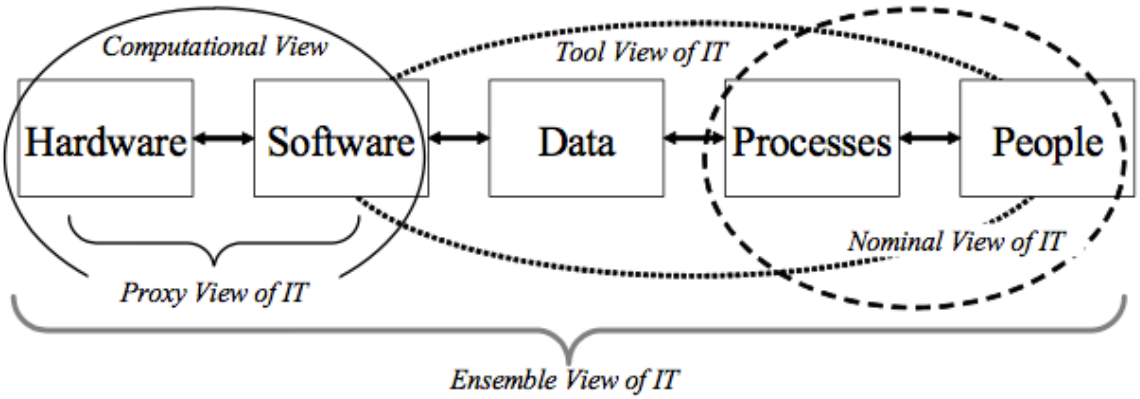

Figure 5. Relationships and Views of IT, taken by [47]

Other articles like the one from Lehmann & Fernadez [48], acknowledge IS as a *"hybrid"* model of IT, procedures and people within an organisation. The authors suggest that in order to do research within the hybrid of IT and IS we will have to take a socio-technical view. Furthermore, they point out that this view poses comprehensive investigation of the *"nominal"* (process, people) and the *"computational"* (hardware, software) elements of the proposed system (**Figure 5**). As brief conclusion for all the distinguished characteristics that IS research has from other fields, Lee [49] proposes the following definition.

> *"research in the information systems field examines more than just the technological system, or just the social system, or even the two side by side; in addition, it investigates the phenomena that emerge when the two interact".*

4.2.1 Qualitative Research and Information Systems

Qualitative research is the social sciences method that investigates human behavior and allows the researcher to understand the reasons enabling that behavior [50]. Klein & Myers [50] claim that qualitative research in IS is interpretive if it *"attempts to understand phenomena through the meanings that people assign to them"*. Additionally, Walsham [51] states that interpretive methods of research in IS are *"aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context"*.

According to Geode & De Villiers [52] IS can been seen as a social activity and interpretive research would be the most effective approach in order to understand the context of an IS and the processes that influence its adoption. Moreover, according to the authors, qualitative research can be viewed as interpretive research, as it is able to investigate phenomena like feelings, thought processes and emotions. Their proposed qualitative research method for achieving those results is Grounded Theory (GT).

GT is an comparative, inductive and interactive research approach that allows flexibility and freedom in order to explore any phenomena in depth [53]. GT is often used as a research methodology in IS research. Matavire & Brown [54] contacted a survey and released a paper on the number of IS-centric journals published from 1985-2007 using GT as their research methodology. The authors state that the have been approximately 127 studies published over this period, employing various GT approaches.

From the previous paragraph we understand that interpretive research techniques like GT are extensively used for studying IS. Thus, choosing GT as our methodology we believe it will give us the opportunity to investigate thoroughly the socio-technical issues regarding

the adoption of Cloud computing within organisations. In the next sections we present our selected methodology along with its preferable data collection procedure.

4.3 Grounded Theory

GT was first introduced in 1967 by Glaser & Strauss and it was originally identified within the social sciences. It was defined as the process for *"... the discovery of theory from data systematically obtained from social research"* [55]. Later Strauss & Corbin [53] developed a more detailed description for developing GT theory in 1990. As a result the method could be used more broadly, even outside social sciences, primarily because it could incorporate both quantitive and qualitative data sets for analysis.

4.3.1 Method

Strauss & Corbin define GT as *"the theory that was derived from data, systematically gathered and analyzed through the research process"* [53]. The difference with other methods is that the theory *"derives from the data"* rather than collecting data in order to test a theory or a hypothesis. Therefore, the key feature of the method is that it does not need prior hypothesis in order to begin research on a subject. Additionally, Strauss & Corbin state that GT can be used for *"complex subjects or phenomena where little yet is known"* [53].

This type of framework according to Cairns & Cox [56] allows the researcher to go into the *"research without knowing what they want to find out about a particular area"* making it suitable to study about people's perceptions, interactions and opinions. Combining that with Strauss & Corbin [53] statement that this method offers *"openness, a willingness to listen to and 'give voice' to respondents"*, is easy to understand that this type of approach aligns perfectly with a novel, ambiguous and multi-defined phenomena like Cloud computing.

4.3.2 Procedure

Strauss & Corbin state as theory the *"explanation of a phenomena"* and theorizing the procedure of *"conceiving or intuiting ideas and formulate them"* [53]. In order to create a theory and produce a potential hypothesis, we have to collect data. The difference of GT with other methods is that the theory not is developed when the data is completely collected. As Cairns & Cox [56] note the *"method proceeds through cycles of data gathering, analysis and theorizing"*, this way the researches is able to validate and expand the theory. Moreover, they state that the procedure stops when the theory reaches 'saturation' meaning that *"each new item of data can be fitted into the existing theory without requiring the theory to be modified"*.

Another key element of GT is the 'constant comparison' method for the collected data. As the researcher analyzes the data is able to make changes or rearrange his ideas for the emerging concept. To be able to follow this procedure and enable the theory to occur in a structured manner Strauss & Corbin [53] have come up with three major coding stages: open, axial and secretive coding.

Open Coding

Open coding is *"the analytic process through which concepts and categories are identified and their properties and dimensions are discovered in data"* [53]. Through open coding, is called open because there is no pre-determined set codes, we are able identify concepts, create categories and define properties or dimensions. In order to achieve this we use the 'constant comparison' method in collaboration with memos. As a result, we are able to name concepts, classify categories and appoint attributes to properties or domains to dimensions [56].

Axial Coding

Axial coding is defined as *"the process of relating categories to their sub-categories, termed 'axial' because coding occurs around the axis of a category, linking categories at the level of properties and dimensions"* [53]. This procedure allows to to identify the high-level phenomena and identify the relationships between the categories that were created in open coding. Moreover, we are able to investigate the conditions, actions/interaction and consequences that derive from the predefined categories [56].

Selective Coding

Selective coding is *"the process of intergrading and refining the theory"* [53]. In selective coding we can identify the core category and then built around it the the theory. We are able to do that by creating a story and conceptualizing its storyline. The identification of the central category is very important and has to be validated using the 'constant comparison' method opposite to the raw data. This enables us to identify gaps in the proposed category that can only be filled with further data collection. Furthermore, the core category must relate with all major categories that derived from the previous steps [56].

Performing Coding

One of the predominant procedures for performing coding according to Strauss & Corbin [53] is microcoding. Microcoding is a detailed line-by-line analysis of the data in order to identify categories and suggest relationships amongst them. It is usually done at the be-

ginning of the research as soon as the first data is available. The researcher looks at each word and tries to work out what it 'really' means. In order to do this Cairns & Cox [56] suggest that the researcher should start asking questions about each word in order to build sensitivity towards the data. This way the researcher will have the opportunity to see in the data something that previously was not so obvious.

As the researcher builds sensitivity towards the data the line-by-line analysis would gradually start to give its place at phrases, paragraphs and the understanding of the bigger picture. It is worth mentioning here that for a novice ground researcher this is a very demanding procedure. Cairns & Cox [56] state that *"the lines between the different levels of coding are artificial"* and that microanalysis is a quite daunting experience. In addition to that, microanalysis is a very time consuming procedure that generates a lot of ideas and is very important to make memos in order to keep track.

4.4 Data Collection Method

There are three types of data collection in qualitative research: interviews, observations and archives [57]. All three of them can take many forms. For example in interviews we find the structured interviews, semi-structured interviews and the unstructured interviews.

Using GT as our methodology and considering its characteristics, we selected interviews as our data collection method. Moreover, we had to choose a form of interview that would allow the participant to provide extensive opinions on the delivery model. Furthermore, the selected type of interviews should allows us to cover several topics and have the freedom to create follow-up questions probed by the participants answers.

4.4.1 Interviews

In order to grasp the opinions of our participants and be able to freely interact with their answers, we decided to select semi-structured interviews as our method. In addition, we used open-ended questions which are extensively used in qualitative research methodologies [58].

Semi-Structured Interviews

In semi-structured type of interviews there is an outline of topics to be covered with suggested questions. This is done in order to have some consistency and to have some basic topics covered with all the participants. Usually the interviewer starts with the pre-planed

questions. Then depending on the participant's answers, tries to extract further information. Typically those type of interviews are informal allowing the participant to feel comfortable. Finally, most of the times those type of interviews have to have the form of a normal dialogue and give the participant room to give answers freely [59].

Open-Ended Questions

Open-ended questions allow the respondent to answer each question uniquely. There are no predetermined answers. Most of the times they are used in order to achieve an in-depth understanding of the selected subject [59].

5 IMPLEMENTATION

Having selected interviews as our data gathering process, in this chapter we will present the implementation of our selected procedure. We describe the participants' selection process, issues regarding the arrangements for the interviews and their profiles. Furthermore, we talk extensively about the interviewing process along with the issues and concerns we had to take into consideration before, in the actual process of interviewing and after the end of it.

5.1 PARTICIPANTS

We decided to have five interviewees for our study. This number allowed us to be flexible around the time limitations and be able to organize the excessive amount of time needed for analyzing and transcribing. Additionally, we believe that this number enables us to complete a whole cycle of data gathering, analysis and theorizing within the restricted time limits of the project.

5.1.2 Selection Process

For the selection of the appropriate participants for the specific project we decided to split our candidates into two different group of people. By doing that we would be able to get various options on the specific matter. So, we tried to select people who were either experts in the field or either people who have gone through the process of considering or selecting the delivery model for their business.

Although we needed this variety, we also needed our participants to share some common characteristics. The selected interviewees had to be senior staff that would influence their own company or advise other ones in strategic IT decisions.

Another element in the selection process had to do with the company or organisation that the participants worked for. It was important to us to try to have a sample of people spreading from Cloud providers all the way to Cloud users. It is worth mentioning, that we were also interested in people that were standing in the middle of this spectrum. Meaning, we wanted to have some participants who went through the selection process without in the end successfully adopting the delivery model.

5.1.3 Arrangements

Due to the nature of this project arrangements with the participants would not be possible without the help of the project supervisor. Even from the initial talk about the project there were some exploratory contacts with potential participants.

The most common way to contact them was through email. In collaboration with the project supervisor we edited an email that consisted a small description of the project, ethical issues concerning the participant, the length of the procedure and clearly stated to the participants that the procedure would be recorded.

Due to the fact that we wanted to talk with senior staff, which most of the times are very busy, we allowed the participants to chose a convenient date and time according to their schedule. Additionally, because of the iterative nature of our methodology the arrangements continued through to the late stages of the project.

5.1.4 Profiles

In this section we provide the profiles of the participants. We provide information about their position, their years of experience on the field, their responsibilities and their level of education. Our goal is to give as much details as possible in order for the reader to clearly understand what type of people we interviewed and what kind of characteristics they have that helped us to build our theory.

Participant One

ID	P1
Age	40-50
Gender	Male
Education	Computer Science
Experience	More than 20 years. Most of them in IT support
Previous Roles	Research Associate
Current Role	Senior level position in software support
Company	Academic institution
Duties	Responsible for managing, supporting and selecting software applications involving email and file storage

Participant Two

ID	P2
Age	35-45
Gender	Male
Education	Astrophysics, Theoretical Physics
Experience	More than 15 years
Previous Roles	Research Associate, worked in Telecoms industry
Current Role	Senior level position in systems integration
Company	Academic institution
Duties	Software extensions programming, project management, introducing new systems, management of information systems

Participant Three

ID	P3
Age	40-50
Gender	Male
Education	Economics
Experience	Approximately 24 years in the IT field
Previous Roles	Positioned in IT department in various companies
Current Role	Executive-level position in IT architecture
Company	Multinational computer, technology and IT consulting corporation
Duties	Lead architect in outsourcing accounts, technology innovation related projects, activities for large enterprises, consulting companies in investing in Cloud Computing services

Participant Four

ID	P4
Age	55-65
Gender	Male
Education	Physics
Experience	Over 45 years in the IT field
Previous Roles	Systems engineer implementing hardware and software
Current Role	Executive-level position in IT services
Company	Multinational computer, technology and IT consulting corporation
Duties	Working closely with large enterprises looking at difficult technological challenges, concentrated in the financial field

Participant Five

ID	P5
Age	30-40
Gender	Male
Education	Physics
Experience	14 years in the IT field
Previous Roles	14 years with the same company in various consulting roles
Current Role	Senior level position in IT architecture
Company	Global management consulting, technology consulting and technology outsourcing company
Duties	Leading design in projects, mainly involved in capital market, technical performance testing

5.2 Pre-Interview

Having selected the participants and arranged the date and time that the interview would take place, there were some further issues that needed to be considered. Drawing advise from several qualitative research manuals, we had to think of 'social conventions' issues. Arriving on time on the meeting point, dressing up formally and more generally, taking good care of the impression we were giving to your participant were some of the most important.

All of these issues along with other ones described in the pre-interview phase, may seem easy to understand. Nevertheless, they were very important in order for our participants to take our research seriously and act accordingly.

5.2.1 Consent Form

The document informed the participant for the nature of the investigation, covered any issues about confidentiality, anonymity and voluntary participation. Furthermore, it made clear who were responsible for the research project stating out the name of the researcher, the supervisor and the department Computer Science, University of York as the supporting institution for the research.

Participant had to sign the form and agree to the conditions for the procedure to take place. A complete copy of the consent form is attached in Appendix A.

5.2.2 Questions

Having selected the semi-structured style of interviewing and open-ended type questions for our data gathering process we had to carefully prepare both in the pre-interview stage. The questions are presented divided into three main types: demographic questions, core questions and clarifying questions. It is worth noting, that a sample of the questions used in the interview process is presented in Appendix B.

Demographic Questions

This type of question are normally used in order to get factual data (age, role, etc). from the respondent. We designed them having in mind to extract the information presented in Profiles section (see 5.1.4).

Core Questions

These were the basis of our communication with the interviewee. The questions were well structured and it was essential for the participant to easily understand their meaning.

We used these questions in order to identify the key themes of our research. Having brainstormed around the potential issues and concerns regarding Cloud computing we tried to identify the key areas where we should look for answers. The questions where constructed in way that allowed us to extract perceptions and opinions on the matter.

Clarifying Questions

This type of questions were used in collaboration with the core questions in order to check the meaning of the responses given by the interviewee. In the GT methodology these questions are considered as the key tool in order to approach the themes or gaps that come from the analysis procedure. These questions were not be planned but gradually became more comprehensive as the interviews process moved on.

5.2.3 Location

Getting into this type of research, location is one of the practical issues that have to be taken into consideration. Cost of traveling and the limited time schedule of the participants make the location selection a bit complicated. Furthermore, the selection of a quiet location where the interview would not be interrupted, is reasonably important.

We were in a way lucky enough to have most of our participants coming to our department due to the professional relationship they had with the supervisor. We conducted the interview in conference rooms at the department allowing us to have no distractions whatsoever. Furthermore, some of our interviews were contacted at the same location but over the phone.

5.2.4 Length

Participants were informed as to the length of the interview from the initial contact stage. Most of the reference books in qualitative research clearly state, that interviews should not take more than an hour. The primary reason is to keep the interviewees' attention and respect the time they take out to help you.

Taking these into consideration we decided to conduct interviews that would last 30 to 45 minutes. This way we were able to attract more participants and have a reasonable amount of time to interview them in depth.

5.2.5 Equipment

Although often underestimated, the interviewing equipment is by far the most valuable part of the whole process. Not surprisingly, in all of the reference manuals for qualitative analysis with interviewing, the authors point out about the importance of reliable equipment is crucial for the success of the process.

We had to think of practical issues like, the batteries for the recording equipment and the quality of the recording. In addition, we tested the equipment prior to the interview and make sure it worked properly.

We used an OLYMPUS (VN-6500PC) digital recorder with noise reduction features and an external stereo SONY (ECM-MS907) microphone for our interviews.

5.3 Interviewing

The actual running process of an interview is not an easy task. One of the biggest challenges was the familiarization with the process. As the interviews moved on, we started to feel more comfortable with the process and we were able to be more productive.

Drawing the structure proposed for interviewing by Peerce et al. [60], we divided the interview process in five steps: introduction, warm-up session, main session, cool-off period and closing session.

5.3.1 Introduction

In the beginning of the interview we introduced ourselves to the participant and gave some more details about the procedure. Moreover, in this step the interviewee had to read and sign the consent form in order to acknowledge their understanding of the procedure and obtain their agreement.

5.3.2 Warm-up Session

Warm-up session was used to ask the participant demographic questions. Questions regarding their role, years of experience in the field, studies and the duties involved in their position were asked in this session. Moreover, this step helped us to get familiarized with

the interviewees' line of work and also 'break the ice' so both sides could feel more comfortable.

5.3.3 Main Session

In the main session we had the chance to make questions relevant to the key issues of the research. In this session we tried to use the core questions we planned in the pre-interview process and take advantage of the participants' responses in order to ask clarifying questions. We have to note here, that no matter how well you have planned an interview, it is a very demanding task to have full attention to your interviewee's answers and also trying to think of your next question.

Hopefully, in the main section we were able to extract opinions on Cloud computing, ask the participants about their involvement in projects that had to do with adopting Cloud services and tried to identify perceptions on the matter. Moreover, we asked our participants to describe the Cloud computing model as they understand it and identify it's area of use.

5.3.4 Cool-off Session

The cool-off session consisted of easier questions for the interviewees. Questions in this session could be followed by explanatory ones, as in the main session, but they were normally less demanding for the participant.

In this area we were able to ask questions regarding the social part of Cloud computing. We wanted to find out participant's opinion about Cloud computing as a social phenomenon, how it is affecting the society, they way we work and the way we do business. Additionally, we asked some questions regarding the future of the model and the technical or social changes it might evoke.

5.3.5 Closing Session

During closing session, the interview process moved into its final stage. The participants were informed during the last questions that the process is closing to an end. This way we were able to demonstrate a structure in the interviewing process and gently guide the participant to the end of the discussion. Last but not least, we thanked each interviewee for taking part in the research.

5.4 Post-Interview

As soon as the actual interview finished we had to start thinking about the selected data. There two main tasks in the post-interview stage: transcription and analysis. Both of them are key features of a qualitative research and are prone to complications. Furthermore, qualitative research, especially the one conducted with in-depth interviews, is closely connected with experience. The only way to gain this experience and build confidence is by doing the previously described tasks over and over again.

5.4.1 Transcription

Transcribing an interview is time-consuming and highly taxing. Handbooks in interviewing procedures state that an experienced secretary would need around 5 hours to type an 1-hour interview. Additionally, from personal research we discovered that outsourcing interviews is rather highly taxing task. Offices like King Audio Transcription and Typing Services (KATTS)[24], offer these type of services and charge wages of 0.9 to 1.2 pounds per recorded minute.

Talking into consideration both of those issues we decided to personally transcribe the interviews. This was not only a good solution for practical reasons but it was also the best way for a novice researcher to gain a first-hand knowledge of the data collected. Moreover, we had to make sure, when listening again the recorded material, not to leave out anything but also grasp the feel of the discussion.

Transcription of the interviews was a daunting and challenging experience. Listening back the interviews from the digital recorder we needed 4 to 6 hours to transcribe each of our five 40-minutes interviews. Thus, a significant amount of project time was spent in transcribing the selected audio material.

5.4.2 Analysis Procedure

The result of transcribing interviews gives us the pure data and as a next step it needs to be analyzed. One of our main reference handbooks for this project, points out that an 1-hour interview when typed gives around 20 to 40 pages of typewritten data depending on how fast the participant talks.

For our 30-45 minute interviews we had around 15 to 20 pages of transcribed material to analyze for each interview. Because of the iterative nature of GT methodology, it was nec-

[24] King Audio Transcription and Typing Services (KATTS), http://www.kingaudio.co.uk

essary to transcribe each interview before next one took place. Moreover, we had to analyze the data in order to move forward. This way we were able to prepare the questions for the following interview having in mind the issues that were brought up in the previous one. A large part of the project time, around 5 to 6 hours for each interview, had to do with the analysis phase.

Overall the analysis of the transcribed data was a difficult but fulfilling process. Analyzing our own data gave us the opportunity to understand the research problem in depth. Furthermore, it allowed us to understand our mistakes during the interview process and provided in each occasion the time needed to correct them for our next interview.

6 RESULTS AND ANALYSIS

As previously described, using GT allows you to analyze your results as you move on with the data collection procedure. This means that we were able to have some results as the interviews were done. Through 'open coding' and the use of microanalysis we were able to identify concepts, create categories and define properties in the collected data. Additionally, using 'axial coding' we had the opportunity to identify the relationships between the categories that were created in 'open coding'. Finally, 'selective coding' allowed us to identify the main categories and build our theory around it.

As expected when using GT methodology, common themes come up as you move on with the interview procedure. This way we were able to identify the main themes of our research even from our first interviews. Furthermore, the repeated themes not only gave us the opportunity to create core categories for our theory but enabled us also to start focusing on novel concepts and discuss about them in later interviews.

The coding procedure described before is not easy to be presented as it is an integral part of the GT methodology. In this chapter we will present a summary of the results, separated in categories, by providing quotes from the transcribed interviews. Moreover in the analysis, we will focus on the two most influential categories and the relationship between them that we believe helped us create our theory.

All through the chapter we will be referencing to our participants' quotes with the ID given in the Profiles section (see 5.1.4). So, for example P1 will be the Participant One.

6.1 RESULTS SUMMARY AND CATEGORIZATIONS

Through the interview process we had the opportunity to ask people about a lot of issues regarding the adoption, perceptions, problems and potential benefits of Cloud computing both from a technical and social perspective. In this section we will present the general categories around Cloud computing that emerged from the coding process along with their properties.

This type of approach will give the reader the opportunity to understand the extent of our work. Furthermore, we will have the chance to present an overall perspective of the themes that emerged through the analysis process, before describing the two central categories that enabled us to come up with our theory.

6.1.1 Definition

As described in the literature review, Cloud computing is difficult term to describe. Having the chance to directly talk with different people in the IT industry, we thought that it would be a good idea to ask them to define Cloud computing.

As first reaction to that question, some of them started of by acknowledging the difficulty to describe the term, like P4, P2 and P5 for example,

"I see it as sort of a vague term"
"Cloud computing is a very difficult term to pin down"
"Cloud computing is..., I can remember going through so many ways of describing this, it could mean a lot of different things."

Other ones that felt more comfortable with it and were able to give a quicker like P3 for example,

"Cloud computing for me it's a consumption and a delivery model."

Moving on with other given definitions we are able to identify the properties of anonymity and trend in the definition category for Cloud computing. For example in the definition give by P1 we clearly find both,

"This is where your services are provided externally by someone who looks after them for you really and you don't quite know where they are or how it's done [...] generally people thing is interesting idea."

Additionally, P3 identifies the anonymity property of the term and adds that the user is not necessarily interested to know from whom the service is provided,

"The user of the service wether it's IT service or business service consumes the service without necessarily knowing or caring about the delivery model behind it."

Another interesting outcome from this question, is that people do not necessarily see it as a novel term. P4 for example states,

"Like a lot of movements in IT, people then take what is an original idea and then take it to somewhere else and start re-badging stuff that's around."

One other property that came out from this question had to do with the size of the Cloud computing providers. Some of our participants identified in their description for the term,

that Cloud services can be provided only by colossal companies like Amazon, Google or Microsoft. P2 interestingly notes for example,

[...] being global providers there is somehow a kind of attribution of that these people are way bigger than any of us. I used to tell people that, it used to be that God was use to sit in the cloud but know it's not God is Google or Microsoft."

Overall, it is not difficult to see that Cloud computing meant a lot of different things to people depending on their involvement around the upcoming technology. In addition it is worth mentioning that many of them described it by identifying its key features. These features will be presented in later sections.

6.1.2 Delivery Models

Having identified in literature review the Cloud computing delivery models, it would interesting enough to find out if the professionals in the IT field recognize similar ones. So in question about the provided Cloud services and the potential Cloud models that a company can adopt, P3 identifies three different delivery models for the Cloud,

"We have already mentioned number of different delivery models, so you could have a cloud, public cloud service, a private cloud service an increasingly you see an in between those two, a shared private cloud or hybrid cloud that take attributes of both."

So our participants identified three attributes for this category: private cloud, public cloud and hybrid cloud. In addition, other participants pointed out that each Cloud model shares common characteristics but has different benefits and implications. For example P2 mentions that a private cloud could give solutions for existing legislation issues deriving from the use of global Cloud providers,

"I hope that the data legislation environment will change. If it doesn't change at least will maybe have clouds which are within the UK or clouds which are within the EU so we can do more Cloud computing among ourselves if we can't use the global providers."

In later section we will have the opportunity to discuss for the issues regarding the potential adoption of those models.

6.1.3 Economics

One of the integral characteristics of Cloud computing is undoubtedly cost. Many of our participants identified cost as one of the main features of Cloud computing even from

their initial description for the term. P3 for example states as part of his definition for Cloud computing,

"[...] ,the delivery model has a number of beneficial characteristics such as cost efficiency [...]"

Other mentioned cost along the way, as one of the main reasons they were interested in adopting Cloud services, noting down the possibility of getting those services even for free. P2 for example mentions,

"The cost means that they can offer it at a lower cost for enterprises, sometimes for free like the Gmail would be free for us by they way."

As ending quote for the importance of cost in Cloud computing P3 states,

"So I think if anybody talks about cloud and they say the main drive is not cost, I personally question that."

6.1.4 Features

Part of this analysis for the Cloud computing platform is to identify the features of the upcoming technology. All of our participants identified common features in the Cloud computing model and that helped us to create the properties of this category.

Types of Services

As we mentioned before, some of the participants mentioned important features of the technology even from their definitions. For example P3 and P5 describe the delivery model as follow,

"So it can be data storage over the network or it could be an application that you use is sort of in the network in the state it actually has or it can just be raw CPU cycles in the case of Amazon's EC2 project service"

"At very basic level, it is the ability to access services wether this is Software services or Infrastructure services or other services via the Internet."

From the previous quotes the participants identified generic layers of the Cloud service like the IaaS, SaaS, described previously in the Literature Review chapter.

Overall, many of our participants identified some of the generic layers of Cloud computing stating one way or the other various different services that the model provides.

Payment Model

Our next attribute for this category has to do with the commercial value of Cloud computing. From a business perspective many of our participants identified the pay-as-you-go characteristic of Cloud services. For example P3 and P5 state about the commercial side of the service,

"There is number of key commercial aspects about cloud in some purest sense which a sort of more a pay-as-you-go model if you like. "

"Pay-as-go it is a big selling point for the cloud [..]"

In addition, some of our participates discussed about the opportunities that the Cloud model offers for start-up companies. For example P5 states,

"Cloud is fantastic if you are a start-up and you have nothing and you want to get up and run very quickly, perfect!"

Furthermore, participants identified the lower entry barriers for new companies. For example P3 states,

"There is also new entrants in the market and you have your Amazon and you have got new players who can come in very quickly because they can set effectively start-up companies [..] they have to put a data centre and some capacity or is somebody else's data centre and they can start of providing cloud services without the overheads of the traditional players."

These type of commercial characteristic of Cloud computing have made it popular among companies with different needs for IT capabilities. Overall, most our participants identified that Cloud computing has significant business value.

Issues

Apart from the types of services provide by the Cloud model, our participants also identified many issues regarding its adoption.

P3 for states some of them like standardization, security and loss of control,

"But also has some implications, there is things like it hasn't a standardize service, there is a number of implications there. Potentially a lack of architectural control for the client. Potentially other implications such as security and service levels [...]"

Other participants identified issues on connectivity and availability. Since Cloud services are provided, as we mentioned before, via the Internet they mentioned that people who use them become more depended to their network. P5 and P1 state for example,

"Because suddenly, you are not dependent not on your hardware but you depend on your network links onto to the cloud."

"Other issues that put us off at the moment, I think is availability cause there has been some fairly bad downtimes of these services."

Furthermore, other participants identified issues like Cloud services support, services coordination difficulties and migration issues. P2, P4 and P3 state for these issues,

"We keep all that to a Cloud supplier [...] and we really, really, really, really need to know what we can ask and what can expect in terms of support."

"So if you went into a bank and you said, how many applications do you have? Someone would scratch their head and say, I don't know 3000-30000. So you get this, how do I manage all those applications or their connectivity in the cloud."

"I think one of the big barriers that Cloud computing has is that you need to spent a lot of effort migrating into it."

Moreover, as part of the disadvantages of the upcoming service, P4 mentions about the ambiguity of the model,

"I think the big disadvantage is the no one can truly define what clouds are, [...]."

One of the most interesting issues regarding the adoption of the Cloud computing model, is that some of our participants described it as an immature service. In a question about the disadvantages of the model P5 states,

"[...] the one big disadvantage is… I would have to say immaturity at the moment of Cloud computing."

Finally, nearly all of them stated that Cloud computing is currently driven mostly by fashion and not so much by business needs. P5 states for example,

"It's a fashion and it's a little immature at the moment and people are trying to figure out how Cloud works."

In the next section we will discuss more about this process of adoption by presenting the potential risks and trust issues that were mentioned from our interviewers.

6.2 Analysis

In the previous section we tried to present a description of the Cloud computing model along with its main areas of interest for the IT people. In this section we will try discuss about its adoption by presenting the two main categories that mostly influenced the creation of our theory. Moreover, our proposed theory is presented in the last section.

In an effort to extract as much information needed to understand about the potential adoption of the Cloud services from companies or organisations, we asked our interviewees to give examples of issues regarding the procedure. All of our participants mentioned that there are risks in its adoption. More importantly they stated that there has to be created a wider trust for the upcoming service from the providers. As a result we decided to identify risk and trust as our two main categories and the trade-off between them as our main theme for our theory.

6.2.1 Risk

Starting off with this category it worth mentioning that many of our participants argued that the adoption of Cloud services is closely related with the specific needs and context of each organisation. So in a question for the considerations that an organisation has to make before adopting a Cloud service, P3 talks about the context and workloads of any organisation,

"So I would say two things are really important, the context of the client's organisation overall and then the context of their specific workloads."

We mentioned the previous quote, in order to point out that the risks laying in the adoption of Cloud computing are focused mainly on the nature of the organisation and the product or services that it provides. As a result, one of the main risks in the Cloud computing model has to do with the type of data that each organisation handles. P2 in a discussion about the potential adoption of email services on the Cloud, states about privacy concerns,

"I think people don't think of that aspect until it has actually happened and then it hits off that this isn't a private conversation anymore."

Furthermore, other issues have to do with legislation concerns in the Cloud. P3 talks about the appropriate selection of a Cloud model depending on data regulation issues on public clouds,

"They must put their workloads on the right model, if they put it the wrong model they put their regulated data on the public model and is now being delivered from India or America and is not in the EU they are breaking regulations and they are going to have serious fines and serious market pressure to them because that will then become public knowledge."

Moreover, other issues that concern potential Cloud model adopters have to do with the immaturity of the service. Immaturity of the Cloud services might effect, according to P3, the public figure of a company for example,

"They don't want to get their newspaper because something goes wrong they want to see other people do things fail and then things be fixed before they use them."

Other participants identified risks that are associated with loss of control over critical services and the risk of adopting a service that might be immature enough even to disappear from the market. P2 for example, identified the specific matter as one of the major risks for adopting Cloud computing services,

"It's the loss of control in terms of what happens if that service disappeared and it's loss of control in terms of the data."

Additionally, some of our participants identified technical risks in adopting Cloud solutions. Problems like customization of Cloud services, testing in the Cloud, data lock-in issues and others, all of which add to the previous risks for considering such a service.

The risks associated with the adoption of Cloud computing, we can say that they cover a wide spectrum. They have to do with the general understanding of people towards the service, they are associated with technical issues, location issues and even social issues.

Lastly, some of the potential disadvantages that we mentioned in the previously were also identified as show-stoppers for the potential adoption of the services. P2 for example mentions legislation risks as a drawback for the adoption of Cloud computing by his organisation,

"[...] the side that let us down if you like was legal staff [...]"

6.2.2 Trust

In the previous section we focused on the issues that made people hesitant towards adopting a Cloud service. This indecisiveness from professionals on choosing such solutions, is closely related with the sense of trust that they might have for the specific service.

From our interviews trust emerged as one of the major categories of our research. For example P2 tries to draw the different trust levels that exist for well established IT systems against immature Cloud systems,

"We understand mainly what we are doing [...]. So if you have that trust in your own processes then why hand that over to a Cloud service [...]"

As a result from the previous quote, we understand that the process for someone to move to a Cloud model is closely related with the established trust towards his in-house systems. The adoption of the Cloud computing model can be successful if it offers greater benefits than the traditional IT model and if it is applied to the appropriate workload. So choosing the appropriate model for your services and most of all trusting it, is very crucial for any company or organisation.

Another theme that emerged in this category, was the assumed difference between Cloud computing models and traditional IT outsourcing models. Nearly all of our participants agreed that the traditional IT outsource models have been at the market long enough to be considered trustworthy. In our question of how Cloud computing is different from these models, P5 mentions,

"They are complementary, I don't think they are different."

As a result, talking with one of our participants that provides Cloud services, we asked how they are proposing Cloud services to their clients. We found out that in order for the providers to built trust for their Cloud offerings, they are not recognizing Cloud computing differently from traditional outsource models. P3 mentions for for example,

"I think it's an extension or change or an evolution of the outsourcing model in a way."

Unarguably, Cloud computing providers are in a tough position at the moment. On the one hand they have created novel or re-badged old ideas in effort to offer better services over established computer networks but on the other hand they are forced also to build creditability for that new service. P4 mentions for this need,

"IT suppliers, who have always been the classic ones from Microsoft to IBM are practically trying to say, yes we are in the cloud as well, and we can do cloud, and we understand cloud, having to build credibility in oppose to say, yes we can do it."

Moreover, in a similar question about the credibility of the Cloud providers, another participant mentions that people tend to trust the bigger suppliers mostly because of their brand name in the field and the perception that they never fail. P2 for example mentions

that IT industry people feel safer when they have to deal with giants like Amazon or Google for their services,

"If it's a big supplier like Amazon or Google or whatever they don't care because they trust them. They trust them more than they trust anyone, the brand that this guys have is just so huge, even so Microsoft has that image, they are just to big to fail. That's what people feel."

Furthermore, in order for companies to build credibility for their proposed services on the Cloud some of our participants talked about 'educating' people before they adopt Cloud services. P3 who works for a large Cloud provider argues, that due to the immaturity and the nature of the Cloud services his company provides workshops to its clients,

"We have a one-day workshop [...]. A lot of that workshop is an initial discussion about cloud, the different cloud delivery models and the different types of services."

As a conclusion for the trust issues regarding the adoption of Cloud computing, it is worth mentioning that other participants mentioned also issues like standardization of services and private clouds for specific workloads. This way they proposed their own opinion on how the Cloud services might gain wider trust in the future.

6.2.3 Theory: Trade-off of Risk Vs Trust

Cloud computing is in very crucial point at the moment. People are interested more and more in the upcoming technology but are sceptic on the risks they will have to take in order to successfully adopt Cloud models. Moreover, Cloud providers are trying to create a fancy selling image for Cloud computing, without having necessarily solved all of its issues. This way they are tying to built a much necessary trust in order to persuade their potential clients.

In the previous sections we acknowledged the risks and trust issues regarding the adoption of Cloud computing by companies or organisation. This section presents our theory which is closely related with the balance between those two core themes regarding the adoption of Cloud computing.

Trying to clarify the process needed for a company or an organization to start considering moving their services in the Cloud, we asked our participants to describe their attitude towards such a move. P3 for example, mentions for the importance to identify that balance as part of the decision process,

"I think you have to think very clearly as you articulate what are these constraints and challenges are for your organisation. "

Additionally, another participant acknowledged that most of the people who are considering moving to their services to the Cloud must think of this balance, between the risk for their services and the trust they have to Cloud providers. In a question about this inevitable procedure P2 mentions,

"So, I think that most people that come around Cloud computing have come to realize that's a trade-off you make."

Moreover, another issue that has to be taken into consideration when start thinking about adopting Cloud computing model has to do with the vision of each company. It is really important to understand that in order to start considering the risks that a company is willing to take and the trust issues that is willing to overcome, decision makers have to think of how Cloud computing fits to their company. This way they will have a clearer picture for selecting the appropriate Cloud model. For example P5 mentions for the important of vision in the adoption procedure,

"I think there is more than just trust and risk. It's about vision as well. If a client has a particular vision for his company picking out Cloud technology over something has to be because is the most appropriate for him. Then is a secondary question of trust and risk and how you resolve this."

As a last attribute of the relationship between risk and trust we find the users. Most of our participants agreed that the our society has been familiarized, over the last years, with the use of the Internet and all of its aspects. Additionally, some of them added that the transparency of Cloud services works in favor of the upcoming service. P2 for example mentions,

"I can see it if there is a whole bunch of issues and you can trade-off one to the other and then the end users don't have to question, they get the best functionality. They don't really care if there is a button over here instead of over there."

Form the previous quote, we understand that after the process of balancing your trade-offs against your benefits, users will eventually only care for the best functionality of the service. Because the changes happen in much lower level, people using Cloud services do not really see any difference against services they already use.

As a conclusion, we believe that the balance between risk and trust in Cloud services adoption is a core issue. Additionally, inside this relationship we find the properties of vision and users. Companies or organisation considering such a move have to take into consideration how Cloud computing fits their overall IT strategy. Luckily, conversance of users with web services and transparency of Cloud services, allows them to focus on more important aspects of the adoption procedure.

7 CONCLUSION

In this chapter we will present a brief summary of our project and an evaluation of our work.

7.1 SUMMARY

Linking back to the Introduction chapter, we set out to do a project that investigates the factors, both social and technical, that influence an organisation's decision making regarding the use of Cloud computing. We tried to achieve that by talking to decisions makers or opinion formers within a number of organisations. This way we wanted to understand the perceptions of benefits and issues surrounding the adoption Cloud computing.

Using interviews as our data collection method and GT as our qualitative research technique, we achieved to categorize our results and present the most important factors influencing the adoption of Cloud computing. Additionally, in our analysis we came up with a theory that describes the trade-off between risk and trust regarding the adoption of Cloud computing by an organisation.

7.2 EVALUATION

Conducting qualitative research and using GT as a technique for analyzing the collected data can be daunting experience. The nature of our research gave the opportunity to extensively learn about the technologies and services provided in Cloud computing. Moreover, the adoption of an interpretive research technique like GT improved our critical and analytical skills. Last but not least, the interactive nature of our project allowed us to take a creative journey that managed to develop us both personally and professionally.

Being newly introduced to GT research and analysis, we believe that the project successfully managed to expose cohesive results referenced to the opinions and perceptions of the participants within the predefined time restrictions. However, if we were given the chance to do the research again we would try to have more participants in order to have a wider variety of opinions. Additionally, with the knowledge collected from this project we would be able to analyze the results even more meticulously.

Overall, it was a challenging but worthwhile learning experience.

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APPENDIXES

APPENDIX A

PARTICIPANT CONSENT FORM

The purpose of this form is to tell you about the study and highlight issues concerning your participation.

My name is Athanasios Matzanas. I am a Masters student in the department of Computer Science, University of York and I am conducting a research project about the use of Cloud Computing.

I. The nature of the investigation

This study aims to investigate the factors that affect the decision to use, or not to use, cloud-based services, platforms, and infrastructure by organisations when they create and deploy information systems.

II. Confidentiality

All information provided will be treated confidentially, as specified by the Data Protection Act, 1998. All of your data will be anonymised before being analysed and in particular, if published, your name will not be associated with any of the data. We may use quotes from your interview but will make every effort to ensure you cannot be identified from what you said. Also, any demographic details will on be presented in aggregate with all other participants.

III. Voluntary Participation

Your participation is completely voluntary. You therefore have the right to withdraw from the investigation at any time, and, if requested, your data can be destroyed.

IV. Questions

Please feel free to ask me any questions you might have regarding the procedure. After this study has been completed I will be happy to answer any questions you might have about the project itself.

If you have any questions in the duration of the study, feel free to contact me, or my supervisor, Simon Poulding, at any time via email at:

Athanasios Matzanas am659@cs.york.ac.uk
Simon Poulding smp@cs.york.ac.uk

V. Consent

Please sign below if you agree to take part in this investigation. This will indicate you have read the above information and understand your rights as a participant, as well as understanding my obligation to keep your data confidential.

Participant's Name: _____

Signature: _____

Date: _____

APPENDIX B

Interviews Questions

What do you understand by the term Cloud Computing?

Do the companies understand this difference between the private and the global cloud?

What changes have you seen in their business, their everyday to how it was before their IT service and how is it now using the cloud?

So do you feel there is a difference between the Cloud Computing outsource and the previous outsource that there was in the IT organizations?

Do you think that cloud computing is something new or is it an old thing in a new package?

Could you give one big advantage and one big disadvantage of Cloud computing?

Do people really trust those big companies that easily? I mean going to Amazon, going to the big players. People trust them so easily?

How do you think the Cloud Computing might change things in the future both technically and socially?

What your do clients understand of Cloud Computing? How come they ask for it?

Why may a client choose Cloud Computing over a classic outsourcing model?

So do you think your clients are skeptic about it or they just following the hype?

So what is the economic value for those enterprises for Cloud Computing?

Why do they not implement critical data to the Cloud?

What are the type of business models coming out of the specific delivery model?

What will drive people to accept more and more those type of models?

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