Czech University of Life Sciences Prague

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Diploma Thesis

Analysis and design of cloud solution for a company

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DIPLOMA THESIS ASSIGNMENT

Suman Bhandari

Informatics

Thesis title

Analysis and design of cloud solution for a company

Objectives of thesis

Main aim of the thesis is to analyse and design a cloud so
Partial goals of the thesis are as follows:
- to make literature review of current state of the art
- to develop a case study of the company with desi
- to formulate final conclusions.

Methodology

Literature review is conducted using meth

Practical part is made of the case stud
analysis. The new cloud solution desi

Final evaluation and conclusion wi

lution for a small company.

of cloud solutions for small companies,
gn and selection of the cloud solution,

ods of literature review and secondary data analysis.

y of a company, analysis of the current situation and requirement
gn is selected by multiple criteria analysis (MCA) method.

ll be based on literature review and result of the case study.

The proposed extent of the thesis
60-80 pages

Keywords
Software, computer, company, mobile, application, network, connectivity, cloud

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Declaration

I declare that I have worked on my diploma thesis titled "**Analysis and design of cloud solution for a company**" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on: 31/03/2016 ----------

Suman Bhandari

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Analysis and design of cloud solution for a company

Analýza a návrh řešení cloudového úložiště pro firmy

Abstract

Cloud computing has observed as the important paradigm for the deploying application and services for both end-users and enterprises. Discussing on these various aspects of cloud and their importance for smaller organisations and the business sector, this thesis will diagnose the problems in the cloud paradigm and finds the optimal solution of the cloud service providers to small and medium sized enterprises (SME).

The main purpose of this thesis is to discuss in the selection process of cloud service providers in Nepal for the small and medium sized companies (SMEs) and a small virtual company Shine Info-Com has been created to conduct this by the author. To choose the appropriate cloud service provider for SME, the Multi criteria decision analysis (MCDA) will be conducted and the Analytical hierarchy process (AHP) will be applied for calculation for getting the weighted values of the criteria on the SMEs requirements. The pairwise comparison among criteria and alternatives and the degree of consistency has been measured on each pairwise comparison. After finishing the calculation the alternative with the highest weighted value was selected. The cloud service provider Access World has been chosen as the best alternatives for the SME i.e. for Shine Info-Com.

Keywords: CSP, SME, Cloud Computing, SaaS, PaaS, IaaS, XaaS, MCDA, AHP, ANP, MAUT/UTA, TOPSIS, Degree of consistency, Pairwise Comparison, Normalisation

Abstrakt

Na Cloud computing je nahlíženo jako na významný vzor pro zavádění aplikací a služeb jak pro koncové uživatele a podniky. Byla provedena diskuze ohledně těchto různých aspektů v oblasti cloudu a jejich význam pro menší organizace a podnikatelské sféry, kde následně bude tato práce diagnostikovat problémy v Cloud paradigmatu a najde optimální řešení u poskytovatelů cloud služeb pro malé a střední podniky (MSP).

Hlavním účelem této práce je diskuze ve výběrovém řízení poskytovatelů cloud služeb v Nepálu pro malé a střední podniky (MSP) a malé virtuální firmy Shine Info-Com, která byla vytvořena autorem. Pro výběr vhodného poskytovatele cloud služeb pro malé a střední podniky, bude provedena vícekriteriální analýza (MCDA), kde jsou bude aplikován analyticko hierarchický proces (AHP), který se použije pro výpočet pro získání vážené hodnoty kritérií uvedených požadavků malých a středních podniků. Párového srovnání mezi kritérii a alternativ a stupeň konzistence byla měřena na každém párového srovnání. Po dokončení výpočtu byla zvolena alternativa s nejvyšší váženou hodnotou. Poskytovatel služeb cloud Access World byl vybrán jako nejlepší alternativa pro malé a střední podniky to znamená pro Shine Info-Com.

Klíčové slova: CSP, malé a střední podniky, cloud computing, SaaS, PaaS, IaaS, IaaS, MCDA, AHP, ANP, MAUT / UTA, TOPSIS, Stupeň konzistence, párového srovnání, Normalizace

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Acronyms

SME: Small and Medium sized Enterprises

CSP: Cloud Service Providers
SaaS: Software as a Service
PaaS: Platform as a Service
IaaS: Infrastructure as a Service
XaaS: Anything as a Service
NIST: National Institute of Standard and Technology
ENISA: European Network and Information Security Agency
DM: Decision Making
MCDA: Multi-Criteria Decision Analysis
MCDM: Multi-Criteria Decision-Making
AHP: Analytic Hierarchy Process
ANP: Analytical Network Process
MAUT: Multiple Attribute Utility Theory
UTA: Utility Additive Method
TOPSIS: Technique for Order of Preference by Similarity to Ideal Solution
GPS: Global Positioning System
GM: Geometric Mean
VPS: Virtual Private Servers

1 Introduction

The worldwide usage of Internet is increasing day by day and there are a great deal of new programs are introduced for the improvement of Internet functions and practices (1). In fact, in every place, every sector, even within the decade, there is tremendous change and huge improvement of doing work and performing services by the new and innovative ideas on the Internet and its uses. People can even performed their lives without the Internet and computer technology before 20 years, but now we can't even imagine what happens if these systems are destructed only just for 10 min. This is the creation of computer and data engineering (2). If we induce a proficient information and good technology then we can apply our ideas in the innovative sector that definitely make the best solutions.

The use of the Internet has now enabled us to share and store the different forms of information (3). Now finally we have come at this place where we can think the huge benefits of the use of the Internet that surpasses in every sector. Today, there is a lot of buzz in IT world about the Cloud Computing (4).

The remarkable development of cloud computing in recent years is attracting more and more interest from various users of the Internet and computer looking to make the most of the services and applications available online through the web fashion-demand services and usage billing. This is a new business model that cloud computing promises for ICT. Indeed, the model promises a shift in the mode of investment and operation of IT resources. Today organization has the choice to migrate to a cloud computing model where they can buy or rent online resources (5). This model saving them the cost of internal management, as IT resources are administered at the supplier level of Cloud Computing.

The availability of online services also gives the possibility of no longer appropriate computer equipment, but to pay the fee depending on the use of resources. This model is already attracting a large number of companies including small and medium enterprises (SMEs) and very small enterprises (6).

In a simple word, it means that we can allow the users that have access to the Internet to use software and storage that they are not on their own computer but it is borrowed from remote site by the use of the Internet. This signifies that the users don't need to have storage the programs they want to use. Instead of this they just need a device to connect to

the Internet and they can get everything they want in the instance (7). There is a more efficient technology that the saving off set-up cost for companies, the easy access of whatever they need and not having to worry about the maintenance and upgrade. But as every rose bears thorns, we should look upon the complications of implementation of such a model over the Internet. We will see the sides that attack such practices and most importantly, we will attempt to alert the users of the security risks involved in cloud computing and the things to keep in mind while making a commitment.

Cloud computing is offering the scalability in IT resources (hardware and software) and their availability, in terms of volume and time, according to customer needs and to their request. In an economy where companies seek to maximize the return on investment and reduce operating costs, cloud computing presents itself as the solution of tomorrow.

According to Gartner, the cloud-based security services market was $2.1B in 2013, rising to $3.1B in 2015 (8). According to the same source, cloud computing arrives, in 2017, half of the big enterprises deployed cloud computing. As Forrester predicted that in 2016 the SaaS software revenue will be reach 106 billion US Dollar, increasing 25% of projected spending level in 2015 (8). That means the as the outlook of the tech market in 2015 the most of enterprises will spend towards enterprise process apps like ERP and CRM. So this is the fact that this cloud sector will rise brightly in coming years and will be a prominent factor for IT (4).

Despite the many benefits of cloud computing, its successful adoption in companies requires a prior understanding of this new dynamic IT services. Often it is necessary to develop specific expertise in the areas of administration of data centres and trade relations before the implementation of cloud computing concept (9).

Currently, insufficient legislative and regulatory frameworks with appropriate instructions do not favour the rapid adoption of cloud computing and the establishment of trust between stakeholders (10).

2 Objectives and Methodology

The small and medium sized enterprises needs the cloud service providers for the virtualised office infrastructure to run their business. The main objectives of the this thesis is to choose the appropriate cloud service provider for SME in Nepal to reduce the investment in infrastructure or to get the enhanced and innovative services from the operator.

Nowadays it's a trend to have the server for any company and it is essential to perform their work with full efficiency. To have this every big company is going to make their own data centres and they make enormous data centres all across the world. By the development of broadband Internet technology, it is easy to share the data at tremendous speed through the Internet and there is a huge buzz in the marketplace around the cloud computing. In a simpler word not every company can acquire their own data centre as a result they want to hire it and the bigger company who has enough infrastructure gave them to an icy in a proper contract called SLA. And now this thesis is talking about the small and medium sized enterprises SME which is evidently unable to get own data centre or they don't desire to spend their huge capital rather their wants is to rent it.
The Company *Shine Info-Com* needs the cloud helps to store the data and utilize the virtual office software services from the CSP. There will be more than one alternative for CSP and there are also conflicting criteria of our needs which determines the selection of CSP. They may be cost, security, Availability, service extension and customer care and hence along. Thus the principal aim of this dissertation is to choose the suitable cloud service provider from the set of alternatives according to the SME needs. And so the decision making process the MCDM has used because it was quite similar to employ in our case in multi criteria with multiple at alternatives.

The study is carried out by obtaining the information through different electronic non printed as well as printed sources. The author studied the research papers of different others regarding the cloud computing architecture and business models such as paper from National Instuite Of Science and Technology, European Union, Google scholar, Several IT

related web pages like Gartner, and some of the market analyzing company profiles like SAP and so on. And after the author conducted the several stage interviews with experts and other personnel to get the swot analysis of the company and to get the weight on the criteria with the alternatives on this research. Then after getting the values from the experts, and making the hierarchy of the criteria, the author was gone for the calculation and pairwise comparison of each of criteria to each of the alternatives and calculations were done. On the calculation part below, all data were analysed in the excel 2010 and presented in the table.

3 Literature Review

The exact definition of cloud computing varies from different perspectives and purposes. When considering the different types of characteristics of cloud we can find more than twenty different definitions.

For example, according to Buyya et al; “Cloud is a parallel and distributed computing system consisting of a collection of interconnected and virtualised computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers”. (11).

In a broader definition, Armbrust et al., define cloud as the “data centre hardware and software that provides services”. (12). As accordance of Sotomayor’s perspectives, “cloud” is a term that mostly refers to the IT infrastructure that is deployed on the Infrastructure as a service provider data centre.

Gartner defines cloud computing as a style of computing where massively scalable IT-related capabilities are provided “as a service” using Internet technologies to multiple external customers. (13).

A more formal and most cited definitions for cloud computing is provided by the National Institute of Standards and Technology (NIST). According to NIST, “Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” (14)

European Network and Information Security Agency (15) agree cloud computing to be a new way of delivering computing resources that are available for a long time. So, it is not a new technology, but rather an approach that shall alter the face of traditional computing.

According to Opencrowd.com, cloud computing is accompanied with “extremely efficient, massively scalable multi-tenant data centres offering organizations an alternative way of building, deploying and selling IT services at a significantly lower price.” (16).

This feature of cloud of having scalability and flexibility has serious impact on its security. In cloud there is a high concentration of data and information that makes an attractive target for the attackers. But defence can equally be robust, scalable and cost effective.

3.1 Demand of cloud

The characteristics of Cloud as mentioned in the introduction are: Virtuality, scalability, reliability, efficiency and flexibility. With relatively inexpensive mobile devices and their advanced networks as a fact, processing increases. All computers that have a cloud, to lead to this need very quickly. Emergency and auto leasing is a favourite strategy planned after processing in the cloud computing paradigm on request. Most of the strategies are automatic planning and consideration of the maximum use of resources. To achieve optimal or sub-optimal allocation of emergency services in the cloud, mid-cloud security is the best option (17).

Cloud computing is less expensive compared to other models of processing; no fees to the service provider responsible for the availability of services and customers are free of maintenance and management problems of resource machines, so that organizations do not need to pay for it and review their internal IT solutions (18).

3.2 Cloud service providers

A cloud computing provider is enterprises or a company that provides the required technology to enable a cloud computing service. The company host and provide the infrastructure required to be able to offer the service (5). The vendor can also use a hosting provider, but the important aspect is that the user doesn’t have any hardware locally.

They manage the infrastructure required for the provision of services, working on cloud software services which are provided by them and services over the network. As there is a definition that "Cloud service provider represents the company's offers some of the components to the cloud: Infrastructure as a service, software as a service and platform as a service - to other companies or individuals" (7). Amazon is officially the first cloud provider with the offer of the Amazon Simple Storage Service (Amazon S3) in 2006. Furthermore, the Amazon another well-known cloud provider for Apple, Cisco, Citrix, IBM and other prestigious and big organizations.

As a comparison to Nepalese IT sector its use in day to day life, it is quite slow and less developed infrastructure and the government policies are still not cleared but they are trying to make it seriously. Nepalese government started to invest in this sector and helped to the entrepreneur to provide the best facility to them, so they open IT park in Banepa (19), near the capital of Nepal with all facilities. Many organizations are going to open their offices there and Nepalese entrepreneur also going to invest there. As now from the public sector, there are around 6 cloud service providers.

They are Cloud Himalaya, Otel communication, Subisu Cablenet, and so on which we are going to describe in further chapter.

3.3 Cloud service users

The user of a cloud may be any company, enterprises or individual user who uses the cloud services provided by the cloud computing provider (20). The user (company, enterprises or a person) doesn't have any hardware of infrastructure in-house, but uses the provided service from the provider through the Internet connection (21). Cloud customer contacts provider and himself chooses which of the services offered by the cloud provider needs, after which contract to use them with the provider.

The users of SaaS can be organizations / institutions that uses access to applications. SaaS can be charged based on the number of end users, time of use, the used network, the size of stored data, or duration of a data storage (22).

The users of IaaS can be systemic developers, system administrators and IT managers who are interested in installing, creating, monitoring, and managing services for IT infrastructure operations. The IaaS users should have the ability to access these resources machining, and to pay according to the size or timing of the resources. Such as used hours of CPU - virtual computers, the size and timing of a data storage, network bandwidth used and the number of IP addresses used in a certain interval (7).

Some cloud service requires an application to be installed on the users' computers, but there are some who believe that this cannot be categorized as a cloud computing.

3.4 Major specifications of cloud

There exist a lot of definitions of cloud computing, there are some common characteristics amongst all these definitions. These characteristics can be classified the major five categories of Resource aggregation, Self-service automated access, Resource elasticity, Pay-as-use business model and Ubiquitous network access (7).

3.4.1 On-demand self-service

According to NIST, in a cloud "A consumer can unilaterally provision computing capabilities such as server time and network storage as needed automatically, without requiring human interaction with a service provider" (14). The on demand services can help the client as there is no need to manage the services and the client get their desired services from within the click on their computer. This helps to reduce the cost of unwanted program and software for a particular group of people. As compared to the student and farmer, the student need the academic software and programs like office, SAS, SPSS but for farmers it may be not required SAS or SPSS rather they can get other agricultural programs and they can access without the presence of service providers physically.

3.4.2 Broad network access

"Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g. Mobile phones, laptops and PDAs) as well as other traditional or Cloud based software services" (14). As there is network to access to the cloud then every client should get and interact with the services in any form of electronic media. But as a traditional computer hardware system, to access the program, first it should install and run through your device and sometimes if you have limited capacity of storage disk then you cannot access them. But as the comparisons to that the cloud infrastructure and services helps as that is not needed to install on the device and that services can use online and needs a little space in your disk to save that work after use as compare to the installing the whole program.

3.4.3 Resource pooling

"The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned to consumer demand. There is a degree of location independence in that the

customer generally has no control or knowledge over the exact location of the provided resources, but may be able to specify location at a higher level of abstraction (e.g. Country, state or data centre). Examples of resources include storage, processing, memory, network bandwidth and virtual machines. Even private Clouds are tended to pool the resources between different parts of the same organization" (14).

3.4.4 Rapid elasticity

"Capabilities can be rapidly and elastically provisioned- in some cases automatically- to quickly scale out; and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time" (14). It is easier to add and remove the desire services and you can even do better through cloud. There is no need to do all the lengthy process, in within a second after paying to your service provider you can access that service immediately.

3.4.5 Measurable Service

"Cloud systems automatically control and optimize resource usage by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g. Storage, processing, bandwidth or active user accounts). Resource usage can be monitored, controlled and reported for providing transparency for both the provider and consumer of the service" (14).

3.5 Cloud Service models

There are mainly three different service models which are used in cloud to describe the different services that can obtain. The detail information about them is as follows

3.5.1 Software as a service

Software as a service (SaaS) is focused on renting the application to users as accordance to their subscripted time. As it is on rent so the application is not owned by the user, but the provider makes the user to use smoothly as per their pay and time span. The provider is fully responsible for the maintenance of the application if needed.

According to NIST's cloud computing definition SaaS in the renting of both infrastructure and application of totally managed by the provider through a web client like web based

email. The total infrastructure is situated in data centres. The required configuration that can be done by users is the setting for the application the rent (23).

3.5.2 Platform as a service

Platform as a service (PaaS) is much more similar to SaaS. It focuses on the rental of the infrastructure so the user gets a platform to build their own applications with programming tools provided by the provider. It includes servers, operating systems, storage space and the help with building an application. The difference between SaaS and PaaS is SaaS gives you a little space to build something of your own while PaaS gives the room for maintaining the application on own terms (24).

This types renting service gives the user free handles to perform and maintain their own applications. It is a good option that PaaS lets the organisation to hire the necessary supportive infrastructure for their application.

3.5.3 Infrastructure as a service

Infrastructure as a service (IaaS) is one step further than SaaS and PaaS. It is when providers are handling only the infrastructure for a user and the user can run and develop software within the hired cloud infrastructure which is situated in a datacenter often. The user can run operating systems and applications of their own terms, maintain the storage and makes the network they want by deploying firewalls (25).

In this system, providers are only for maintaining the infrastructure so it may also refer as hardware as a service (HaaS). Often the user pays for the hardware to the provider as accordance to used time.

3.5.4 Anything as a service

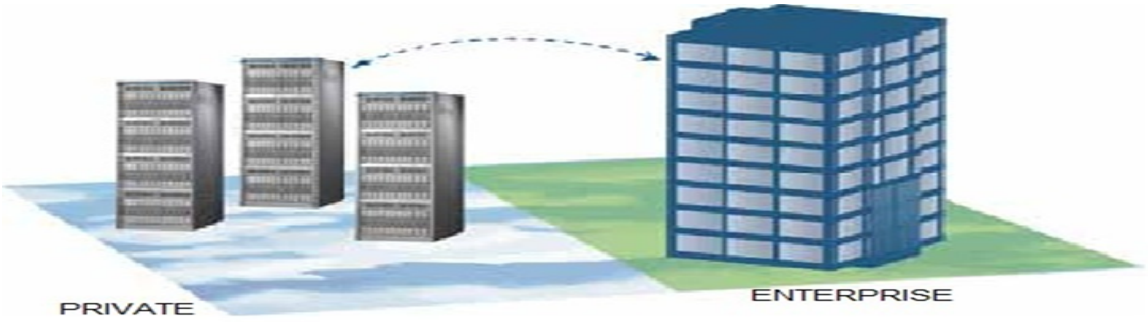
Anything as a service (XaaS) is a service model which offers any services to its clients depending their needs and requirements. It can also understand as everything as a service, anything as a service (26). In this model any services can allow to provide the costumers like Storage as a service, disaster recovery as a service etc.

3.6 Cloud Deployment Models

There are four different kinds of deployment models for cloud computing. These models are independent of the type of SPI concerned. So, these four models form the basis for the use of cloud computing.

3.6.1 Private Cloud

"The Cloud infrastructure is operated solely for a single organization. It may be managed by the organization or a third party, and may exist on-premises" (24).

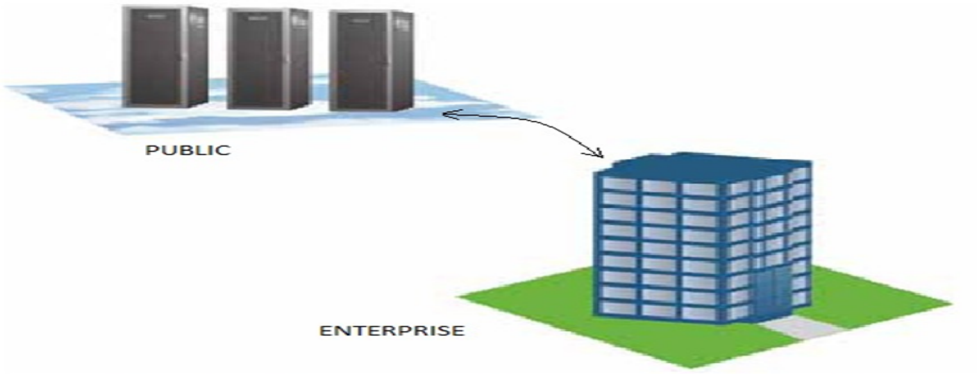


Private clouds may be hosted at a colocation facility or in an enterprise datacenter. They may be supported by the company, by a cloud provider, or by a third party such as an outsourcing firm.

Figure 1: Private Cloud

3.6.2 Public Cloud

"The Cloud infrastructure is made available to the general public or a large industry group and is owned by an



A public cloud provides services to multiple customers, and is typically deployed at a colocation facility.

organiz ati

on selling Cloud services" (24).

Figure 2: Public cloud

3.6.3 Community Cloud

"The Cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g. mission, security requirements, and policy or compliance considerations). It may be managed by the organizations or a third party and may exist on-premises or off-premises" (24).

3.6.4 Hybrid Cloud

"The Cloud infrastructure is a composition of two or more Clouds (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g. Cloud bursting for load-balancing between Clouds)" (24).

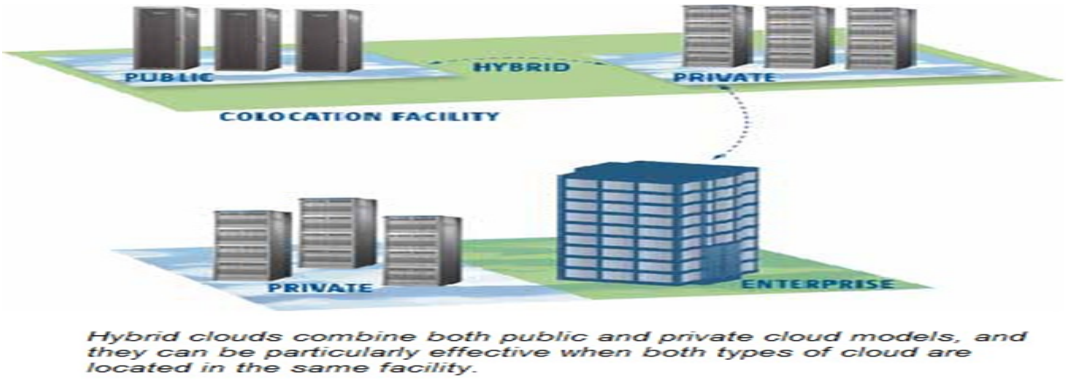


Figure 3: Hybrid Cloud

3.7 Cloud application models

As the application of cloud services we can discuss about different types of cloud solution for a company. Some company needs more features of cloud and some don't. So as the basic idea of cloud is use the required service and pay the least amount of fee so here are some models of cloud according to their uses:

3.7.1 Storage as a service

In this type of service, the cloud provider provides the only storage as a service. Nowadays, many users don't want to take their storage device and they want their data online. These types of clouds provide on demand service through the Internet at any time. This is like a secure Internet account and the users can browse it through the Internet. According to tech target, storage as a service is a business model where a smaller company rents the storage spaces from large company's infrastructure (27). There are so many service providers for these types of services. For examples google provides google drive, Microsoft provide OneDrive, Dropbox, Amazon cloud drives are the storage services of cloud computing.

3.7.2 Office application as a service

In this type of service, the company only provides the office tools as a service. Because of all the users do not need all the other services, but they may want to use the office tools as a service. So this kind of cloud service is known as office application as a service. Microsoft office 365 is the best example about these types of service (28), where they provide office tools as Word, Excel, PowerPoint, Onenote as a service.

3.7.3 CRM as a service

CRM stands for customer relationship management. This type of service is used to store the customer related files in one place. It can track all the related documents and information through the Internet in any kind of devices and able to read and write on it without download. One of the best examples of this type of cloud is *salesforce.com* and most of the other cloud providers also provide these services. In this kind the data are Fully Scalable and fast access and can store any attachments in cloud and it shares the files between CRM and other cloud solution of the same kind.

3.7.4 ERP as a service

Enterprise resource planning (ERP) is a planning approach of making cloud computing flexible accordance with the enterprise process of transformations (29). It is fully scalable and as low hardware cost so it benefits customers and users. Many organisations use the public cloud ERP as they wants to acquire cloud ERP without managing hardware, software and updates. The customer can build their own cloud ERP server own their office premises with local access to their data server can manage greater control and integration. In this type of services the customer also can manage their privacy as low and high level of their data, and it is free to innovate to add new functions and features on their cloud and any time if you wish to move your data and you are able to do it. As an instant this is a service what costumers wants and accessible.

3.8 Overview of cloud computing

This is a conceptual model of Cloud Computing which is taken from National Institute of Standards and Technology (NIST). This is basically a model that summarizes the characteristics, service models and deployment models of cloud computing.

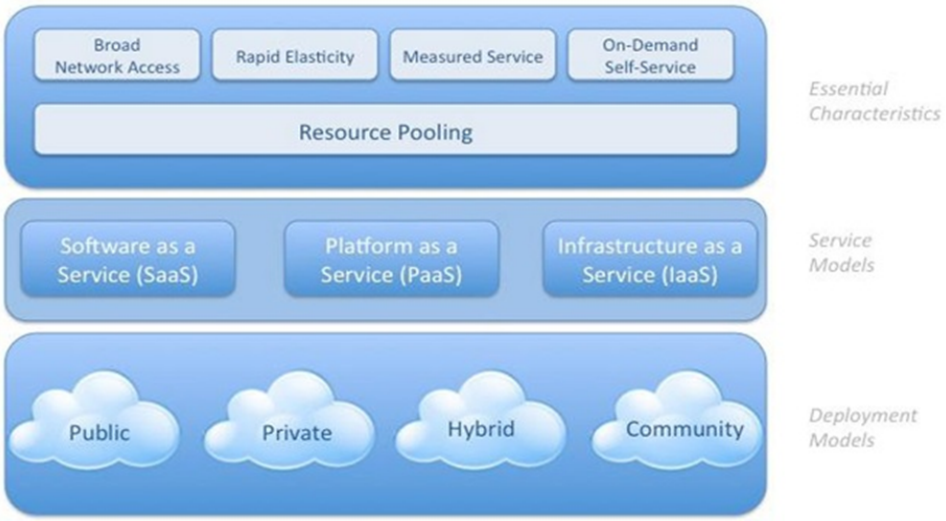


Figure 4: Working Defination of Cloud Computing (7)

3.8.1 SPI overview model

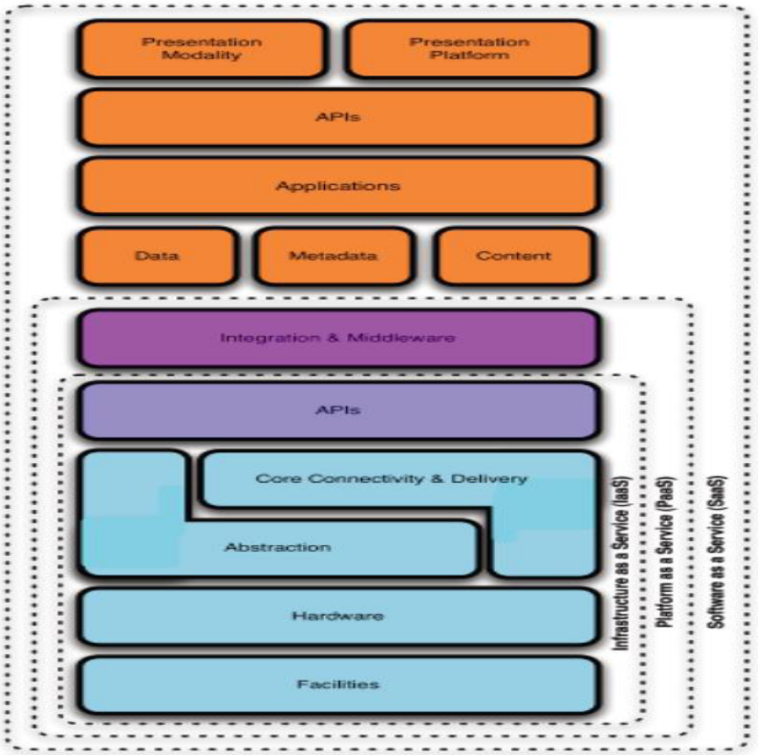


Figure 5: : SPI Overview and multi tenancy model (7)

This figure displays the basic overview of layers in software, platform and infrastructure (SPI) services in cloud computing.

3.9 Advantages and drawbacks of cloud service

As we know that in every cloud service there may be a problem to provide services and security concern, so here the author is going to specify the common advantages and disadvantages of this service.

3.9.1 Advantages

The cloud computing is paid per the uses of services or length so it is often easier to reduce the cost by controlling the unwanted and unnecessary uses of the services (18). As compared to the computer or may be small server used by the enterprise, there may get more spaces of storage through the cloud service provider. The information technology should be up to date day by day with the latest release and it is managed by the provider so the IT department can also focus on other tasks and issues. The employee and other people can easily get the desired data and information and can easily get connected through the system with many different sources like tablets, smartphones and laptops (21). The cloud system makes the information technology sector more flexible and more obtainable through different sources and also makes it easier to perform the work (22).

3.9.2 Drawbacks

The first drawbacks that come into minds when talking about cloud computing. A user can only trust and trust and hope that the provider has a good policy towards security and privacy of his data. Many companies hesitate because their data is handled by an external source and the may not be satisfied with their policy about data security (5). Many companies like to have the all access and control over their data; naturally the lack of control is an issue of not selecting the service which provides them.

In other drawbacks of cloud is, it cannot deal with large data sets, i.e., it is hard to move huge amounts of data through the cloud. It may not be fast and may get trouble to transfer data like several terabytes of sizes and at the use of cloud it has needed the good bandwidth of having good connectivity of the internet and it may trouble the organisation when if there is problem in connectivity.

3.10 Multi Tenancy

Multi-tenancy is the simplest form that multiple customers can use the same public cloud. According to cloud security alliance, it is the using the same resource or application by multiple users of the same or different organizations (24). In cloud it is an important aspect to deliver to the costumers that a single service can be used by many users and the organization to take the benefits from it. It needs to imply for policy –need enforcement,

isolation, and service level for different customers. “Multi tenancy is any application to broader towards IT cloud adoption and it is a key common attribute in private and public cloud and it can also apply in all three layers of cloud computing (30)”.

3.11 Advantages of Multi-Tenant in cloud Architecture

Multi-tenant in SaaS architecture is more prominent and becoming useful among cloud service providers. In this environment, all clients and users can use the services as same platform of technology, components of sharing technology stack covering data model, database and layers and servers (31). There are significant benefits of multi -tenant which are as follows:

3.11.1 Scalability

A multi-tenant infrastructure changes the capacity of service providers as required and desirable time. When a company adds a new hardware to its system, then it is scalable i.e. the total capacity of the system increases (32). It is not only important for a single customer, but it is for all entire client base system. This makes the advantage for clients and costumer to hire more system at a particular time and then they can replace it with normal uses. As an example, when a television channel can broadcast the most important breaking news then all wants to know about it, then more than its audience can visit its website, then it may crash the server the Chanel or loading problem, but to solve this the channel can take additional infrastructure for that time and make a smooth connection to its audience. This may happen for the TV Chanel at time of election and so on. So they hire the hardware just for few time and scalable with their old system and get operated in a smarter way.

3.11.2 Performance

The multi-tenant architecture is helpful as a single tenant architecture environment to increase the performance of several elements in technology multiplicity, so optimum speed and reliability can be insured. This model provides, more exactly access in the facture of IT Architectures like speed, utilization across platform more efficiently whenever needed (33). Sharing with the tenants can be said always it is beneficial to single tenants too.

3.11.3 Service

Besides managing several technology stacks for each and every client, the SaaS service provider can give more efficient and effective values and support services by monitoring just one platform. This decreases operational charges for service provider and they can even deliver their services more effectively (34).

3.11.4 Upgrades

In this model the upgrades in the software version of the technology stack like operating system, database is easier because of the single and centralised place to acclimation, install patches and so on. At any particular time the service provider can do upgrade and as they upgrade to their system more tenants can get it so as compared to single tenant architecture (35).

3.11.5 Overview of Multi-Tenancy

Some exerts believes this model is good for costumer perspective, not the service provider perspective as if their system fails, then they are unable to deliver the services for all their clients and users which can damage their reputation (36). And by one problem every customer is affected and this is bothering for them. They have to invest and make more secure and effective system which can sometimes cost them more. As an overall aspect this helps to the whole IT sector and especially the country like Nepal, many people can get services and benefits from this.

3.12 IT Adoption

IT adoption means a lot of things which are important to know what IT adoption means in cloud computing. In the accordance with information technology adoption of IT has a lot of different views, a lot of like cloud computing. It is possible due to present of a lot of different technologies and sometimes it is hard to choose a common general definition for it. Many peoples remember first on their mind that a technology means computer and Internet while other people may think of cameras and other devices at the same time (37).

We are in the mobile dominated world so we adopt technology in accordance with under different circumstances.

To describe the adoption of IT we can present it with five different steps.

1. Awareness – The potential users can learn enough about technology and apply its benefits to their daily life if they want to get more by using it.

2. Assessment- The users checks the usefulness, usability and benefits and may think to adopt such technology.

3. Acceptance- After investigating and decision the users can go forward to get such technology or leave this thought.

4. Learning – the users can develop the essential knowledge and skills to use that technology in an efficient manner.

5. Usage – the users may use in an efficient way.

In conclusion, we can say that the adoption of IT is a process which the users can go from awareness to use in an efficient way. By user to user they may adopt the steps differently, but the main theme remains same that is to use the technology in proper and much more efficient way.

3.13 Government roles in cloud computing

Despite the fact that there remains a number of unanswered questions in the area of governance of regulatory compliance around cloud computing, this new IT resource utilization model grows rapidly and supported; mainly because of its ease of use, accessibility of services directly via the Internet and especially because of the productivity improvements and cost savings from the adoption of cloud computing (38).

On the other hand, it is certain that the cloud computing environment, although relatively new, the weight to be given to good governance and integrity systems and data.

But questions remain about the ability of firms adopting cloud computing technology to continue to meet all applicable standards of governance established and applied to the conventional IT business environment: Will he regulatory principles established specifically to protect users of cloud computing? What services of cloud computing that meets the requirements of the best practices and recommendations already established?

All these questions have many business challenges not only directly involved in the provision and use of cloud services, but also for governments and other actors involved in corporate affairs (39).

In this respect, there is now a body of opinion which does not believe in the possibility of compliance of cloud computing services to good governance practices of the IT companies (39). Justify his pessimism that companies cannot take responsibility for the control of those who can access their data, or the responsibility of the storage of such data; saw that one of the basic principles of Cloud Computing is that data can be hosted and stored "anywhere in the world."

On the other hand, the actors of cloud computing say the basic principle of this new technology is the integrity of the audit process, ensuring compliance with the rules of good corporate governance. Indeed, it is a process that requires keeping track of all the elements of data - whether located in data centres owned by the company itself or somewhere in the cloud (7).

However, questions remain about the ability of the actors of cloud computing to quickly meet the following requirements:

- Compliance with the regular evaluation of management performance and responsibility sharing rules process.
- Identification of incidents of failures in systems administration.
- The need to quickly remedy the shortcomings in the control of internal processes.
- The need to establish good relationships and communication channels more open between all players in the Cloud Computing and regulators.

The concept of cloud computing represents the variety of services (IaaS, PaaS, SaaS) and several possible business models (public and private cloud computing) (7). This makes cloud computing more difficult to decide on a process or a specific approach that will be enough to apply to comply with regulatory requirements.

However, Cloud Computing technology is constantly evolving. Issues related to compliance and alignment of a cloud computing environment with best practice in terms of corporate governance are treated by specialists internationally and solutions are regularly made (22).

These developments mean that organizations and companies adopting cloud computing will have access to cloud services completely secure and in compliance with the requirements of good governance (38).

3.14 Small and medium sized Enterprises (SME)

Small and medium enterprises (SMEs) account for over 95% of all businesses and 60-70% of employment; it is they who create much of new jobs in all most all countries' economies (40). They have advantages and disadvantages are their own. Due to the effect of globalization, technology and other factor, the economy scale becomes less important in many activities and it results that the potential contribution of small businesses is huge. At the same time, many of the problems they face are traditionally inadequate funding; technology operating difficulties, limited capacity, managerial, low productivity, and regulatory burden are increasing in a globalized world where technology becomes dominant. Small businesses need to improve their management skills, collection of information capacity and technological base. It is for the authorities Public improve access to finance for SMEs, infrastructure information and international markets. Ensure regulatory framework legal and financial conducive to entrepreneurship and therefore the creation and the development of small businesses should be a priority.

The best way to boost small and medium sized enterprises (SME) sector is to encourage the partnerships of public and private sector of small businesses. Based on local production systems, small enterprises can be more flexible and responsive to customer which is quite beneficial to them (41). These groups allow them to pool their resources and to share the costs of training, research and marketing; they facilitate staff exchanges and dissemination of technologies and creating new opportunities for efficiency gains. Moreover, these networks and systems local support can help SMEs to meet the challenges of globalization. The public policy must take into account regional factors and Local affecting

entrepreneurship and rely on these features to encourage the partnerships within small businesses. It must use the institutions; business groups and inter-linkages locally to create and strengthen micro links that will target the competitiveness globally. SME policy should be based on local assets, supporting the new dynamics of entrepreneurship and clusters of small businesses to meet the challenges of globalization (42).

3.14.1 Difference in EU and US SME definition

SMEs are defined as independent companies have a number of limited employees. This number varies depending on the system of national statistics. In the European Union it is most common for 250 employees (43). However, in some countries, for the SME employee is limited to 200 and in the United States they consider that SMEs means all companies which have less than 500 employees (44). Small companies are generally those, which are employed less than 50 employees and micro-businesses count a maximum of ten, sometimes five. We also defined by the assets Financial: in the European Union, SMEs are those whose annual turnover does not exceed EUR 50 million and / or whose balance sheet value does not exceed EUR 43 million (43).

3.14.2 Roles of SME to Economy

In the European Union, SMEs play a major role in the growth Economic and it is they which create most new jobs. Over 95% of companies this area are SMEs, representing 60 to 70% of employment in most countries like in Europe (40). As large companies downsize and outsource more and more functions, the weight of SMEs in the economy increases. In addition, the growth of the productivity and consequently, the economy expands due to competition linked to the birth and death, and out of small companies. High levels of Job rotation and brewing labour market, it involves an important element in the competitive process and structural change. Less than half of new small businesses survive more than five years, and fraction is the core of highly successful companies which are the engine of innovation and industrial performance. This is important that the public authorities should reform the policies and conditions that govern the creation and business expansion to optimize their contributions which they can make to the growth the economy.

3.14.3 SMEs contribution to sustainable Development of Economy

Many efforts are made to improve the environmental performance industry through measures that encourage reduced emissions and encourage efficient use of energy and resources. However, Small businesses are usually less conscious than larger environmental externalities and legislation governing their activities. They have fewer resources to invest in improvements environmental and tools management that could make their more viable business for the environment. However, they can occupy market niches environmental goods and services. Involve the whole range of SME research, the sustainable solutions is a great challenge. With advances in ICT, governments and other parties' stakeholders have the means to reach, to inform and influence small business, but it remains to authorities to set a strategy and effective environmental small businesses to take more awareness of the need for such a strategy as to their level.

3.14.4 Government policies Towards SME

To get the role of SMEs in the restructuring of the economy, first of all the governments must promote entrepreneurship, facilitate the creation and development businesses and improve access to venture capital and other forms of funding. It is in this perspective that governments undertook to promote the development of secondary market values, in order to facilitate the entry and exit of investors; lighten the taxation of gains, interest capital and other dividends for the facilitation of the development stock options in small businesses. They encourage the networks that connect small businesses and investor's potential. The reduction of administrative burdens facing small businesses may be one of the major ways to stimulate entrepreneurship.

Regulations designed for large companies, with their procession of bonds may create difficulties for SMEs. The importance and complexity of formalities and the fact that the economic regulation prohibits certain activities constitute them the heaviest loads. So for encouraging the small business all the government should give the facility in some of this cases accordance to their contribution. But in Meanwhile, because of their relatively weak bargaining power and their lack of liquidity, SMEs need regulatory frameworks to ensure the reliability of transactions.

Encouragement for group companies can also improve performance and competitiveness of SMEs. Small businesses working group can acquire the same advantages as the major businesses while maintaining the benefit of specialization and flexibility. Governments (local, regional and national) may encourage links between small companies setting up public private partnership frameworks. Their role is generally indirect and consists of helping for skills development and identifies ways while eliminating constraints that oppose stronger interaction between companies.

To implement these initiatives and reforms for SMEs, governments put in place action plans and specialized services. In most countries of the world, services or organizations are responsible for promoting specific development of small businesses by providing capital, reforming the practice's budget, reducing the load administrative, by providing training, particularly in terms of management, improving the distribution information and access to markets. The establishment a regulatory, legal and financial conducive to the creation and the development of small enterprises depends on a range public institutions of all levels; local, regional, national and International.

3.14.5 Benefits of cloud for SME

The Cloud has a policy of storing data on a server or a remote data centre, not even within a company. The company thus accesses these data through a browser and an Internet connection. Many services have been developed through the Cloud: collaborative tools (modifications and real-time sharing of documents), SaaS management software, online data storage, unlimited access from any object connected to documents etc. all solutions involved in the production of the company. The use of cloud in principle allows optimal securing an organization's data. These are suppliers that ensure the physical protection of servers and a data encryption and a software monitoring. Many companies still use their own physical storage. Although this solution has many advantages, it can be risky. A company is never Flight shelter, virus or backup oblivion.

SMEs are the most affected by these risks since they do not always have the means to deploy a real IT safe for their data. Financially, cloud computing also has many benefits for small businesses. Subscription fits most often the real needs of the business, so it is possible to reduce costs by purchasing services at the height of the structure. No need for unnecessary storage capacity. Also, the cloud does not require whopping investment: the

payment is made according to the use. It is the company that decides the services they need and pay accordingly. Finally, the Cloud allows savings in maintenance and updating: it is the supplier to defray these often costly for a small business.

3.14.6 Challenges of cloud to SME

A small organisation has the minimum number of staff to operate the company. The team work in a small group and co-operation between them can lead a company further growing. In these types of model not all the members in that group are technology experts and this leads to disturbance to provide the services at any time of absence of a particular member. So the biggest issue is to provide the correct skilled oriented workshop by the company and for this they should hire the expert and their charges may higher. As a result company must bear the higher cost to provide the training which sometimes not possible due to limited financial fund. Other challenges are system failure, which can mislead the company reputation. As the company cannot open its own private cloud and system, then there may it happen due to third party so in the SLA with the cloud service provider they should clearly note about this. Cloud obviously help to smaller enterprises as compared to make own infrastructure because at the minimum cost, the enterprises can use the more services, and most secure system they can own. As the maintenance and taking the licence from different service providers they can get the same service in minimum charge which further helps them to grow up their business.

Cloud not only saves money to upgrade hardware or buy software licenses, but also frees the user from occasional maintenance operations of the system. Also the use of cloud and provides a high level of security and privacy. Before the small and medium enterprises to transform its system to accept the services using the cloud, they need to identify which service or services that are needed. They can create a catalogue of services to define parameters that will be in future need to get from the cloud service provider. And in the time of agreement between two parties, they should be clear about the model of service uses which in the future can help to maintain the security of data and services.

3.15 Service Level Agreement

Nowadays, many business companies use the services of cloud service providers. It is quite simple and beneficial to them as compared to make their own infrastructure and maintain it. But they often worry about the main common terms, confidentiality and security of their data because the data is stored outside of the company and manage and handled by third parties (i.e. Service provider). As a result, at the time of agreement between any business form and cloud service provider, it should be good agreement concerning security, backup and handling it, otherwise if the data lost or handled by wrong person it not only disaster for company somehow it is a disaster for society and the nation too (45). As an example the military data are so much sensitive for any nation and if it is lost, then it creates disaster if it is obtained by terrorist or other criminal minded people. The hackers get privilege to get the access through the cloud and like this happened in June 2, 2011. The notorious group called LuizSec hacked million user accounts from Sony website by hacking the cloud service provider called Cloudflare and published in internet (45). This is also the same kind of problem regarding data security and cloud infrastructure are giving them to platform for distributing codes, to spread out their damages and communicate and exchange their ideas between the other groups (45). So any company small or big, they should research and make minimum criteria about the service provider and their data safety and security and design the principle for both functional and non- functional aspects (46). After making this the company should hire the service hosted by another organisation and allow them on the criteria which are generally called a Service Level Agreement (SLA).

Service Level Agreement (SLA) is an agreement that binds the consumer and the Service Provider (SP) to certain laws that governs both of them regarding the service the provider is offering and the one the client is buying (47). It clearly defines the service that should be delivered and the actions that would be undertaken to failure to comply. The typical Service Level Agreement includes the following (SLA Information Zone) (48).

- Services Delivered
- Problem Management
- Performance
- Customer Duties

- Security
- Warranties and Remedies
- Disaster Recovery
- Termination of services

The SLA definition should be implied with much care and study. It could prove very important for the customers and providers as well. Negligence on this shall result in any one party, especially the customers being afflicted (49). The services from google like Gmail" can be disturbed for a few hours in a day; and they can still say that according of their SLA rules, the email service is 100% uptime."

It is Impossible as it may sound, the SLA wrote by the Google for its Apps (including Gmail, Google Docs, Google Calendar and more) allows them to get away from this blunder. The key parts quoted from the Google Apps in SLA:

The "Downtime Period" in SLA means, it is for a domain in the period of ten consecutive minutes of Downtime.

This means that Intermittent Downtime for a period of less than ten minutes will not be counted towards any Downtime Periods. A worst case scenario is that over a day (24 hours), Google Apps can have 21 hours and 36 minutes of downtime and still Google can ignore it while calculating the final uptime percentage.

By this example, the importance of SLA is exhibited and the whole study on this report concentrates on these matters which the customers should focus on while using the cloud services. So SLA is the important area before implementing a cloud system over your enterprise network (50).

Apart from the regular SLA, there are other SLAs as well that deal with specific areas. Following two are of important concerns for this study:

3.15.1 Web Service Level Agreement:

Web Service Level Agreement (WSLA) is the standard for service level agreement for monitoring of the web services (49). The agreement allows the authors to specify the desired level of service, the performance and the actions that should be taken in failure to do so. This is more like a regular SLA but since it incorporates technology and also a third party to manage the infrastructure, it must include something more. A WSLA comprises of

mainly three entities Parties, they are service providers, service consumer and the third parties (50).

SLA parameters: Here, SLA parameters are specified by the metrics which define how service parameters can be measured.
Service Level Objective (SLOs): These are the set of formal expressions having if...then structure.

3.15.2 Cloud Service Level Agreement

For the cloud level, the agreement should, however, incorporate all the things mentioned earlier. It is a service and is concerned with the web. But most importantly, it is a utility service that is similar to the electricity usage in houses where customers pay as per use (48). Thus, most of people agree that usage and cost shall be included in the agreement and that it should be dynamic. That is to say, if the scale in services increases, the measures have to be adaptive (46).

3.15.3 Trust

Trust is a very important aspect of cloud computing. Regarding the security issues and the Service Level Agreement, it is concluded that trust and authority are of great importance in Cloud Computing Security (51). HP Laboratory defines trust as "reliance on the integrity, surety, ability, strength, etc., of a person or thing (52)." The typical definition of trust contains such elements as:

- The willingness of the one party says, (trustor) is to be vulnerable to the actions for another party (trustee);
- Acceptable expectation of the trustor that the trustee will perform in the way favourable to the trustor;
- The uncertainty of harm to the trustor if the trustee will not behave accordingly to the agreements, and
- The absence of trustor's administration over the actions operated by the trustee.

3.16 Decision making in general

In the classical sense the decision is equated to the act by which a individual (with the power to decide) take measures to promote the creation and distribution of wealth in a company based on a set of information available on the market. In its more modern approach, the decision appears rather as "a progressive engagement process, connected to there, marked by the recognized existence of multiple paths to achieve the single goal ".

The evolution of the concept of decision is indicative of a certain number of developments in the way of understanding the process of decision making. The decision is no longer a single, constant measure based on research profit, but is based on a successive series of decisions shorter range. The decision is not based on research of one objective, but incorporates a larger number of variables. Decision intervenes in a more uncertain context in the sense that the way to achieve the objective pursued can go through different types of actions. These developments are understandable because they only underscore the changes in the production system: the corporate environment becomes more complex, as more uncertain and the decision is not based more on a single individual, but can be shared between a high number of actors operating within the company. This multiplying the number of decision makers also reflects the diversity of decisions to be taken in an enterprise.

Generally, after making the further mission and vision and setting the goal of the organisation of the management there moves forward to take place for decision. A good decision after more accurate research can take a company to its desirable state whether there is also a vital chance to lose its reputation if the decision is not correct, i.e. if the organisation fails to address its challenges and opportunities, then it may happen. So decision making is not a simpler way like implementing of a more server in the database for IT Company. It is like installing software to its system which can increase their profit as well as efficiency and improves their credibility and if you install a wrong then it may crash your system too. So for any organisation, it’s a higher prioritising factor for further grow in the market.

As accordance with Dr. Pam Brown, for a good decision, the required criteria are as follows:

1. Specifying the goal and possible outcomes
2. Collection and gathering of data
3. Use the brainstorming tools, i.e. developing alternatives
4. Analyse the alternatives as their pros and cons
5. Make the decision
6. Implement this to organisation
7. Learn from and reflect on that decision

Decision-making is very intuitive once considering single criterion issues, since we tend to solely ought to select the choice with the best preference rating. However, adopting a data management system isn't simply one criterion downside. Decision-makers ought to assess the alternatives supported multiple criteria. (53)

3.16.1 Multiple criteria decision making

Multi criteria decision analysis is an important way to analyse and make complex decisions in any field. This method is used to make the concrete decision from best possible alternatives. It helps to characterise and recognise the important factors and for any organisation and choose the right decision from their best weighted values. According to Keeney and Raiffa's (54) seminal book in MCDA defines "an extension of decision theory that covers any decision with multiple objectives." The MCDA is mainly useful for:

- Fractionalizing the decision into smaller and understandable parts
- Analysing every part
- Integrating the parts to overcome the specific and significant solution

Using for group decision, MCDM helps to discuss them for their opportunity in such a way that to allow them to consider each view in every values are important. It provides the idiomatic capability for the people to hold and talk the complex communication through alternatives. As a result, It is helpful for the decision makers to think, query, re-think, decide, and think more, adjusting and testing and finally decide. As defined by international society on multi criteria decision making, "it is the study methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning process" (55).

MCDA problems are de-factorised in five parts (53)

1. Setting Goal

It is a goal or set of goal or aims which any organisation or individual want to achieve after the analysis.

2. Decision makers' Preferences

The decision makers should determine the characteristic of analysis problem. They should be aware of the result and make their preferences for analysis. After that, they can analysis what actual them or their organisation needs and set their requirements.

3. Criteria for evaluation

Choosing the criteria is most important for decision making. For this the individual of a company should discuss about their needs and requirements and set the criteria. What types of service or features they want, they should make it. It is a vital part of decision making because without proper criteria the research is incomplete or waste.

4. Alternatives

After their goal and preferences and criteria, it's time to search for alternatives. For any organisation what are the possible alternatives of their search and then they should research about the availability of alternatives and their features. And then is time for pairwise comparison between criteria and alternatives.

5. Outcomes and consequences associated through alternatives

After choosing criteria and alternatives and applying their values and calculations, the best possible alternatives are chosen according to their adaptability to a company or individual.

3.16.2 Alternatives

This is a choice between at least two or more available options or possibilities. It is sometimes also be known as substitute or a variant case when there is no element of choices present and only option is to choose best to secure alternative. For any enterprise environment of business is changing and the strategic manager should focus on the alternatives like safer small investment or risky changes that can lead to an organization on the right track (56). If they choose right alternatives, then obviously it will increase your business and vice versa.

3.16.3 Criterion

The criterion can be said as a rule, a standard or a test in which the entire decision or judgement procedure is based on that. In our daily life and daily uses there are so many conflicting and confusing criteria and options are available and we have to choose the best of them, so to make this judgement we need to set up a standard in which our expectation will meet. So for this we need to set a standard and we should also think about the available alternatives. Some common criteria are price, service after buying, insurance and warranty of the product and so on. An individual person or a company may choose a costly higher quality service than the lowest quality service having low cost. So it is very important to be focused on such cases, while setting the criteria. The criteria in sometimes may not be measurable to get the rank of alternatives, or it may intangible but it definitely helps to get the best option of alternative on the basis of their characterization and priorities and this decision making get only the best solution if it is used in many criteria and sub criteria associated on it (57).

3.16.4 Matrix

To get the all number of alternatives with respect to their evaluation with attribute we need to place them in an organized chart form which we can say the matrix form. It is the most used tool for carrying the pairwise comparison on criteria and alternatives. Matrix is a presentation of a rectangular array of numbers where mathematical operations mainly addition and multiplication (58). The horizontal and vertical lines on it are called row and columns, respectively. The numbers in it are called its elements. And for a size, if there are i rows and j columns in a specified matrix, then its size is called I × j where i and j are known as its dimension.

$$\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} \end{pmatrix}$$

Figure 6: Example matrix (59)

3.16.5 Weight

Every mass is attracted towards the centre of gravity according to the gravitational attraction and its measurements is known as weight (60). This is applicable definition of weight on physics, but what is in pairwise comparison of MCDM, it is like the same, but we take it in comparison of attributes area, length, mass and capacity, and relative fields of criteria and their alternatives. It is used to compare two objects with the same measurable attribute to see which is more or less useful and effective and what may the difference between them. This is the most important to do the every criteria and alternatives to do the pairwise comparison among them to get the average and in their average the best one is chosen (61).

3.16.6 Utility

Utility is the satisfaction measure and it helps to determine the condition or quality of usefulness of certain things. All attributes have their utility values in accordance with their priorities and generally utility of the criteria or attribute may be shown on a utility function in which their relation is captured and their mapping is given between the range of [0,1] (53). The maximization in the expectation of utility is called as a principle of rational behaviour. So for utility the alternates of attributes must be available.

3.17 Methods used

3.17.1 AHP

The Analytic Hierarchy Process (AHP) is multi criteria decision making (MCDM) technique which is proposed of Saaty (62), that integrates pairwise comparison ratios into a sample ratio scale. The AHP allows the inconsistency in decision making because people are more cardinally inconsistent than to cardinally consistent because not all people can estimate accurate measure values although from a known scale. The AHP uses the principle of Hierarchic composition for delivering the compound priorities of alternatives in respect of different and multiple criteria of their priorities in each of the criteria (63).

This method involves creating special categories of problems in prioritizing the related alternate solution and consists of three major factors (64).

1) The first part of this technique is to determine the relative criteria and follow the alternatives of it.
2) Finding and attaching the numerical values and finding the importance to the criteria and its impacts in their alternatives. This is the complex task to do so for this method, it may take the expert advice to fill out the pairwise comparison of criteria values and is impacting on alternatives. The pairwise comparison characterises the nine points, scaling rule and this is usually applied in AHP analysis.

Intensity of Importance	Definitions
1	Equal Importance
3	Moderate importance over another
5	Strong or critical importance of one over another
7	Very strong importance
9	Absolute importance
2,4,6,8	Intermediate values between to adjust judgments
Reciprocals of Above	If one factor of above "i" numbers are placed in it the adjacent diagonal factor will be the reciprocal value when compared with i.

Table 1: AHP Comparison Scale (65)

3) The after this there is the numerical processes to find the exact ranking of criteria and their alternative solutions.

3.17.2 Saatys' Method

The process of selecting quality choices by the use of MCDM depends on the proceeding for scoring alternatives and discovering the applicable criteria, weighting and structuring for the criteria trees (8). The solution of this problem was suggested by Saaty (66). Let us consider $\Psi i \geq 0$; i= 1, 2….n be degree of the belonging numbers up to n. From relative weights of i of the matrix, the jth elements will be $\Psi i/\Psi j$. Then Saaty follow that vector $(\Psi 1, \Psi 2 \ldots \Psi)^{T}$ is the eigenvector similar to largest eigenvalue. The other all eigenvalues are zero.

Here Estimating the matrix of relative weight is the main theme and then getting the eigenvector ($\Psi 1, \Psi 2 \ldots .. \Psi n$) of the corresponding largest value of related weight matrix is the second part of this process. To compare of the set of n objects having relative weights

in pair, Saaty marked the objects by A1……An, and the weight by Ψ1, Ψ2 ….. Ψn. The pairwise comparisons are shown in the matrix below:

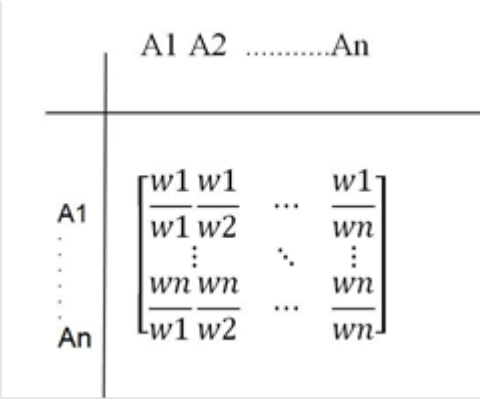


Figure 7: Representing pairwise comparison on matrix (Own Source (63))

The above matrix is called reciprocal matrix and it has everywhere positive entries and it satisfies the reciprocal properties, i.e aji = 1/aij, by multiplying this matrix with the vector $\Psi = (\Psi 1 \ldots\ldots \Psi n)^T$.

$A\,\Psi = n\,\Psi$ (1)

$(A-nI)\,\Psi = 0$ (2)

It is a homogeneous linear equation of having a non-trivial solution in only one case if and only if the determinant of that matrix (A-nI) vanishes. This shows us that n is the eigenvalue of that matrix A is this matrix is also consistent.

In general, the values of Ψi / Ψj are unknown and they must be estimated. As eigenvalues are distracted by small distraction of coefficients, the equation (1) becomes

$A'\Psi' = \lambda max\ \Psi'$ (3)

Where, λmax is the highest eigenvalue of matrix A'. For simple notation, equation (3) can be written as

$A\,\Psi = \lambda max\ \Psi$ (4)

Where, A is a Saatys' pairwise comparison matrix. The largest eigenvalue of the associated vector is our desirable vector of weights (65).

3.17.3 Consistency measures

For the finding consistency of reciprocal pairwise comparison of matrix, A = (aij), as there is cardinal transitivity among the decisions that is shown as,

Aijajk = ajk, I, j, k =1,…… n, Saaty indicated that inconsistency in conventional- AHP, when prioritizing the Right Eigenvector Method (EVM) is used for that procedure, can also be calculated by the single number (λmax – n) which reflects deviations of aij from the estimated priorities ratio of Ψi/Ψj.

To give a measure independent of the order of the matrix, n, Saaty propose to use of consistency ratio (CR). This is taken from the ratio between (λmax – n) to the expected value with over large positively numbers of reciprocal matrices of orders n, for which their values are randomly chosen from number set of {1/9,……..,1,……,9}. For consistency measures, Saaty makes threshold of 10% to accept estimation of Ψ (10). If the CR is greater than the threshold value, i.e. 10%, the inconsistency decisions with the huge difference in aij and Ψi/Ψj are generally modified to derive the new Ψ.

3.17.4 Row Geometric Mean method

Although making a strong defence of the EVM, use of the Row Geometric Mean Method (RGMM) or Least Squares Method, in prioritizing AHP was introduced and now still this has been a great consistency measuring tool in decision making.

In conventional-AHP (63), the priorities (Ψi, i = 1….n) can acquire by solving eigenvalue problem

$$A\Psi = \lambda max \Psi \Sigma \quad (5)$$

Where A is a positive pairwise comparison matrix with order of n, λmax with principal eigenvalue of the matrix and Ψ is priority vector.

Prioritizing procedure, Saaty (63) introduced the measure of consistency in judgement, known as a consistency index (CI), and is given by

$$CI = (\lambda max – n) / (n-1) \quad (6)$$

Where λmax is judgment matrix's principle eigenvalue and its order is n.

If the comparison of reciprocal matrix is consistent, $\lambda max = n$ and the value of CI is zero, otherwise this value is always a positive number. To reduce the dependency on CI, Saaty introduced a normalized measure CR and is given by

$$CR = CI/RI \quad (7)$$

Where RI(n) is the consistency of Random Index of n order of the matrix. It is defined as the expected value of CI corresponding of matrices of n order (RI=E[CI(n)]), where simulated the judgements in sets of {1/9,…..,1,……9} and for prioritizing the EVM is used.

N	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Table 2: Random consistency index values of RI (66)

The CR gives us the measures for judgement in pairwise comparison; the matrix lies in totally random and consistent. When CR=1, then the CI=E[CI(n)] and there is random judgement (Low Precision). The more inconsistency is obtained by higher values of CR so

we are interested to make possible lower value of CR to make it consistent. For accepting consistency of matrix Saaty (66) suggested the threshold of 10% or less (CR<0.1).

4 Selection of Cloud service provider for *Shine Info-Com* in Nepal

Nowadays there is a huge competition in the market and it is quite hard to stay in a market and do business because we can find the so many alternative opponent companies that are also providing the same services likes us. So to be established in the market, we have the separate and ideal plan and innovate service style. By the use of creativity, innovation, and modernization and changes in technology the business sector is in complexity and in a competitive environment and this is also helpful for the costumers to get the huge facilities. The organisation, like small and medium companies are using the varieties of concepts and modifying themselves into the flexible and easiest service provider.

The advancement of technology facilitates for the company to hire and use the different services and also reduces the licence and storage cost for the instant which helps to do business smoothly and also helps to get desired goals and reduces the operational cost which leads to help to increase the benefits for the company. As far there is to adopt this technology company staff and officials should think about the other features like security, data storage and functionality of cloud and also about the privacy of data and then also expertise the employee to introduce the new technology and must provide trainings and other professional development packages.

There are many cloud service providers which provide the various services to the small and medium sized enterprises. In order to go for an agreement to adopt cloud Service the enterprises should check the offers and services provided by them. Then the company should overlook the different factors like features, cost, security, quality etc.

There are several traditional methods to select the targeted cloud service providers and in our case it may not be so efficient to use those methods or may not meet the enough criteria and requirements for the enterprises. So we should need the certain technologies that should have the entire criteria and should able to evaluate the possible cases showing the maximum benefits for any company.

In this research, the researcher is using this method to choose a cloud service provider among the set of different alternatives for the virtual supplier Company created by the author.

This supplier Company is virtually created by the author to make a way of writing the thesis and it doesn't exist in anywhere in Nepal.

The details of company are as follows:

Shine Info-Com, as ("SIC")

- is located in Kathmandu, Nepal on Omini Group.
- is a finest supply forms for computer and other electronic products in Kathmandu, Nepal and as well as in around the country.
- is a leading supply company and provides the various services for our retail and corporate customers.
- We provide the services such as supply and renting of all electronic products including computers, ups, mobiles, parts and accessories, fashion products etc.
- We are accepting the different method of payments like online bank transactions, card payment, cash, and cheque and others mode of payments.

Total Assets	NRs 200 Million
Average Number of clients (per year)	13000
Number of branches	3
Number of employees	70

Table 3: Key facts as of 12/01/2015

Supply Company connects with the costumers, firms and corporate houses by accessing various services through different channels such as shipments, maintenance, supply and check of the equipment and getting orders and processing them.

Now the supply company is trading the business in the main cities of Nepal and it is essential to do the market research to find out the best possible cloud solution and current market situation. So for this first we are going to do Swot analysis, from where we can find the appropriate condition of the market and then after other methods.

4.1 SWOT analysis of Shine Info-Com Regarding the cloud computing

In simple word swot analysis is to find out Strength, Weakness, Opportunity and Threat. This analysis helps to find the positives and negatives of an organisation and gives the suitable decisions. I have used it as to describe to find the situation of Shine Info-Com which is needed for the strategic planning and for the decision making. "A SWOT analysis is a subjective assessment of data which is organized by the SWOT format into a logical order that helps understanding, presentation, discussion and decision-making (67)". The benefit of this method is its simplicity and it is applicable to a variety level of operations. The terms prepared for SWOT for Shine Info-Com is as follows:

4.1.1 Strength

Higher reputation: Omini group is one of the best trading solutions in south East Asia. Its main head office is in Singapore and operates more or all shipping procedure from there. Now it is also recognised in Nepal as it gives all types services here. It does its business according to Nepalese rules and pays huge tax for the government. It is the first company in Nepal to introduce the complete online selling. And its processing charge like handling charge, shipment chare is competitively low to other company because it has its own shipment agency as well. It has maximum number of outlets in Prague and other cities, so customers can get better services and it is hassle free. It has the computer based services and it is a paper free company so its employees have the good and skilled knowledge in computer and IT. It has good infrastructures and has the high speed Internet so that data is transmitted very fast. It is a customer based company and has to work with a computer so the processing time to operate a work for costumer is really short so still now they are satisfied with us.

4.1.2 Weakness

As our company has the comparatively higher service charge. It is because that some product is transported from the overseas and the shipment charge will be higher for that product. It has additional charges for different types of delivery like fast shipment, cargo,

or normal delivery of product. It may be expensive for that customer who does not want to pay extra.

There are also some complains of customers that from online services through a bank. It may due to transaction problems of bank to our account because of inter banking network connection problem. And also a remarkable issue is that all of our company staff is not computer literate. This has sometime creates problems like for delivery of product and so on. But our company is going to fix this problem within the end of this fiscal year.

4.1.3 Opportunity

The small and medium sized enterprise sectors are increasing rapidly in these days and there are a lot of opportunities in this sector. As this sector is increasing, but the entrepreneurship and mode of business are changing day by day. Today's generation wants more profit in a certain short period of time and for this they want to use the latest possible advanced technology. Our supply company is highly interacted with this generation and we provide the latest it based instruments to them. The market of our products is really a huge that means the market of our Mittal Supplier is also good.

The cost is also reduced in the business due to availability of different sources of delivery and is also remarkable development of IT; we are getting good and skilled manpower for the company. We are also accepting the all most all types of payment systems and upgraded our network into modern office systems so there is also time reduction to process the order.

Our company is planning to open the various new branches have been remote areas of Nepal as the availability of Internet with appropriate bandwidth.

4.1.4 Threats

There is the highest risk of the hacker as they can get into our main operating system. Their network is quite strong and we do not have the good securing software so we may become the victim of them. We have many opponent companies so the customer can choose the other company as our system and service charge is high. But our company doesn't want to happen this so we are going to make further strong security for our valuables clients' accounts and have the strategic planning to reduce the service charge.

Strength	Weakness
➢ Higher Reputation ➢ Sufficient skilled staff ➢ Flexible services ➢ Complete online services	➢ Additional charges ➢ Higher service charge ➢ Technical problem
Opportunity	**Threats**
➢ Growing sector ➢ Development of new technology ➢ Opening of various branches	➢ Hacking privileges ➢ Company's competitors

Figure 8: SWOT analysis of Shine Info-Com regarding cloud service provider

Suppliers' competitors: there are many competitors for our company which may be the main threat for us. An increasing number of suppliers in the market and financial problem of Nepalese economy are also risky for any company to do its business. There is always a risk of moving customer to another company.

Internally, our company has some advantages in the supply industry. We are planning to decrease the additional service charges in online orders, and also going to reduce the transfer charges with doing mutual cooperation with our major money transferring company. Also Omini Supplier is going to introduce a Toll Free Number for every part of Nepal.

Beside this, our parent company Omini group decided to make a strong network solution for its every company so we are getting a high speed Internet (broadband) for every office so it will be better to perform work in the company. This is also quite interesting to perform cloud service and so on.

4.2 Selection criteria for cloud

4.2.1 Cost

The lower investment in Cloud infrastructure helps to get higher profit for any company. The implement in the new technology and new terms in business help to move the organisation to move in further milestone. It is directly connected to the any companies'

financial sector. It means the company searches, the possible candidate of cloud service provider operating the optimizing services in lower price (18). According to the computerworld, “cost is the amount of money that you need to move from the common system to the cloud and it is for the backup of your data, for security, for upload and download fees and also the maintenance fees” (68).

4.2.2 Data security

“Data security refers to protective digital privacy measures that are applied to prevent unauthorized access to computers, databases and websites. Data security also protects data from corruption. Data security is the main priority for organizations of every size and genre.” (69). The company knows challenges in the security of their data and wants to secure the more confidential files in the best possible secure way (70). So they trust the computing company which has more power to tackle todays’ issues and able to make the safe.

A cloud service provider provides the various services to the company. The company should secure all of its client’s data as well as their own data. As long as there is highest secured Cloud service provider, it automatically reduces threats to the company. Company needs tight data security system, more layers of encryption on their data, immediate messaging and response services from a service provider, disaster control system and good backup and archive for their data (17). The network and platform misuses and fraud protection, virus and malware protection, system failure, botnet protection, etc. are the most important security solution which *Shine Info-Com* needs. And the main thing in the company is to secure data from the third party access and keep is like in own company. Salesforce.com says “The understanding of the confidentiality, integrity, and availability of their costumers’ information is vital to their operations” (71).

4.2.3 Data Integrity

“The stored data in cloud storage should be anti-tempered and it shouldn’t be available for the hackers to modify the data while transferring data over the Internet or storing in the servers” (72). The message digest is common practice+e for data integrity at the time of transfer the data from one system to another. At the time of system failure the multi-step transaction should be done step by step to avoid loss of the information. For example, if

anyone is transferring the funds from one bank account to another and if that time the system fails, then at the recovery phase of data, the person should be checked and void of the data to ensure the correctness and integrity.

4.2.4 Accessibility

As in every part of business, if you cannot get access in your desired document or program then you can't get the result. That means it is strictly essential to access to your assets to use it for getting the result. The same theory in the cloud is also applicable. So every company wants to access to their data and they use the standards like ODBC, JDBC and ADO.NET (73). These are the standard data access APIs used by the entire IT world. While providing the data from the server there should use the standards and in the future the integration of the data to any enterprises may have the problem. To solve this, they may use of their own CRM or they may use like force.com or google app engine but there is still the challenges in the surfing the data through Internet and it should be done within the firewall to reduce the number of round trips in the data centre to the application and again to datacenter of the cloud service providers and in future it may branched out as the making the new architecture which helps to use the services within absolute control inside the firewall (73).

4.2.5 Availability

Cloud data availability is an important part of service providers in where their actual excellence is tested by the users. The availability of the data is needed disaster tolerance for the use of cloud based business (74). Nowadays, business of small and medium sized enterprises are mostly operating on cloud based IT infrastructure so it is essential to automate and analyse the strategy for the business. For business continuity the system of entire business should be able to manage single point failure to mitigate downtime and should improve the system availability. So the hardware failure of a cloud, software defect, and natural and normal man-made disaster, the service provider should guarantee for the users that the services continue in those cases and if the system is not available, the57n they are responsible for it, so it is also a main part in the service level agreement (SLA) too (74).

4.2.6 Location

Location has also an important role to use the services or not. As for location it is also essential to know about the rule to use the services from other countries as the provider is not physically present in your country. Such as many companies operate the services all around the worlds, but they don't have their company in any particular place and it may be difficult for the disaster recovery time and it may pose too slow to get the actual data from them because they may need the special permission from the court. As for the IT infrastructure it is not a serious issue, but for the maintenance and connectivity and data security the users want to take care about it too. As, for example in china google cannot operate its services as the government has a special ban as it stores the data outside the china and it may cause the problem in their security threat. So basically it depends on the government policy too.

4.2.7 Device extension / licensing

The extension of use of cloud in your several devices has the remarkable ups and downs in cloud services. If the service providers are providing the services on many devices in the same price or are able to use the licence in the several your usable device then obviously the use of the services increases. It is obvious that nobody wants to add more on investing licence for your use if you are using for your personal purposes and same as enterprises use because of if the system allows using in five devices then people go it rather than choose the same service for three devices.

4.2.8 Office application

The more office application on product helps to increase the use of any product. Nowadays people want more and more application in one solution that can help them the saving in their resources. If some organisation wants to use the cloud services then obviously they need email server and app engine too. They may not only satisfy by your office app and additionally they need the ip telephony, analytical tool for business and so on. So providing the other useful application on your main brand leads to success for the service providers and also helpful to the users too.

4.2.9 Customer care:

The cloud service plays vital role to any SME if they have chosen the most services by them so the service providers must do 27*7*365 customer care services to their client. It may depends on the basis of their SLAs but that if they are unable to response the customer it will be negative impact on their reputation and obviously slow down the business of the users. To increase the customer satisfaction the service provider should deliver services for emergency requests, support more resources for the customer, get the feedback immediately and apply it, and should become more personalised to your costumers (75). The adoption of cloud is increasing each year and by end of 2020 the global public cloud will reach $191 billion from $53 billion as from 2013 (5), so it is most important that costumer should be more happy to use the services.

4.3 Introduction to SAATY'S Method:

This is the method to insure the applicable data and calculation to be effective on the selection process. In this method, there is used the multi-criteria decision approach which may use here analytic Hierarchy Process (AHP) to make the best appropriate and reliable decision. Many SME chooses the cloud service provider to insure the better secure and lower price investment on infrastructure to get maximum benefits and they look for the better one in every time which are available in IT industry. For any organisation security may be their first issue to get the trust and be reputed in market and then the next important criteria may be the pricing. And other criteria are like accessibility and service extension are also vital for company benefits and so on. After analysing the criteria and alternatives used in AHP, then it will provides priority rating for each and every elements for choosing the cloud service providers and it determines the most favourable criteria for choosing.

4.4 Prioritizing the Criteria

The main important and the critical way in decision making is the designing of the selection model. The selection of alternatives existing for the option for the SME with the

set of criteria in evaluation is the main goal for selection process. It also needs to approach the main and its sub –criteria which helps to get more useful or excellent output to achieve the goal. In here these criteria includes: C1. Cost, C2. Data security, C3. Accessibility, C4. Availability, C5. Data Integrity, C6. Location, C7. Device extension, C8. Office application, C9 Costumer care. The hierarchical problem structure of S*hine Info-Com* is given below.

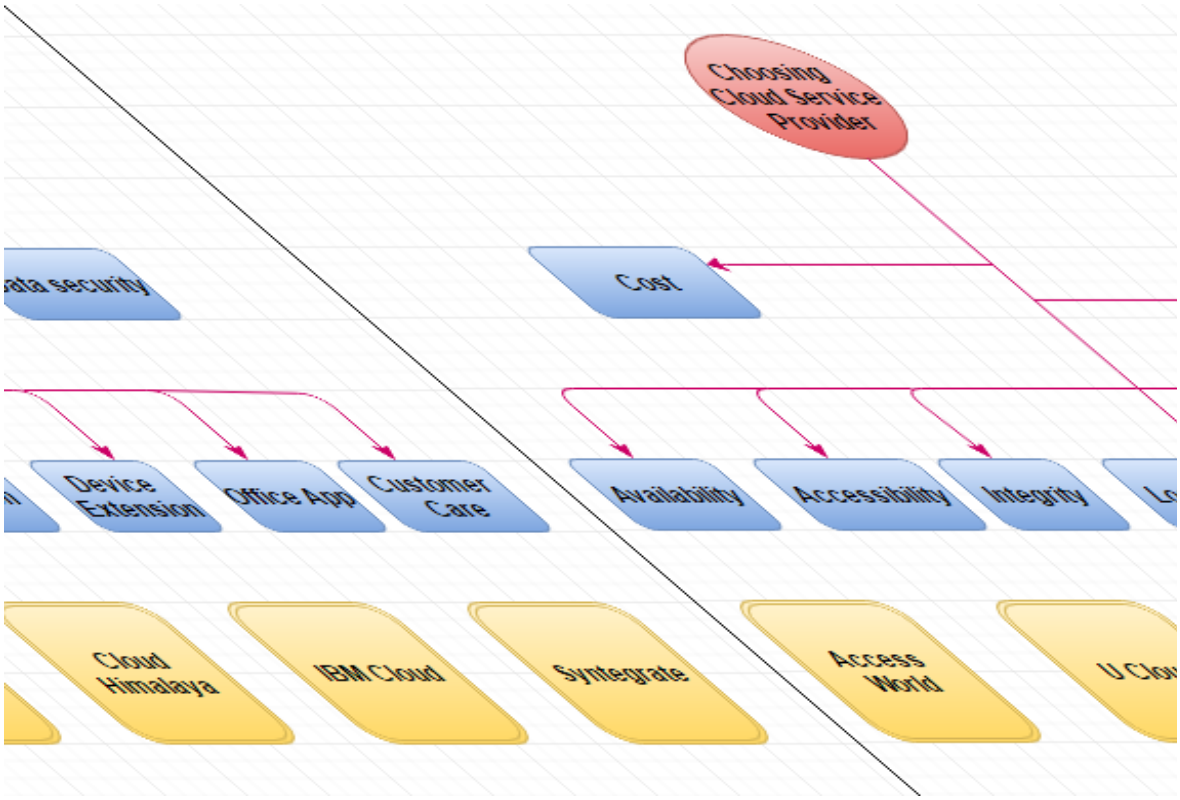


Figure 9: Hierarchical Problem Structure of Shine Info-Com (own source model according T.L Saaty (62))

Factors	C1	C2	C3	C4	C5	C6	C7	C8	C9	GM	Normlised GM
C1	1.00	5.00	5.00	5.00	7.00	9.00	9.00	9.00	7.00	5.481	0.376
C2	0.20	1.00	3.00	5.00	3.00	7.00	5.00	5.00	7.00	2.812	0.193
C3	0.20	0.33	1.00	3.00	7.00	5.00	7.00	7.00	5.00	2.287	0.157
C4	0.20	0.20	0.33	1.00	3.00	3.00	3.00	7.00	7.00	1.375	0.094
C5	0.14	0.33	0.14	0.33	1.00	3.00	3.00	5.00	7.00	0.963	0.066
C6	0.11	0.14	0.20	0.33	0.33	1.00	3.00	3.00	3.00	0.596	0.040
C7	0.11	0.20	0.14	0.33	0.33	0.33	1.00	3.00	5.00	0.494	0.033
C8	0.11	0.20	0.14	0.14	0.20	0.33	0.33	1.00	3.00	0.314	0.021
C9	0.14	0.14	0.20	0.14	0.14	0.33	0.20	0.33	1.00	0.230	0.015
										14.556	

Table 4: Pairwise comparison and Normalization between the Criteria

4.5 Cloud Service Providers (CSP) in Nepal

Further, the major cloud service providers and their characteristics and other information of their services are briefly introduced here.

4.5.1 Access World:

This is the first IT Company in Nepal which is certified by ISO for quality, information security and IT service management system (76). It has its main office is in Kathmandu and has other branch office across the world. This company provides the entire cloud infrastructure for enterprises platforms and applications. It provides mainly as networking services, security solutions and resource management of customer business data. It provides the cloud hosting (VPS), web site hosting, and Cloud platform hosting and enterprises secure email. It has many data centres in Nepal and additionally outside of Nepal as well.

4.5.2 U Cloud:

U cloud claims that they are the first company in Nepal which provides all types of cloud services elated to business model (77). They offers the infrastructure for the business and managed services and web hosting as well as they provide the virtual private clouds and

they supports most of common operating systems for their platform from Linux to windows and most of the database software. They established their business in Nepal at 2014 in Kathmandu and they started the services to the public from 2015. They have different types of cloud services as public and hybrid and other services as managed services, web hosting, and migration and so on.

4.5.3 Cloud Himalaya

Cloud Himalaya has the largest Tier 3 data centres in Nepal and one of the best company delivering the cloud storage services to public and private sectors in Nepal. It manages the business data and has the professional solution for the company for increments of their IT infrastructure and can support them by providing world class data centre facility in the secure and reliable manner (78). They provide the all kinds of cloud solution for company by offering the delivering models in the private cloud, public cloud, community and hybrid cloud too. They operate 24*7*365 on site and on-call support and they prioritise the response and resolution of the problems of critical to normal problem and they are able to manage the system within one hour. Accordance to customer care they are really reliable and supportive for users. They have collection service packages, disaster recovery and industries package services where the company can choose and get as accordance with the service level agreement (SLA). They make the models for the companies like healthcare, banking and finance, manufacturing according to their needs and they can make more adaptable as prior SLA.

4.5.4 IBM Cloud

IBM is a big IT company in the world and they are providing various services across the world. IBM cloud computing is providing the set of cloud services for the business in several models. They include the services infrastructure as a service (IaaS), platform as a service (PaaS), Software as a service (SaaS) with public, private and hybrid cloud delivery models. For the business purposes of small and medium sized enterprises they have the solutions and already inbuilt models like MSPs and CSpsas the managed and secured cloud infrastructure. They have s per you grow financing option on the scalability of resources which is suitable for any SME.

4.5.5 Syntegrate

Syntegrate is a Singapore based IT company which provides various IT services in Nepal and Singapore. It was established on 2001 and it provides comprehensive integrated solution for the company and it is focused on IT infrastructure, virtualization, business community, systems management data management and application management. They have the varieties of services like firewall as a service to virtual data management service, security application delivery, mail and collaboration service and high availability and disaster recovery services for the securing the organizational data. They are able to manage all the services through cloud and they have other software services for industries. They have the virtual office model through cloud and anywhere in anytime the users can get access to this. They are using the secured and also providing amazon web services to the users.

4.6 Pairwise comparison and Normalisation between the Alternatives

4.6.1 Cost

Cost	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	3.00	7.00	5.00	9.00	3.936	0.538	0.202
U cloud	0.33	1.00	3.00	3.00	5.00	1.718	0.234	0.088
Himalaya	0.14	0.20	1.00	3.00	3.00	0.762	0.104	0.039
IBM	0.20	0.33	0.33	1.00	5.00	0.644	0.088	0.033
Syntegrate	0.11	0.14	0.33	0.20	1.00	0.254	0.034	0.013
						7.315		

Table 5: Pairwise comparison and Normalization between Alternatives

4.6.2 Security

Security	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	3.00	5.00	5.00	9.00	3.680	0.493	0.095
U cloud	0.33	1.00	5.00	3.00	7.00	2.036	0.273	0.052

Himalaya	0.20	0.20	1.00	3.00	5.00	0.902	0.121	0.023
IBM	0.20	0.33	0.33	1.00	3.00	0.581	0.078	0.015
Syntegrate	0.11	0.14	0.20	0.33	1.00	0.254	0.034	0.006
						7.455		

Table 6: Pairwise comparison and Normalization between Alternatives

4.6.3 Accessibility

Accessibility	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	3.00	5.00	3.00	9.00	3.322	0.453	0.071
U cloud	0.33	1.00	3.00	5.00	9.00	2.141	0.292	0.045
Himalaya	0.20	0.33	1.00	1.00	7.00	0.858	0.117	0.018
IBM	0.33	0.20	1.00	1.00	5.00	0.802	0.109	0.017
Syntegrate	0.11	0.11	0.14	0.20	1.00	0.203	0.027	0.004
						7.329		

Table 7: Pairwise comparison and Normalization between Alternatives

4.6.4 Availability

Availability	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	3.00	3.00	5.00	9.00	3.322	0.449	0.042
U cloud	0.33	1.00	3.00	7.00	9.00	2.290	0.309	0.029
Himalaya	0.33	0.33	1.00	3.00	3.00	1.000	0.135	0.012
IBM	0.20	0.14	0.33	1.00	5.00	0.543	0.073	0.006
Syntegrate	0.11	0.11	0.33	0.20	1.00	0.241	0.032	0.003
						7.398		

Table 8: Pairwise comparison and Normalization between Alternatives

4.6.5 Integrity

Integrity	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm	Uij

							GM	
Access World	1.00	3.00	3.00	7.00	9.00	3.553	0.468	0.031
U cloud	0.33	1.00	3.00	5.00	7.00	2.036	0.268	0.017
Himalaya	0.33	0.33	1.00	5.00	7.00	1.312	0.173	0.011
IBM	0.14	0.20	0.20	1.00	3.00	0.443	0.058	0.003
Syntegrate	0.11	0.14	0.14	0.33	1.00	0.237	0.031	0.002
						7.583		

Table 9: Pairwise comparison and Normalization between Alternatives

4.6.6 Location

Location	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	3.00	3.00	5.00	7.00	3.159	0.470	0.019
U cloud	0.33	1.00	3.00	3.00	3.00	1.551	0.231	0.009
Himalaya	0.33	0.33	1.00	3.00	5.00	1.107	0.164	0.006
IBM	0.20	0.33	0.33	1.00	3.00	0.581	0.086	0.003
Syntegrate	0.14	0.33	0.20	0.33	1.00	0.316	0.047	0.001
						6.717		

Table 10: Pairwise comparison and Normalization between Alternatives

4.6.7 Device Extension

Dev.Ext.	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	5.00	5.00	7.00	9.00	4.359	0.552	0.018
U cloud	0.20	1.00	3.00	5.00	5.00	1.718	0.217	0.007
Himalaya	0.20	0.33	1.00	3.00	7.00	1.069	0.135	0.004
IBM	0.14	0.20	0.33	1.00	3.00	0.491	0.062	0.002

Syntegrate	0.11	0.20	0.14	0.33	1.00	0.254	0.032	0.001
						7.893		

Table 11: Pairwise comparison and Normalization between Alternatives

4.6.8 Office Application

Off.App	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	5.00	5.00	7.00	9.00	4.359	0.548	0.011
U cloud	0.20	1.00	3.00	5.00	7.00	1.838	0.231	0.005
Himalaya	0.20	0.33	1.00	3.00	5.00	1.000	0.125	0.002
IBM	0.14	0.20	0.33	1.00	3.00	0.491	0.061	0.001
Syntegrate	0.11	0.14	0.20	0.33	1.00	0.254	0.031	0.001
						7.943		

Table 12: Pairwise comparison and Normalization between Alternatives

4.6.9 Customer care

Customer Care	Access world	U cloud	Himalaya	IBM	Syntegrate	GM	Norm GM	Uij
Access World	1.00	5.00	7.00	5.00	9.00	4.359	0.555	0.008
U cloud	0.20	1.00	3.00	3.00	7.00	1.659	0.211	0.003
Himalaya	0.14	0.33	1.00	1.00	5.00	0.750	0.095	0.001
IBM	0.20	0.33	1.00	1.00	7.00	0.858	0.109	0.001
Syntegrate	0.11	0.14	0.20	0.14	1.00	0.214	0.027	0.0004
						7.843		

Table 13: Pairwise comparison and Normalization between Alternatives

4.7 Consistency Analysis

Table No.	Ψ max	CI	RI	C.Ratio
1	10.522	0.190	1.95	0.097
2	5.283	0.070	1.12	0.063

3	5.388	0.097	1.12	0.086
4	5.355	0.088	1.12	0.079
5	5.428	0.107	1.12	0.095
6	5.331	0.082	1.12	0.074
7	5.348	0.087	1.12	0.077
8	5.439	0.109	1.12	0.098
9	5.365	0.091	1.12	0.081
10	5.386	0.096	1.12	0.086

Table 14: Consistency Analysis of Each Pairwise Comparison

4.8 Total Utility of each Alternative

Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	Total	
Access World	0.202	0.095	0.071	0.042	0.031	0.019	0.018	0.011	0.008	0.501	****
U Cloud	0.088	0.052	0.045	0.029	0.017	0.009	0.007	0.005	0.003	0.259	***
Himalaya	0.039	0.023	0.018	0.012	0.011	0.006	0.004	0.002	0.001	0.120	
IBM	0.033	0.015	0.017	0.006	0.003	0.003	0.002	0.001	0.001	0.085	
Syntegrate	0.013	0.006	0.004	0.003	0.002	0.001	0.001	0.001	0.001	0.033	

Table 15: Calculation of Total Utility of Each Alternative

4.9 Case Analysis

The main goal of this thesis is selecting the best possible cloud service providers operating their business in Nepal for a small and medium sized enterprise. Access World, U cloud, Cloud Himalaya, IBM Cloud and Syntegrate are the main cloud service providers in Nepal. They are the alternative options for the *Shine Info-Com***,** the virtual company which can use their services. The set of the main criteria for the *Shine Info-Com* are Cost, Data security, Accessibility, Availability, Data Integrity, Location, Device extension, Office application and Costumer care in which the company is interested to see while choosing cloud service providers (CSP).

These are the main steps while doing AHP in this research for the calculating total utility of each alternative in this method:

1. The decision making process was conducted by decomposing the hierarchy of criteria and the alternatives.
2. The alternative for each criterion were rated as accordance as AHP model.
3. Then there were developed pairwise comparison matrix for each criterion.
4. The resulted matrix was normalised for corresponding rating after averaging the values in each row.
5. Calculations and checking of consistency of result was done.

Likewise the same process was done for all the alternatives for each criterion. At the last, the total value is calculated for each pairwise matrix corresponding to each criterion.

The above method for decision making could be used in *Shine Info-Com* to choose the best alternatives. As per the result, Access world has the higher utility value (0.501) among others cloud service providers in Nepal, i.e., that would be the first choice for *Shine Info-Com*. The decision supports that the future cloud service provider for Shine Info Com. From the above result, Access world has a highly secured network with affordable cost for SME, and they are providing the best services and has good impacts on availability, integrity, device extension and so on.

Although it is not the best in location, but all the other factors are good so they are the best possible choice for the company. U cloud also provides good services and second in utility from our calculation (0.259), so they may become the alternative choice or the second option for the company but they are not as good as Access World.

4.10 Suggestion of Budget

The cloud solution for any SME in first is quite expensive, but by the **pay–as–you–go** model it is not much more expensive now. But according to the author's calculations and discussion of the people in some companies and by the information from the website from the host company, it is still cheaper than to have own infrastructure and as the time frame of three years, it is 50% cheaper and user friendly and hassle free.

In the research above in Nepal, if the company Shine Info- Com wants to have its infrastructure, then it takes around $45,000 but by the calculated alternatives, if it is taken for each and every computer VPS then still similar prices like $40,000 (79), but if the company negotiated with the Access World then it will be obviously less costly and beneficial for the SME. As compared to India the rates are quite higher because of the Nepalese market for the IT is growing in these days and there is not still much more facilities or the service providers from the governments. In India, if the same company runs in the cloud there and it takes from $35,000 to $60,000 (42).

5 Results and discussion

This research shows that the implementation of cloud in SME is much more beneficial for them to have their own infrastructure and manage the licencing of the softwares and so on. Now in European Union, the European Commission is helping to create the network of specialist centres for the software developers for creating on demand designs and simulation, and it is on their project the "Factories of the Future Initiative" which helps the SME to design, manufacture and manage the essential and useful products for their business (80). Although in Nepal, the country has just completed its 10 years of the transitional period of constitutional making and is able to address some of the problems. The author hopes that the IT sector of Nepal will become more open to all the companies in the near future and it is more obvious that Nepal lies in between two giant countries in IT sector, i.e. India and China, but to help the IT companies and to the entrepreneurs in Nepal the government already constructed the infrastructure house called "IT Park" in Banepa Near Kathmandu city (19). In near future they are able to implement IT in every sector and the SME like *Shine Info-Com* will exist and use their services and this type of research will be applicable.

This research finds the suitable designs of cloud for SME and is able to address what are the main criteria for SME to select the cloud. These findings are based on expert interviews, communicating with the cloud service provider company representatives and general research among the IT related individual and cloud service users. In this research, a small window is shown from the vastness of finding as the author has the limited space for the research and this research is based on the experts in which sometimes it may not be accorded with the exact market trend. The MCDA is used in case of more criteria and alternatives in a single case so prioritizing the criteria and calculating their weight in each and every alternatives can give the best result to the decision makers. So for this method, the choosing goal and making the rank of criteria may be difficult and the selection of the methods is important and it may be a problem for the researcher if they choose wrong (81). There are several methods like AHP, ANP, MAUT/UTA, TOPSIS and so on and it depends the research sample and research type to choose a method (81).

This paper gives a general outline of SME while selecting the cloud service providers and gives the model for the selection when passing through the conflicting similar and suitable alternatives. The author found that the implemented costs are quite higher at first to SMEs in Nepal but it will be certainly beneficial in the long term.

6 Conclusion

The main goal of the thesis was to find the design of a cloud to a small and medium sized company in Nepal based on their necessity and their essential requirement of the infrastructure. This paper shows that the Access World offer may be the first choice among available alternatives. This was done from several findings and investigation of requirements, the available and suitable methodology, the interview with experts and professionals in IT and cloud related persons and by calculations as according to their marking and weighted points on that.

This thesis allows to use of AHP method for choosing the cloud service provide (CSP) for the *Shine Info-Com*. The vital part of this method is to get the values of all the criteria relative to alternative's weight. Choosing the cloud service provider is of an acute importance for an SME to achieve its goal on time. The all alternatives have their own strengths and value in IT market but the decision has to be made in favour of the SME to get the optimal solution.

There can be applied different methods of decision making depending upon the particular cases and it is our belief that the AHP can be useful for our model as it has been useful for other cases in past as well. In AHP, the major assets is to adopt the verbal judgements of expert choice, verification and consistency of the results. The AHP has also some limitations such as the criteria we assume are independent as we do not test them for correlation. Also the judgement scale and choice of hierarchy are critical and difficult.

As per market trend, SMEs always want to reduce their operational cost to increase their performance so this method will be more useful if input is taken for the several small and medium sized companies and as well as the more experts in different fields can get the accurate results. Likewise, it was found that the SME uses one or more than one CSP to reduce their operational cost as cloud service providers are scalable and different and limited pricing for particular services. Therefore we can conclude that the AHP may be the best systematic analysing tools to analyse among several options on cloud service providers with several experts valuation n criteria and hope that this technique has more improved to use in MCDM analysis.

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