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Master Thesis

A four-quadratic view in adopting Sustainable cloud storage service

Author
Jayakumar Mediboina
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Advisor
Prof. Prof. Dr. rer. pol. habil. Hans-Knud Arndt
Department of Wirtschaftsinformatik-Management Informationssysteme
&
Dr.-Ing. Sascha Bosse
CVLBA, VLBA Lab - MRCC-OVGU

Declaration of Work

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where states otherwise by reference or acknowledgment, the work presented is entirely my own.

Jayakumar Mediboina

Topic: A four-quadratic view in adopting Sustainable cloud storage service

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Abstract

The Product sustainability has been growing a major discipline in all organizations like from Energy, Processing Industry, Information & Communication technology (ICT),Textile etc. Although, there are several measures has been taken in order to sustain their product by the Manufactures but still it is failing in a long live due to the regular changes in the customer Interests. The main key success factor for any Manufacturer whether it is Energy, Telecommunications, ICT will come through only by predicting customer interests otherwise it cannot be sustained under this dynamic environment. Coming to Information & Communication technology (ICT) this prediction is furthermore a challenging task as they vary in the form of Technical features, Economic-cost, Social-Safety & Security over the period of time. So, it is clear that the sustainability of Product cannot be defined in any one- or two-Dimensional customer interests rather it needs to full fill the objectives of Four Dimensions Technical, Social, Economic & Environment evenly. During the last three decades, the Development and usage of the ICT products Integration into every Business Domains is at very large scale. Out of these products, the cloud storage services are one of the most adoptable products for the organizations as Files can be accessed from anywhere, Easy development in it, time & Money savings. But in contrast to advantages, due to the recent Data breach incidents on the cloud services it raises a question from the customers How it can be sustained under this Environment in securing the Data. The main clause of shifting the Business process from local storage to cloud storage by the customer is to secure the Data. Failing in this aspect causes a drop-in sustainability as it is no longer a adaptable product for the customer. The main aim of this study is to investigate the Goal & Techniques used in Four Dimensions: Technical, Social, Economic& Environment in the process of adopting a Sustainable cloud storage services by the users. In this study the objectives of each Dimension are described very well in problematic structure based on the issues faced by the user in the recent years. Along with this, the factors & Techniques required in achieving the goals of Four dimensions is illustrated in descriptive way with examples by taking legal laws, Protocols, case study results, Interview opinion, reviews, Recent Literatures . Finally, a case study & Flow chart is developed for user to give an idea for choosing Sustainable cloud services**.**

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1.0 Introduction

In the recent years the *Sustainability of Product* has been growing a major importance in the Engineering sciences. Companies from the different application Domains Energy, ICT, Automotive, Telecommunications etc. set their own Definition in Sustainability based on their Product priorities like Technical or Social or Economic or Environmental aspects in which product can sustain in long run Business years. But in actual context, none of these definitions are balancing the four Dimensions aspect [3] equally. When it comes to Information & Communication Technology (ICT) it is further far away from actual goal [3] as it emerged in every Business Domicile like Banking, Telecommunications, E governance, Traffic, Transportation systems. The primitive definition of the "Sustainability" is "*Meeting the Needs of the customer in longer run"*. But, In the recent years the definitions have been completely revised due to the concerns raised from the Environment, Social, Economic aspects. According to Collins [1] defines sustainability as 'the ability to be maintained at a steady level without exhausting natural resources or causing severe ecological damage' whereas UN- Brundtland [2] report says that the "Sustainable product needs to full fill the goals of Technical, Social, Environment Dimensions". Penzenstadler and Femmer [3] professor form TUM- Germany, defines the Sustainability of product should be viewed from the Four dimensions, Technical Dimension: The product needs to fits the customer application , Economic Dimension: It should be viable for the customer as per his financial status, Social Dimension: The data under this software is welly protected and Environment Dimension: It should causes less harm to nature. Although the definitions from the different authors, professors, organizations, Certification company is varying from one to one; the sustainability of software is purely based on the Application where it gets applied. For example, In Banking sectors they are much concerning about the aspects Technical: Process of their Business application & Social: Data security Dimensions whereas the Medium scale users like single user or small scale companies customers gives the priority in Technical & Economic Dimensions. Among the different software's in ICT, like web services, office products, CRM, ERP; the Cloud Storage services is gaining a high importance in the IT as it carries advantages like Economically feasible, Easy for Business process like development & storage of Data, reduction in own servers about to overall 30%.According to research done by IBM,KPMG [4] 93% of IT companies is opted to choose the Cloud storage Services as it reduces the operating cost by 25% and with capital cost 50%.Increasing in the usage numbers of cloud storage services in recent years is getting high as it delivering the best results in favor of Technical & Economic aspects. But, on the other hand it raises several questions from other Dimensions social: securing data & Environment: CO_2 emissions by looking into recent security breach incidents that has been took place in the last 10 years [39]. The main function of the cloud storage service consists of three

phases is Extracting, Transmitting, Storing of Data in different applications. The attack and/or breaching of data cloud take place at any of these three phases. Now, this puts a question from the users- individual, organizations, political law makers, certifications companies are these cloud storage services can withstand or sustain under the security threats? The main aim of this study is to analyze what are the requirements from the customer in adopting Sustainable cloud storage Service from the prospective of four-Dimensional view by giving major concern to Social & Environment Dimension.

1.1 Problem formulation

The biggest challenge in any Industry is, the developed product needs to meet the Customer goal without compromising in any aspects like Technical, Social, Economic & Environment. In simple words we can call it as *set of factors,* where they are the key factors for the Product Sustainability in a long run. Coming to ICT, this factor is still missing factor as it is not balancing the four dimensions objective equally. According to studies [1,2 & 3] Defining "*A good product is sustainable for longer years*" just not by assessing it in terms of Technical dimension: Fulfilling the Technical process but also it should full fill the aspects of Economic Dimension: Cost effective, Social Dimension: Securing the Data, Environment Dimension: Less impact on the Environment (CO_2 Emission). In the recent years the Sustainable Product plays important role in the serval organizations in the form of key performance indicator in the Technical-Business process. Across the several organizations in the present world the Executives, stake holders, CEO, IT departments focusing on highly in IT Application software's (cloud service, CRM, office etc.) to reduce the processing time of their Business. But, still there is a gap in achieving or choosing right software to their Business model due to lack of expertise in the objectives of Four Dimensions. The main objective of this study is aimed at the readers "*who works in organizations or an Individuals planning to adopt the sustainable cloud services which it full fills the objectives of four dimensions"* .This study comprises, Firstly by defining 1.what are the objective in each Dimension 2.How it can be achieved by analyzing & Evaluating the techniques that are recently used by the Organizations.

1.2 Purpose & Research Question

The main purpose of this study is aimed at the "*Requirements needed by the customers whether it is Individuals or Organizations is planning to adopt the sustainable cloud services who is much concern about the security & Privacy: Social Dimension of their data while storing in cloud services*". To achieve the purpose of the study, objectives of Social & Environment Dimension is more deeply analyzed in the various prospects along with Technical & Economic Dimensions. The goal of this research question is formulated into four-dimensional problem.

1.0 Technical Dimension: The main objective of the Technical Dimension is How Technical feature requirements of the cloud services will sustain over the period of 5 to 10 years? To answer this question ,firstly we need to evaluate features required by the customer in cloud services. This can be achieved by answering the sub questions

1) What is software? And how these software's are classified?
2) what is cloud storage service? How they are implemented?
3) What are the features that are required by the customer in choosing the cloud storage for their Business process?
4) How the quality Model with metrics helps the customer to assess the Sustainability of these features of Cloud storage?

2.0 Economic Dimension: The main objective of this Dimension is How the cost Estimation model helps the customer in choosing the sustainable cloud services for his Business? To answer this question, we need to answer following sub-questions first

1) How much the service provider going to charge the usage of product?
2) What are the factors that influences in the cost estimation model?
3) How the Cost Estimation can be modelled?

3.0 Society Dimension: The main objective of this Social Dimension is How can the Data of user or customer can securely store the Data in the cloud services? To answer this question, we need to answer the following sub-questions first

1) How the Data leakage or breach impact on the society in terms of Privacy, Trust & Product sustainability?
2) What are requirements from the lawyer's view?
3) How Data protection policy is varies from country to country? what are the impacts of them on the Data?
4) What are the requirements from the user view in securing the Data?

4.0 Ecological Dimension: The main objective of the Environment Dimension is How the Cloud storage causes the CO_2 emissions? To answer this question following sub-questions needs to answer first

1) what are sources that causes carbon emissions?
2) what are the techniques needs to be implemented in order to prevent the Emissions by the Data centers?

1.3 Outline of the Work flow

Section 1: This section describes firstly by stating the Introduction of this this study. Secondly, The motivation of the writer towards this research Topic. Thirdly, it describes what the research problem of this study by is illustrating it deeply in the four dimensions what is the purpose & objective of this Research question in subsection wise.

Section 2: This section describes the research design with simple block Diagram. Later on, it describes the literatures that are used and what are the sources for Data collection used in this study.

Section 3: This section starts with firstly with basic definition what is software and how they are classified, what is cloud services & classification of them. And then next the major part of this section is classified into four subsections. In the first sub section the objective of the technical Dimension is explained and then it describes what are the latest features required by the customer and also How a quality model with metrics helps in achieving the Technical Dimension goal. The second subsection describes what is the goal in this section and then How a cost model which is used in present techniques helps to achieve this goal. In third sub section, the goal of this section is explained briefly by giving the examples based on the recent incidents that has been took place in several organizations and later on the goal is achieved by describing the requirements from the view of user & Lawyer in securing the Data. In the last fourth subsection it describes goal, later on in this section we will discuss what causes this problem arises and how some factors help achieving the Goal.

Section 4: In this section at first a small case study result has been presented to assess the cloud services performance in context of the above-mentioned goals with metrics or models that are described in the above four subsections. And in the next some recommendations are presented with conclusion. Finally, some tips are recommended for future work based on the finally outcome.

2.0 Research Design & Literature Search

Research Design

The main aim of this study is originated from the research papers [1,2&3].It has been founded in these papers there exists a gap in achieving goal “How to choose a sustainable Product in ICT”. In this study, the problem has been formulated by collecting the problems faced by the users in their Day to Day business which was mentioned in the research publications, books ,magazines, conference talks, blog post and forums, available on the Internet .In order to achieve this goal, the analysis has been carried out on the Latest research Publications papers, Interviews, Case study results, Certification company policies, Legal law policies. This quality of the work is maintained throughout the study as we ensure the readers can have broad view on the problems and their solutions faced by the Business organizations.

Literature Search

The literature used in this study are collected from the recent published papers & Book in the following search Engines. The literatures used in this study almost related in context of Sustainable software Engineering, Sustainable product in Technical ,Social, Economic, Environment aspects

SpringerLink

ScienceDirect/Scopus

IEEE Digital Library

ACM Digital Library

3.0 Four Dimension View

3.1 Technical Dimension

To main purpose of the software is to automate the process by reducing the time, workload and also cost effective. Irrespective of domains like Private companies, banking sector, Governance; choosing the right cloud storage for their Business application is always challenging task for the customers in process of adopting it. No matter whether the customer is single, small, medium or large in across all Domains, having expertise in the requirements "IT" -Technically doesn't gives enough knowledge in choosing the product rather it needs one more important term called "Business". It always helps the customer in aspect of the Key performance vs Investment curve Indicator of a Product. The main objective of the Technical Dimension is not just ensuring that the product is well fitted *"Technically"* to the respective application process but also it needs to answer the question How can the performance of product can be is assessed in terms of *"Sustainability"* over the period of time 5 to 10 years under the complex environment?

1) What are the features that are required by the customer in choosing the cloud storage for their Business application process?

2) How the quality Model with metrics helps the customer to assess the Sustainability of these features in Cloud storage services?

Before going to answer this question at first, we will discuss basic of software definition & their Classification, Cloud storage service types and then we will discuss the features & Quality model for Cloud storage.

3.1.1 Basics: Software Definition & Classification

Definition of software: "A Software is a generic term it refers to is a set of instructions or Data or programs that instructs a computer to do specific tasks". These software's are mainly classified into two categories

1.*System software*: These are the software's that runs on the system Hardware, in simple terms we can call it as Interface between user and Hardware of computer for the functions required by the user and as well as it supports to other application software's.

2.Application software: These are the software runs on the computer with only system software for different applications like Banking, Governance, Education etc. The below Fig 1 shows the architecture of software classification.

The usage and development of Application software's in the recent years has been drastically increased in various Domains. Out of all application software's, the usage of the cloud storage furthermore plays key role in the customer business process due to increase in the data storage by the e-mails, documents, Transactions, presentations, databases, graphics, audio files and spreadsheets. Basically, cloud storage service is a network connected with distributed data centers. Typically, these data can be stored and accessed via API in real time. The organizations facing unprecedented changes due to usage of their Business applications is now in the hands of the customers. Now this is challenging task for the industries to adopt the right Cloud storage in order to meet the customer demands. According to Microsoft[5],it is published there are key considerations that needs to be accounted while choosing features of cloud storage by the executives, CEO & IT-Team in banking & Private organizations. Before going to discuss these features in detail at first, we will go through short introduction about the cloud storage definition and Types of Cloud services. Cloud storage services are mainly classified in to mainly SaaS, PaaS, IaaS.

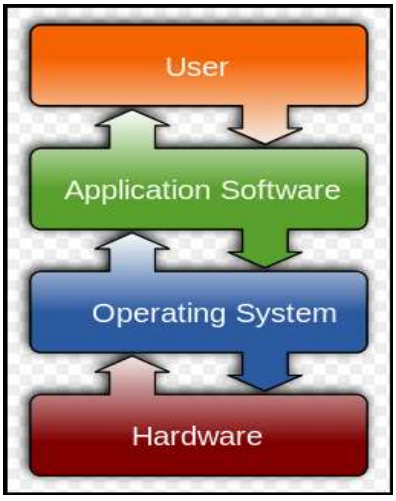


Fig 1: User interacting with Types Software

3.1.2 Types of Cloud storage services

- *Software-as-a-Service (SaaS):* This service model is mostly used in the accounting, CRM ,ERP, invoicing, human resource, management, content management, and service desk management where the user or customer can accesses the services and data vis web browsers.

- *Platform-as-a-Service (PaaS):* This model services are used for Application development, interface, database development, storage, and testing in the different business model. Advantages with this mode is easy to maintenance and support of custom applications, lowering costs in terms of assets management in software's & Hardware's.

- *Infrastructure-as-a-Service (IaaS):* This service model provides fully outsourced service rather than purchasing servers, software, data center space or network equipment. The following below Fig 2 shows the cloud services Dropbox, Sales force, windows azure ,amazon services that are categorized based on the three services.

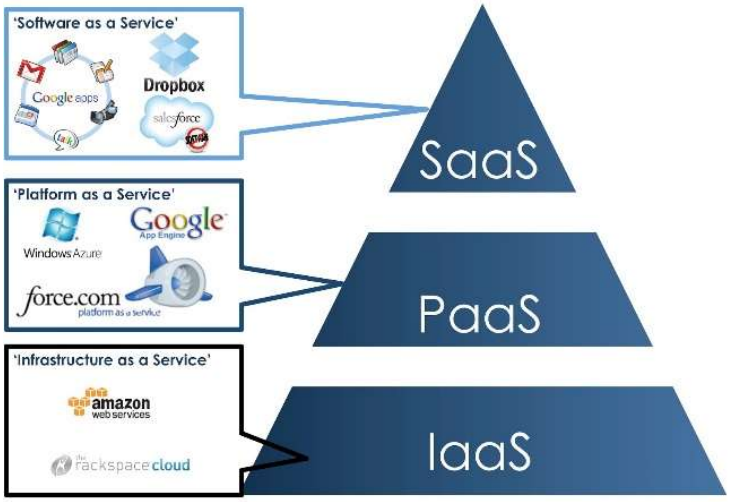


Fig 2: A three level Cloud services

In practice these service models are deployed in three different ways.

- *Private clouds:* This service is independent and unique operated by third party services for each organization. This is the most conceptual way to store a data for the companies.

- *Public clouds:* The cloud services are accessible to public or a large industry group by maintaining by its own organizations.

- *Hybrid clouds:* The cloud services are classified in to two types private and public .But, they have associated each other in terms of administrative services. Following below figure shows the basic Cloud Infrastructure services with Deployment models that are used in Banking & Private organizations.

Over the recent years the usage of the cloud service's in the private companies increased due to adoption of the digitalization across all Business application process. For example, at present the Dropbox is holding 25 million users, while Mozy and Ubuntu is having one million users. The sustainability of the cloud services is purely depending upon the features that were offered by the providers. Although there will be variation in several features offered by the providers, the most common important feature is Trust, security of the services. The companies store sensitive information like Business process, property, research data in cloud is having a value at High level. Disclosing of these information's to public via Hackings in illegal way causes the Business collapse and also Loss in Trust on the product software. According the IBM study [6] eighty nine percent of CEO's of different companies are going to adopt cloud services soon in Banking & private sectors. So, it clear that the providers of the cloud services has to tailor their product features based on Business application process for various customers in order to lead and sustain their product for longer years. In the following we will discuss features that are required by the customers.

3.1.3 Features of Cloud storage

1.Copy, Backup, Synchronization, sharing

2.Interfaces:1. Proprietary Software Clients 2. Browser Interface 3.Application Programming Interface

3.Optimization: Deduplication, Delta Encoding, Compression

4.Legal & Security, Encryption

1.1 Copy: This feature creates duplicate data folder in the cloud. Generally, there are two ways to upload data from to cloud 1. Customer has to be upload data 2. The software that is installed in personal will automatically upload the new data.

1.2 Back up: This feature is used to back up any kind of data version that was stored in the cloud over the period. The entire process can be done by software that has to be configured in the customer PC with stetting of time interval hourly or daily.

1.3 Synchronization: This feature is very important when cloud services is used in different devices like laptop, tablets, mobile. In regular process the user can access & edit the same file in cloud from different devices, these changes are necessarily to be detected by the software and should keep synchronization between devices without any conflict.

1.4 Sharing: This feature is used to share the file in the cloud between the set or group of peoples or colleagues. Typically the sharing is done three ways 1.subscribers who uses the same service 2.outside organization people 3.with every one.

2.Interfaces: The accessing of the cloud data can be done in three way using 1.Proprietary Software Clients 2. Browser Interface 3.Application Programming Interface

2.1 Proprietary software: This is most comfortable & easy way to access the data from local PC. This software is provided by the cloud services with feature of what data has to be transmit, share, synchronization to cloud

2.2 Browser Interface: It is the most commonly way to access data with help of browsers by the users.

2.3 Application Program Interface: This most advanced feature that is required for the companies where the developers have access to data from the API that is provided by the Cloud services for the development to different applications. It serves a most advanced features like revision of previously stored files over the time period and deduplication . The most common way to access this web services using API in the standardize protocol SOAP [7].In the section 3.3 we will discuss most commonly used protocols in cloud services.

3.Optimization: The optimization techniques are very important for the consumers in order to save the storage capacity & Money, Bandwidth. There are three methods are in practice for optimization technique

3.1 Deduplication: The goal of this technique is stored a single copy of each data is stored where the total disk or storage size is significantly reduced. If further user wants to save pervious file, the service will create a new link instead of duplicating the data. Further the Duplication is classified into six types File level , Block level ,Server-side ,client-side, Single user ,cross user [8].

3.2 Delta Encoding: This feature ensures that the new version of all files that are previously stored in the cloud storage with minimal usage of Bandwidth. The most algorithm used in this encoding is rsync[9]

Note: The Legal & Security, Encryption feature is discussed in the section Social Dimension 3.3

3.1.4 Quality Attributes

The software development process includes mainly four stages 1. Problem specification 2 Planning 3. Software designing 4. Execution & Testing. All the goal in each phase is to be deliver the product to meet the needs of the customer not only in present condition but also, it needs to sustain in long term goal. In order to use these products in a long run it is quite necessary that the product needs to be maintained over the years, and also it should have capability(portable design) to withstand for any changes that has been taken place in the Hardware component, it should easily understandable for the users. The process of tailoring the features needs to be fast within given Time span as it needs to achieve the goal of customer. So, therefore the chosen product is not only viewed in the "Is it Technically fit" but also the customer needs to assess that the product can it be sustainable for longer years 10 to 15 or not. In software engineering, the sustainability of product can be evaluated using the collection of attributes accessibility, accuracy, maintainability, modifiability, reliability and reusability [10 & 11]. In simple terms these attributes are also called as software quality attributes in IEC standards (software quality ISO/IEC 25010: 2011). More often these attributes are also called Non-functional requirement attributes [12 &13].

The nonfunctional attributes are defined as "how the software will do it in performing a task?". kindly note that in this work we are considering attributes of Non-functional requirement rather than Functional requirement: " what the product or software must accomplish to produce required behavior and/or Task?" as we are concern about the customer point of view. Initially these Software quality attributes (Nonfunctional requirements) was not defined in IEEE standards -1990 article [14]. But later years it gains much importance in software development process. In year 2007 researcher Ginz [15] developed a special taxonomy for the nonfunctional requirement and defined it as major constraint in the software design process of a system. Upon on this researchers Bajpai and Gorthi [16] defined these quality attributes are playing a major role in software developing process based on the problems encountered by the software developers [17].So therefore these attributes are defined and published in the new standard article of ISO/IEEE/IEC in 2010. The quality of software product is now considered as an essential element in business success [Veenendaal and McMullan, 1997] [18].When it comes to cloud computing solutions in the Private organizations, the quality of software plays key role in their business process in terms of Functionality , Security, Reliability etc. Upon the ISO/IEC 25010: 2011 standard quality model, there exists several other models 1. McCall's Quality Model. 2. Boehm's Quality Model. 3. Dromey's Quality Model. 4. FURPS Quality Model.

1.Functionality
2.Usability
3.Reliability
4.Miantainbility
5.Efficeincy
6.Portability

In the following section, out of the several quality models, we will discuss standard ISO/IEC 25010: 2011 model attributes in this study as it internationally acceptable with the metrics that are used to measure degree of the attributes. These metrics are significant in evaluating the services of cloud. Following below Fig 3 shows the architecture of ISO quality model attributes & Metrics.

1.Functionality: It is a quality attribute that measures the degree of the satisfaction of customer up to what level the Technical aspect of the product is satisfied. The functionality attributes is further classified into 1. Suitability: This attribute describes How much percent software suite to the existing business process. 2. Interoperability: It is an attribute that describes capability of existing programs exchanging of data between them under the different file formats & protocol [19] 3.Security:It is an attribute ,that describes the security level(How secure is data) of the software. Furthermore, details see section 3.2. The functionality of the software is often rated in the scale [Very satisfied, Satisfied, Neutral, Dissatisfied , Very dissatisfied]. The metrics used to test functionality of software is based on the grouping of the scale ratings in two Percent of completely satisfied customers , Percent of dis-satisfied customers.

Complete: This is one of the important metrics is to measure the total number of functions currently specified or not. It can be evaluated by

$$Q = n_u / n_i \times n_s$$

Where, n_u is the unique function, n_i is the stimulus input of the function n_s is the state input of the function

2.Reliability*:* It is defined as How much percent the product performs specified functions under specified work load conditions for a specified period of time. The reliability attributes are further classified into

Maturity: Hou much percent the product is reliable under normal operation.

Availability: It is defined as ON time or product available time for use.

Fault tolerance: It is the time where the products is available for operation irrespective of hardware or software faults.

Recoverability: It time require to set back to normal condition from the fault condition.

The reliability of software is calculated by using metric Mean time between the failure(MTBF)[20].

MTBF= Total time Measures/Total no of features

Another important metric in the reliability is the Availability of service. It is defined as the Amount of the time the service is active without any interruption.

Availability= MTBF/(MTBF+MTTR) where MTTR-Mean time to Repair

3.Efficiency*:* It is defined as the degree of performance of a software in relative to the amount of resources used, under stated conditions [20].Further, efficiency is classified into

Time behavior(TB): It is defined as the response time of software to perform specific functions. It is calculated as

TB= Execution time/Total service Invocation time

Resource utilization(RU): It is defined as the amount of resources utilized by the software to perform a task. It is calculated as

RU = Amount of allocated resources/Amount of pre-defined resource.

4.Usability: It is defined as the degree of the software product is understandable to learn, usage, by the user in the entire real time of utilization [21]. It is further classified in to

Understandability: It is term that defines how much percent the use can understand product in performing specific Task.

Learnability: Its is defined as the how much percent that the user is learn about the product from the resources that are available in the product documentary & other media

Operability: It is defined as the how much percentage the user can use features of the software in an easy way

The most common metric used to measure usability Problems per User-Month (PUM).PUM is calculated by each month in scale of wither by percentage or rating from poor to very good.

PUM = Total Problems that customers reported (true defect and non-defect-oriented problems) for a time period + Total number of license months of the software for a specific period

5.Portability: It is technical attribute that defines the existing software can be transferred from one hardware to another operational environment usage [22,21]. It is further classified in to

Adaptability: It is defined as the percentage of how efficiently software is adapted to another environment

Install ability: It is defined as the How much percentage that software can efficiently installed on the different hardware.

Internally consistent: It is defined as the percentage of functions of software is suitable to present hard ware.

$$QI = n_u - n_n / n_u$$

Where, n_u is the number of unique functions specified n_n is the number of unique functions that are non-deterministic.

6.Maintainability: This is one of the most important attributes which quantifies the degree of effectiveness and efficiency of a product against to the modification in terms like to improve it, correct it or adapt it to changes in environment, and in requirements [23,24]. This attribute is further classified into

Modularity: It is defined as the effect of change in one module component in the software
should have the minimal effect on the other component.
Reusability: It is defined as the asset that is used more than in one system.

Analyzability: It is defined as degree of tolerance or sustainability of software when there is failure in the software or when the parts is modified.

Modifiability: It is defined as the degree of the implementation of software after the modifications.

Testability: It is defined as the degree of the validation of software after the implementation of with modifications .Once after the product has been in running phase, it cannot be modified much. But, from the maintenance point of view it is very important that the product performance has to calibrated in ruining phase as it need to be sustained for longer period. Typically, the calibration has been done by using the following metrics.

1.Fix backlog and backlog management index (BMI): It is defined as the rate of defect arrivals to the rate at which fixes for reported problems become available. This metric very helpful for the process of the maintenance purpose by counting the total reported problems that are still not yet rectified in the end of the month.

BMI = (No of problems closed/No of problems arrived) * 100

2.Fix response time and fix responsiveness: It is defined as the mean time of the problems from state active ON to OFF.

3.Percent delinquent fixes (PDF) = (Total no of problems are ON after the fixed Time response set by criteria/No of problems rectified or OFF within fixed set time) * 100

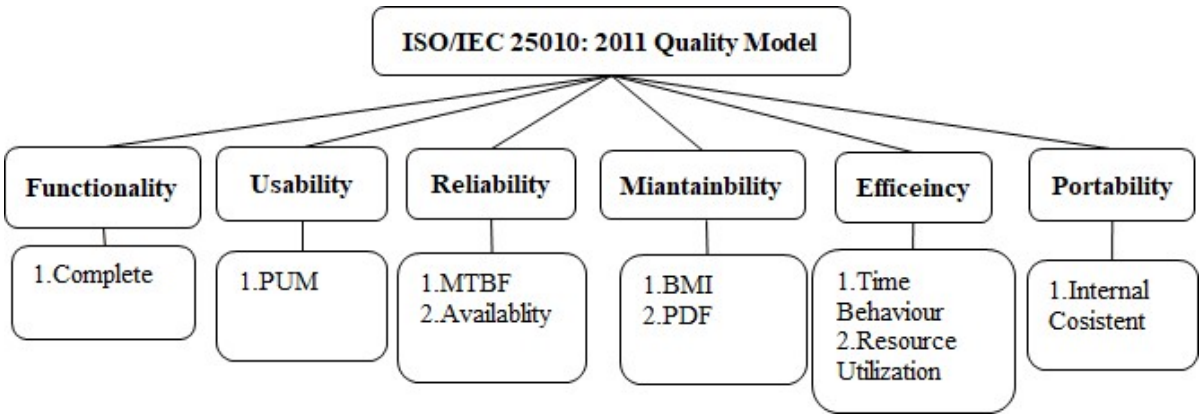


Fig 3: ISO 25010:2011 Quality Model with Metrics

These are the metrics used in the evaluating the Technical Dimension aspects used in the cloud services like (SaaS, Paas, Iaas). As discussed above, there exists several quality model along with ISO model, 1. McCall's Quality Model. 2. Boehm's Quality Model. 3. Dromey's Quality Model. 4. FURPS Quality Model. Among all these quality models, the ISO model is the most accepted model that is used in evaluating performance of the cloud service as it is developed on international consensus and agreement from all the country members of the ISO organization. Nevertheless, in some other environments often customers prefer other model for e.g. McCall quality model as it offers additional attributes -metrics when compared to ISO for evaluating the cloud services.

In the following below table, a simple comparison of quality models is presented in Table [1]. Apart from the standard models, there are several organizations globally involved in the certification of cloud service quality performance. Following are the some of the recognized organizations shown in Appendix I(a).

Factors/Attributes/Characteristics	ISO 9126	McCall	Boehm	Dromey	FURPS
Correctness		×			
Efficiency	×	×	×	×	
Flexibility		×			
Functionality	×			×	×
Human Engineering			×		
Integrity		×			
Interoperability		×			
Maintainability	×	×		×	
Modifiability			×		
Performance					×
Portability	×	×	×	×	
Reliability	×	×	×	×	×
Reusability		×		×	
Supportability					×
Testability		×	×		
Understandability			×		
Usability	×	×		×	×
	×	Indicates the feature Availablity			

Table 1: Comparison of the Factors of five quality Models

3.2 Economic Dimension

Another important dimension of the sustainability is the “Economic” aspect. In general, the sustainability of the product is also based on the level of the satisfaction of the services that is offered by provider at the rate of customer Economic-Financial condition which meets his affordable price[25].It is very important that the customer has to opt the services not only in the view of the technical rather one also look after the background or Track record of the service provider. For example, the destruction of contract in middle of the services can cause severe damage to the customer in Technically way like migration of data from one to one machine which may not be feasible and also it causes rise in budgeting to the services. The performance quality attributes for long run discussed in the technical dimension like efficiency ,Maintainability ,reliability etc. of Cloud services exhibits their results based on the services that were adopted by the customer as per financial Budget health. The services & Features of any product is highly varying with the factor “pricing” that is paid by the customer. For example, in the cloud Services, the price is adequately proportional to speed, storage, Bandwidth. Adopting

higher speeds or Bandwidth services causes the increase in subscription price of the product. So, it is evident that there exists a clear linkage between the Technical & Economic dimension in terms of sustainability. Now this raises a question in the customers Increase in the bandwidth or Storage prices by the service providers over a period could causes the raise in maintenance cost which is an additional budgeting and it is unsustainable for their Business process. Under this scenario now the customers' needs some kind expertise in order to Estimate the Cost of Product before adopting it. In this study, the main objective of the Economic dimension is How the cost estimation is modelled in cloud software services? To answer this question first we need to answer below questions at first

1.how much the service provider going to charge the usage of product?
The pricing of service is based on the per use, subscription, prepaid.

2.What are the factors that influences in the cost estimation model?
The factor like Technical & Non-Technical

3.How the Cost Estimation can be modelled?
Algorithmic approach

Firstly, in the following section we will discuss pricing model: Techniques used in pricing model and next we will evaluate Factors effecting on cost Estimation Model and at last Cost Estimation Model Process is established using these Factors.

3.2.1 Pricing Model: The billing of customer is based on the services opted by the customer. In cloud services the pricing model can be done in two ways 1.Pay per use: it generally calculated as per user or per hourly or per monthly base. This model is also called as the Dynamic pricing [26]. 2.subcription pricing model: In contrast to the above pricing model, Here the services are charged based on the contractual terms between service provider & customer. Thus, this services is also called as the Fixed pricing. These pricings are discussed below in detail.

Pay per use: According to [27],most of the cloud services are offered timely manner, pay per use pricing is modeled based on the metric or meters from the customer end rather than service provider. In simple in can be defined as the pay the pricing based on the services that are used in time. This model is advantages in term of the small scale customers as it saves from the unwanted billings services which were not used by the customers in day to day business. In cloud computing this pricing model is applicable on the service features like Data storage(GB),Bandwidth, Assets (Hardware & software).

Subscription: This pricing model is mostly adopted by the large scale customer for their business process at they are avail for all the features & due to increase in the business[28]. The standard way of this pricing is contractual terms between provider & customer based on the end to end dates. The main disadvantages of this model is unwanted billing for the services as some times the customer don't use all features. This causes over burden.

Prepaid per-use: In this model the consumers need to buy credit that may be required for their business under the high demand of usage services.

3.2.2 Factors for Cost Estimation: The estimation of cost in cloud storage services is quite complex as the services is vary based on the features adopted by customer. These feature plays significant role in the cost estimation for example Increase in the asset cost cloud increase or decrease the total cost. The modelling of cost Estimation is based on the set of factors called "Cost effecting Factors" which is directly impacting on the Costing model. In general, these factors are divided in to two types 1. Technical Factors 2.Non-technical Factors. Further each of these factors are sub-classified into various types shown in Fig [4].

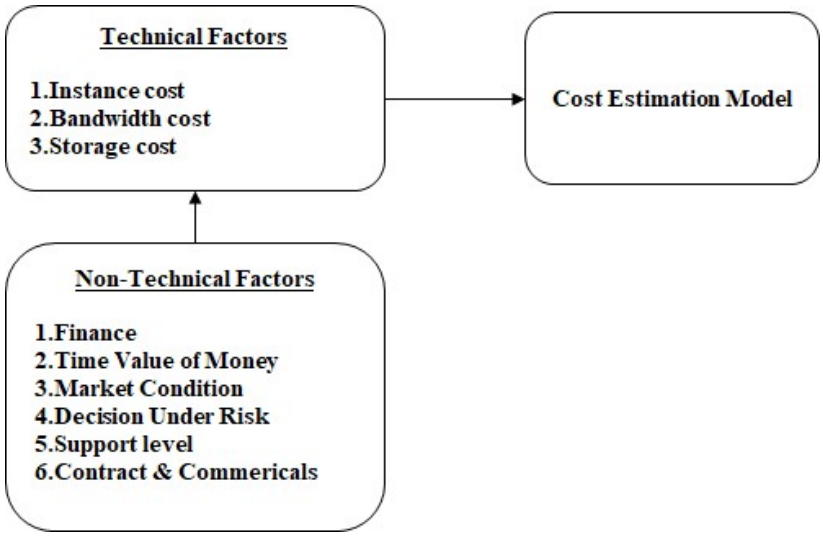


Fig 4: Factors that effects on Cost Modelling

3.2.2 (a) Technical Factors: It is defined as the factors or the resources that are used by the service provider in setting up Cloud services. More often these Technical factors are also called as the Chargeable factors used for the Cost Estimation model discussed in the below section 3.2.3. Technical factor is further classified in to three types 1.Instance cost 2.Bandwidth cost 3.Storage cost. In the following section we will discuss each of these factors with sub factors. In this study the following architecture Fig [5] is assumed as the Cloud service network for the web app running.

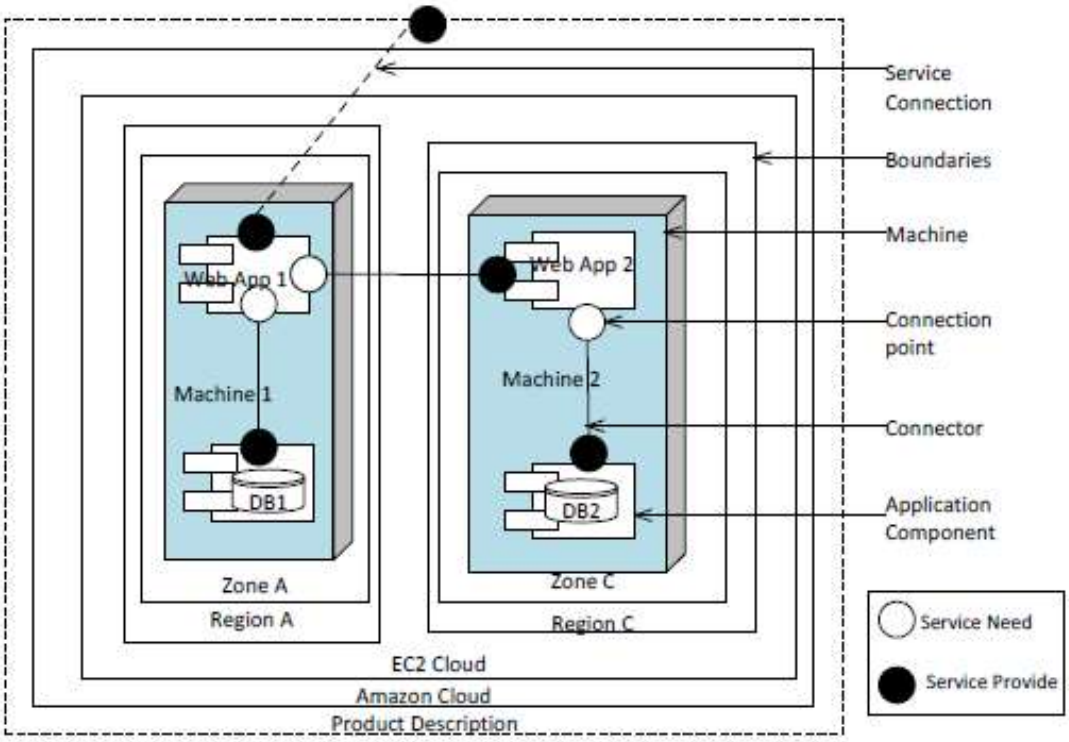


Fig 5: A simple architecture of cloud service network integration for Client Application software Development

Instance cost: It is defined as the total cost of the virtual machines described for a software components deployment**.** The instance cost consists of mainly five parameters

Service operation: It defined as the service which is opted by the user (Iaas, Saas,PaaS)

Duration ($T_{duration}$): It defined as the duration of the complete cloud storage is active

Machine Type: It is defined as the basic charging unit for measuring machine size cost

Machine size: It is defined as the size of the machine using measurement unit of small, medium large etc.

No of amount or Instance price: It is defined as the renting price for each machine size.

Bandwidth Cost: It is defined as the total cost where the data is transferred from the Customer machine & to the customer machine defined at boundary shown in Fig 5 as service connection with use of the connectors & level of the agreement. The main algorithm of the data transfer

count is based on the peer to peer connection type shown in Fig 6. The following are the parameters used in the calculation of the Bandwidth cost factor.

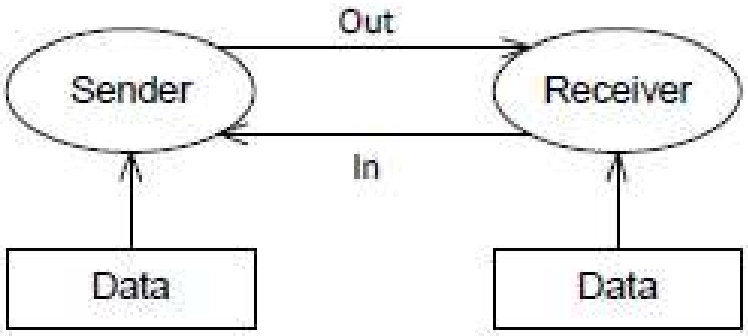


Fig 6: Peer to peer Connection

Connector: It is the point where the data gets IN & Out from the application software to the cloud storage. The point of the connector is gets integrated with traffic communication. Generally, the connector is placed at Boundary level at customer work place like Zone c in Fig 5. These Connectors are classified into

1.Type of connector: Defines what type of the customer is using
2.No of connectors :Total no of connectors used by the customer
3.Type of port: It defined as the port used for interface with the connector

Data In & Out: It is defined as the data that is transferred IN & Out from the customer service boundary level to services storage center. In general, it is denoted as the Data transferred from & to the port.
Machine IN & Out: It defined as the data that is transferred In & out of machine with in cloud services used at customer end.
Machine Intra: It defined as the data that is transferred between machines.

Network Boundary: It is one of the significant factors in cost estimation. The cost estimation value rapidly decreases or increases based on the geographical condition of the customer location. Bandwidth of the customer required services is based on the parameters like amount of the information that is generated & communicated within the service.

According to [29] the network boundary is firstly classified in to “regions” and each of these regions consists of “zones”. Firstly, the pricing of the service is depends

upon the regions where the services is going to deploy and later final price is evaluated based on the Zone, shown in the Fig [5].

Service provide: It defined as data communication point for a component to provide the needed service.

Storage Cost: It is defined as the amount of storage used by customer in the form of (Bites).The storage is based on the customer business application. For example, if the customer uses it for application software development, it needs more space for communicating between the software components during development & running. In those cases, the local storage may not be efficient, so it needs the additional storage. As discussed earlier in the pricing section 3.2.1 the dynamic pricing can be opted upon the existence services. In these cases, mostly customer prefers the additional storage upon the existing infrastructure. The major disadvantage in this scenario is, pricing of the services will charge higher than the normal flat rate due to dynamic change in the usage of the application process. Following are the most important parameters used in the storage cost.

Storage capacity: It is the total amount of the capacity available for user to store the data

Storage In & Out: It is defined as the amount of data that is transferred to cloud storage

Storage amount price: It defined as the basic unit charge for measuring the storage amount cost

Storage price: It is defined as the amount of static storage used for deployment of a service.

3.2.2 (b) Non-Technical Factor: According to Microsoft Cloud computing services [5], the costing model is also influenced by the Non-Technical factors like Market condition, Trust-Security, Contract & Commercials & financial health of the service provider. For example, change in the Bandwidth prices in Market causes variation in the total Estimation cost. Further these factors are helpful in Trusted & Secure agreements between the customer & Provider. In the following we will discuss these factors in detail.

Finance: It is foremost Factor that gives the support financially for adopting the services of a customer. It is mainly evolving within the parameters like Time, Money & Risk. Financing of a services is depending upon the Technical Factors & infrastructure that is available at customer. In general Finance budgeting of a services is evaluated on the concept of Time value of Money.

Time value of Money: It is defined as the value of the money is changes over the period of time. The evaluation of the services provided by the provider can be done by normalizing the cost & Risk at present value. Over a period, it is very important for the customer to forecast the running cost of the services. In cloud services out of the total cost the running cost is dynamic when compared to installation & Deployment cost as it changes based on the third-party charges basically satellite network communication. Increase in the satellite cost could causes the raise in running cost of the cloud services. This leads the customer over budgeting in some cases. Under these scenarios the customers' needs to consider the inflation & deflation in forecasting model. In corporate financial terms the *Time Value of Money* is also called as ROI. Which is evaluated in the form of benefits to the investor. The detail evaluation is illustrated in the article [58] which helps the customer to calculate ROI.

Market Condition: The variance of the product price is depending upon Market competitors available in that Region & Zone. As the cloud services operates purely in the High frequency communication, the speed of the services is varying from region to region & Zone to Zone. For example, if the customer is located at semi or low speed network communication zone, the pricing of the Cloud service is high due to the low number of service providers viceversly the cost could be low in the urban areas as their is market competition between the providers. In these environments choosing the right service is quite complex. Therefore, the best solution is opting the service based on the Decision under risk.

Decision under risk: Under the dynamic environment, the decision under risk Techniques are helpful in the to get right outcome by assigning the probabilities for different market conditions. In general, there are mainly four methods used for this evaluation [57].

1. expected value decision making
2. expectation variance and decision making
3. Monte Carlo analysis
4. expected value of perfect information.

Cost Estimation: Estimation of the resources price keeps the business promising. Estimation is used to analyze & forecast the budget in quarterly, half year, Yearly. In general, there are five techniques used in Estimation

1. Expert judgment
2. Analogy

3. Estimation by parts
4. Parametric methods
5. Statistical methods

All these methods directly depend on the Technical factors. The better estimation can be achieved by finding the right factors & and their dependencies between them.

Support level: Sometimes it can be called as the customer support. As the cloud services is 24*7 services the level of the support to customer by the provider is also a key decision-making factor in adopting services. Sometimes the customer prefers high pricing services rather than lower services is due customer support by the provider keeps the infrastructure reliable & Efficient technically. In the return of investment, the degree of the services utilization is the main factor for the customer to understand the service performance. Generally, the degree is calculated based on the what level service provider share or transform the knowledge of the service utilization to the user or employees at customer place. Sometimes the information about the services may not be available structurally. So, it is very important for the customer to obtains the information about the service documents, resource utilization in any kind of media. Upon this another factor is availability of helpline service during break down time either technical & non technical Faults .The customers need to identify this factor during contractual terms with the provider by ensuring the help line 24*7 for the fault rectification the so that keeps the service ON time is high.

Cost Benefit Analysis: This is the factor which is evaluated by the customer to obtain the degree of the benefits that can be obtained from the services from different providers. Generally, the value is denoted in the range 0 to 1.where 1 is the best service provider. It includes some important parameters that are directly affects on the services

1.Effects on user or employee : Directs effects on the employee
2. Effects on non-users or non-participants
3.Externality effects: Effects from the external parameters like rise in the vendor price of service provider.
4.Option value or other social benefits.

Contract, Commercials & Service Level Agreements: The cloud service agreements are very complex structure as it need to meet the goal of the both the parties service provider & customer. In some environment there exists confusion, complicated, termination of contracts due

the roles & responsibilities from both the parties. Therefore thus it needs major concentration towards it. ISO standards for Service level agreements ISO/IEC 19086-1:2016 [30] is the revised version clears the confusion between the both the parties for common level of understanding the agreement. With this standard level both the parties will be beneficial.

Contract: In general, the contract between the parties is structured based on the individual negotiations over their priorities. The main important parameters in the contract are 1.Time period (Quarter, Half year, Yearly) 2.Roles & Responsibilities of Individual activity: It is defined as, the roles of the both parties who is taking care of what section boundaries is shown in Fig [5] Service needed and Service provided 3.Service Management & Availability: It is defined which components is operated under whom whether it done by customer or service provider.

Commercials: In cloud services there exists typically three services. SaaS is the basic level of service payed at peruse, per monthly basis based on the feature like storage requirement.
IaaS, PaaS are the service is offered at high speed level, Storage for Business level customer.

Service Level Agreements: The service level agreements are mainly classified into three types.

1. Service level objectives
2. Remediation policies and penalties/incentives related to these objectives
3. Exclusions and caveats

Service Level Objectives: The are the objectives that are discussed in the Technical Factor. The Parameters like Time duration, Response time, Service capacity, Service availability.

Remediation & Penalties: The customer need the service level agreements for the payments or Transactions in structed way. For example, the payments can be processed Monthly, to Quarterly. Exceeding of these dates cloud cause the penalties. Often these penalties vary with the customers. Sometimes there exists penalty from the provider end if the services is down for a period of time as well. These terms must notify during the initial agreements.

Exclusions and caveats: Uncertainty of service or Payment issues cloud leads the service termination. The customer needs to be cautions in prior if the services are terminated

otherwise it may lead to the customer business process uncertain. In these scenarios the customer has the right to claim money if services are stopped or agreements is violated.

3.2.3 Cost Estimation: It is the process of estimating a cost for the services or resources used by the customer [33]. The resources used by the customer is in the form of 1.Assets:nothing but Installation cost inclusive of Machine, Network components 2.Running cost: It is the cost for the running a service for period of time for using Bandwidth, Network shown in Table [3].The cost estimation process involves mainly four steps 1.service documents requirements 2.chargeable factors Identification 3.charge of the price in each factor 4.Generating the cost equation using the Algorithm model 5.Deployment of service. The main stage of this cost estimation model is choosing suitable Algorithm model. In general, modelling can be approached by two methods 1. Non-Algorithm Method 2. Algorithm Model [34].In following section we will discuss this in detail.

Non-Algorithm Method: The non-algorithm methods are very simple in the real time for evolution as it mainly based on the interfacing & comparing the present scenario with the pervious or reference projects datasets [31]. There are mainly two techniques used in this 1.Bottom up 1.Bottom Down for cost estimation equation. In the bottom up approach at first the cost of each component like Assets, Running Cost is independently calculated and in the final stage both of the cost is aggregated. Where as in the bottom down at first total cost is estimated for overall infrastructure and then for each component the pricing is classified. Further, these non-algorithm model can be found [31,32. These algorithms is not used in practice due to unrealistic behavior for period of time.

Algorithm Method: The Algorithm method way of estimating the cost Equation involves set of variables that are considered at Initial planning stage[34] .In general these variables are Hardware ,software, running cost. The cost estimation through the algorithm method is based on the mathematical function consisting of set of variables. It can be denoted as

$$e = f(x1, x2, \ldots, xn)$$

Here x1, x2, …, xn denotes the Cost factors that are highly influencing the total cost. Whereas the F denotes the function. The most common modeling of this mathematical function is based in the COCOMO II Model.

Cost Estimation Process: The main goal of the cost estimation process is to find out the total cost of the services .In the Cost Estimation process the costing Model Equation is highly varies with the cost effecting factors or chargeable factors discussed in section 3.2.2 (a). Following are the step by step approach for the cost Estimation equation.

1.At First Analyze the service required with Important Cost Factor
2.Analyse the chargeable Factors by identifying the unit price per each Factor
3.Devlop cost Model:

The costing model is based on the Three Cost Factors discussed in the earlier in the section 3.2.2-Techical factors. The parameters used for this costing model is classified on three factors 1.Instance cost 2.Bandwidth cost 3.Storage cost shown in Table [3].

Total Instance Cost	Virtual Machine Type, Machine Cost, Number of amount, Service type
Total Bandwidth Cost	No. of VM, type of connector, No. of port, Type of Port, Types of Port, No. of Port.
	Data in, Data out
	Machine, Region, Cloud service, IaaS Provider
	Cloud Service Type
	Computing power, Storage Capacity, Inbound Data Transfer, Outbound Data Transfer
	Basic Service Charge, Internal Data Transfer
Total Storage Cost	Duration, Data Input

Table 3: Cost Model Factors Classification

The total cost Equation can be formulated as

TCser= TCinst + TCband +TCstor

Instance cost (TCinst): It is defined as Total cost of virtual machines described for a software components deployment. It can be calculated as the

TCins=N machine size × Tusage× Prinstance

Where N machine size is the no of the Machine size, Tusage is the usage of the service for

the period. It is calculated by using factor duration Tusage =Tduration * 24.Prinstance is the price per machine at an instance based on the size of the machine size small, medium, large.

Bandwidth Cost(TCband): It is defined as the Price per data that is transferred from customer machine to In & out to service provider machine. It is calculated as

$$\mathbf{TCband = D_{a(from)} * Pr_{(from\ port)} + D_{a(to)} * Pr_{(to\ port)}}$$

Where $D_{a(from)}$ & $D_{a(to)}$ is the data that is transferred from IN & out to the machine.
$Pr_{(to\ port)}$ & $Pr_{(from\ port)}$ is the price per data at ports IN & OUT.

Storage cost(TCstor): It is defined as the total cost for storing the data. It is calculated as

$$\mathbf{TCstor = TSamou \times Sprice}$$

Where TSamou is the storage amount calculated by using storage capacity factor (Sdc).
TSamou =Sdc/1024.(Sprice) is the storage price.

The aggregation of these cost factors gives the total cost Estimation per services.

$$\mathbf{TCser = TCinst + TCband + TCstor}$$

3.3 Social Dimension

According to the IBM, Human rights & EU publications [3,36, 37,38,40] the impact of the software on the society is prominent and in more complex across world in terms of security, privacy, Trust of a user . The fall in any one of these factors directly influences the Sustainability of the product as it is no longer an option for the user. The latest research papers [39,40] by EU described that the increase in the software's products not only impacts on the security, privacy of user data but also rather it influences highly on the Employment, Value added, Productivity. According to EU Publication [40] the employment rate in software Industry is increased by 16.06% from 2008 to 2013.Due to increase in employment rate, the value-added services is raised up to 3.78%. Now this shows, the usage of the software is increased rapidly over the years in all the Application Domains. The impact of these software's on the society is highly varies with respective to Domain of the software where it gets applied. Generally, these domains are classified into e-cloud storage, e -governance, telecommunications, e-office, e- health, e-education, social media, Digital Market. The Security & privacy of the user Data which is obtained

from these software's is very sensible and needs to be protected from the threats and/or third-party sources. The leakage of the Data either by intentionally or unintentionally could cause the violation of Data protection policy, and loss of trust & security on the software product which declines the sustainability of the software at higher rate as the product is not reliable for the customer. The security & Privacy level settings of user Data in the software is varies in the software's as per the application Domains. The following are the major applications Domains where the software's are highly integrated component in their Business process

E governance: These are the software's used by the government agencies like public, Immigration, Armed forces, Business organizations, Transportation, political parties, Law Enforcement consisting the data like Name, gender, address, bank details, Health insurances, Business strategies.

E cloud storage: These are the software's used by Business organizations, personally, Government agencies to store the data in the amount of huge volume. This data consists of sensible information like Business process, Money Transactions, Employee details, Client Data etc.

E telecommunications: These are software's used in the daily life for communications purpose by the public, Private, Business, Government organizations. It consists of call data, user data, user bank account.

E Social Media: & Gaming: The usage of these software is at high level in the present decades. The software's are mainly used for the entertainment purposes. Among all other domains the software's in this domain is available at free cost for users. These software's consists of data of users like Name, gender, address, bank details, Voice & Video call recordings.

E-Digital Marketing: These are software's used in the Digital marketing. The best example is cookies. It is a code that is stored in the browser. It gathers information's about the user age, location, website behavior, browser data. This helps for the online marketers to extract the right attributes for advertising their products.

E financial: These are the software's that are used in day to day business in Banking, Trading, Currency converter sector. The data stored in these software's are in the form Customer, Currency, Banking etc.

Irrespective of the Domain of software where it gets applied; the data that is extracted from these software is belongs to users, Business organizations, government, financial services is

stored in either local servers at company premises or in Cloud. In the day to day business, the users often access these data via various internet protocols. During this transmission from servers to client PC's the data can be affected from the potential threats (mostly Hacking or Intentionally published by employees), and this causes severe concerns on security level of the software and in Measuresthat needs to be taken in political law system. The Fig [7] shows the Data breach is caused due to several factors like hack on poor security system, Fraud, Huma error -stolen, lost.

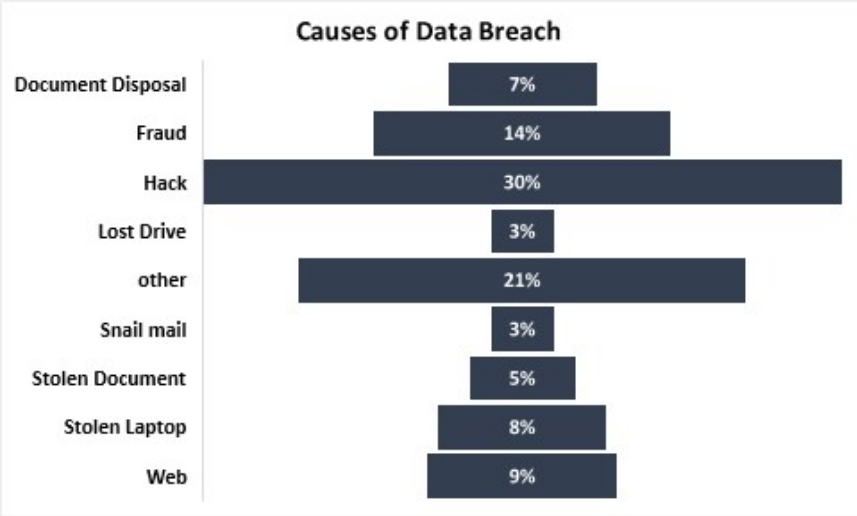


Fig 7: Causes of Data leakage

No matter what the reason could be? due to these consequences the sustainability of product is declined as the users lost trust on it, not only that and also it effects the Business of service provider as well. For example, following below Fig [8] shows the decline of market price value of Facebook soon after the Data leakage in 2018.Looking into the curve it was drastically dropped due to the investors lost the trust on the product.

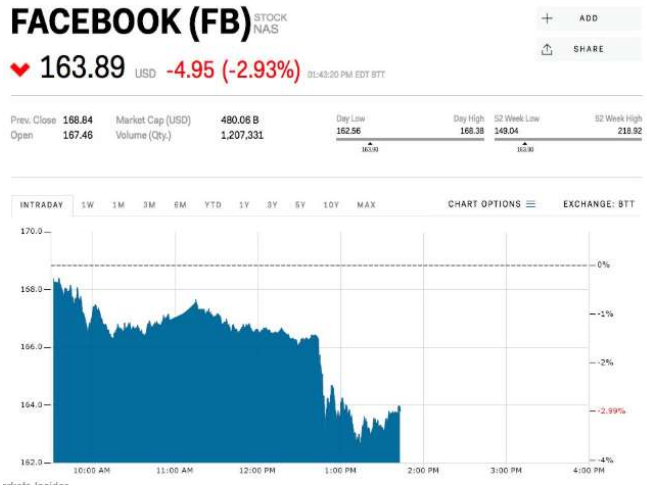


Fig 8: Impact of Data leakage on Facebook shares

It has been estimated that the annual data breaches around the world year by year is increases and will reach at cost $2.1 Trillion by 2020. Following below Table 4 shows the Top 10 Data breach in 2018.By looking into actual figures, Facebook itself recorded with the highest records stolen & Risk score at 10.

Rank	Organization Breached	Records Breached	Date of Breach	Type of Breach	Source of Breach	Location	Industry	Risk Score
1	Facebook	2,200,000,000	4/4/2018	Identity Theft	Malicious Outsider	US	Social Media	**10**
2	Exactis	340,000,000	6/1/2018	Identity Theft	Accidental Loss	US	Other	**9.1**
3	Under Armour	150,000,000	2/1/2018	Account Access	Malicious Outsider	US	Retail	**9.1**
4	Twitter	336,000,000	5/3/2018	Financial Access	Accidental Loss	US	Social Media	**9**
5	Firebase (Google)	100,000,000	6/20/2018	Identity Theft	Accidental Loss	US	Technology	**8.6**
6	LocalBlox	48,000,000	2/18/2018	Identity Theft	Accidental Loss	US	Technology	**8.3**
7	TicketFly	27,000,000	5/30/2018	Account Access	Malicious Outsider	US	Retail	**8.3**
8	Nova Poshta	18,500,000	2/7/2018	Account Access	Malicious Outsider	Ukraine	Industrial	**8.2**
9	AcFun	10,000,000	6/13/2018	Financial Access	Malicious Outsider	China	Social Media	**8.1**
10	Careem	14,000,000	1/14/2018	Account Access	Malicious	UAE	other	8

Table 4: Top 10 Data leakages in 2018

By looking into Domain in the above table, These Incidents not only exists in the Domain of software's: Social media; rather also in other domains as well like financial services, Health, Government, telecommunication, Industries, Cloud services. Now this raises a question from users (single person to organizations), political law makers; how far the data in the cloud storages services is securely store & Protected from third party? as most of the companies is shifted their software application development process into the Cloud Network. The main objective of this Social Dimension in this study is How can the Data of a user securely stored in the cloud services? To answer this question, firstly we need to answer the following sub questions

1.what are requirements from the lawyer's view in securing Data?
2.How Data protection policy is varies from country to country? what are the impacts of them on the Data?
3.What are the requirements from the user view in securing the Data?

In the blow section at first, we will discuss First 1. Requirements from Lawyers with Data protection Law and 2.Requiremnets from the users.

3.3.1 Requirements from Lawyers

The judicial law & legal regulations in the cloud storage is imposed on the entire network process right from the data extraction, transmission, storage. All the active players like user(single or organization),service providers, service contractors (Third party) must be bound to the law. The legal law of Data privacy & security from country to country is varies depends on the Human

rights policy. So, Now the customer is the key player in adopting the services. In the following section we will discuss the privacy policy of Data protection in Germany & Europe union.

Data Protection in Germany: The Data protection act in Germany is called as the Bundesdatenschutz gesetz (BDSG) [41] which was created by the German federal state act. The Data protection act is developed in early 1970 in the state Hessan and drastically amended until 2010.The BDSG is mainly classified into six sections based on the operations in ICT right from extraction, processing, storing.

- First section (§ § 1-11): General and common rules
- Second section (§ § 12-26): Data processing by public bodies
- Third section (§ § 27-38a): Data processing by non-public bodies and public competitor companies
- Fourth section (§ § 39-42): Special provisions
- Fifth section (§ § 43-44): Criminal and civil penalty provisions
- Sixth section (§ § 45-46): Transitional provisions

It always important the user: Single and/or Companies needs to be assessed before choosing the cloud service whether the cloud service is implemented or subjected to BDSG regulation or not. According to the law BDSG § 3(1) [41,48] the data of single user in each process extraction, transmission or processing, storing must be protected by user itself. One of the simplest ways to protect the data by excluding the processing stage objective from public cloud network into private cloud services where all the devices, network will be regulated as per BDSG. But the main disadvantage with this kind of service is, the initial cost for the setup is very high for small & individual users. Another most common cloud services network is public cloud where the user has minimum control on the data safety. In public network main disadvantage is, third party services plays a key role at data communication stage which causes threat to Data from the Hackings. In order to ensure the trust on the data processing network medium, the cloud service provider needs to ensure that the third-party services should be obliged under the BDSG § 3(7) and being monitored by § 11 [41] and also needs to meet the following points.

- The duration of contract work should consists of sub contract issues, user's & service rights
- Data security is implemented according to § 9 BDSG
- Completion of work, Deletion of User data approval
- Ensuring data is not transferred outside the European Economic Area (EEA) according to § 4b BDSG.

The above-mentioned Data protection policy is subjected to kinds of Data of user. But often the user Data is diversely changes based on the Domain. For example, Automobile Industries have the Data in the form of departments like Investments, Taxation, Accounts, Finance, Marketing, Sales, Production ,HRD . According to German Data protection in cloud storage the customer was imposed to certain legal laws for storing these data in order to audit their Business process in the view of Taxation frauds by the companies. Following below is the legal laws on computerized Taxation, Accounts data for storage in cloud.

According to "§ 239 (2) HGB and to Grundsätze ordnungsmäßiger DV-gestützter Buchführungssysteme (GoBS)",all the account details of the customer which is related to the taxation must be available for the Tax verification. Upon this, the Data of this accounts must be stored for 6 years to 10 until under the law § 257 HGB [42,49]. In some cases, there might be an incident the customer might chooses the cloud services in which the servers are based in EU like Ireland or Denmark. Under these scenarios, the customer must ensure that the service provider is obliged under the act of (§ 146 (2a) AO), (§ 147 & 148 AO) [42]. The above discussed Data protection ensures the fair business between the user (Individual & Organizations) and Government Tax monitoring body in a clean & fair way. But, still the problem arises in the small & medium scale customer in choosing Cloud service due to the lack of Expertise in legal issue. In recent years, there are number of Certification institutions has been formed in order to certify the service providers are they are bounded to the law or not? The certification not only includes the auditing process rather it also includes Technical standard testing quality of product with ISO/IEC 25010: 2011. Following below we will discuss few of the certification companies and their objectives.

ISO 27001: It is the international electrotechnical commission placed over the British standard in context to the Information security Management systems (ISMS) in which Business organizations should follow the norms in Implementing , operating & Maintenance of IT infrastructure. This certificate is internationally & Nationally is acceptable by the organizations. In order to qualify this certification organizations ISMS needs to be audited by the Third-party organizations that are accredited by the German "Bundesamt fur die Sicherheit in der Informationsrechnologie"[43].

SAS 70: The main process of issuing this certificate is based on the Auditing. In Germany, this process has been done by the "Institut der deutschen Wirtschaftsprufer"[44].The main goal of this audit is takes place on the control of service providers. The certifications are mainly classified by the into two types

Type 1: It describes the condition of the service provider as on particular Date

- Independent service auditor's report (i.e. opinion).

- Service organization's description of controls.

Type 2: This describes in detail about the service provider controls by testing them for six-month period.

- Both Points in the Type 1 report.
- Information provided by the independent service auditor; includes a description of the service auditor's tests of operating effectiveness and the results of those tests.
- Other information provided by the service organization (e.g. glossary of terms).

Distributed Management Task Force (DMTF): The main function of the DMTF is Developing management standards and promoting interoperability for enterprise and Internet environments [45]. The DTMF is mainly directed by the Broad group of companies Broadcom Inc., CA Technologies, Dell Inc., Hewlett Packard Enterprise, Hitachi, Ltd., HP Inc., Intel Corporation, Lenovo, NetApp, Software AG, Vertiv and VMware. The DTMF offers standards & technologies in mainly four model in Cloud Management system.

1. Cloud Management Working Group (CMWG) – The main aim of this standard woks on Cloud Infrastructure Management Interface (CIMI).It includes the modules management of cloud services, operation and cloud service lifecycle.

2.Cloud Auditing Data Federation Working Group (CADF) – The main aim of this standard is audit the security module in the cloud Environment of the customer. The process of auditing is self driven process by the customer.

CADF has been implemented in pyCADF: A Python-based CADF Library, used by OpenStack (implementations are shared by way of example only, and is not endorsed nor tested by DMTF).

3.Software Entitlement Working Group (SEWG) – The aim of this standard is aimed at quality of software and usage of the product.

4.Open Virtualization Working Group (OVF) – This standard delivers the packaging format for software solutions based on virtual systems.

Data Protection in Europe Union (EU) Regulation (EU) 2016/679: The Regulation (EU) 2016/679 is developed and introduced by the European Parliament and Council of the European Union [46]. Often the customers from Germany prefers the Cloud service which are operated outside by Germany .In those cases Data protection legal laws are subjected to EU Data protection policy.

The Europe Union Data protection policy has been developed in context of the following objectives

- protection of natural persons
- processing of personal data
- Disclosing of data
- Repealing of Data under Directive 95/46/EC (Data Protection Directive)

All the companies who are in the European union region must be subjected to this regulation in terms of customer Data protection in such way that the data must be stored in EU state region. The entire Data protection regulation is classified into Eleven chapters or 99 Articles [46].

- I – General provisions
- II – Principles
- III – Rights of the data subject
- IV – Controller and processor
- V – Transfers of personal data to third countries or international organizations
- VI – Independent supervisory authorities
- VII – Cooperation and consistency
- VIII – Remedies, liability and penalties
- IX – Provisions relating to specific processing situations
- X – Delegated acts and implementing acts
- XI – Final provisions

As discussed in earlier, one thing the customer or user always worry about the security, privacy of their data from stealing or hacking from third parties. In some cases, Data breach is mainly because of the transferring of the personal data to third country either by intentionally or Unintentionally by cloud services, under this scenario the cloud service must be full fill the regulation Chapter V[46]. Where it Defines, “The transfer of Data needs to Third Country need the user approval” any violation cloud causes the severe penalties as per the Chapter VII [46] in the regulation 95/46/EC.

3.3.2 Requirements from the user

In this section we will discuss requirements or the precautions needed to take from the users in all stages right from Extraction, Transmission, Storage for the Data security & Encryption in cloud services. The main goal of the user is to secure the data. The factors that causes the leak in the data is due to improper function of User access credentials, Sever location,

Transmission security layer, Encryption of data, File sharing, Duplication. In the following we will discuss the functions of each

User access Credentials: In the cloud services the user can access the service via Online API. The accessing credentials is register by the user during the contractual terms. The Data leakage or theft can be done by authorizing user information by stealing user credentials by the Hackers. In order to overcome these issues the user must ensure the following methods to put into the practice: Credential's cannot be shared, by keeping the strong password: user must keep the password which consists of number, characters ,special symbols , Backup email in the cases of location change : Backup email must be provided by the user to receive the updates of un authorized access is notified by the service provider, verifying through the mobile: Access code will sent to user in order to authenticate user credentials. Another user access problem is accessing the cloud services from the multiple devices. It is quite often that user access the cloud data either from mobile device or laptop or Tablets. Now this leads sometimes stealing of the user credentials by the hackers via free open source software's that are installed by the user for gaming, entertainment purpose as they have direct access to mobile storage & user location. so, it is always important for the user to keep on change the password regularly, installing trusted third-party apps.

Server Location: The customer needs to clear with the service provider about the server location during contractual terms. According to legal regulations discussed above, the legal laws for the Data protection in servers will differ from the region to region. Thus and therefore the customer needs to address what kind of information needs to be stored in the servers and what are the legal implications upon them.

Transport security layer: The transport layer establishes the synchronization between the customer or user local data folder to the server of service provider using locally installed Software(API) or Web based API from the customer location [47]. The transmission of data over this layer is must be secured with advanced cryptographic protocols as it gets effected by the hackers. So, During the technical survey, the customer needs to consider Transport security layer feature while choosing the service as it ensures the security level of Data. Following below Fig [9] shows the commonly used communication protocols in cloud storage by different services.

SOAP :This protocol uses the XML information format in order to transfer the data from web services to servers.

SCSI: SCSI is the dominant block level access method for disk in the data center. These Blocks are smallest unit which they easily read ,write on the disk.

ISCSI: It is next level of the SCSI protocol where the Data is stored in the form of Packets. Nominally it is implemented on the Internet protocol infrastructure.

NFS &FTP: These are protocols is implemented in Linux Environments based on the file-based storage system.

WebDAV: Web-based Distributed Authoring and Versioning (WebDAV) it is mainly based on HTTP and enables the Web as a readable and writable resource.

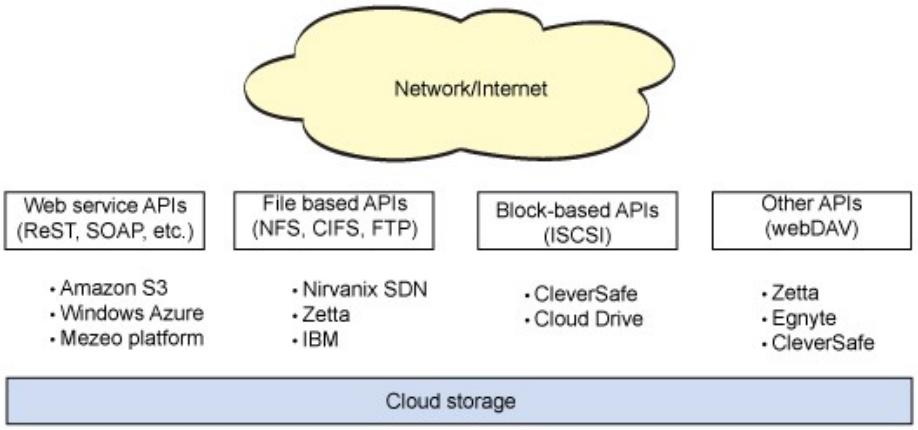


Fig 9: Cloud storage Network classification

File sharing: It is often that the files that are used by the user shares in three different way.

1.Sharing with Everyone
2.Sharing with closed group in the organizations
3.Sharing with others outside the organizations

The shared information by user is accessed by the co-user either by local or web API in with in organizations. In some cases, if the users are from the outside organizations the files can be shared over the URL. Now this URL is enough for hackers to steal the information if it contains any user information. Following are some of the requirements in File sharing

1.URL must not contain user information.
2.The URL needs to be change from file to file
3.Expiry date should be provided to URL
4.Cancellation of sent URL should be possible.
5.The shared file should be Editable or readable. Downloading the File needs the user permission grants.

Deduplication: The main objective of Deduplication is to ensure that the files stored in storage is not having duplicates of itself before it gets copied into storage. The variation of data duplication leads to consumption of storage space, Bandwidth high. Using this technique, the user can optimize the space .The need of the deduplication needs to address both from customer and service provider side. Generally, these techniques are classified into six types

1.File level Deduplication: Single copy of each file will be stored

2.Block level Deduplication: File is decomposed into blocks and each of these single block is stored.

3.Server-side Deduplication: This technique is implemented on the server side. When ever the new file arrives at first it stores, or it creates a link if this file is already exists

4.Client-side Deduplication: This can be implemented on client side. The file of client is transferred via hash value.

5.Single user Deduplication: It is used to create deduplication for each user file transfer by creating link if that record already exists.

6.Cross level Deduplication: It is used to create deduplication for all user file transfer by creating link if that record already exists.

3.4 Environment Dimension

The sustainability of Cloud storage in terms Environment aspects-CO_2 Emissions gaining very important role in the present society & Business. Although there are many initiatives taken by originations like Earth hour, Emission Treaty by the UN, World Wide Fund for Nature-WWF to Decrease CO_2 emissions but still it remains major impact on the Environment due to the increase in adoption of cloud services by the Various Business sectors to decrease their Manual process cost. The world leaders have addressed these problems in the Rio+20[50] summit and they agreed on the “Sustainable development of the Product”. The EU Research & Innovation has been allotted 77 Euro billion funding towards clean & Green Energy development for the period of 2014 to 2020.There are many sources that causes CO_2 emissions like from Industries, Agriculture, Transportation, Energy, Buildings, other Sources, shown in Fig [10].

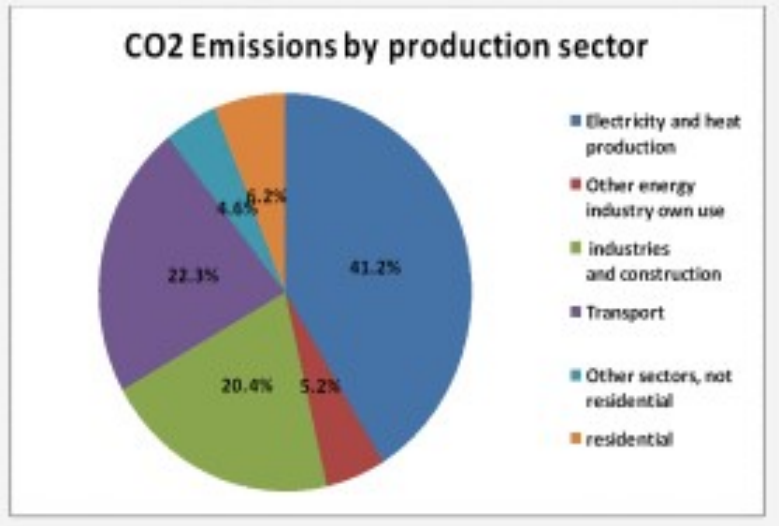


Fig 10: Emissions by sector

Although various sectors contribute the high amount of emissions globally, the emission from ICT (Information & Communication technology) also plays a key role in global Index due to increase in the ICT product usage like computers, mobiles, cloud services, Networks, Home devices. The following below **Fig [11]** shows the emission in Million tons by ICT sources. It has been observed that the ICT contributes 2% of global CO_2 emissions, but when it comes to cloud services it has recorded that 60% is increased in its Emission from 2007 to 2020 [59].

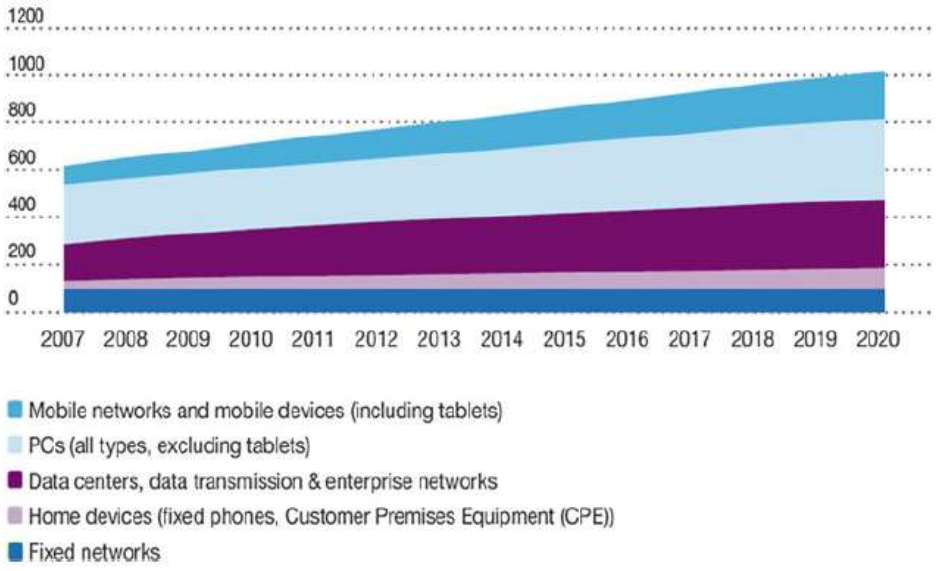


Fig 11: Prediction of Emissions by ICT

The increase in the emission by the cloud storage services mainly caused due to several factors like energy consumption, infrastructure construction ,Maintenance aspects over the period of

life span 10 to 50 years. Now this raises the question from the customer how can he achieve towards keeping carbon emissions low by cloud storage services with an optimal investment cost on cloud services. The main objective of the Environment Dimension in this study

1.what are sources that causes carbon emissions?

2.what are the techniques can be implemented in order to reduce the Emissions by the customers?

The sources Carbon emissions from cloud storage is not only when the cloud service is active or in operation but also it occurs from the stage of constructing Building for Data center until the end of the recycling of the Data center components over the life span of 10 to 50 years. The main causes of emission from the cloud storage is classified into two types 1. Infrastructure Development 2. Maintenance of cloud storage.

3.4.1. Infrastructure Development

The first and fore most step in establishment of clouds storage is constructing the Data center Buildings which is in the large amounts of sqft. This needs large amount of materials like cement, wooden, stones etc. During the mixture of these materials in constructing the walls it exhibits large amount of CO2 emissions. According to research from the Schneider Electric [51] ,to construct the 1MW Data center it exhibits 128 Tons of CO2 emissions. The following below Fig 12 shows the CO2 emissions by the each of the building materials for constructing the 530 m^2 Data center.

Materials - building shell 5,700 ft^2 (530 m^2) office facility	Tonnes of CO_2	Percentage of total
Foundation (concrete)	4.7	4%
Flooring (concrete slab, insulation)	39.9	31%
Ceilings (plaster board)	2.3	2%
Structure (steel beams)	15.4	12%
External walls (brick, insulation)	32.1	25%
Internal walls (wood frame and plasterboard)	8.7	7%
Stairs (concrete)	1.1	1%
Windows (glass and frame)	0.59	0.4%
Internal doors (particle board)*	-0.4	-0.3%
External doors (plastic)	0.6	0.5%
Roof (wood, concrete, insulation)	23.4	18%
TOTAL	128.3	100%

Fig 12: Emissions due to Infrastructure in cloud storages

Looking into figures the amount of the carbon emissions from the Flooring, Walls, Roof is high when compared to other materials as it depends on the sqft area. Therefore, increase in the

square feet leads to the emissions at High level. In order to reduce the sqft the customer needs to implement the optimal algorithms like CRAFT, Graph based Algorithm [52] in designing the Server placement per each sqft. The development of the Minimal space layout using these algorithms not only viewed in the aspect of the minimum space utilization problem but also, we should consider minimal power consumption, GREEN Data center policy [53] like usage of the electrical systems like lightning ,cooling, Ventilation to be at low volume.

3.4.2. Maintenance of cloud storage

Among the total emissions that are produced by the cloud storages the major part of the emissions is from the Energy utilization of cloud storage services while they are in operation & Maintenance. The main purpose of the cloud storage is to be in operational in 24*7. This needs ample of Energy supply without any interruption. Often some of the customer uses the UPS or Generators as back up input. According statistics [54], the consumption of the Energy by the cloud storage services is going to reach 8000 Twh shown in Fig [13].

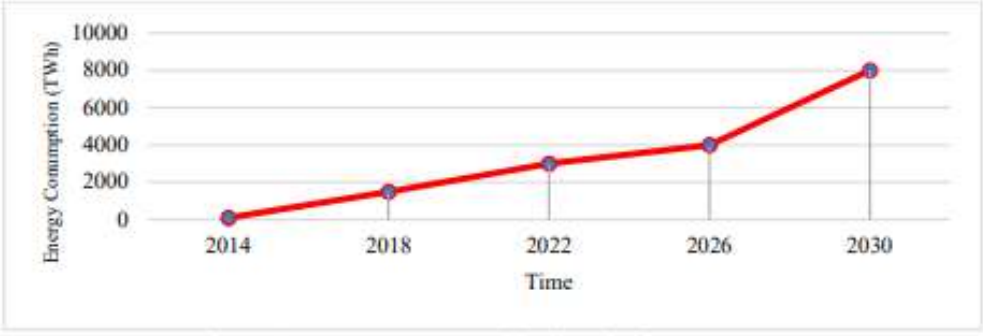


Fig 13: Energy consumption by cloud storages

The consumption of Energy in the cloud storage services is highly varies with the components that are installed in it. According to schinder [51] it has been found that the components like IT components, Air condition, Electric Room ,Cooling Tower, Office, Lighting and Switch Gear consumes Energy as per their kw ratings & operational factor, Shown in figure [14]. The consumption of the high amount of Energy over the period of life span 10 to 50 years leads to carbon emissions at high volume. Sometimes these emissions are varying with respective to location of the servers. For example, the data center in India, UAE, Australia, Western America consumes more Energy when compared to other EU countries due to high temperatures as it needs cooling system. Thus, and therefore the customer needs to take precautions while establishing cloud storage services components by following Green Data center policies [53].In

the following section we will discuss what are the techniques can be used to limit CO_2 Emissions from the Energy consumption of the Electronic Equipment's.

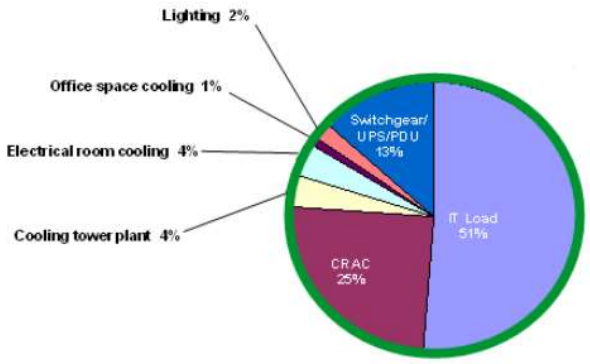


Fig 14: Energy consumption by the Electrical Components in Cloud storages

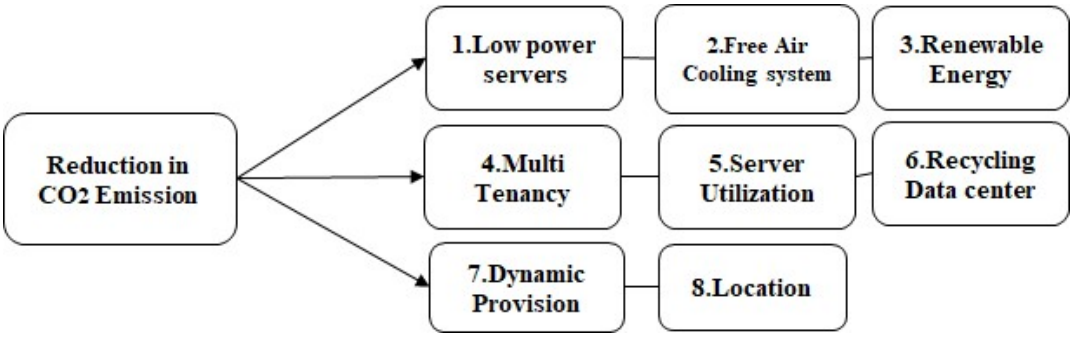
Increasing in the Global warming, Electricity prices is really concern towards the sustainity of cloud storage services over the life span 10 to 50 years. For example, 40 % of cloud storage services located in the US itself. So, it is required that the customer need to trace performance of the cloud storage services and also needs to adopt new techniques while establishing the cloud storage services. In general, the customer can evaluate the performance of cloud storage services using the Metric Power usage Effectiveness (PUE).

$$PUE = \frac{\text{Total power consumed by Entire Data center}}{\text{Total power consumed by the IT Equipment}}$$

In general, the range of the PUE is varies from 1.2 to 3.where 1.2 is very efficient performance & 3 is Very inefficient. At present IBM Data centers are a running at score 1.2.Using this PUE the carbon emission effectiveness can also be calculated which is adding multiplication factor shown in below

$$CUE = \frac{\text{Total power consumed by Entire Data center}}{\text{Total power consumed by the IT Equipment}} * \frac{\text{Co2 emitted(KgCo2eq)}}{\text{Unit of Energy(KWH)}}$$

Assessing the performance of Data center is not only enough for the better sustainity but rather it needs some kind expertise in choosing Green Electronic products for lesser consumption of Energy & CO2 emissions. In the below sections we will discuss the key factors of it, Shown in below.



Low power servers: Using low power servers at Cloud services have the direct impact on the less power consumption. For example, emissions are directly proportional to the KWH unit's consumption & less Heat. As these two factors are reduced further the overall temperature of IT systems needs less amount of cooling system for cooling process.

Free Air-cooling system: Free air-cooling system is one of the efficient Green Air condition system is adopted by the most of the customer recently rather Electronic Air condition System for cooling the Data center. The free air-cooling system needs the construction of Ventilation system with broad Space as the Air needs to pass from outside environment to Datacenter. The main disadvantage with this system is the Air needs to filter & Moisture.

Renewable Energy: The energy that is being utilized by the cloud storage services comes from the various sources like Coal, Fuel, Renewable Energy(Wind solar).The usage of renewable energy for the cloud storage services is not at 100% functional due to unpredictable climate changes. In the present scenario, the cloud storage services use combined energy obtained from the conventional sources and Non-conventional energy sources. The conventional energy sources are Coal, Nuclear which causes high amount of co2 emissions than the Non-conventional sources. This ratio of Energy integration has been a long problem for the customers over the years. To overcome this problem, the customer needs to take new initiatives for example by keeping solar power units on the roof of the cloud storage services, Keeping the low KW wind mills. But the main disadvantage with these is prediction of Climate parameters. So, in order to avoid this, the companies like ABB, SIEMENS has developed Power management Units which basically microcontroller which regulates incoming power sources as per the Demand needed by Electrical systems in the cloud storage services must be integrated to control system. Using this system not regulates power but rather we can monitor & forecast the power consumption.

Location: Choosing the feasible location for the Data center establishment is the key factor in cloud storage. The impact of the location on cloud storage is mainly depends on the three key factors. The customer needs to consider these factors in primary choosing location.

1.Temperature: The temperature is highly varying from the location to location. Increase in the temperature causes the Energy consumption is high and also billing pricing is high varies. For example, the KWH unit price is Europe is very high when compared to Asia market China & India. So now a days most of the customer moving their data center to Asia in order decrease the Energy consumption price. The main disadvantage with kind of movement is Data protection policy as it varies from the countries to countries which is discussed in the social Dimension.

2.Network communication: As the network is the main source of communication. The customer should assess the communication range whether the Datacenter can able to communicate to customer from desired location or not either in the form of OFC, Satellite. Break down in the communication could cause irruption in the client Business process especially in the real time governance like Banking, Rail.

3. Transportation: The transportation has a minimal effect on the cloud storage. It is mainly causing the problem for the employees who is working in the Data center, Movement of the servers if get damaged.

Dynamic Provision: All the customers are so active in the future prospective while establishing cloud storage services in the view Capacity for the life span 10 to 50 years. Due to unpredicted increase in the usage of capacity of cloud storage services , always the customers installed Higher capacity servers than they are actual use in Demand due to factors like 1. Problems causes from the allocation of more space in future 2.Lack of monitoring & Predicting Space consumption in their Business model .This causes over burden of energy & active servers in operation & Maintenance of the cloud storage services . In order use the optimal capacity the customer needs to resolve issues by keep monitoring & Forecasting the storage capacity in 24*7.

Multi Tenancy: The multi tenancy is one of the key parameters used in the power systems in order to reduce the power utilization. It is defined as the ratio to average load to peak load. Keeping this ratio will cause less amount of the energy consumption. The usage of the cloud storage by the companies is varies time to time. So, this needs lot of energy to make cloud storage in active. The optimal solution is to use cloud storage on the same infrastructure by the various customers which reduces the power utilization.

Server utilization: Among the total amount of energy consumption in the Data center, the Energy consumed by the servers is shares higher percentage due to applications run on the cloud storages in 24*7. In the research done by Accenture [55] it has been observed that applications that runs at cloud services with server utilization 70% needs lit bit more power 10 to 20 % for adding a new user rather than running application at each customer premises. So, due to this factor the emissions of CO2 are always at minimal as we are using fewer servers for multiple users. So further better results in Energy consumption & CO2 emissions reduction, it highly recommendable to shift the customer Business operations to the cloud services.

Recycling the cloud storage services : Almost the 85% of the cloud storage services is accompanied with the Electronic Equipment like Servers, Network cables, cooling system, Lightening etc. The recycling of these equipment's is of the key factors after completion of the cloud storage services life span. Many countries have been adopted recycling policies from 1991.Coming to the European union, the recycling of the electrical components is clearly addressed in the WEEE Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) .The aim of this policy is to recycle 85% of total electronic goods. Along with Act, there exists several companies like DNF in US ,SIIMS [56] offering the recycling solutions for the Equipment's of cloud storage based on the following conditions. The main objectives of DNF

1. DNF offers credit for new purchase based on certain benchmarks formulated as per company rules.
2. On a further note, DNF will arrange for pickup and transportation of the equipment to their location.
3. It will then perform a detailed inventory and assessment of the equipment at their facility and the report will be mailed to the user.
4. Data clean up from hard drives and SSDs will also be done by this company on demand.
5. DNF does recycling in a very responsible way. It carefully disassembles the components and based on the recyclable properties of the components it sends them to recycle units.
6. Those which are hazardous to environment and which are not eligible for recycling will be disposed in compliance with US EPA laws.

4.0 Case Study

Although this study is not aimed at comprehensive comparison of various cloud services, A small case study has been performed on the cloud services performances. The performance of the cloud services is evaluated using the metrics and/or factors that are

discussed in the above four dimensions. The ratings have been given based on the considerations of some of the interviews & customer reviews from the various Business organizations[Mentioned in Appendix III]. The range of rating is varying from Bad to very Good. The case study is performed majorly on five cloud services Drop Box, Cloud Me, Crash Plan, Google Drive& Microsoft One Drive shown in the below Table [5]. During this study it observed that most of the companies who develops the OS are also offering the cloud services. The main advantage of these products they can easily integrated to local disk operating system itself which further makes easy operation for the users. But, on the other side it carries drawback about the low level of security features as they access through web API. So, the customer needs to consider security issues like 1.Data been is fully Encrypted during in Transit & Rest of Data or not 2.Encryption of Data in sharing & Storage 3.Location of server: Storing of the data policy is varies from country to country.

Diamension	Factors	Drop Box	Cloud Me	Crash Plan	Google Drive	Microsoft One Drive
Technical	Back up	No	No	Yes	Yes	Yes
	Copy	Yes	Yes	No	Yes	Yes
	Desktop OS supported	Yes	Yes	Yes	Yes	Yes
	Efficency	Good	Average	Very Good	Average	Average
	Functionality	Good	Good	Good	Average	Good
	Maintianbility	Good	Good	Good	Good	Good
	Multiple Devices	Average	Bad	Average	Yes	Average
	Portability	Average	Bad	Average	Good	Average
	Relaibility	Average	Avergae	Good	Average	Average
	Synchronization	Yes	No	No	Yes	Yes
	Update Function	very good	Average	Very Good	Good	Good
	Usability	Very good	Good	Average	Good	Good
Economic	Cost effective	Average	Good	Good for Business Purposes	Good	Good
Social	Access policies	No	Average	Good	No	No
	Certification	SAS 70	Not Avialable	Not Avialable	Not Avialable	Not Avialable
	Deduplication	Good	Not Avialable	Good	Good	Good
	Ease of use	Very good	Good	Good	Very Good	Medium
	Encryption at rest and in transit	Yes	Bad	Average	Yes	Average
	End-to-end encryption for storage and sharing	No	Bad	Good	No	No
	Location	US	Sweden	US	US,Global	US,Global
	Sharing	Yes	Yes	No	Average	Good
	Secure browser access	No	Bad	Average	No	No
	Transport Network portocol	HTTP	ISCSI	HTTP	SOAP	Not Avialable

Table 5: Case study on the performance of Various cloud services

Selecting Cloud Storage service:

Along with the case study in this paper a flow chart (shown in Fig 15) is developed for the users(assuming he/she in Germany) as a tip who are much concern about security of their Data in Selecting Cloud service. Firstly, user needs to evaluate what data needs to be stored & where it shall be located. The main principle of starting with this step in a flow chart as the Data

regulation often changes from country to country. Now this is a main factor for the cloud service provider as they mandatorily need to fulfill or obliged their network structure should be built based on these standards. Finally, the flow chart ends up with cost Estimation model which gives the users to take final call. Kindly note that, this flow chart can be used as Pre-selecting technique of Sustainable cloud services. Apart from this, after the post Deployment of the cloud services user needs to evaluate the quality performance of cloud using the quality model discussed in the section 3.1.4.Another important factor is, in the case of Data leakages during run time of cloud service the customer should refer to Data protection policy in Germany discussed in "Fifth section (§ § 43-44)" in order to sue the cloud service in a legal way.

Influence of social Dimension on other Dimension:

In this study we came across many factors that are influencing objectives of the Technical, Social, Economic & Environment Dimensions. But In contrast to that, always the customer chooses the cloud services keeping in interest towards either one or two more Dimensions rather than considering all four dimensions due to his factors like financial budgets, Technical viable or not, security features. By looking into above Table 5, it can easily identify that never the cloud services balance the goal of all the Dimensions in 100%. For example, the cost of Crash plan is not cost effective for the single or small-scale users as the price is high. So, this kind of services are more adopted by Larger Business scale organizations.

As in this study we majorly concern about the security of Data in cloud services, in the following we see how social Dimension influences objectives of other Dimensions. The major concern from the customer in cloud storage is about How can the Data protected from Data Hackings? One of the simplest ways is adopting the Private cloud network rather than public which is console network for each customer. But, the main disadvantages is 1.It is too expensive for the small-scale customer in term of Maintenance 2.Co2 Emission are high as the servers is installed exclusively for the single user. Advantages: 1.Realiablity, efficiency, Usability Technical features gives good result 2. Security: Hacking of the Data is at minimal level as it is private network. Adopting the services with private network is not worthy for the small-scale customers so in these cases it highly recommendable for the customer to look after into the certified cloud services in Security, Technical aspects which is in affordable budget price.

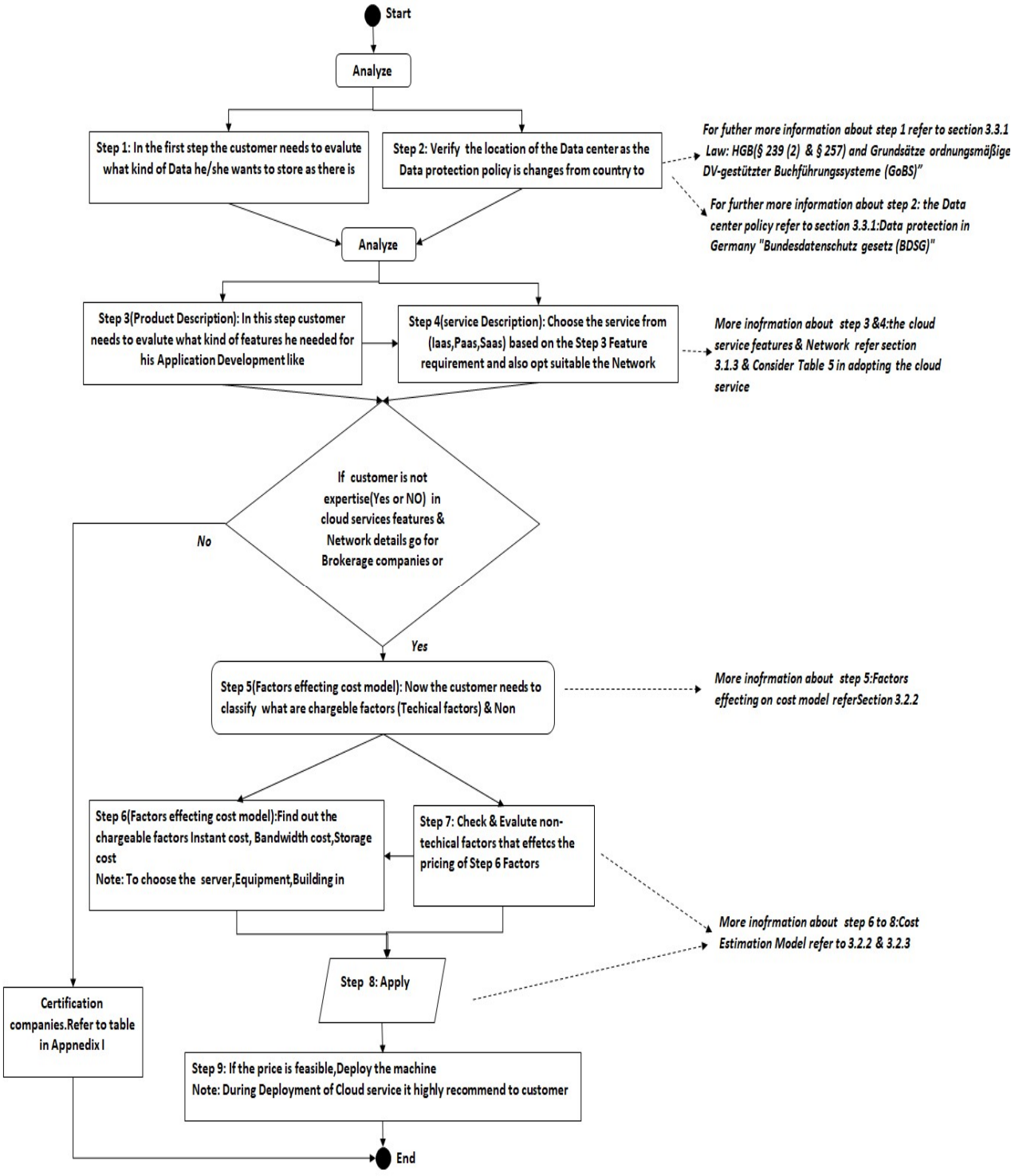


Fig 15: Selecting a cloud service

5.0 Conclusion

This study has defined all the mandatory Goals & Factors that required for the customer in Four dimensional aspects Technical, Social, Economic & Environment while adopting the Sustainable cloud storage Provider. In the last a small case study has been evaluated based on the cloud storage services performance in each Features.

In technical dimension at first, we discussed what are technical requirements from the customer that are used in their Business application. The main requirements Copy, sharing, Security, Synchronization, Deduplication is explained well. Along with this, the major concern from the user is always about the Sustainity of cloud service in their Business organization. To achieve this, we discussed the ISO Quality model with metrices that helps customer in evaluating the performance of the cloud storage in terms of Maintainability, Portability , Reliability, Efficiency ,Usability in a long run process. For the evaluation we mainly discussed ISO model which is strongly acceptable across the world. But In some scenarios, If the customer needs more metrics in order to evaluate the performances he/she can chooses other model Like McCall, Boehm model as they are consisting more no. of metrics and their relations.

In this study, Economic dimension is explained with Cost model. The customer always agitated toward the cost of the Cloud services as it highly impact on their Business investment towards the technical process. The cost Estimation model is highly influenced by three factors 1. Storage cost 2.Bandwidth cost 3. Instance cost. We explained it clearly with an example architecture by defining each term. In this section we used the COCOMO model algorithm for the costing model. In some cases, this model factors may vary from service to service based on the features that are required by the customer. So, it is very important when modeling the Cost Estimation, it highly recommended that the customer needs to identify the factors at first and then go for modeling.

The topics discussed in the social Dimension is played major role in the Security & Encryption of Data of user. The customer often raises the concern about their security in Data. The process of securing the Data is discussed in two views 1. Lawyers view 2.User view. Before adopting the services the customer needs to answer these questions first from layers view 1.what kind of Data he needs to store?:Because there are some legal sanctions in storing the tax or Computer generated accounts data of Business organizations in server needs to be stored for 5-10 years for verification by the Government in order to avoid the TAX frauds 2.Location of server: The customer should be aware of the location of their Data server as country to country Data policies is varies by the legal Regulations and this was discussed in this social Dimension section. Often the customers faced problems in these issues due to lack of expertise. In those cases, the

customer needs to adopt the certified cloud service provider. In social dimension we discussed mainly three companies SAS 70, DMTF, ISO 27001.For the German customers SAS70 is recommendable as certification is provided to Cloud services based on the auditing on their technical standards level. Along with the Lawyers view in this section we discussed about the key factors that are required for the user in securing & Encryption of Data. The factors are 1. User access credentials: One of the major threats to data is stealing the user credentials by the third party. In these cases, user must take the precautions by setting up strong password and also in sharing user details to other members.2. File sharing: In some cases, other members of team or group, subscribers & Non-subscribers can access all the files which they are not supposed to be. To avoid this, the user must create a group for authorized members for file sharing or by creating URL which cannot contain the user details. 3.Encryption of Data: The major part of securing data is Encryption of the Data from the both server & Client side. In regular practice most of the customers knowingly adopted the services like Dropbox which are not providing any Encryption in client side is due to factors of Cost vs Security. Often the customer will prefer the cost-effective services by omitting the Security concerns which causes Data breach. The best way of Encrypting the Sever side Data by enabling the deduplication where it checks the files for attack using threshold. On the other hand, User or client-side Data is encrypted using three main common methods. Method 1: Before transmitting the data to cloud storage user needs to enter personal key which is provided by the Cloud servicers. But in some cases, the service providers may not provide the key. In those cases, Method 2:First create the mirror file " /Mirror_File" to actual file "/actual". Now encrypt the mirror file by installing tools Bit locker, True Crypt with password. In the last step, integrate mirror file to cloud storage rather than actual one which will secure data because as it encrypted with password which is a local folder. But, this method carries disadvantages 1. The tool software may not be integrated to cloud service 2.Files under the mirror file cannot be shared as it encrypted 3.Last version of files in actual file folder may not be updated in to mirror file.

In the last Environment Dimension, we discussed what are the sources that causes emission in the Cloud Data storage. These sources are classified into two types 1. Infrastructure development 2. Maintenance order to reduce the emissions the customer needs to adopt the Green Data center policy. The policy states that installing the Good ventilation, low power consumption will reduce the energy consumption which further reduces the emissions. Apart from this policy, the most important way to reduce emissions is 1. By shifting the customer entire application development into cloud service so that it saves the server cost & Emission free from the client side 2.Multi tenancy: Optimal utilization of single cloud infrastructure by different user groups at same instance .

Future work:

The research made in this study is aimed at the customer who are concern about the Security of their Data while storing in cloud storage. Almost around the world every Business organizations of Technical & Non-technical Domains have been Digitalized. Often these originations evolved in highly Tax fraud evasions as it can be easily manipulated either by storing the data outside the country and/or showing the fake values in their Business statistics Data. Now this raises a severe concern from Political law makers "How fair the taxation in every Business is good ?" as the TAX is the main source of economy generation for any Nation. Looking into this aspect the future work can be carried out by creating a prototype which needs to be Integrated between Business organizations Data and Government E-Tax Department.

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Appendix

Appendix I:

a) [Table [2]: Software quality Certification companies]

S.No	Organizations
1	International Software Testing Qualifications Board
2	IEEE (Institute of Electrical and Electronics Engineers) Computer Society
3	ISO 27001
4	DOD (US Department of Defense)
5	ANSI (American National Standards Institute)
6	IEC (International Electro Technical Commission)
7	EIA (Electronic Industries Association)
8	The Blue Angel
9	DNV GL
10	Fraunhofer Institute for Experimental Software Engineering IESE
11	International Software Quality Institute
12	SAS 70
13	Distributed Management Task Force (DMTF)

Appendix II: Figure sources

Figure1:hanainssiyah[https://commons.wikimedia.org/wiki/File:Operating_system_placement_(software).svg]

Figure 2: mscistemitopeogunsemo.wordpress.com/2013/07/09/the-cloud-computing-adoption-model/

Figure 5: Aminullah, Sharlene, and Carlos Molina-Jimenez. "Cost Estimation of Service Delivery in Cloud Computing." Internet Technologies and Enterprise Computing (2012).

Figure 8: Stock NAS

Figure 9: https://developer.ibm.com/articles/cl-cloudstorage/

Figure10: www.researchgate.net/figure/CO2-Emissions-by-Production sector_fig1_308888962

Figure 11: www.ericsson.com/res/docs/2013/ericsson-energyand-carbon-report.pdf. Accessed on April 2014

Figure 12: Bouley, Dennis. "Estimating a data center's electrical carbon footprint." white paper 66 (2010)

Figure 14: Bouley, Dennis. "Estimating a data center's electrical carbon footprint." white paper 66 (2010).

Appendix III: References for Case study

1. Cloud Computing Magazine: http://cloudcomputing.sys-con.com

2.https://secure.wikimedia.org/wikipedia/en/wiki/Comparison_of_file_hosting_services

3. http://onlinebackupdeals.com/online-backup-comparison

4. By decision of the European commission, Switzerland ensures an adequate level of protection: http://ec.europa.eu/justice/policies/privacy/thridcountries/index_en.htm

5.http://www.dropbox.com

6.Duffy, Jill. "Dropbox Review & Rating". PCMag.com. Retrieved 12 July 2014.

7.http://www.cloudme.com

8."CloudMe 1.8.4". PC Advisor. Retrieved 12 July 2014

9.http://www.xcerion.com

10.http://www.crashplan.com

11.http://www.code42.com/

12.Leonhard, Woody (29 May 2014). "Review: Google Drive leads in features, lags in ease-of-use | Cloud Computing". InfoWorld. Retrieved 12 July 2014.

13.Duffy, Jill. "Google Drive Review & Rating". PCMag.com. Retrieved 12 July 2014.

14.Muchmore, Michael. "Microsoft OneDrive Review & Rating". PCMag.com. Retrieved 12 July 2014.

Abbreviations

API:	Application program Interface
BDSG:	Bundesdatenschutzgesetz
CEO:	Chief Executive officers
CO2:	Carbon Emissions
COCOMO:	Constructive Cost Model
CRM:	Customer relationship management
E.t.c :	et cetera
EEA :	European Economic Area
ERP:	Enterprise resource planning
FTP:	File transfer protocol
GoBS:	GrundsätzeordnungsmäßigerDV-gestützter Buchführungssysteme
HGB:	Handelsgesetzbuch
HRD :	Human resource Development
HTTP:	HyperText Transfer Protocol
IaaS:	Infrastructure-as-a-Service
ICT:	Information & Communication Technology
IEC:	International Electrotechnical Commission
IEEE:	Institute of Electrical and Electronics Engineers
ISCSI:	internet Small Computer System Interface
ISMS:	Information security Management systems
ISO:	International Organization for Standardization
IT:	Information Technology
KWH:	Kilo watt hour
MW:	Mega watt
No:	Number
PaaS:	Platform-as-a-Service
PC:	Personal Computer
ROI:	Return of Investment
SaaS:	Software-as-a-Service
SCSI:	Small Computer System Interface
SQFT:	Square feet
SOAP:	Simple Object Access Protocol

UN: United Nations
URL: Uniform Resource Locator

Bibliography

[1] Dictionary, Collins English. "Definition of hospitality." Retrieved from Collins English Dictionary: http://www. collinsdictionary. com/dictionary/english/hospitality (2013).

[2] United Nations World Commission on Environment and Development (1987) Report of the World Commission on Environment and Development: our common future. In: United Nations conference on environment and development

[3] Penzenstadler, Birgit, et al. "Safety, security, now sustainability: the non-functional requirement for the 21st century." IEEE software 1 (2014): 1.

[4] KPMG Research, “Modelling the economic impact of cloud computing”, pp. 1-52, viewed 5 January2016,Availableat:https://www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/Documents/modelling-economic-impact-cloud-computing.pdf.

[5] Microsoft: How do I choose a cloud service provider?: https://azure.microsoft.com/en-us/overview/choosing-a-cloud-service-provider/

[6] Monta, Theerawut, and Fredric William Swierczek. "CLOUD IMPLEMENTATION IN EMERGING MARKET BANKS: THE IMPORTANCE OF SERVICE QUALITY."

[7] Marc Hadley, Henrik Frystyk Nielsen, Noah Mendelsohn, Martin Gudgin, and Jean-Jacques Moreau. SOAP version 1.2 part 1: Messaging framework. First edition of a recommendation, W3C, June 2003. http://www.w3.org/TR/2003/REC-soap12-part1-20030624/.

[8] D. Harnik, B. Pinkas, and A. Shulman-Peleg. Side Channels in Cloud Services: Deduplication in Cloud Storage. Security Privacy, IEEE, 8(6):40 {47, nov.-dec. 2010

[9] Mayhew, Andrew. "File Distribution Efficiencies: cfengine vs. rsync." Internet: https://www. usenix. org/legacy/events/lisa2001/tech/full_papers/mayhew/mayhew. pdf (2001).

[10] Glass, Robert L. "Frequently forgotten fundamental facts about software engineering." IEEE software 3 (2001): 112-110.

[11] Agarwal, Shalabh, Asoke Nath, and Dipayan Chowdhury. "Sustainable approaches and good practices in green software engineering." International Journal of Research and Reviews in Computer Science 3.1 (2012): 1425.

[12] Iso, I. S. O. "Iec25010: 2011 systems and software engineering–systems and software quality requirements and evaluation (square)–system and software quality models." International Organization for Standardization 34 (2011): 2910.

[13] 24765-2010 - ISO/IEC/IEEE International Standard - Systems and software engineering – Vocabulary

[14] Radatz, Jane, Anne Geraci, and Freny Katki. "IEEE standard glossary of software engineering terminology." IEEE Std 610121990.121990 (1990): 3.

[15] Glinz, Martin. "On non-functional requirements." Requirements Engineering Conference, 2007. RE'07. 15th IEEE International. IEEE, 2007.

[16] Bajpai, Vikas, and Ravi Prakash Gorthi. "On non-functional requirements: A survey." Electrical, Electronics and Computer Science (SCEECS), 2012 IEEE Students' Conference on. IEEE, 2012.

[17] Li, Feng-Lin, et al. "Non-functional requirements as qualities, with a spice of ontology." Requirements Engineering Conference (RE), 2014 IEEE 22nd International. IEEE, 2014.

[18] Veenendaal, EPWM van, and J. McMullan. "Achieving software product quality." (1997): 90-72194.

[19] CESAR, Ioram Schechtman Sette. "Kumo: um serviço para portabilidade em multi-nuvens heterogêneas." (2018).

[20] Jae Yoo Lee, Jung Woo Lee, Du Wan Cheun, and Soo Dong Kim “A Quality Model for Evaluating Software-as-a-Service in Cloud Computing” 2009 Seventh
ACIS International Conference on Software Engineering Research, Management and Applications.

[21] N. R. Herbst, S. Kounev, and R. Reussner. Elasticity: What it is, and what it is not. In ICAC '13, 2013

[22] Matthias Becker, Sebastian Lehrig, Steffen Becker, “Systematically Deriving Quality Metrics for Cloud Computing Systems” ICPE '15 Proceedings of the 6th ACM/SPEC International Conference on Performance Engineering, Pages 169-174, ACM, 2015.

[23] Amid Khatibi Bardsiri, Seyyed Mohsen Hashemi, “QoS Metrics for Cloud Computing Services Evaluation” , I.J. Intelligent Systems and Applications, 2014, 12, 27-33.

[24] Saurabh Kumar Garg, Steve Versteeg, Rajkumar Buyya,” A framework for ranking of cloud computing services”, Elsevier, June 2012.

[25] Pauley, W.A.; , "IaaS provider Transparency: An Empirical Evaluation," Security & Privacy, IEEE , vol.8, no.6, pp.32-39, Nov.-Dec. 2010.

[26] Weinhardt, C., A. Anandasivam, B. Blau, and J. Stößer, Business models in the service world. IEEE IT Professional, Special Issue on Cloud Computing, 2009. 11(2): p. 28–33.

[27] Basem Suleiman, Sherif Sakr, Ross Jeffery and Anna Liu, 2011, “On understanding the economics and elasticity challenges of deploying business applications on public cloud infrastructure, Journal of Internet Services and Applications.

[28] GoGrid, “GoGrid PRicing”, 2012. [Online]. Available: http://www.gogrid.com/cloud-hosting/cloud-hosting-pricing.v2.php#dedicatedservers

[29] James Hamilton. Internet-scale service efficiency. Large Scale Distributed Systems & Middleware (LADIS 2008)„ 2008.

[30] Maeser III, Robert K. A Model-Based Framework for Analyzing Cloud Service Provider Trustworthiness and Predicting Cloud Service Level Agreement Performance. Diss. The George Washington University, 2018.

[31] Idri, A., S. Mbarki, et al. “ Validating and understanding software cost estimation models based on neural networks”. Information and Communication Technologies: From Theory to Applications, 2004. Proceedings. 2004 International Conference on,2004.

[32] Jones, C. “Estimating software costs: Bringing realism to estimating (2nd ed.)”. New York, NY: McGraw-Hill, 2007.

[33] Cost, Pragmatic Cost Estimating Handbook, 2012, [Online], Available: http://cost.jsc.nasa.gov/pcehhtml/pceh.htm

[34] Vahid Khatibi, Dayang N. A. Jawawi ;, “Software Cost Estimation Methods: A Review”, Journal of Emerging Trends in Computing and Information Sciences, Volume 2 No. 1, ©2010-11 CIS Journal

[35] Penzenstadler, Birgit, and Henning Femmer. "A generic model for sustainability with process- and product-specific instances." Proceedings of the 2013 workshop on Green in/by software engineering. ACM, 2013.

[36] Becker, Christoph, et al. "Sustainability design and software: The karlskrona manifesto." Proceedings of the 37th International Conference on Software Engineering-Volume 2. IEEE Press, 2015.

[37] Venters, Colin, et al. "Software sustainability: The modern tower of babel." Proceedings of the Third International Workshop on Requirements Engineering for Sustainable Systems co-located with 22nd International Conference on Requirements Engineering (RE 2014). Vol. 1216. RWTH Aachen University, 2014.

[39] Directorate-General for Communications Networks, Content and Technology (European Commission): https://publications.europa.eu/en/publication-detail/-/publication/b8605784-f84a-11e8-9982-01aa75ed71a1/language-en

[40] Directorate-General for Communications Networks, Content and Technology (European Commission):https://publications.europa.eu/en/publication-detail/-/publication/480eff53-0495-11e7-8a35-01aa75ed71a1/language-en

[41] BfDI. Der Bundesbeauftragte f ur den Datenschutz und die Informationsfreiheit, Federal Data Protection Act (BDSG), June 2010. http://www.bfdi.bund.de.

[42] BMF. Bundesministerium der Finanzen, Abgabenordnung (AO), April 2011. http://www.gesetze-im-internet.de/ao_1977/ index.html.

[43] ISO/IEC. Information Technology - Security Techniques – Information Security Management Systems - Requirements, December 2005. http: //www.iso.org.

[44] AICPA. Service Organizations, Applying SAS No. 70, as Amended, 2009.

[45]https://www.dmtf.org/standards/cloud
[46] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l14012

[47] Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., ... & Zaharia, M. (2010). A view of cloud computing. Communications of the ACM, 53(4), 50-58.

[48] March, Stefanie, et al. "Data protection aspects concerning the use of social or routine data." *FDZ Methodenreport* 12 (2015): 1-22.

[49] AWV. Arbeitsgemeinschaft f ur wirtschaftliche Verwaltung e.V.,Grunds atze ordnungsm aiger DV-gest utzter Buchf uhrungssysteme (GoBS), November 1995. http://www.bundesfinanzministerium.de/nn_314/DE/BMF__Startseite/Service/Downloads/Ab__IV/BMF__Schreiben/015,templateId=raw,property=publicationFile.pdf.

[50] "Rio+20 – United Nations Conference on Sustainable Development". Uncsd2012.org. 22 June 2012. Archived from the original on 18 August 2014. Retrieved 4 August 2014

[51] Bouley, Dennis. "Estimating a data center's electrical carbon footprint." white paper 66 (2010).

[52] Goetschalckx, Marc. "An interactive layout heuristic based on hexagonal adjacency graphs." European Journal of Operational Research 63.2 (1992): 304-321.

[53] Kumon, Kouichi. "Overview of next-generation green data center." Fujitsu Scientific & Technical Journal 48.2 (2012).

[54] Anders SG Andrae, and Tomas Edler. "On global electricity usage of communication technology: trends to 2030."Challenges, vol. 6, no. 1, pp. 117-157, 2015.

[55] Albano, D., et al. "Cloud computing and sustainability: The environmental benefits of moving to the cloud. Accenture." (2010).https://storageservers.wordpress.com/tag/dnf-recycling/

[56] Clemons, Eric K., and Yuanyuan Chen. "Making the decision to contract for cloud services: Managing the risk of an extreme form of IT outsourcing." *System Sciences (HICSS), 2011 44th Hawaii International Conference on*. IEEE, 2011.

[58] Rynes, Andreas. "The Role of Corporate Finance in Eval-uating a Cloud Computing Strategy-A Chief Financial Officer perspective." (2018).

[59] Ericsson (2013) Ericsson energy, carbon report. On the impact of the networked society. EAB-13:036469 Uen. Ericsson AB. http://www.ericsson.com/res/docs/2013/ericsson-energyand-carbon-report.pdf. Accessed on April 2014