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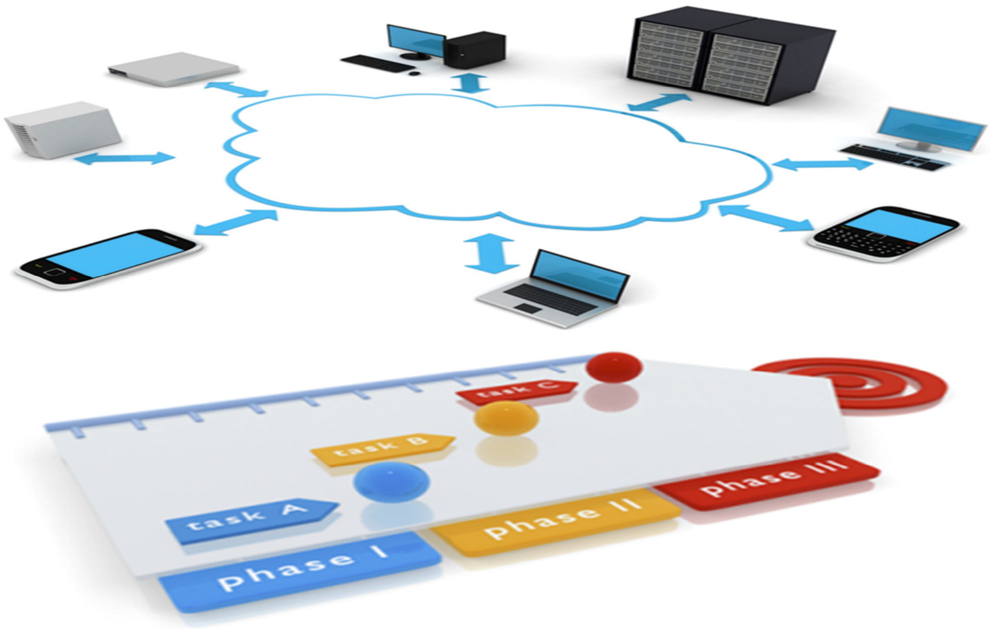

Exploring the Cloud

Evaluating the Possibilities and Limitations of Cloud Computing for a Project Based Organization

Master of Science Thesis in the Master's Programme

International Project Management

MAZHAR ALI

Department of Civil and Environmental Engineering

Division of Construction Management

CHALMERS UNIVERSITY OF TECHNOLOGY

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Cover:
Figure – Cloud computing and project management. Source: The author.

Reposervice / Department of Civil and Environmental Engineering Göteborg, Sweden 2014

ACKNOWLEDGEMENTS

A substantial amount of time and determination has been required by all parties involved to make this dissertation possible. The author would like to express his sincere appreciation to all those took their time to support throughout the thesis writing process. The research was made possible by company contact and staff who provided an opportunity to explore the existing business environment and required information about the case study organization.

A special gratitude is devoted to the two academic supervisors Mattias Roupé at Chalmers Technical University, Sweden, who supported throughout the thesis process.

In the end, the author would like to pay a big thank you to the friends and family, specially my mother, big brother Muhammad Nawaz and wife Humera Makhdoom, for their unconditional support, understanding and blessings.

The thesis work would not have been possible without you all.

Mazhar Ali

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ABSTRACT

Project based organizations (PBOs) conduct their business in ever changing environment. Different projects require different set of resources, including IT infrastructure to support their work process. Cloud computing offers various alternatives to choose from and remain competitive in the industry without any huge investments and arrangements. Therefore, the aim of this thesis, through a case study, was to explore the possibilities and limitations of cloud computing for a project based organization. Furthermore, to understand the need and potential of cloud computing for a project based organization, the current IT infrastructure utilization as well as how other industries use cloud computing, is reviewed in this thesis.

The research has found that cloud computing offers various possibilities both for project based organization (PBO) and conventional business. Although cloud computing may cause reduction in cost, less upfront investment, reduced IT equipment maintenance and increased information, document sharing and collaboration, it does not explicitly mean that cloud computing may be the ultimate choice of a company. There are various other aspects to be considered, for instance, the technical, company culture, management style and potential change it may bring into an organization.

Key words: Project based organization (PBO); cloud computing; collaboration; information sharing

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GLOSSARY

Project based organization	Organization of departments and personnel around a project
Cloud Computing	Scalable IT resources available through internet
Software as a Service	Software applications running through internet connection
Platform as a Service	Computing platform over cloud/internet
Infrastructure as a Service	IT equipment over cloud
Project	A distinctive and time restricted effort to create change
Project management	A field of study to manage projects and achieve its deliverables

Preface

In this thesis, possibilities and limitations of cloud computing for a project based organization (PBO) have been evaluated. The thesis has been carried out from January 2014 to June 2014. The work is a part of a M.Sc. International Project Management. The thesis is carried out at the Department of Civil and Engineering Environment – Division of Construction Engineering at Chalmers University of Technology, Sweden.

The purpose of this thesis to contribute to the understanding of possibilities and limitation of cloud computing concerning project based organization (PBO). A qualitative research study has been performed in a Swedish construction company. The research targets to answer the primary research question modelled at the beginning of the introduction, is:

What are the possibilities and limitations of cloud computing for a project based organization (PBO)?

The thesis has included following objectives: evaluating the possibilities of cloud computing, investigating the limitation of cloud computing, use of cloud computing in other industries.

In addition, the research aims to produce a direction for future research of evaluating integration and user management issues associated with cloud computing.

1. Introduction

This chapter assists as an introduction of the thesis/dissertation. It starts by presenting the foundation for commencing the study. The purpose is to elaborate on the basic research question as well as aims and objectives of the proposed study. It presents the description of the participating company. Furthermore, the scope, method and limitations of the study are discussed. Finally, the dissertation structure is elaborated.

1.1 Rationale for the Study

The constantly changing worldwide business environment has become more demanding; in terms of rivalry among the competitors, efficient use of resources, more robust solutions and greener environments are some of the challenges. This changing environment exposes possibilities as well as threats to the business/industrial world. A company may leverage from new technologies by timely adaptation, up gradation, managing existing infrastructure and efficient utilization of resources. On the other hand, it is expensive to have in house infrastructure and keep the system up dated with new fascinating technologies all the time, because it involves heavy costs and other resources, especially in project based organizations. It is due to the fact that every project is unique and different in scope, time duration and costs involved.

In recent years, cloud computing has emerged as a prevailing paradigm, broadly embraced by companies (Thiruvathukal & Parashar, 2013). Cloud Computing is of an important attention among IT, academics and network technologists as well as business leaders and CIOs, because of its established potential to decrease costs, grow income, and improve overall client experience (Weinman, 2011).

There are number of broadly used cloud services by individuals and since quite a time. These services include Flicker, YouTube, LinkedIn, Facebook and so forth. On the other hand organizations had not begun to leverage cloud technology until recent past to meet their growing needs and competition (Lin & Chen, 2012). However, the knowledge of using cloud-based services in the automobile industry is exciting improvements in automobile design, production, sales, and marketing (IBM, n.d.)

Cloud computing has got tremendous popularity in the industry and extensive research is being carried out in this domain. However, the use of cloud computing from simulation to collaboration, in the project based organization, especially in construction, is not so popular

(Marston et al., 2011). To investigate this further a review of how other industries have leveraged the cloud technology, what possibilities and limitations are prevalent in near future concerning the cloud technology, future may lead towards a potential benefit or support with the adaption of cloud services and its impact on the project based organization/construction industry.

Projects based organizations are continually breaking obstacles of complexity and scale and constantly pursuing enhanced competence, sustainability, energy performance, and cost-value. Large scale data processing and simulation are important features of this process. Computational influence proposes the means to deal with the multifaceted dynamics of a cohesive entire construction/building projects (Iorio & Snowdon, 2011).

Critically examining diverse industries and their corresponding use of cloud may contribute to adoption of cloud computing and assist in benefiting from cloud technology. Furthermore, it may contribute to academia to attain a more comprehensive understanding of impact and importance of cloud technology on management of projects and organization.

1.2 Research Aim and Research Question

The aim of this master thesis is to study how the cloud computing is used within a project based organization in the construction sector. Furthermore, to investigate how project organization may benefit from potential of cloud computing technology (such as improved documents sharing, collaborations and simulations for better design) in order to achieve enhanced project objectives, improved project delivery and to predict that what possibilities and limitations are there in the near future to benefit from cloud technology. In order to lessen uncertainty and gain validity the research limits the case study to one project based organization in the construction sector. The core focus of the research is to explore the possibilities and limitation of use of cloud computing in the company in question.

In order to address the research aim, the motivation is to answer the following question:

What are the possibilities and limitations of cloud computing for a project based organization?

1.3 Research Aim Breakdown

The primary research question may be broken down into areas of interest. These areas can then be treated as subdivisions of primary research question. Some of the subdivided research questions are listed below.

How the current status of cloud computing does look like at the organization (if any)?

How do other industries use cloud computing and its services?

How cloud computing facilitate to deliver better projects?

The primary research question is divided as the research requires investigating the current state of affairs at the company and reviewing it in the light of academia. This is attained through examining the current project work process, IT infrastructure and use of technology in the organization.

Within the current business and IT environment 'cloud' is wide and ambiguous term, which refers to application provided as service through internet and systems software and hardware in the data centres which enable to deliver those services (Armbrust et al., 2010). The term 'cloud' or 'cloud computing' are inter-changeable and limited to the core applications used through internet within the case study organization. The restriction is required and applied due to the variety of IT tools and services are being used in the project life-cycle.

1.4 Research Objectives

Once the primary research question is dismantled and subdivided into the questions, the core features can be associated, and recommendations can be suggested for application. However, it is worth mentioning that due to the difference within field of expertise, one solution or recommendation may not equally be implementable as the requirements might be diverse. Therefore, the purpose of the main objective is not only to propose the recommendation, but to attain a comprehensive insight of cloud computing and its service on the project work process.

Currently, the term cloud is ambiguous and remains unclear concept to many. This term is used in variety of context and perceived differently among individuals and organization. As Lin & Chen (2012) mentioned, the usage of term 'cloud' is abstract and usually refers to a huge number of practical resources, e.g. software and hardware that are easily accessible and provided over the internet. Cloud computation brings possibility to transform a huge portion of IT industry, by providing software as more efficient service and shaping the trends of hardware acquisition and design (Armbrust et al., 2010). The cloud computing has a huge potential to influence the businesses. While there is a potential to benefit from this technology, a study by Lin & Chen (2012) conducted in Taiwan suggests that most of the IT companies are reluctant to adopt cloud solutions, due to the ambiguity and uncertainties related with cloud. Those ambiguities include lack of standardization and security, and non-existing of successful cloud computating business models. The situation is similar in other industries such as construction.

1.5 Research Scope and Method

Project organizations are enforced to produce more efficient and cost saving projects. This is due to the competition among the rivals, the environmental requirements; stakeholder expectations and sustainability, among others are the major reasons. Technology plays a vital role in managing the projects, as we can clearly observe the use of technology. For corporate information technology, cloud computing has become core to the present-day discussion. In order to evaluate the impact that cloud may assert on companies, it is crucial to assess the contentions made in present literature and analytically review against the pragmatic evidence from the industry (Venters & Whitley, 2012).

The motivation for using the case study company was initiated as it allows using various approaches depending on the circumstances. The research reviews are based on interviews and observation as well as informal meetings with the concerned persons at the company. During the interviews or meetings questions arose were noted down and investigated afterwards to increase the understanding of the subject. This was particularly done to reduce the uncertainty, as researcher or participants may harm the validity of data (Biggam, 2008). If only one researcher carrying the observation, it decreases the risk of difference of interpretation (Bell, 2005)

Another approach is unstructured interviews, nevertheless which also expose weaknesses, for example, the interviewee idealizing their experience and substituting authenticity, also the interviewee may not possess the adequate knowledge or role to analyse the subject, which may severely tilt the results (Biggam, 2008).

1.6 Thesis Structure

The arrangement of the research structure is as follows. Chapter one outlines the introduction, which provides the foundation of the research. Chapter two presents the literature review, which will cover following areas.

- Overview of cloud computing

- Possibilities and limitations of the cloud computing
- Use and applications of cloud computing in different industries

All the areas included this thesis are supported with recent concept and developments within the academia and industry, in order to stretch comprehensive sketch of the current situation. This is followed by the brief literature conclusion, summarizing the present situation and relates to the following chapter methodology. Chapter three outlines the methodology adapted to study the research question raised. Chapter four describes the data analysis/findings and associates result to the research aim. Chapter five is discussion following analysis and data collection. Chapter six summarizes the conclusion of research, it comprises the recommendations and outlines suggested further research within the subject.

2. LITERATURE REVIEW

This chapter, by exploring the existing literature, will present the modern and historic academic view concerning the cloud computing. The literature review seeks to gain the insights of the research domain. The first subsection will elaborate what cloud computation is and its historical background. Afterwards the possibilities and limitations are discussed, which are perceived by the academia, professionals and the industry. Later on, the use of cloud computation is investigated. Since the topics are correlated with each other the review will emphasis on the main features of the mentioned subject areas, in order to provide an inclusive analysis of the literature.

2.1 OVERVIEW OF CLOUD COMPUTING

Cloud computation has been one of the most popular research topics in recent past. The advancement in technologies and specially cloud computing is of significant important for assisting in effective collaboration among project members, since numerous resources for a project may be varied and scattered geographically (Chang et al., 2012). The users may access services and resources patently without thinking about how many and where the services are located geographically. Basically, all organizations desire to improve the resource utilization, this can be achieved by cloud computing, as it allows available resource sharing with multiple users on-demand requirements and anytime, anywhere (Chang et al., 2010).

Cloud computing facilitates resource-reserved consumers to economically subcontract their gigantic computation assignments to a cloud server with enormous computational strength (Lei et al., 2013). Virtualization is considered to be the primary notion of cloud computing. This notion of virtual machines, was originated by (Popek & Goldberg, 1974) in their white paper virtualization requirements. Virtualization is a means to provide a computing environment that physically does not exist, but is generated in another hosting environment. However, big companies such as Yahoo, Google and IBM started to heavily invest in cloud computing and it became popular term at the end of year 2007 (Chang, Abu-Amara, & Sanford, 2010; Sadashiv & Kumar, 2011). It is a computing model which provides the pool of various resources a user can access via internet (Sadashiv & Kumar, 2011). The basic principle of computing in this model is done over the network. This means, enterprises use the various resources such as network, storage, applications, servers, services and so forth via internet. All these resources can be acquired without any heavy investment, easily implemented and maintained. Resources are available on-demand and can be requested as per need without any previous arrangement and therefore eradicate overprovisioning and enhance the resource utilization. Furthermore, cloud computing allows different cost packages for the use of resources, such as pay-per-user or pay-as-you-go access to software as service, applications and computing infrastructure (Voas, Zhang, & Bojanova, 2013). It provides improved and efficient computing through better agility, availability, scalability and collaboration. As the technology is changing at rapid pace, many people do not understand the concept of cloud computing, even they are using it. Therefore, it is important for the organizations and individuals to have an understanding of the cloud computing concept. This may help them to leverage from this expanding technology, and use several cloud services to improve their work and project process. Also, this may help balancing the work and personal lives and create a work friendly environment in the organization.

Cloud computing is defined in several ways. Some of the widespread definitions are presented here. Educause (2009) defines cloud computing as provision of scalable IT resources over the internet, on the contrary to operating and hosting the those resources locally on the machines or sites, for instance, company premises or university network. The resources may comprise services, applications and infrastructure on which they function.

Cloud computing is the next phase in development of the internet. It provides the means through which everything, from computing infrastructure to computing power, business processes, applications and personal co-operation can be provided as a service on need basis anywhere required (Hurwitz, et al., 2009). The cloud denotes set of hardware, storage, services, network and infrastructure that empowers the provision of computing as a service over internet. While there are several technical considerations, one important factor about cloud computing is that, it is a business and economic model. Cloud services may include, either as complete or separate platform, storage, software and infrastructure, based on customer demand. Another concise definition is that cloud refers to a pool of distributed computing resource, in which the applications may exist anywhere on the network (Chang, Abu-Amara, & Sanford, 2010).

Finally, National Institute of Standards and Technology (NIST) defines cloud computing as "*a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or* *service provider interaction*" (Mell & Grance, 2011). The cloud model consist five basic characteristics, three models of service, and four deployment models, which are as follows.

2.1.1 Essential Characteristics of Cloud Computing

On-demand self-service: a customer can easily access the required/necessary computing services, such as server time or storage over network, without requiring human collaboration with the service providers (Mell & Grance, 2011).

Broad network access: broad network access provides ability to access various cloud services from different devices, such as smart phones, desktops and other handheld internet capable devices.

Resource pooling: resource pooling refers to the shared or pooled computing services are provided to the users by using multi-tenant model. This model provisions various physical and virtual resources vigorously allocated and reallocated according to the consumer demands. Consumer may be using resources from across the world without knowing the exact location, but with the exception of highly abstract information such as country, state or datacentre. Resources may include network bandwidth, storage, processing and memory.

Rapid elasticity: rapid elasticity enables consumers to purchase capabilities that can rapidly be scaled up or down, depending on the requirement. Often, services available to the consumer appear to be unlimited and therefore, can be adopted in any number at any given time.

Measure service: this service is a metering capability, used by the cloud system in order to automatically optimize and control resource usage. Cloud services normally function allowing to pay-per-use business model, this lets the system to take advantage of the resource used.

2.1.2 Service Models of Cloud Computing

Software as a Service (SaaS): service provider's applications running on a cloud infrastructure are provisioned to the consumer on a cloud infrastructure. Consumers can access those applications through various client devices and interfaces, such as a web browser, mobile devices and desktops/laptops (Mell & Grance, 2011). The consumer does not have control, maintain or manage any of the cloud infrastructure including, operating system, servers, network or storage. However, there is a possibility to configure user-specific settings for the application in use.

Platform as a Service (PaaS): this service provides opportunity to the consumer to deploy their own created or acquired applications onto the cloud infrastructure supported by the provider. The consumers do not possess the control or manage cloud infrastructure, except configuration settings for a deployed application hosting environment on a cloud.

Infrastructure as a Service (IaaS): this service provides basic computing services to a consumer, such as storage, networks and processing, where a consumer can install and execute random software, it may include applications and operating system. As in all other characteristics or service models, similarly the consumer does not control the cloud infrastructure. However, a consumer controls the deployed applications, storage and operating system.

2.1.3 DEPLOYMENT MODELS OF CLOUD COMPUTING

Public cloud: the cloud infrastructure is made available to the general public for open use. In this deployment model, the cloud infrastructure exists on the supplier's sites. The cloud may be operated, managed and owned by an academic institution, government, business or a combination (Mell & Grance, 2011).

Private cloud: the cloud infrastructure is provided solely for a single organization's use, it may consist of various consumers in the organization. It may be operated, managed and owned by the organization, a third party or combination. The infrastructure may or may not exist on the organization site.

Hybrid cloud: this cloud infrastructure is combination of two or more discrete cloud infrastructures, such as community, public or private, that remain exclusive units. However, those units are bound together by the proprietary technology or the standardization that facilitates application and data transportability.

Community cloud: the cloud infrastructure is provided for restrictive use by a particular group of users from organization that have common concern (e.g., policy or mission). It may be located on or off the organization site and operated, managed and owned by one or more organizations in the society or a third party. The following figure 2.1 depicts the NIST's model of cloud computing, which is described above.

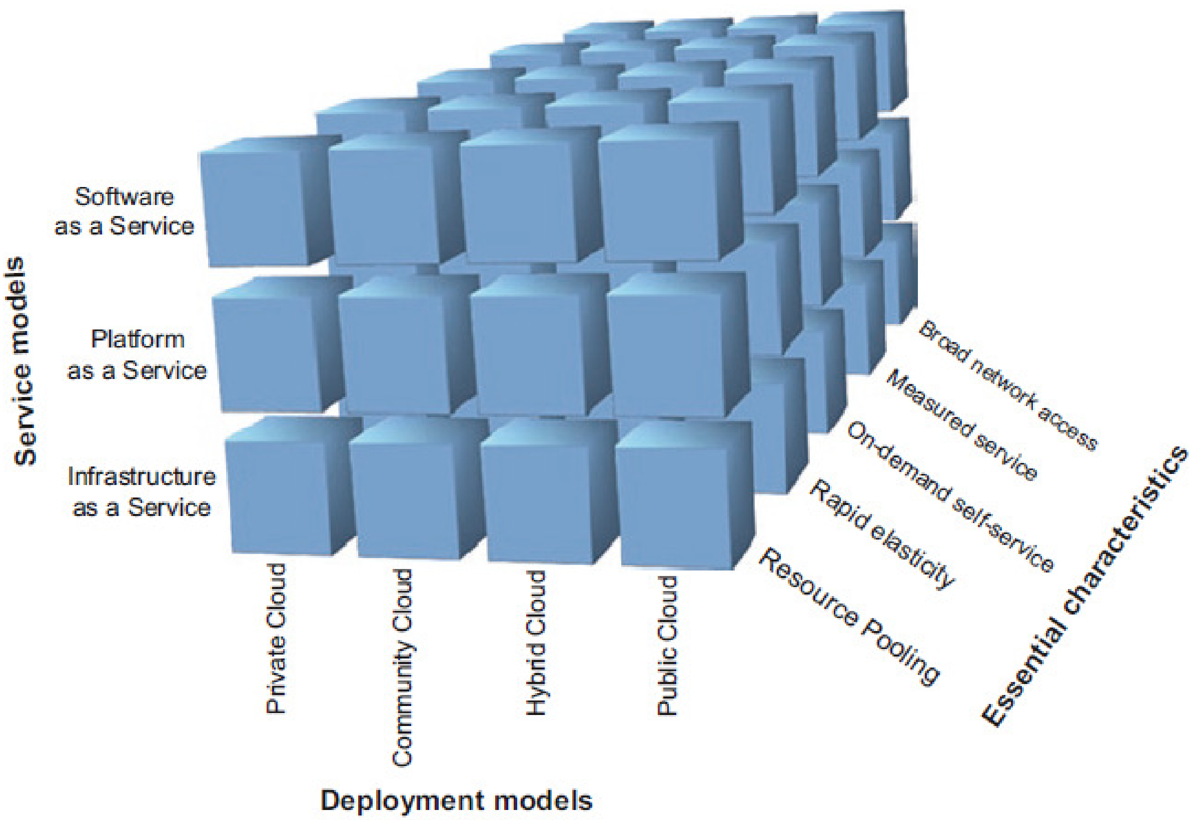

Figure 2.1: The NIST model of cloud computing according to (Chang et al., 2010, p. 8)

There are different actors involved in providing and using the cloud resources and services. Those actors such as providers and cloud consumers have different scope and control over the models discussed above. The following figure 2.2 shows differences in control and scope between cloud service providers and consumers. Five abstract layers of general cloud environment are presented in the diagram which applies to all deployment models including public and private (Jansen & Grance, 2011). The arrows show the estimated range of the cloud consumer's and provider's control and scope over the cloud setting. The higher level of support provided by the provider denotes the less control of consumer over the cloud environment. The lowest two layers are fully controlled and administered by the cloud service provider, regardless of the model. The facility layer represents the physical components of the cloud environment, such as air conditioning, ventilation, heating and power. While, hardware layer denotes to the storage, network, computer and other necessary physical elements for the cloud environment.

Rest of the layers refer to the logical components of the cloud setting. The virtualized infrastructure layer involves virtual machines, storage, data and virtual network elements used to develop the structure upon which computing platform can be established. Likewise, the platform architecture layer includes, middleware, utilities, libraries and similar kind of tools, software and development elements required to deploy and implement applications. Software applications are installed and deployed at the application layer, which are targeted towards consumers and provided over the cloud.

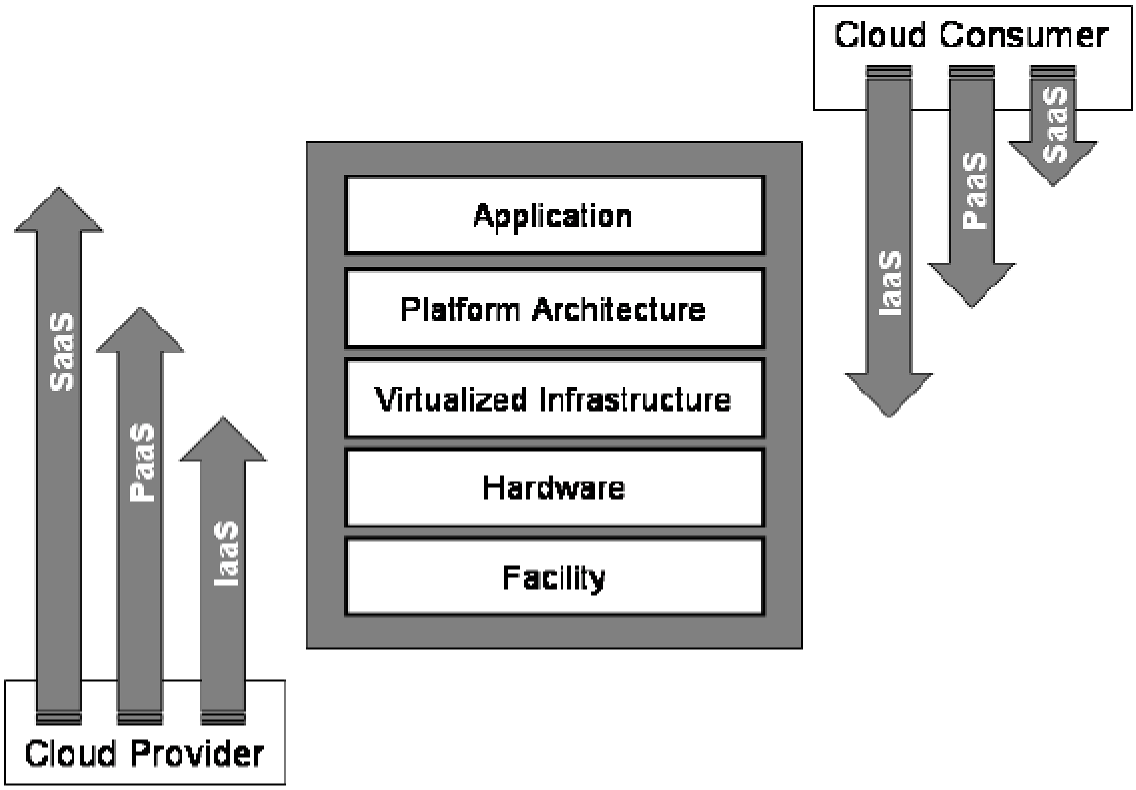

Figure 2.2: Differences in Scope & Control among cloud service models according to (Jansen & Grance, 2011, p. 5)

The above mentioned actors in the cloud infrastructure are on very high level. There are several other actors associated to cloud infrastructure. Some of the important actors are listed below with brief description.

Software Developers: The distributed scalable applications are designed and implemented by the software developers through cloud development tools or cloud platforms (Chang et al., 2010).

Datacenter Managers: Usually, large scale systems are managed by the data center managers by using the optimized elements. Role of the data center managers, typically involves the maintenance of the premises, power, air-conditioning, handling real estate and installation of new devices, applications, as well as support the users.

Service Provider: Service providers provision the services by operating and possessing the cloud in a private fashion. The providers develop services, for example, platform, software, and infrastructure resources available to the consumers via internet.

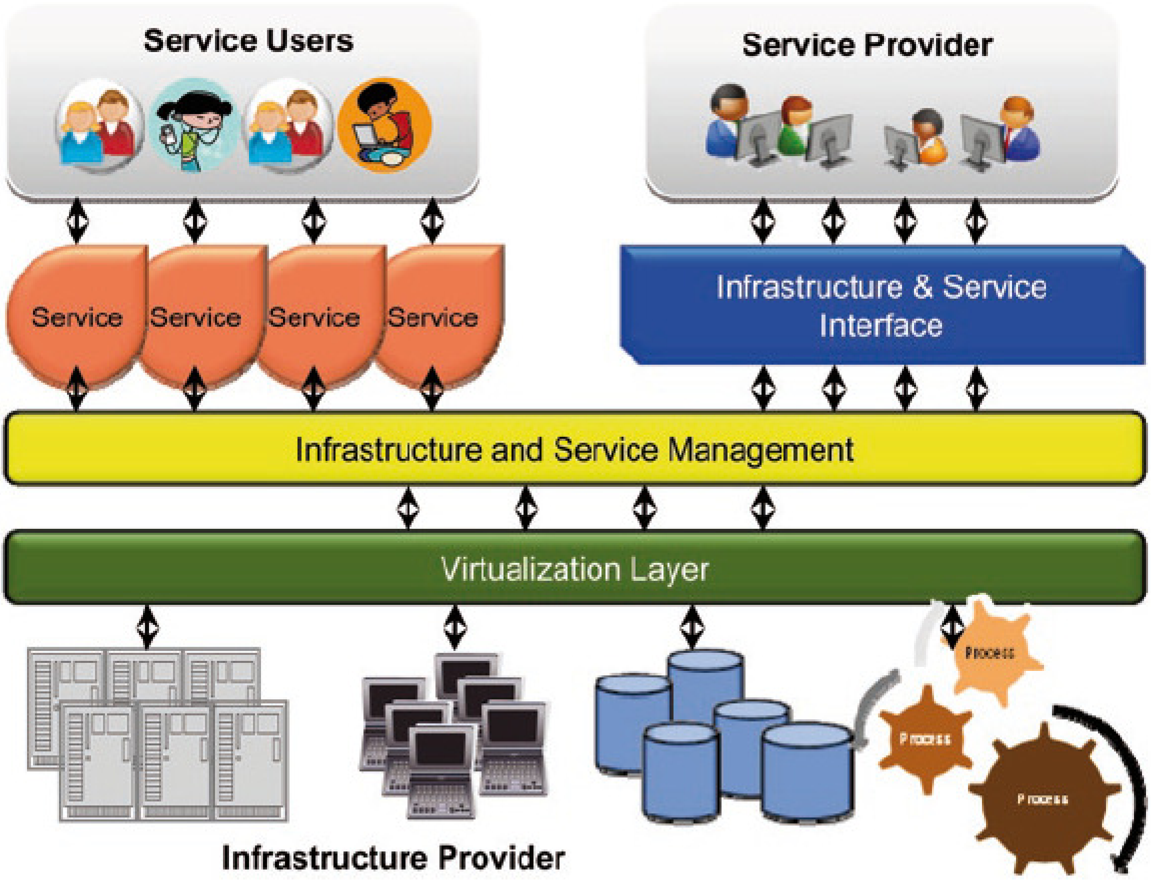

Figure 2.3: The relationship between service users and provider through the Cloud actors according to (Chang et al., 2010, p. 13)

Cloud Integrators: Cloud integrators are considered as bridge between the service users and providers (Chang et al., 2010). The integrators help their service users in managing, incorporating, improving and organizing their heterogenous IT environment.

Cloud Infrastructure Vendors: Cloud infrastructure comprises software and hardware. Software vendors provide solutions to meet the market requirements. The hardware dealers build particular servers, gateways, routers, storage, grids, clusters, and other components for datacenters. The suppliers build and install enhanced hardware and software to run the scalable and gigantic application through the cloud.

Among these, other actors include service designers, third party value added providers, and continent providers. These providers are not discussed here, as they are far more technical and therefore, may not fit into the scope of this sections and the research.

2.2 Possibilities and Limitations of Cloud computing

Developments in service oriented architecture (SOA) have taken us near to the once fictional visualization of creating and running a cybernetic business, a business in which majority or all of its business utilities are subcontracted to online services (Motahari-nezhad, Stephenson & Singhal, 2009) Cloud computing proposes a recognition of SOA in which IT resources are presented as services that are more elastic, salient and inexpensive to businesses. As cloud is fast developing technology, that has removed the burden of purchasing licensed software and applications (Brohi & Bamiah, 2011). In an internet based survey, regarding the future of internet conducted by Andersson & Rainie (2010), reveals that a majority of the partaking specialists and other stakeholders expect that by the year 2020, vast number of people will use software applications over internet and will share information via distant server networks, rather than largely depending on information and tools installed on their personal computers. Furthermore, the participating experts assert that cloud computing will be prevailing than the desktop in the coming decade. This will definitely affect the way organizations work in future, especially project based-organization.

Cloud consumers or customers do not need to maintain software applications or hardware devices, so it avoids management cost and time for company (Brohi & Bamiah, 2011). Cloud technologies bring various possibilities, which encourage organizations to adapt this rapidly growing technology and meet the organizational needs. Industry sectors, such as finance, education and healthcare, are furthering towards the cloud solutions due to the increased efficiency, scalability, on-demand, security, cost reduction, increased productivity and location and device independence. The main advantages of the cloud computing are discussed in the following section.

2.2.1 Possibilities of Cloud Computing

The cloud computing technology has been part of the computing setting for years. With the growing use of internet and the extensive disposition of broadband communications services, more and more companies and individuals are embracing this technology (SIIA, 2011). Cloud computing has potential to offer various benefits, among others, on-demand, automation, elasticity with the awareness of indefinite resources, pay-per-use, enhanced computational power and freedom from buying licensed software, no advance investment expenses and so forth (Cook, Milojicic, & Talwar, 2011). In this section, some of significant advantages associated with cloud computing and its adaption are explored.

2.2.1.1 Lower IT Infrastructure and Computer User Cost

One of the foremost difficulties to entrance in fresh markets for organizations, is embodied by the great up-front expenditures of entry, frequently linked with physical and ICT investment expenditures (Etro, 2009). Cloud computing permits prospective organizations to save in the fixed expenses linked with hardware/software acquisition and with common ICT investment, and makes part of these expenses into flexible costs. This in turn, decreases the restrictions on entry and supports business creation. Cloud computing proposes calculated services, considerably like utility (Turner, 2013). Cloud is economical as demand levels in the organization change with time. Some companies may only require infrastructure as a service on cloud, while some of the departments may still need platform and software to address requirements at particular time. This business model provides freedom and does not bound customers into a long-term obligation and permanent charges. This may be of especial interest and suitable for the project based organizations, where each project is unique and may require different set of technological infrastructure at different geographical locations. Cloud-based business model provides flexibility to enterprise and its consumers pay for services only in usage and therefore, decreases the general maintenance work and user expenditures (Chang et al., 2010). Cloud computing provides the flexibility to pay for the resources only consumed. This means there is no expenditure if the resources are not in utilization (Brohi & Bamiah, 2011). Furthermore, there is no maintenance expenses involved for the management of various resources, such as storage, software applications, infrastructure, depending on the subscription of cloud model in use. Cloud computing models provide nimbleness to the business as well. There could be various payment methods available to the businesses, which could cause cost reduction, such as pay-per-use, time based, usage of application and so forth.

Companies have flexibility to adapt the cloud services on demand, which in turn, will save the heavy up-front investments, and may enable to spend in accordance with their requirements and production needs (Etro, 2009). An example of hourly cost, is that to finish the computation faster, organizations may use cloud computing: using 1,000 Amazon's Elastic Compute (EC2) machines for an hour, which costs equal to running a machines for 1,000 hours. But this gives far more computing power of 1,000 machines and thus, saves the times (Armbrust et al., 2010).

Cloud computing provides an opportunity to enterprises and individual customers to reduce expenses linked with 'in-house' IT infrastructure, maintenance and management of computing services (Buyya et al., 2009). However, customers require assurances for service delivery, as some of the application may be critical to the fundamental business functions. Usually, the assurances are provided through Service Level Agreements (SLAs), negotiated between customer and the service provider. The simple scheme of pricing for the cloud service, such as Software as a Service (SaaS), is time-based or pay-per-use, exploiting the episodic fees arrangement (Lyons et al., 2009). Another typical model uses on-demand pricing built on per-transaction, feature or per-use. This is typically suitable for small, medium size and project based organizations as well. This model gives the flexibility to switch, scale up or scale down as per need basis. Therefore, the strategic decision makers may benefit from these cost/pricing models by wisely exploiting the technology. Another important factor, which encourages the companies to shift towards cloud computing, is the contninous decline in bandwidth costs (Dubey & Wagle, 2007). This makes reasonable for companies to buy the level of connectivity that lets online applications to run and perform efficiently. Furthermore, cloud computing lowers the cost of ownership as well. Th following figure 2.4 shows the differences in total cost of ownership (TCO), by adaption of cloud computing, such as in form of Software as a Service (SaaS), compared to traditional licensed software installed on the local machines.Thus it saves the costs. The following figure 2.4 shows the sample placement of CRM software (200 licenses).

	Total cost of ownership, $ thousand		
	Software on premises	Software as a service	Sources of savings with software as a service
Implementation, deployment			
Customization, integration	108	72	• Reduced deployment time, limited customization, self-service through on-boarding scripts
Basic infrastructure testing, deployment	54	0	• Does not require infrastructure and application testing
Application infrastructure testing, deployment	30	0	
Ongoing operations			
Training	101	34	• Lowers training requirements through –Simpler user interfaces –Self-training, service capabilities
Management, customization of business process change	94	0	• Does not require ongoing business process change management – Vendors monitor customer usage to enhance offering – Customers provide feedback to influence feature functionality
Data center facilities rental, operations; security, compliance; monitoring of incident resolution	750	0	• Includes vendor's costs to serve in subscription price (ongoing operations, back-end hardware and software)
Software			
User licenses, subscriptions; maintenance	480	1,500	
Other			
Unscheduled downtime	308	0	• Provides 99.9% general-server availability vs 99%
Unused licenses	92	0	• Reduces unused licenses by 20%, users added as needed
Total costs (including those not shown here)	2,298	1,640	

Figure 2.4: Total cost of ownership differences according to (Dubey & Wagle, 2007, p. 5)

In a robust cloud computation context, organization would be capable to improve IT services and react to changes in the capacity on the run, thus saving investment cost that could be re-allocated to programs, which add strategic value to the organization (Educause, 2009). It is worth mentioning that cloud computing also reduces the cost of purchasing costly computers for users (Aljabre, 2012; Miller, 2008).

2.2.1.2 Fewer Maintenance Issues

As mentioned above the cloud computing, significantly lessens both, hardware and software maintenance for enterprises of all sizes (Miller, 2008). With less hardware, such as server and other IT equipment installed on an organization's premises, maintenance and associated cost is instantly reduced. Same applies for software packages; the cost is reduced as all cloud apps are deployed elsewhere. There is limited or no software maintenance on an organization's computers or premises, for IT staff.

2.2.1.3 Improved Performance and Scalability

As applications are hosted and installed on a cloud, users are not required to have powerful computers to run those applications, thus it can improve the performance of desktop pc or laptop (Aljabre, 2012). Users can get better performance from their pc's by simply connecting to cloud computing. Computers will run and boot faster, because of the lesser programs and processes load into memory (Miller, 2008). Furthermore, cloud computing can provide opportunity to perform supercomputing, by utilizing the power of thousands of servers and computers availabe via cloud. In simple words, companies can perform greater jobs in the cloud than on desktop. It is possible for cloud customers to scale up or ramp down capacity through high-level management tools (Chang et al., 2010). This will assist them to perform quicker and permit for easier procurement to produce new offerings for their marketplaces. As capabilities can be added at any time and anywhere, cloud customers and organizations can add resources to meet their market demands easily and quickly. This particularly, could be of interest for project-based or small and medium sized organizations. For example, if there is a project of different and unique nature, which requires special IT resources, the cloud provides opportunity to get those services immediately, cost-effectively and with reduced maintenance and management time.

2.2.1.4 Reliability and Availability

Cloud computing offers organizations with a diverse model of operation, one that gains benefit of the development of networks, web applications and the growing interoperability of systems to offer IT services (Educause, 2009). Cloud suppliers have expertise in certain services and applications, and this capability lets them to competently manage maintenance and upgrades, disaster recovery, backups, and failure function. Therefore, this becomes source of increase reliability, although costs decrease because of economies of scale and other elements involved. Now a day, enterprises need reliable and 24/7 available software applications. Reliability of core IT applications is crucial for enterprises (Waters, 2005). Software as a service vendor, for example, can provide the reliability features, which otherwise could be difficult for a company to achieve, such as multiple backup, power and internet connection with primary-source and round the clock monitoring service. In addition to this, most of the SaaS providers make reliability assurance as an important part of the contracts, with a guarantee of 99.5 per cent uptime to use. For very important applications that requires stability of processes and catastrophe recovery. Cloud vendors can provide improved reliability by proposing services from several redundant locations (Chang et al., 2010). Advocates of cloud computing argue that, a system operated by a large service vendor, having various resources and redundant equipment should propose certainty of availability, as compare to an in-house infrastructure (Leavitt, 2009).

2.2.1.5 Data Safety and Security

Cloud provides the functionality of storing data securely somewhere on the cloud. Unlike PC or desktop computing, where a hard drive crash can result in loss of valuable data (Miller, 2008). If any computer crashed in the cloud, it will not affect the storage of data. Cloud has a superior functionality of automatic back-up and storage. Therefore, nothing is ever lost in the cloud system; even your desktop computer is crashed. In usual desktop environment users need to back up their daily data. On the other hand, cloud does it regularly and automatically with no loss. Generally cloud services propose improved overall security, due to the reason of centralized data and increased security-intensive resources (Chang et al., 2010). Another positive side of cloud security is, third parties can leverage from economies of scale to provision increased level of security, which otherwise could be difficult and expensive for the companies (Grossman, 2009).

2.2.1.6 Portability and Improved Collaboration

Cloud computing provides increased portability of documents, files and other important data. All data and documents reside in cloud, which makes it accessible from anywhere and with any device (Miller, 2008). All required is, a computer with internet connection. Cloud computing enhances the portability of applications (Chang et al., 2010). It allows products from different suppliers to be executed on same device. Furthermore, cloud customer can access their procured services, such as platform, infrastructure or software from anywhere in the world. Due to the accessibility and availability of data and documents from anywhere, this leads to increased sharing and collaboration features (Miller, 2008). User can always access the latest version of modified documents. For vast number of cloud users, this is the most significant feature offered by cloud computing, the capability for several users to straightforwardly collaborate on projects and documents. Easier group collaboration and documents sharing leads to faster accomplishment of group projects. It enables full participation from all members involved in the project. Cloud also works as bridge among different project teams, located at different geographical locations. Thus, it is considered as enabling technology, for better group collaboration, sharing and exchange of information and for better project delivery.

Furthermore, cloud users are no longer required to use only one device. With the change of computer or device, currently purchased application/services and documents follow the user through cloud (Miller, 2008). Also, if users move to another portable device, documents, applications and services are still accessible via internet connection.

2.2.2 Limitations of Cloud Computing

Like every systems, cloud computing also have some limitations. There are number of reasons, why companies may not want to adopt the cloud computing (Miller, 2008). Companies with mission critical applications, which need utmost level of uptime, may be sceptical, as they evaluate cloud computing (Turner, 2013). Particularly if they already have a system in place, that may work more reliably than cloud service. However, those limitations depend on what type of cloud model is in use. For instance, private cloud infrastructure is implemented, managed and controlled by the enterprise itself (Jamil & Zaki, 2011). Usually, private cloud is managed internally and implemented in company's data centre. Thus, it reduces legal, regulatory and security risks associated with cloud, as all the data and resources are under legal and contractual control of the company.

2.2.2.1 Requires Constant and High Speed Internet Connection

Often cloud services are at a remote location, and are accessed via internet, thus this may represent a band-width related concern for the cloud users (Grossman, 2009). It requires an stable internet connection, without internet connection even own documents would not be accessible (Miller, 2008). In areas with limited or unreliable internet connection, it could be problematic to access the documents and applications. This may lead to no work. Without internet, cloud simply does not work. Sometimes, even with a reliable and high speed internet connection, cloud based application can be slower in response as compared to those of installed locally on the machine. However, exception is with an application which provides functionality of work offline, such as Google gears.

2.2.2.2 Security and Privacy

Security is considered one of the prime challenges to the cloud model (Hofmann & Woods, 2010). With cloud computing, all the data is saved on the cloud (Miller, 2008). On one hand that's all well and good, but on the other hand question arises, how secure is the cloud? Often cloud customers show reservations regarding the security provided by the cloud vendors.

Customers lack the confidence with the level of security provided, especially if the stored information is confidential and critical to the organization (Brohi & Bamiah, 2011). IT and other enterprise executives show reluctance to adopt the cloud, as their business information and other important IT assets being outside the company firewall, makes it vulnerable to attacks (Leavitt, 2009). Furthermore, customers desire to be assured that their cloud-computing supplier is practicing standard security regulations, which requires inspection and disclosure. For example, customers do not want to share the same resources with multiple customers. Another security and privacy concern from customer perspective is that data stored in the cloud could be used somewhere in the world and therefore, might be subject to federal or state laws concerning data protection and privacy.

2.2.2.3 Interoperability and Data Lock-in

As cloud technology is maturing, still there are challenges with portability, migration and interoperability (Hofmann & Woods, 2010). In cloud computing model, organizations do not control their data and have no longer control on their own IT infrastructure. Every cloud service provider has different setting and therefore, it may create a situation of data lock-in. Often main cloud providers offer exclusive and proprietary data storage such as Amazon's Dynamo and Google's BigTable. It is not easy for cloud customers to extract their programs and data from one platform to another (Armbrust et al., 2010). This is one of the reasons, preventing companies to adopt cloud services. Companies may think they are vulnerable to price hike or vendor going out of business. According to Jamil & Zaki (2011), there are very few tools and techniques or procedures, which allow an application, data and service portability. This can also hinder customer to switch cloud service provider or extracting data back in-house. This exposes the data lock-in and dependency on a particular vendor, especially if the data portability option is not negotiated. This leads to vendor lock and forbids customers to choose from substitute offers instantaneously in order to improve their resources at different levels within an organization. As mentioned, each cloud services operates in its own way, on how customers applications and services may interact (Dillon, Wu, & Chang, 2010).

2.3 Use and Application of Cloud Computing

The environment of the Internet is radically changing. The use of internet has also changed, previously it was used to surf the web, which has now moved to run the software applications on internet (Surcel & Alecu, 2008). Cloud computing paradigm includes the notion of software as a service. It refers to the data and software stored on remote servers that can be accessed through internet. In simple words, cloud means or refers to the internet. Cloud computing allows to transfer the processing tasks from the local machines or devices to the data center facilities. There are several cloud computing applications already available for businesses, in the market to choose from. These applications help companies and individuals to give means and work smarter by shifting to the cloud. Several technology giants offering cloud computing services and systems, to the industry, such as Nimbus, Amazon EC2, Microsoft Azure, Google App Engine (GAE), and IBM Blue cloud (Rimal, Choi, & Lumb, 2009).

When it comes to the actual world applications, there is no one-size-fits-all sort of cloud technology. Cloud computing technology may enable companies to combine in several ways to accomplish their anticipated business outcomes. PC Connection (2013) conducted a survey of 500 companies, reveals what companies are looking in cloud technology and rate of cloud adoption among different companies. The survey uncovered that around 70% of the respondent companies in various industry sectors are in the process of implementing cloud technology or they already have cloud applications in place. The following Figure 2.5 shows the results.

Figure 2.5: Results of cloud computing survey according to PC Connection (2013)

The cloud strategy is an important factor in adoption of cloud computing. If there is cloud strategy in place, the adoption becomes easier. In response to the question, "*How far long is your organization's cloud strategy implementation*"? The survey reveals that around 50% are in process of implementing cloud, while 19% have already implemented and 31% have no plans to adopt cloud computing technology. Furthermore, 24% of the survey participants companies are accessing company requirements and 9% defining which application to shift on cloud, while 10% are in progression of migration to cloud. The following Figure 2.6 depicts the survey results.

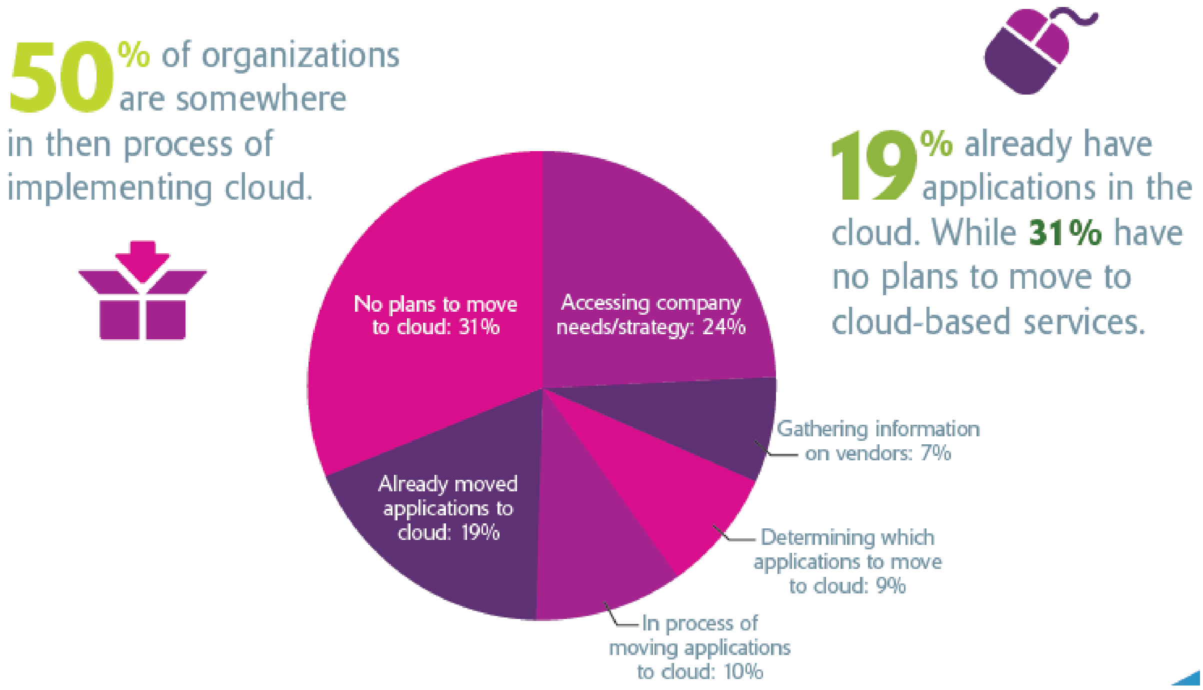

Figure 2.6: Results of cloud computing survey according to PC Connection (2013)

2.3.1 Cloud Manufacturing

Cloud computing is used in almost all industry sectors, in one way or other, such as software as a service (SaaS), infrastructure as a service (IaaS), platform as a service (PaaS) and other types of cloud services. In manufacturing, there is a particular use of cloud computing, which is called cloud manufacturing (CMfg). As cloud computing is quickly moving from early adopters to typical companies. Cloud computing has developed as one of the main concerns of several CIOs in terms of strategic business contemplation (Xu, 2012).

Cloud manufacturing is developed from existing advanced manufacturing models, such as ASP, AM, NM, MGrid and enterprise information technologies with support of cloud computing, virtualization and service oriented technologies (Tao et al., 2011). It targets to achieve the circulation and sharing, optimized and on-demand utilization of manufacturing capabilities and resources by provisioning reliable, safe, high quality, inexpensive manufacturing services for the entire manufacturing lifecycle. The high level running principle for CMfg is shown in Figure 2.7.

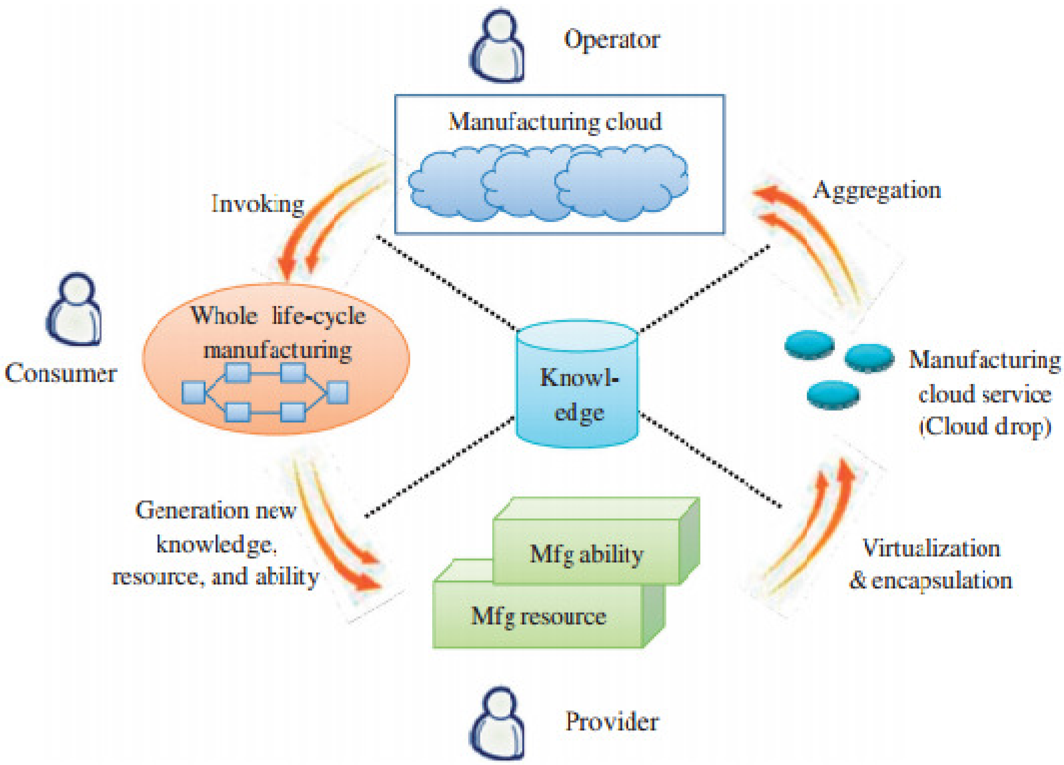

Figure 2.7: A high level CMfg running principle according to (Tao et al., 2011)

Some manufacturing sectors have already started gaining the advantages of cloud adoption, transforming into an age of smart manufacturing with the scalable, agile and effective business practices, substituting conventional manufacturing (Xu, 2012). Cloud manufacturing appears as an attractive and obvious solution, while changing from production oriented to service oriented manufacturing. It offers to encapsulate distributed resources into cloud services and a centralized management system. Cloud manufacturing can be used according to requirements. Cloud manufacturing delivers improved solutions to the manufacturing industry, that is becoming progressively disseminated and globalized. Cloud manufacturing denotes an innovative way of leading manufacturing industry, which means everything is supposed as a service, be it a service you demand or a service you offer. All manufacturing capabilities and means involved in the manufacturing life cycle are intended to be made available for the user in various service models based on traditional ones (SaaS, PaaS, IaaS) and including the following major ones (Tao et al., 2011):

- Design as a Service – the design resources are used as a service
- Manufacturing as a Service – manufacturing abilities & resources are used as a service
- Simulation as a Service – the simulation ability & resources are used as a service
- Experimentation as a Service - the experimentation resources are utilized as a service

Cloud manufacturing offers similar advantages, like any other cloud service. For instances, it reduces idle capacity and improve the resource utilization, reduction in up-front investments, decrease in administrative and infrastructure costs, up-grades, energy savings and maintenance as well (Tao et al., 2011).

2.3.2 Simulation on Cloud (Simulation as a Service/SimaaS)

Most people relate cloud computing with easily accessible storage on a web. While cloud-based storage, which simplifies and eases data redundancy and sharing, is certainly transformative, the cloud offers much more services than just storage (Autodesk, 2012). Besides, those already mentioned potentials of cloud computing, simulation as a service is also an attraction of cloud computing available to those who depend on simulation capabilities. Software, hardware cost and capabilities may limit the use of simulations required in product design. For instance, a single simulation may require and occupy a pool of resources for long time, providing little time for design variation analysis and finding alternatives designs. Therefore, simulations on the cloud, in the form of simulation software as a service (SimSaaS) provides the advantage of exploiting huge resource pool, such as availability of all types of platforms, large space for storage, and powerful processing capacity (Guo, 2012).

Simulations on cloud, has become an area of research. Simulations can leverage from cloud computing with its various computing capabilities, such as computing power and ability to scale up and down on demand (Tsai et al,. 2011). Cloud offers virtually infinite capabilities to utilize, without any heavy up-front investment of software, including licensing and accompanying hardware cost, which may be too heavy investment for a project based organization, using a few simulations per project (Autodesk, 2012). Another benefit with cloud simulation is that, companies do not need to keep pace with advancement in simulation technology, as it is offered as a service and updated by a vendor. Companies can leverage from cloud simulation, releasing most of the cost and capacity load linked with conventional simulation. Companies may run simulations on a cloud as much as required on pay-as-you-go or rental business model, without being tied to hardware infrastructure. For project based organizations (PBO) or companies without prior access to advanced simulation technology, the possible benefits could be even better. These companies can use cloud computing for simulation as a service, taking benefit of an on-demand business model, suitable to their needs.

Along with above mentioned use and applications, cloud computing is also used for Management as a Service (MAaaS) and Integration as a Service (INTaaS), offered by some cloud vendors (Tao et al., 2011)

2.4 Literature Summary

The topics evaluated in the literature review give a wide yet comprehensive understanding of the research area and ties well with research question and aim. The demands of meeting customers' requirements and being competitive in industry, forcing project based organizations to adopt new and sophisticated technologies.

Cloud computing provides an opportunity to project based and operational organization to leverage from several of its offerings. Companies may use SaaS, IaaS and PaaS, depending on their needs to deploy those services on public, private or hybrid cloud. Cloud computing has potential to offer costs savings, less maintenance, no heavy investments, supercomputing, device and location independence, and better project management through improved collaboration and document sharing.

There are some limitations associated with cloud computing. Those limitations include, possibility of data lock-in with a particular vendor, requires a constant high speed internet, privacy and security concerns are prevalent ones. However, most of renowned vendors provide reasonable security and privacy measures. Now a day, most of vendors facilitated satisfactory data migration and extraction. A company has to search for availability of cloud application which suits its business and offered by a reliable vendor.

3. METHODOLOGY

This chapter debates the rationale behind choosing the selected method of research as well as its advantages in striving towards the research question. Numerous different approaches and methods have been assessed, such as questionnaires, observations and interviews. The overview of methodology and tools are represented, in order to describe both the strengths and weaknesses of the chosen method. At the end, ethical concerns, research ethics and are presented which permits decent research practice.

Data collection is a challenging effort on which ideal methodology greatly relies upon the case at hand, and the data which is expected to be gathered (Silverman, 2006). Furthermore, it is considerably significant to recognise that a research may expose the risk for the parties engaged directly or indirectly due to the information involved, and hence, discretion and sensitivity is recommended (Rogers, 1987). Research within a company setting is constructively conducted through case study, as it may allow a researcher to incorporate particular circumstances in an appropriate arrangement (Bell, 2010). Maintaining the balance concerning revealing research details is significant in order to produce a good research, which is prepared through evaluating the importance of the information to use a suitable amount to authenticate the research (Biggam, 2008).

3.1 RESEARCH APPROACH

Data can be collected in various ways, such as observations, interviews and a questionnaire. Nevertheless the fundamental element is whether a data collection approach is a quantitative or qualitative. Biggam (2008) asserts that the quantitative data collection refers to answer the 'how' question of the research, on the other hand qualitative data gathering addresses the 'why' question. Quantitative research is founded on measurements and numbers which are assessed in search of statistically important outlines. Bryman and Bell (2007) state that, quantitative research method is an approach that highlights quantification in the gathering and study of data. The counterpart qualitative research links to the inspecting and growing comprehensive investigation of hypothesis. Furthermore, qualitative research generally focuses on words relatively than quantification in the gathering and analysis of data (Bryman & Bell, 2007; Bryman, 2012). However, it is worth mentioning that it is not the research strategy that defines quantitative or qualitative orientation of a methodology, which is a general mistake according to Biggam (2008). The research approach coupled with data gathering technique and objectives helps discover the nature of the research. Normally, qualitative data is congregated through observation and interviews, while quantitative data depends upon surveys and other factual numbers (Bell, 2005). The research strategy bundled with the data collection method and objectives assists finding the nature of a research. Commonly, qualitative data is collected through interviews and observation, while quantitative relies on surveys. The term qualitative research methodology serves as an umbrella, due to the reason it covers extensive range of research methodologies involved in different epistemological positions (Petty et al., 2012).

The critiques of qualitative research, when equating with quantitative research methodology, argue the dispute of the research being too subjective, hard to reproduce, problems in generalization and nonexistence of transparency (Bryman, 2012)

Applying a mixed-method approach does not bind the researcher, as it tolerates for both related and additional data gathering. For example, mixed method can be applied to refine the variety of data, through an early model being scoped into a more narrowed research. Basu (2010) states that mixed method is often considered a favoured solution due to its intrinsic self-improving nature, if appropriately applied. However, other researchers (Ma & Norwich, 2007; Denzin, 2012) focus its' key weaknesses, time consuming as well as the possibility of data corruption, which makes it not always a feasible choice. Moreover, mixed method has equally strong side as it's weak elements, and therefore is best fit in settings that allow a balanced evaluation of both quantitative and qualitative aspects (Moehle, 2011). Though, it is refuted by Basu (2010), as he asserts that regardless one method being weaker, it is supplemented by the power of the other. Mixed method could have been a suitable approach for the case study, however the author observed the extra time-consumption (Denzin, 2012; Abowitz & Toole, 2009;) outside the scope of a Master's thesis.

Primarily this thesis research relies on qualitative data collection. This methodology is considered as the most distinguished research approach in the academia, as it has a natural remedial factor that reinforces the credibility of a research (Basu, 2010).

Mainly the data is collected through meetings and observations, as the shortcomings of method can be alleviated with the research context and therefore, rich data may be composed. However, in order to supplement the data collected interviews and informal meetings were held in order to get more comprehensive exposure of different aspects of the subject. The author recognises that the advantage of interviews as well as informal meetings offers an opportunity to approve or reject findings from the observations.

Generally the quantitative and qualitative approaches are associated to diverse minds-sets concerning three key characteristics as can be realized in Table 3.1.

Table 3.1: Primary difference between qualitative & quantitative research approaches according to Bryman and Bell (2007, p.28)

Principal Orientation	Quantitative	Qualitative
Relation to Theory	Deductive	Inductive
Epistemological Orientation	Natural science model, in precise positivism	Interpretivism
Ontological Orientation	Objectivism	Constructionism

Quantitative research is deductive due to the reason it emphasize on testing theories, on the other hand qualitative research generally focuses on the creation and foundation of theories. Based on this assumption the author determined that qualitative research suits best to response the research question. The motivation is associated to the natural difficulty in evaluating elements involved with adaption of cloud computing, investigating the current state of cloud computing usage in the case study organization and finding its possibilities and limitations. As both the current state of cloud computing and finding its possibilities and limitations for the case study organization is greatly founded on requirements of case study organization, which can be explored through observation, meetings, interviews and literature review by an objective researcher. The core of the thesis is an inductive study, breaking down current state, possibilities and limitations of cloud computing for a project based organization to improve their IT infrastructure and performance.

3.2 Research Strategy

The research strategy benefits the opportunity of reviewing techniques from diverse fields, which increases the completeness of the results and their validity. When researching diverse industrial areas the studies may be subject to ambiguity due to dissimilar operational settings, which is lessened by the fact that the case studies have limited scope of being restricted within one company. This case study is divided into three sub-sections; each comprises a separate aspect, as illustrated in figure 3.1.

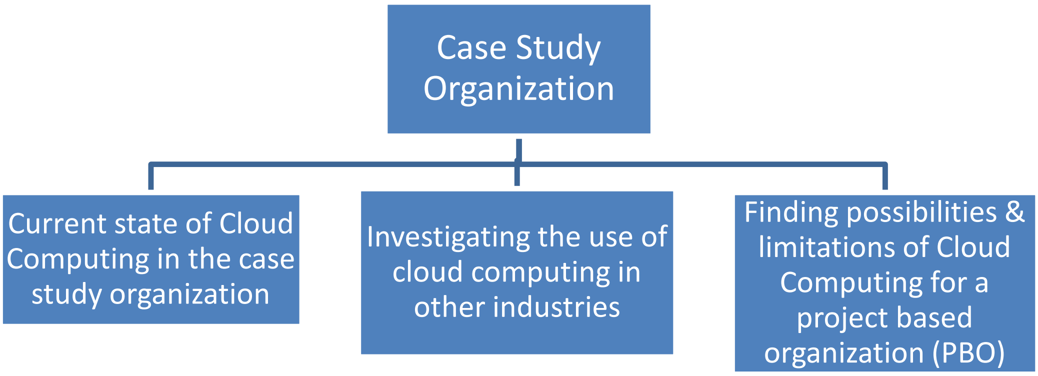

Figure 3.1: Breakdown structure of the case study

A case study allows the researcher to discover the existing situation, relating theory to practice (Levine, 1996). The subtle communication between parties engaged, which else may be missing, are gathered by the researcher (Lipson, 2007). According to Biggam (2008) case studies have become increasingly popular due to their intrinsic emphasis on one or part of an organisation. Furthermore, there is hardly a mixture of data gathering methods which simplifies the approach. Lipson (2007, p.100) proposes that before employing case studies, a researcher needs to answer two basic questions:

- Why use case study at all?
- Why use the particular case?

The first question is associated to the possibility that case study provides. In this thesis the case study provides a platform to witness the research objective in an existing business context. The nature of the data composed is empowered through the case study to provide a raw and unaltered interpretation on the current environment (Lipson, 2007). The second question is responded by the research cross-industry characteristic, which supports the researcher to investigate a general perception contrasting to the hypothetically narrow view of one industry.

In this case study, data collection greatly rely on the interviews, observation and informal meetings, it includes both the interviews and informal meetings and observations aspects.

The informal meetings and interviews act as a supplement to the observations and may contribute in covering on areas that are not appropriately undertaken during the observations.

Research can be established on single or several case studies. Nonetheless, when handling with several case studies it is vital to use the same research method throughout each case study, as it may otherwise obscure the comparison and diminish the research results (Biggam, 2008).

3.3 Selecting the Case Study

As the business situation is ruthless and unpredictable, many companies may act tentative to provide adequate access to information, which may limit or twist the data gathering. While the researcher should behave responsibly, participants may feel uneasy as their work practice gets analysed. Therefore, it is vital both for the researcher and the participants to set a high ethical and moral ground in a business setting. This is achieved through the participants consent form, in which the researcher gives an opportunity to the participants to review the contextual of the research and mention requirements of their contribution.

The case study organization is one of the leading property development and construction companies in the Nordic region. In this thesis, the energy department is explored. The company is operating in the whole Nordic region as well some other countries. It has four different units within the main organization, which are construction, property development, roads and housing. The company consist of approximately 18,500 employees all over. Often, for different projects cross-disciplinary teams co-operate and work together in order to achieve the project objectives as a whole. The company mainly operates and located in the Nordic region. The company sketches themselves as a cutting edge construction company. This is visible through adaption of latest technologies such as use of BIM within infrastructure and construction projects, as well as moves towards adaption of robust cloud services.

The company was selected as it facilitated the review of different types of projects being carried out, for different types of clients in a rapidly changing international context. There is an urge from within the company to strengthen their existing IT infrastructure for better collaboration among project teams, information utilization and availability for better project delivery and satisfaction of clients. Thus, the company provided excellent opportunity for the research within the area of cloud computing and its use within the project based organization.

The case study consists of three different aspects to review, as depicted in Figure 3.1, and one corresponding to possibly develop on the conclusions. The aspects were selected in consultation with a company contact. The data was primarily gathered during interviews and observations. The researcher did attend the formal interviews and informal observatory meetings. Furthermore, additional interviews were held outside the company, with professionals from different industry sectors, to shed light on the possibilities and limitations of cloud use. Also, external interviews gave insight on how other industries are using cloud computing and how provider trends look like. Throughout the research, interviews and observations were documented in order to analyse and gain understanding of the current use of cloud computing within the Case Study Company and possibilities and limitation of cloud computing. The interviews outside the company were selected by keeping in mind the nature of business those professionals work with, and possibility to provide required information. This enabled the researcher to provide the concluding remarks on the subject area.

3.4 Data Collection

According to Creswell (2009) the data collection process is a set of associated activities, which probably best defined as a circle. It may include locating individual or site, gaining access and preparing report, sampling, data gathering, information recording, storing data and solving field matters. Creswell (2009) asserted that these steps are essential in order to gather qualitative data. The research is established on data gathering through interviews and supported by the observations, to achieve a more inclusive research conclusion. The data collection is described in the following Figure 3.2.

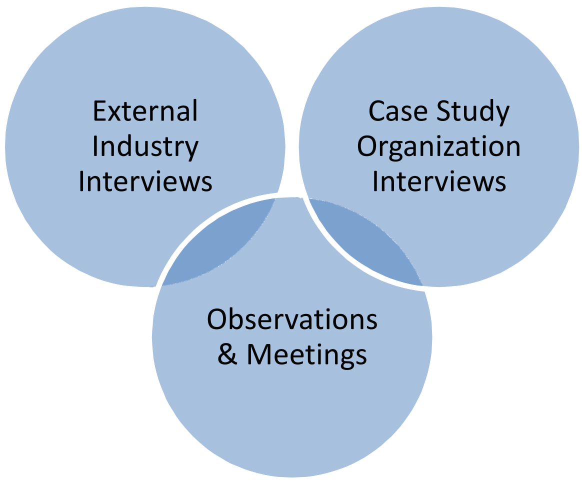

Figure 3.2: Description of Data Collection

3.4.1 OBSERVATIONS AND MEETINGS

Observations are considered exclusive scientific method to acquire substantial insights when exploring actions, agendas and managers (Nothhaft, 2010). Observations require to be organized in order to be productive (Biggam, 2008). Preparedness helps to enhance the data gathering resulting in an improved collection of data. Farenga et al,. (2003) asserted that observation is a process to find patterns. Observation is a pragmatic process directly established on the researchers' preceding understanding. Furthermore, there is a potential that observations cannot truly be impartial (Biggam, 2008).

According to Farenga et al,. (2003) there are repeating constituents within a decent scientific observing, as shown in Table 3.2

Table 3.2: Constituents of decent scientific observations (Farenga et al., 2003, p.57)

Component	Description
Plan	Use a strategy to lead the observations.
Senses	Use all senses to collect general and clean information.
Measurements	Make significant variables measureable to complement observations if required.
Changes	Note natural changes arising, but whenever suitable make thoughtful changes and observe the reaction to alteration.
Questions	Keep an open mind, however be attentive to inconsistencies. Ask questions when required, as they may guide to novel information

The observation is conducted with professionals in one department of the case study organization. Observations took place during several visits to the company's regional head-quarters, which helped the researcher to collect sufficient insights.

The significance of gathering rich data initiates from its ability to go underneath the surface which may expose a new aspect for the research (Charmaz, 2006).

3.4.2 INTERNAL AND EXTERNAL INTERVIEWS

The semi-structured interviews were conducted in order to gain rich data without the intrusion of the researcher. According to Bryman & Bell (2011) interviews in qualitative research generally have a variable structure permitting the subject to be discovered in an appropriate manner, as the participant present the explanation within its' own industrial setting as well as their understandings of the subject at hand. The idea is that this may offer an appropriate platform supplementing the data composed throughout observations by satisfying possible breaks in experience and knowledge. Nevertheless, the researcher will mention the primary concept of the thesis to the participants, in order to explore the subject. This safeguards a predefined setting without restricting the interviewee.

In qualitative research interviews pose weaknesses, such as interviewee 'idealizing' the past experience, substituting authenticity and not having appropriate knowledge or role to comment (Denscombe, 2010). In addition to this, interviewee intelligence and vanity may become a reason to cause the gathered data potentially be corrupted (Charmaz, 2006)

The data gathered during the interviews was concisely summarized and organized to be used as a supplement to the observations.

The external interviews refer to the interviews conducted outside the case study organization. The interviews were held with professionals from different industries. It helped to outline the current trends of use and adaption of cloud computing within different industries. It provided an opportunity to further explore the use of cloud computing. Furthermore, through external interviews perceived benefits and the potential limitations associated with cloud computing were explored.

External interviews are the least used data collection technique. It is primary utilized to gain the insight of industry trends of adaption of cloud computing and thus, to attain more comprehensive results and recommendations.

3.5 Data Analysis

Qualitative data analysis methods vary within academia. However, there are a few recognized and acknowledged guidelines available (Bryman & Bell, 2011). Usually, the data is gathered, assessed and organized in an iterative method. This empowers to tailor the interviews, if required, to include significant elements revealed throughout the observations.

Similar approach was adapted for this research. The interviews were conducted in a series, a brief summary was written after each interview, which integrates the key points and vital words from the interview. The objective is to allow the interviews complement and not suffocate the observations. The interviews were done in a series, spanning over sometime. This allowed the researcher to analyse the interview and, if required add or remove the questions for next interview. The researcher assumed that this approach would increase the richness of data gathered. In addition, interviews with external industry professionals and their views linked knowledge gaps encountered through interviews.

The interviews both internal and external, observations and literature review helped to create an understanding of current state of cloud computing usage, as well as anticipate the possibilities and limitations of cloud computing for the case study organization. The author briefly analysed the current status of the IT infrastructure and applications used for projects with theoretical knowledge explored in the chapter two to the current situation to establish the potential benefits and limitation organization may achieve. Once the potential benefits and limitations were established, the recommendations were tailored to fit within the company. The recommendations are provided in the conclusion section, which emphasize on the possibilities and limitations of cloud computing for the case study organization.

3.5.1 RESEARCH PARTICIPANTS

It is vital to find the right mix of participant from the case study organization as well as external industry professionals. In order to get a comprehensive insight of the research subject and the needs of the case study organization. A strategy of targeting participants with different roles and needs was established. The company supervisor helped and advised the author to identify and schedule the interviews with target interviewees. The internal case study organization participants include from energy, construction and IT department. These participants are involved in different projects. In addition to this, the author used his social and personal network to establish contact with external industry professionals for research participation.

Total of seven persons participated in this research, four from internal case study organization, who work in different departments (e.g energy, construction and IT). Another three individuals from external industry participated. These individuals belong to different professions (e.g project/program manager, IT/cloud specialist and senior management). In order to maintain the anonymity of the participant, as requested by the external industry professionals, each interview is allocated a code. Therefore, they will be referred to these codes in this study. The Table 3.3 below describes the codes, category, roles and medium of interview.

Table 3.3: Description of interviewees, roles and medium of interview

Respondents		Department	Role	Medium of Interview
Internal	External			
IR 1		IT	IT Manager	Phone
IR 2		Energy	Energy & Installation Leader	In person
IR 3		Energy	Energy & Installation Leader	In Person
IR 4		Tech: & Sustainable Development	3D Modelling Expert	In person
	ER 1	IT	Cloud Specialist	Phone
	ER 2	Executive Management	Program Manager	Email
	ER 3	Executive Management	Managing Director IT	Email

3.5.2 ETHICAL CONSIDERATIONS

Confidentiality and anonymity are the most significant ethical concerns, which requires an special consideration by the researcher (Longhurst, 2009). Data was composed through interviews and observations from the case study organization and external industry professionals, who agreed to contribute in the thesis research. All parties participating in the research, such as companies and individuals, are anonymous and therefore not stated with name in the thesis. If any of the participating party explicitly demands to be listed with name, a formal written application will need to be submitted, which is considered according to the appropriate rules and regulations of both Chalmers Technical University and Northumbria University.

Due to the nature of case studies, it is likely to encounter the company and individual confidential information. However, it is omitted from the final thesis and interview/observation notes. Confidential information is a continuous issue in business setting. Therefore, it is advised that complications can be avoided by an open discussion between the participating parties an researcher.

As the data collected may be sensitive with a personal or company perspective, therefore, it needs to be carefully selected and stored in order to show the proper consideration. The collected data is stored on a secure cloud-storage with a Secure Socket Layers (SSL). Furthermore, only single personal computer is used during the whole data collection, analysis and thesis writing process. All the data collected and stored by the researcher, and provided to Northumbria University are kept safe and secure. The gathered data and information will be kept secure until it is considered to be obsolete, thereafter, will be destroyed properly.

4. Data Findings and Analysis

As previously described, the data gathering methods included interviews both internal and external, observations and informal meetings. The results are presented in the following sections of this chapter, each explaining the findings of semi-structured interviews, observations and informal meetings conducted during the research. This will enable to reflect on the research objectives and questions established earlier in this thesis.

In the beginning of this chapter, a brief sketch of the Case Study Company and department is presented. This will give an opportunity to get an insight of existing settings and use of IT infrastructure for better management of projects.

The respondents are denoted with their codes, as explained in Table 3.3. This is to distinguish internal and external industry interviewees. For instance, IR 1 refers to internal respondent 1, who is an IT manager within the company and so forth.

It is worth noting that, even though an extensive amount of data was collected through interviews, observations and informal meetings, however, only relevant and important portion of the collected data is utilized for this particular thesis.

4.1 Over view of Case Study Company/Department

The case study company in broad-spectrum has several different organizations. This includes the construction, housing, property development and roads. This research focuses on construction organization within Sweden. In particular, the thesis was carried in the energy department of the construction unit within the company. The following Figure 4.1 shows the organizational chart.

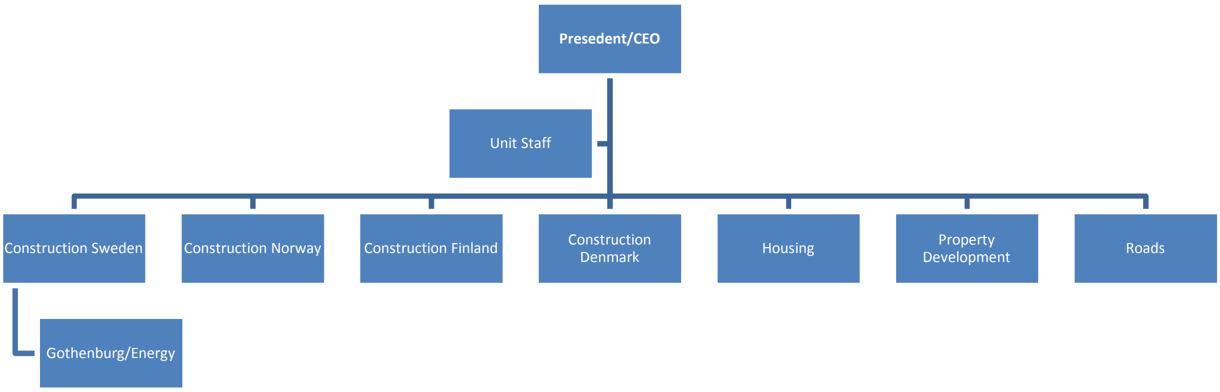

Figure 4.1: Organizational chart of the case study company

The company is a project based organization. It is mainly because the nature of the business in which company operates. Construction of each building or infrastructure is a project within the company. Various tasks are carried out at the energy department of the company. This includes calculation of energy consumptions within the buildings, running the simulations to optimize the design, in order to fulfil the energy consumption requirement set by the customers and monitor the energy consumption over a certain period of time. Furthermore, the department works within the environmental compliance standards set by the government and other agencies to meet the requirements. This means, building the environmental friendly and sustainable building infrastructure, with least possible carbon footprints. In order to achieve various standards and meet the requirement, the company and in particular energy department uses various tools to carry out their project work. The department requires frequent collaboration and information sharing with different parties involved in the project from very beginning in the design process.

4.2 Current IT Infrastructure and Cloud Use at Energy Case Study Company/Department

According to IR 1, the case study company in general uses various software and application to support the business and project work processes. Around 25 systems and 55 applications are currently running on the company data centres. Those data centres are located at different places/cities to support the project and daily operations of the company business. Most of the applications are running on corporate enterprise licensing with unlimited use. Basically, these corporate enterprise application licenses cover all the employees. There are also some network licenses, which are called active user base licenses. These licenses for example include Autodesk® platform for 3D modelling etc. On average, a corporate enterprise license cost around 650,000 SEK. There are around 3500 users who use 3D modelling applications and total number of employees is approximately 7,500. About one third of employees use line of business applications, which are core to the company to generate business. Additionally, most of the project sites have network connection to share the information and data. Mobile devices can also be used with 3/4 G internet. The following Table 4.1 depicts the data in table form.

Table 4.1 Overview of IT Systems and users on company network

Description	Representation in No
No of main systems	25
No of Applications/Software on company network	55
Average cost of a corporate enterprise license	650,000 SEK
No of employees using 3D applications	3,500
Total number of employees supported	7,500
IT infrastructure on cloud in approx. %	20-25%
No of employees using major business applications	33%

The IR 1 further revealed in the interview that the case study company have taken some initiatives within cloud adaption. The company is using a few cloud services such as storage, collaboration and communication, elastic compute for huge data analysis and generation of drawings, when required some additional computing power. Approximately 20% of overall case study company's IT infrastructure is on cloud. As previously mentioned, the cloud services include mainly storage and automatic generation of drawings and data analysis. Cloud services are used to collaborate with external parties, and ability to use many computers for short period of time. These services are used, for instance, automatic generation of drawings, visualization and analysis, since last couple of years. However, the staff at energy department are not aware of these developments. As the according to IR 2, IR 3 & IR 4, they do not use any cloud services.

4.3 Use of IT and Energy Tools within the Case Study Department for Projects

According to IR 2 and 3 who work closely with energy simulations and calculations, use two energy calculation/simulation tools to optimize the building performance. The primary simulation and calculation tool gives a 3D view, while the other one is in table form. Both of the IR 1 and 2, most of the time uses these tools. The primary tool is used at the early stage to optimize the design and save costs. Both IR 2 and IR 3 utilize the primary energy simulation and calculation tool approximately 20 hours per week hands-on, which is approximately equal to 50% of their weekly work time.

In normal working environment only 1-2 simulations for building performance are carried out. This is primarily because; usually it is not required to execute large number of energy simulations as the building energy performance demands are met by executing one or two simulations. The IR 2 and 3 mentioned that in total around 5 simulations may be executed from inception to the completion of a project. Number of simulations depends on a building data and results. If the results are not achieved, simulations are run over and over until desired results are achieved. It is worth mentioning that there is capacity to run more simulation and optimize the design and building performance, as it does not take long time and computer resources. If the building has complex structure and huge size, there is possibility to run the simulations overnight and results can be achieved in the morning, without affecting the daily work routine.

The IR 3 states that the primary energy simulation and calculation tool normally takes around 30 minutes, however in some case, up to 8 hours per simulation. The time variation is dependent on the building design, size, number of floors and various other factors. Furthermore, IR 3 mentioned that normally 1-2 simulations are carried for a building, but if the desired results are not acquired more simulations and calculations are run, until the required results are achieved. IR 4, who works within construction of 3D and 5D modelling, asserts that previously this modelling tool was not good but now it has improved quite well. The IR 4 uses around 80-90% time working on 3D and 5D modelling tools.

4.4 Project Information Sharing and Communication

Most of the respondent within the case study company revealed that there is a possibility of missing the latest information required to carry out the task given for project completion. According to the IR 2, 3 & 4 information is shared mostly through emailing and if required calling the person, even though it is possible to store and retrieve the latest information via centralized server for different applications used within the department.

As mentioned by IR 2 data and information is received from various stakeholders such as architects, constructor, project manager, mostly via email. Although, there is possibility to share the information through a centralized project management tool within the company by logging in. The centralized information sharing and collaboration tool is not extensively used by either of IR 2, 3 and 4, as they may not be interested in all the information available there. All the respondents perceive it is time consuming.

The IR 4 indicated an interesting thing, that even though there is possibility to share the information and data via a centralized tool, but it is not practiced. Instead the information is shared in weekly personal meetings, so called 'Project Studio'. The purpose is to meet with each other during the whole day and get all the information required such as building floor number, height of the roof etc. IR 4 furthermore, revealed work is done on a model during whole week, and the model is updated once a week on the centralized tool. This is due to avoid the misunderstanding, as someone may change something and the other person may start working according to that model. This may lead to pay for the extra work done.

4.5 Limitations of Existing IT Systems

According to IR 1, the limitation associated with current information sharing and collaboration is that, the information can be retrieved only when the application is running. Also, it may not be possible to get all the information available 24/7. These restrict to get the latest information all the times. Similarly, the IR 3 mentioned that it is possible to access information required for a project, but information may not be the latest one. This may lead to a wrong direction and cause extra work. All the respondents IR 2, IR 3 and IR 4 asserted that even though it is possible to store and retrieve the information via centralized systems, but it is easy to miss the latest information. This is mainly due to the reason that, everyone may not be working on the centralized system and storing their information regularly.

Installation of software up-dates for the tools used within the case study department and company by non- IT staff, could be a problem. As mentioned by the IR 4 that, sometimes staff is required to update their software application by running the update package. It is mainly required to ensure the proper functionality of software. However, sometimes it is problematic if update is not installed properly by a user, especially if a user is inexperienced. This may cause delays and eventually software has to be updated by someone.

4.6 Why Cloud Computing

According to IR 1, the construction site has not changed since many years and productivity has decreased. In other industries such as manufacturing, productivity has increased up to 285%. Therefore, to increase the productivity effective production and project management methods are required. IR 1 asserts that efficient construction is required to enhance the productivity. One way to increase the productivity is to establish shared IT architecture, which provides the ability for analyzing, integrating information around projects, products and the company systems. The ultimate goal of the case study company would be to enhance efficiency in work force, providing greater value to customers, cost reduction and being competitive in the industry.

There are various driving factors which encourage adapting cloud services. ER 1 stated that adoption of cloud services depend on the size and nature of a business company operates. For instance, family owned midsize business would be more interested in sustainable way of investment. On the other hand, project based organizations would want certainty that margin is attractive. In addition, ER 3 expressed that pricing and computing power offered by cloud services, ease of use, less administration, maintenance, and IT staff may focus on improving the infrastructure, rather than just keeping it alive, are major driving factors among others. Furthermore, ER 2 mentioned that cloud services provide control of the resource cost, equipment to house data and which software applications to rent/hire, as well as ease of maintaining the data and equipment on which data is stored. In other words, a company may have more control over the IT expenses by having choice which service to acquire, for how long and no maintenance required for that service.

According to ER 2, IT staff may focus on the IT projects that support the company mission and business, rather than IT maintenance tasks. For instance, beside the reduced maintenance, the need to update software version on local machines could be reduced with adaption of cloud services. Additionally, adapting cloud services could be a strategy to utilize limited resources effectively. Furthermore, IR 3 argued that saving the cost with better pricing options, better disaster recovery, more redundancy and scaling up and down are the advantages associated with cloud computing.

IR 1 stated that, the case study company did some cost analysis, which showed around 10% cost savings in cloud storage. Cloud solutions provide potential to save cost as compared to traditional in-house IT cost expenditures. Furthermore, cloud computing is scalable, for instance, potential to use elastic compute services by a cloud vendor. Also, cloud solutions may increase the efficiency, when it comes to information sharing within team members as compared to emails exchange. In addition, IR 1 pointed out the counter productivity of mobile devices with regards to sending the information via mobile devices. It is not easy to send the information through mobile devices, thus becoming counterproductive.

According to ER 3, usually there is less down time in cloud environment, due to the fact that if a machine requires reboot, another machine can be started simultaneously and traffic can be redirected to the second one, while the first one reboots. This is second by the ER 1 that Service Level Agreement can be negotiated with the provider and normally the uptime is 99.5%, which is sometimes hard to manage in-house.

4.7 Use of Cloud Computing in Different Industries

Cloud technology has already been established in big organizations, as asserted by ER 1. An in-house cloud computing, a cloud storage server is one of the examples. Data centers will become more of a service in near future than maintaining in-house IT infrastructure. In addition to this, cloud computing is an enabler, which provides enhanced computing power with simulation, visualization and collaboration through smart phones, tablets. Information would be available around the globe, anywhere, anytime and by anyone, added ER 1.

According to ER 2, cloud computing is used in almost all industry sectors, ranging from established companies with extensive IT and data center needs, as well as small start-up companies that are looking to purchase IT services, in order to focus getting their products to market. ER 3 stated that cloud computing is almost everywhere these days, from small companies, that want to host their website, files and information storage and big organizations, which are interested in calculation tasks, data analysis, and simulations.

All industries are using cloud computing, added ER 1. For instance, InfraWorks 360 from Autodesk® on cloud provides the capability to analyze big data scenarios. It is used to engineer large-scale initial designs and collaborate with various stakeholders almost anywhere and anytime. It provides ability to access specialized industry tools and create 3D models in a suite and access via internet. The project may include different domains, such as streets, squares, subways and electricity etc. Cloud computing empowers efficient collaboration among project teams. Team members may share the model via a mobile device or web browser with different stakeholders, who may not have reach to desktop application. Once models are synchronized or published to cloud based tool, additional changes are automatically reflected both with a local and online version of a model. Big city development projects such as Tokyo and Mexico cities have used this cloud based tool for better management of their large scale civil infrastructure projects.

4.8 Cloud Computing Deployment Model and Services in Demand

According to ER 1, large and public companies are inclined more towards the public or hybrid cloud model. If a customer company has critical data/information, private or hybrid cloud model would be of interest to that company. Furthermore, the ER 1 mentioned that public cloud is a good choice, as the secrecy is revealed in anyways. There are lots of competitors who are ready to copy your products once it is out in the market. Therefore, a hybrid cloud could be the best option to adapt, as a customer company may keep their sensitive data on private cloud and the non-critical data on the public cloud.

Furthermore, the IR 1 stated that the company would be looking for some sort of hybrid cloud model. Again, this is due to the reason as combination provides potential for saving cost and securing the critical data. However, ER 3 mentioned that public clouds are more in demands as those models have potential for more cost savings.

When it comes to the services, there are several options to choose from. It depends on a customer company's needs for projects, corporate IT strategy and ultimate use of the service. According to ER 3, various cloud services are available. The most commonly used ones are, Amazon Elastic Compute (EC2), Simple Storage Service (S3), these two instances can be used to host Windows Server or Linux. Furthermore, Google App Engine, AWS, Microsoft Cloud products such as Office 365, SQL, Exchange, Dynamics, SharePoint and many other SaaS are in demand.

ER 1 asserted that there is variety of services to choose from. In general, Infrastructure as a Service (IaaS) and Software as a Service are in great demand. Examples are storage on cloud with automatic backups and Autodesk 360® for AEC industry. Additionally, it depends on a customer company's requirements and project needs. The project and company needs decide which services to use. However, according to IR 1, the case study company would be interested in cloud products which may potentially increase capacity for quicker and several design alternatives and analysis, more efficient collaboration with different stakeholders such as owner, management, architects, project management and teams.

4.9 Why Cloud Computing for Projects

According to ER 2, cloud based service, for instance software as a service (SaaS) is in demand, as many people can access same application from multiple locations on different kinds of devices. Thus, it enhances the collaboration and information sharing among different stakeholders, even those who do not have access to desktop applications can also benefit from this service. Similarly, the database or storage can also be rented for a particular project, as cloud service does not require any up-front investment, without any physical installation of IT equipment, ready to use and minimum maintenance. Additionally, cloud services provide flexibility with different business models available to choose from or negotiate with a vendor. Those business models include pay-as-you-go, price per work hour, transaction or capacity to use from. With completion of project, cloud service may also be terminated.

According to ER 1, cloud provides dedicated project space where a customer company may store their own data with no access to any other party. This kind of storage space is automatically synchronized and backed-up. Possibility of consumption based pricing. The cloud service can be managed with a VPN or dedicated direct connection, which requires no big IT infrastructure for a project. Furthermore, cloud computing provides opportunity to utilize super computing power by using several server available on demand for big data analytics, which previously was not possible with traditional in-house IT infrastructure. The ER 3 mentioned that with cloud, it is possible to start as many servers as needed, without purchasing and installing in in-house data center. Additionally, cloud assists in creating agile processes and faster access to the market. This is because of its readymade services available to choose from according to project requirements.

There are several project management tools available on cloud to choose from, added ER 1, 2 and 3. These tools have no boundaries, as they can be used from anyone, anywhere through any device. This may increase the traceability, availability of information round the clock, always the latest version of document or information, and no information silos with a single point of access for all the information.

Furthermore, as IR 4 mentioned that installation of up-date sometimes cause a problem with proper functionality of software. This no installation by a user is a possibility with cloud service, especially with software as a service (SaaS).

The ER 1, 2 and 3 all mentioned different project information challenges. These challenges include file retentions, up-dated funding records for the funding agencies, document control and duplication of efforts (as mentioned by IR 4), different document control process in different department, and information silos. Cloud computing has potential to decrease the level of these problems to a great extent, if a suitable cloud application is adapted for project management. Company has to consider various aspect of the new application being adapted, such as usability of new application, how different is it from an existing one. Also, how it may provide benefits as compared to the existing one.

According to ER 2 and 3 (with little varying argues), online cloud based project management platform enables project team to manage and capture all project information and data on a single, secure and centralized neutral location. This enhances project collaboration among different project teams, resulting in better completion of project. Furthermore, cloud services provide transparency. According to ER 1, a classic project based organization, for instance, hire a cloud service for a particular project and business model may include 18 months of time, 100 licenses of a particular SaaS to support the project XYZ, which costs 100,000 SEK. Furthermore, a project organization may be able to know which licenses are used at most and usage time for example. This gives the transparency and help in analyzing the software/application usage trends, which as a result may help to define the future corporate IT strategy.

4.10 Limitations of Cloud Computing

Like any other service or application, cloud computing has some limitations as well. According to ER 3, it is not common to transfer services between different cloud providers. Architecting and setting up application communication is considered another problem associated with cloud computing. Integration of information, multiple systems and users, privacy and security are the biggest obstacles in cloud adaption. According to IR 1, as the number of cloud service provider grows user management and integration with growing number of cloud services become complex and hard to manage. For instance, if the case study company gets services from 5 different cloud service providers, there will be 5 different user management and integrations to manage.

Privacy and security as mentioned earlier, is considered the fundamental trust barrier for cloud adaption. Customer companies are concerned how secure is the cloud, for instance added by ER 2. According to ER 1, usually local laws apply for privacy; however, in some cases it is not explicitly clear. Normally, certain level of privacy and security are built-in offers, which meet the security and privacy standards in general. The vendor data center location is also not known by default.

Data lock-in is another limitation of the cloud services. According to ER 3 that risk of migrating data safely is a concern for customer companies. Some vendors may not provide a satisfactory support for data migration and switching a cloud vendor. However, ER 1 stated that, data extraction and migration is not a problem these days. Cloud service vendors provide the functionality to save data locally on hard drive or on the cloud. Some providers may back up the data for a customer company and send that data to the customer, depending on the arrangement. Additionally, Customer Company may not have 100% control over hardware. The ER 2 stated that biggest limitation of cloud computing is security and integrity. This again refers to the concerns of customer company, how safe is the cloud and cloud vendor. Training the cloud service provider on company policies and ensuring the provider actually provides the services contracted could be another limitation. Furthermore, setting up regular review cycles and emergency protocols, are hard to establish added ER 2.

Cloud service provide flexible business model. However, this could lead to be more costly than in-house software/application. According to ER 1, considering a scenario a project based organization hires a capacity business model. Capacity model refers to pre-defined resource pool. For example, 100 instances of simulations on the cloud. In this scenario, if a company does 10 simulations for a building to perform energy calculations, and still not satisfied. On one hand there is flexibility and scalability that company may utilize the instances as much as required, on the other hand, company may run out of the capacity pool quickly as more and more simulations are executed, thus resulting in more cost. But it all depends what business model is in use. Mostly, project based organizations rent cloud services as long as they need.

Support is clearly one of the concerns for customer companies, in adaption of cloud computing. The ER 1 asserted that, it may be difficult sometimes to get the support from a cloud vendor. It could be tricky for a cloud vendor to provide effective support in case of platform as a service, for instance. The support staff needs to understand first, where the problem has occurred and it needs effective coordination, and figure out that who is causing the problem, which may become difficult in some cases. However, some cloud service providers have effective support and feedback system to improvise the services offered. Furthermore ER 2 mentioned that, knowing who to contact at a cloud service provider company, in case of any problem with service to resolve the issue may become reason to escalate the problem. Also, if there are financial impacts on the down time, who would be responsible to bear, is another perspective associated with cloud support.

5. Discussion

This chapter is structured to separate three aspects of cloud computing for a project based organization. Those are possibilities, limitations and use of cloud computing. This structure would enable to form an association with previous chapters as well as research aim, which is foundation of this research.

5.1 Cloud Computing for IT/Case Study Company

The interviews revealed that most of the respondents perceived cloud computing as an alternative option to shift the fixed to operational cost. As cloud computing does not involve huge up-front investments (Etro, 2009). Reduced maintenance of resources (Brohi & Bamiah, 2011; Miller, 2008) both in hardware and software, is one of the major driving factors in adaption of cloud services. Various business models associated with cloud computing are appealing, such as pay-as-you-go, capacity pool, rental etc. as argued by (Etro, 2009).

Most of the ERs also reflected that cloud computing provides enhanced security and backup of data (Miller, 2008). In addition, cloud service providers have security centric (Chang et al., 2010) measures on their disposals to protect client information and data. The IT department can benefit from this service, as it is already in use. The company may move their non-critical data to be stored on the cloud and save cost up to 10% as mentioned by IR 1.

5.2. Information Sharing/Collaboration and Project Management

Internal and external respondents both reflected that advancement in technology helps to better manage the projects, as it offers location, device independence and effective project collaboration among project teams, asserted by the interviewees and (Chang et al., 2012). Independence of location/device and increased collaboration is perceived valuable advantage of cloud computing. This notion is called the virtualization as mentioned by (Popek & Goldberg, 1974).

Increased portability (Miller, 2008) and availability of important data round the clock could be achieved by adapting cloud computing. However, just moving the project management and information sharing tool on a cloud may not be suitable for the case study company or energy department. As IRs mentioned that most of the information and documents are shared through emails, information silo is visible in this scenario. This may cause the delays in completion of a project.

The project management organization needs to spread awareness and motivate employees regarding potential benefits of using existing online project management tool. Alternatively, the management may initiate a training program and encourage the employees to exploit the new tool. Create a culture in the company to adapt the changes and reap the benefits of easily available information and collaboration possible through the proposed tool.

5.3 Possibilities of Cloud Computing for the Energy Department

The needs of energy department, up to a great extent, within the case study company differ from IT department or the corporate as a whole. The IT department or the case study company as a whole seems interested to save cost on IT infrastructure. The IT department does not deal in projects but supports the company operations and projects.

Currently, the energy department is using two different energy calculation and simulation tools as mentioned by IR 1 and 2. For understanding, these are referred as EnergyCalc and EnergySim tools. The department uses the same centralized project management and information sharing tool as all other employees.

Given the above situation, one possibility is to carry on using existing setup for the EnergyCalc and EnergySim tools as stand-alone software application and pay for one time unlimited use corporate license. Let's assume that the EnergySim license costs about 100,000 SEK and this software is used for two years. The software is up-graded after two years. The up-gradation also costs about 100,000 SEK. There is no limit on how many calculations or simulations are carried out. Normally the department executes 1-5 simulations for building energy performance. However, there are exceptions in some cases, in which requirements are not met and simulations are executed over and over, until desire results are achieved. Usually, 1-5 simulations are run and results are achieved. A normal simulation for a building takes 30 minutes as mentioned by IR 2 & 3.

With above scenario, if the energy department would consider optimizing and getting alternative building designs at the early stage of projects, to build less energy consuming and efficient buildings, then adapting a cloud services could be an option. There is a possibility that either the energy department may use these tools on cloud in software as a service (Mell & Grance, 2011) or simulation as a service manner (Autodesk, 2012). Now the questions arise would it be beneficial for the department to use any of these tools in software as a service or simulation as a service manner? This needs thorough technical analysis, which may include IT, migration, and integration and users/external actors' management. At the same time, it requires senior project management approval as well. The reason is by shifting to cloud service may change the whole working process within the department throughout the company. Management of information, collaboration and document sharing may become rather difficult, without any suitable consideration or preparedness both from intended users/employees and management. Additionally, integration of external stakeholders involved in various project into the new system may cause problems as well.

As mentioned earlier, normally 1-5 simulations are carried for a building to calculate energy consumptions and building performance. The energy department may do analysis whether SaaS would be cheaper to only pay for what is utilized as compared to full cost of the software. For instance, a yearly subscription of EnergySim tool on cloud, software as a service cost 100,000 SEK with unlimited use; seem a reasonable option. With software as a service for EnergySim, there will be improved portability, location and device independence. Employees would not need to be on company network or use a particular computer, with installed software. With software as a service, potentially there will be reduced software maintenance, increased up time (Waters, 2005) and always running the latest version of software. Also, there is possibility to save cost on buying lighter and cheaper computers for employees. However, the department has to consider the availability of high-speed and stable internet connection (Grossman, 2009; Miller, 2008), in order to use the service on cloud. Furthermore, the department has to explore if such solutions are already available in the market, which meets its needs as well. Additionally, the department may also need to evaluate service provider to analyze the data portability, extraction and migration possibilities, in case of switching a vendor.

There are various disciplined involved in any building project using CAD/CAE tools such as engineers and architects to design energy efficient buildings by simulating various aspects of building (Lin & Gerber, 2013). Due to various aspects of these CAD/CAE tools, such as interoperability, domain expert discontinuation and essential research requirements into the effect of simulation on design procedure, these tools hardly support decision making at the initial phase, where design decisions may have an enduring effect on total building structure performance. If the company has capability to adapt multidisciplinary design optimization framework, this may enhance the possibility to quickly generate design alternatives. This may be a possibility through cloud computing. However, it may require developing an MDO framework to be used on cloud. This would enable to incorporate multidiscipline at the early phase of design and thus produce and explore various design alternatives at beginning of projects. This could potentially be the most attractive solution for the energy department. It is worth mentioning that incorporating this kind of system may bring huge changes, which executive management needs to consider. Also, the existing IT and project management governance system may require a revisit.

Alternatively, the energy department may subscribe for the EnergySim software as a service based on a capacity resource pool. Capacity resource pool means pre-paid or given number of energy simulation instances. The department may consume as per need basis and potentially save cost, as currently only 1-5 simulations are carried per building. However, it may cost more than in-house software license, if the service is used extensively. The resource pool may be consumed quickly and a renewal of subscription will be required to carry on projects. For example 20,000 instances of simulation per subscription with price of 100,000 SEK, may cost more with increased demand and use of software.

Another possibility is that the energy department may use cloud for simulation as a service (Autodesk, 2012). The energy department desires to be able to do more and quicker energy simulations. It may be possible to do quicker simulations on cloud; however, it may require a software or application designed in such a way that supports to use multiple cores.

As mentioned in the data findings section, the internal interviewees revealed that usually a simulation takes approximately 30 minutes. Now the question arises, how quick and faster simulations, the energy department wishes to do? It is possible that an employee can run a simulation and work on other tasks, while the simulation is being completed. In the current situation, just to do quicker simulations on a cloud may not be the best option for energy department. However, the department may move on to a cloud based simulation as a service, which possibly does impact on the time duration of completing a simulation. For instance completion of a simulation in five minutes will save time; it may also change the working process of entire department.

Considering the above scenario, if a simulation is done in five minute on cloud as compared to 30 minutes in-house, it may save a great amount of time in the end. The following Table 5.1 demonstrates the savings in terms of time.

Table 5.1 Simulation time comparison in-house vs Simulation as a Service

In-house installed software			
Simulations/year	Time/Simulation in minutes	Total time/year in minutes	Total men hours/year
10000	30	150,000	2500
Simulation as a Service on Cloud			
5000	5	25,000	416.66

The above table shows the potentials of saving men work hours, if a suitable simulation as a service is adopted by the energy department. Such an application would be even more beneficial in case, an employee is not able to use computer/software during actual simulation on locally installed software.

On the other hand, there is possibility to save time, by running the simulations on existing software overnight. In order to get different building performance and design alternatives, multiple simulations can be run on various computers on company network overnight. The cost analysis and implication also needs to be considered, as compared to in-house energy simulation setup.

5.4 Change Resistance and Management Aspects of Cloud Computing

Before implementing any cloud based application, the IT team has to investigate whether the particular system or application is cloud able or not? Once it is determined, the other management aspects can be explored as well. Such as cultural and management changes it may cause. Besides systems integration, migration and user/employee management on a new cloud based systems, adaption of cloud computing is mainly management decision. Some cloud services may bring radical changes, while others do not. For instance, implementing a cloud based email system may impose a minimal effect on daily work. On the other hand, induction of a new cloud based system such as project management, multidisciplinary design optimization (MDO) or energy simulation tool, may have a large impact on the management and staff working process.

There could be various reasons employees at the case study company, not using the existing online project management tool. Few of the possible reasons could be unfriendly user interface and lack of motivation/training to benefit from the system. Marakas & Hornik, (1996) assert that user resist as a response to threats related with new system. User defiance to change is strictly associated to cultural barrier and reflected as the prime aspect when it comes to implementation of a different information system (Kim & Kankanhalli, 2009). Resistance may be produced by different internal aspects associated to users as groups or individuals, such as background, gender, age and belief.

Resistance may develop from design of the system or application being utilized. As mentioned above unfriendly user interface or difficulty to disseminate information and documents. Most of IRs share documents & information through email and collaborate personally via phone. Having said that, the management has to consider various aspect of change, its implication on the working process and impact of change before deciding to adapt any cloud based service.

5.5 Limitations of Cloud Computing

With growing demand of cloud computing, security and privacy is the biggest concern of customers. Respondents of external and internal interviews reflected security and privacy as one of the major challenge, also asserted by (Hofmann & Woods, 2010; Brohi & Bamiah, 2011). Although, as previously mentioned most of cloud service providers take adequate security and privacy measures to satisfy their customers, the question still lies there that how secure is the cloud? This is naturally because the IT infrastructure is out of the company firewall. Data center location of cloud service provider, security and privacy laws may not explicitly satisfy a customer company.

In general data lock-in as reflected by the ERs and (Chang et al., 2010; Hofmann & Woods, 2010)) is considered an obstacle in cloud adaption. However, data migration is supported by major cloud service providers, as cloud technology is becoming mature and standards are being developed. Some cloud service vendors offer to copy and dispatch the data to their customers, if required.

Integrating large number of user and different systems, with different cloud service problem could be another big problem as reflected by one of the internal respondents. As the number of cloud service provider increase the user management and system integration becomes complex. This is a challenge for major cloud service providers, but as mentioned by one of the ER, European Union is working towards standardizing the cloud services at a great speed and soon there will be industry-wide standards available.

With limited internet access, it could be difficult to access the cloud applications, for instance on remote construction locations. Cloud services are best utilized with stable and high-speed internet connection as explained by (Grossman, 2009). This is considered as another limitation associated with cloud computing. However, as IRs stated that most of the main construction sites are supported with a stable and high-speed internet connection. Furthermore, with gradual decrease in band-width prices and increased availability of good internet seems resolving this limitation.

According to some of the ERs, limited or no control over the hardware on cloud makes it less attractive to adapt cloud services, as security and integrity is a big challenge. Particularly, with mission critical information (Miller, 2008) trust is a significant issue to be dealt with. However, private or hybrid cloud deployment model may be an option to resolve this concern. Another perspective could be to negotiate the terms and conditions of the contract in details with service provider. Cloud computing may become even more costly, in some cases as mentioned by an ER. For instance, renting a capacity pool model on cloud, this refers to predefined set or resources to use from. If the results are not achieved, it may cost additional money to rent/hire extended resource pool as the previous may be consumed quickly. While with in-house installed software application there is no restriction how much and how many times a user uses that application. However, it involves huge up-front investment which could be much more expensive than hiring/renting a cloud service.

5.6 Use of Cloud Computing in Different Industries

The use of internet is changing and shaping the working environment. Previously, the internet was used only for web surfing, but now software are being moved and used through internet as asserted by (Surcel & Alecu, 2008). Variety of cloud products are available to fit needs of different business sectors. As mentioned by ER 1, that cloud vendors are shaping their products to best fit with business needs without any additional requirements. More and more businesses are project driven these days, therefore, vendors offering cloud services for almost all business sectors and needs. Many different kinds of companies using cloud services, such as media, research, education, automotive, governments and gaming companies are to name a few, described by ER 3 and a survey by PC Connection (2013) reveals that around 70% of

500 survey participant companies are in process of adapting cloud services. The list of companies includes various different companies.

ER 2 mentioned that different companies are using cloud computing, such as medical research institutes, manufacturing industries (Xu, 2012) in the form of cloud manufacturing (CMfg) including other services and IT industries are the early embracer of cloud computing.

All the ERs asserted that depending on the needs of company, cloud services are adapted. There are some particular use of cloud computing as well, apart from typical SaaS, IaaS and PaaS. Companies using cloud for Design as a Service (DesaaS), Manufacturing as a Service (CMfg), Simulation as a Service (SIMaaS), Experiment as a Service (ExpaaS), Integration as a Service (INTaaS) and Management as a Service (MAaaS) as argued by (Tao et al., 2011).

6. Conclusions

The chapter will begin by revisiting the research question and objectives and connect those to the data findings and discussion. Afterwards, the chapter concludes by outlining recommendations and future research suggestions in this area.

6.1 Research Question and Objectives

The aim of this research was to explore the possibilities and limitations of cloud computing for a project based organization. The primary research question, as outlined in the introduction chapter focuses as under:

What are the possibilities and limitations of cloud computing for a project based organization?

As previously described in the introduction, analysis and discussion chapters, the research was broken down into sub questions. Breaking down the questions helped to design the interviews and lay a foundation for a rational research scope both within project based organization and academia. Later, the incorporating objectives of this research were recognized as follows:

- Exploring the potential advantages and disadvantages of cloud computing for the case study company
- Potential benefit and limitation of cloud computing for the case study department
- Improved information sharing and project management through cloud computing

The research objectives were attained by conducting literature review, observations, informal meetings and interview questionnaire designed to reflect and include the objectives accordingly. The mixture of selected respondents' roles and responsibilities also assisted to address the pre-defined objectives and validity of the discoveries.

6.2 Answer to the Research Question

The research has identified that the case study company has taken some initiatives and adapted some cloud services. Those services are primarily within storage, elastic compute and data analytics. The case study company is saving around 10% of cost with adaption of different cloud based service (e.g. storage).

Cloud computing certainly facilitates in saving cost, when it comes to adapting new technology or even moving existing IT infrastructure on cloud (e.g. storage). As there is limited up-front cost involved. Furthermore, the case study company may exploit the power of supercomputing for faster energy simulations (if an application support) and huge data analysis, automatic generation of drawings. Additionally, the company may achieve up to 99.5% up time, with software as a service. The case study company may store their non-critical data on public cloud, while confidential information on private/hybrid cloud as data is protected and secured with increased security centric solutions, automatic backup and disaster recovery settings. However, the case study company may need to consider various technical, cultural and management aspects, which may bring a noticeable change within the company.

It is suggested that simply, adaption of cloud based project management and simulation tool at the case study company or energy department may not improve information sharing and collaboration or generate several building design alternatives at early stages of projects in current working environment. There are two reasons behind this, first there is already an online project management tool available. Secondly, the existing online project management and information sharing tool as well existing simulation software are not utilized at their full capacity. However, the possibility is either the employees shall be trained and motivated or they are forced to store, retrieve and send the information via existing online project information sharing platform or a new cloud based application.

At this stage, energy department in particular, may not need to adapt simulation as a service (SimaaS), as it may require specially designed software which uses the multiple cores to do faster simulations. However, simulation software as a service on a rental basis may be an option. As limited number of simulations are executed per building project. It is suggested to do thorough cost analysis as compared to existing software license costs.

The major challenges associated with cloud computing, as found with this research is usage of cloud based application or service. It is not explicitly obvious that all types of companies can benefit from cloud computing. Although, number of cloud applications are available, that does not necessarily mean that it would fit with any company's needs. Therefore, a company needs to evaluate the usage of application, vendor security and privacy arrangements before signing any contract. In addition to this, data lock-in and integration of cloud services seem to be the major challenges.

Another important aspect is the impact of cloud adaption, which may cause visible changes. These changes may influence the management of projects, such as information, document sharing and collaboration as well as culture to adapt the changes. On one hand, it may force employees in positive way to leverage from the new cloud services/tool. On the other hand, it may appear as non-effective as a result of user unpreparedness and resistance to the new system. This is primarily a management decision, which needs to be evaluated on full scale and staff shall be engaged from the early stage.

6.3 Recommendations for Adopting Cloud Services

Within the business settings investigated, it is found that different employees were using different IT tools. This exposed challenges of information sharing in cross disciplinary manner. One way to solve this issue is encouraging employees to use existing online project management and information tool. Another possibility is adapting cloud based services, which only allows storing and retrieving information via cloud. While, adapting any cloud service, the company needs to do thorough analysis of that cloud product or service, such as ultimate use of the service acquired. It may include but not limited to, cost saving, user integration and management issues within the existing system and goal of the adapting particular service. Same may apply for moving the existing infrastructure on cloud.

Furthermore, it is also important to evaluate the vendor's capability to provide services contracted and the security and privacy arrangements. Data migration and extraction arrangement may also be considered along with application of laws, in terms of vendor or customer company's local laws.

6.4 Limitations of Study

The study had some limitations predominantly tangled to the time constraint. Supplementary time would allow the observations to be extended in order to warrant the validity of the perceptions discovered in the semi-structure interviews. However, the study did discover concepts that lead towards areas of development. Furthermore, the conclusions and recommendations are constructed on a solid theoretical background recognized from literature review, which reveals a general perspective and should therefore be relevant outside the case study organisation.

The conclusions were not verified due to time restrictions. Therefore, the conclusions are limited to the academic characteristic of how cloud computing can help in better management of projects and thus increasing the productivity within the organization and enhanced utilization of resources.

6.5 SUGGESTIONS FOR FUTURE RESEARCH

The research leaves a few unexplained ends, which could be intricated by further research, such as:

- Evaluating integration and user management issues associated with cloud computing
- Investigate how mature are company services and what services are appropriate to move to the cloud
- How should a company adapt IT infrastructure to enable such a decision?

Additionally, as the research was conducted in only one company it would be desirable to further discover the topic in different settings and industries to confirm its broader pertinence.

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