



**UNIVERSITY OF NAIROBI**

**AN ACADEMIC CERTIFICATION VERIFICATION SYTEM BASED ON CLOUD  
COMPUTING ENVIRONMENT**

**BY**

**NICHOLAS MWANIKI MUSEE**

**P58/63483/2011**

**A REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF**

**THE DEGREE OF MASTERS OF SCIENCE IN COMPUTER SCIENCE**

**JANUARY 2015**

## **Declaration**

This project as presented in this report is my original work and has not been presented for any University for any Award.

Signed: .....

Date.....

Nicholas Mwaniki Musee

P58/63483/2011

The report has been submitted as partial fulfillment of requirements for the Masters of Science in Computer Science of the University of Nairobi with my approval as the University supervisor.

Signed: .....

Date: .....

Professor William Okelo-Odongo

School of Computing and Informatics

University of Nairobi

## **Abstract**

Cloud computing is new technology that involves moving of software, services and data storage from computer desktop to remote servers, allowing user to access these resources from anywhere on demand. There are different cloud computing models which includes IaaS, PaaS and SaaS. The cloud There are several things which researchers can do with cloud computing. They can set up cloud computing environment and share resources. They can also identify what can be demand in terms of software, data storage and Platform. The researcher can construct and build these services that will be available on the cloud. Several cloud computing models will be discussed.

In this study we have developed a prototype which is used as SaaS to provide certificate verification. Verification is the process of establishing the truth, accuracy, or validity of something such as the verification of official documents. In this study the document in reference is the academic certificate.

In this prototype the user can request the certificates verification through online. The cloud computing environment is used to contain the data in a virtual machine. This prototype enables a convenient demand, on-demand access for shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort.

We developed a prototype which allows users to make request to get the academic certificates verification by filling the name of institution, course name, year of graduation and the verification code. All this process will be carried out in private cloud and can be accessible for all web based prototype.

The fifth generation cloud computing is prepared due to high demand of services in the current high rate of changes in Technology and it can be available in 24/7 days throughout the year.

Finally the prototype was hosted in the cloud environment with the domain called vericert.co.ke

**Key Words;** Cloud Computing, Software as a service, Platform as service, Infrastructure as a service, Verification

## **ACKNOWLEDGEMENTS**

First of all I would like to thank God the Almighty for having given me strength and kept me in all this time, to have enabled me to do research and write this research work in sound mind and good healthy.

Secondly I thank my Family- my wife, Sons and daughters for their endless love, care, prayers and encouragement with full of moral support.

Thirdly special thanks goes to my Project Supervisor Professor William Okelo-odongo for his ideas, guidance and support with full of wide experience and endless dedication to see that I finish my MSc project.

I also thank the members of the project defense panel for their valuable time, effort and feedback in the examination and evaluation.

Finally I would like to thank the students of University of Nairobi, Librarian for willing and participating in research of this thesis.

## **DEDICATION**

This project is dedicated to my family for the support and guidance they gave me and the sacrifice they had to make for me to realize my dream and reach this far.

## TABLE OF CONTENTS

Declaration.....	ii
Abstract.....	iii
ACKNOWLEDGEMENTS.....	iv
DEDICATION.....	v
TABLE OF CONTENTS.....	vi
LIST OF FIGURES.....	x
LIST OF TABLES.....	xi
LIST OF ACCRONYMS.....	xii
CHAPTER ONE INTRODUCTION.....	1
1.1 Background.....	1
1.2 Problem statement.....	3
1.3 What Are the Risks.....	4
1.5 Objectives of the study.....	5
1.6 Research questions.....	5
1.7 Research hypothesis.....	5
1.8 Significance of the study.....	5
1.9 Contributions of the study.....	6
1.11 Project scope.....	7
1.12 Definitions of important terms.....	7
CHAPTER TWO LITERATURE REVIEW.....	9
2.1 Introduction.....	9
2.2 Cloud Computing.....	9
2.2.1 Cloud Definition.....	10
2.2.2 Cloud Computing Characteristics.....	16

2.2.3	Cloud Computing Technologies .....	17
2.2.4	Cloud Service Models.....	18
2.2.5	Cloud Deployment Models .....	20
2.2.6	Cluster Computing.....	24
2.2.7	Virtualization Technology .....	25
2.2.8	Cloud computing features .....	25
2.2.9	Cloud computing characteristics.....	25
2.3	Authentication and Authorization methods .....	26
2.3.0	Introduction.....	26
2.3.1	PKI on clouds.....	27
2.3.2	Related Work on Verifications .....	28
2.3.3	Public Key Infrastructure in cloud computing .....	33
CHAPTER THREE RESEARCH METHODOLOGY .....		35
3.0	Introduction.....	35
3.1	Target Population.....	35
3.2	Sampling Design.....	35
3.3	Research Instruments for Data Collection .....	36
3.3.1	Questionnaires.....	36
3.3.2	Personal interview.....	36
3.4	Data analysis Methods .....	36
3.5	Agile Methodology .....	37
3.6	Reasons for using Agile Methodology.....	37
3.7	Ways the Cloud Enhances Agile Software Development.....	39
3.8	Verification process .....	40
CHAPTER FOUR ANALYSIS, DESIGN AND IMPLEMENTATION .....		41

4.1	ANALYSIS.....	41
4.2	Functional Requirements .....	41
4.3	Non-Functional Requirements .....	41
4.4	Architectural Design of the prototype.....	42
4.4.1	The role of each Components .....	43
4.5	Design Framework for Codeigniter .....	46
4.6	Database Design.....	51
4.7	Process flow diagram.....	54
4.8	Prototype Implementation.....	55
4.9	Resource Needed .....	55
4.10	Setting up the Environment.....	55
4.11	Modules in prototype .....	56
4.12	Process of implementing the private cloud.....	58
4.14	Test Process .....	59
	CHAPTER FIVE SYSTEM EVALUATION.....	61
5.0	Introduction.....	61
5.1	Results.....	62
	CHAPTER SIX CONCLUSION AND RECOMMENDATIONS .....	67
6.0	Introduction.....	67
6.1	Achievements.....	67
6.2	Finding .....	68
6.5	Data collection method .....	68
6.6	Recommendation .....	68
6.7	Future Work .....	69
6.8	Conclusion .....	69



7.0	REFERENCES .....	70
8.0	APPENDICES .....	72
8.1	APPENDIX 1: QUESTIONNAIRE .....	72
8.2	APPENDIX 2 USER INTERFCES .....	76
1.3	APPENDIX 3 SOURCE CODE SAMPLE .....	80

## LIST OF FIGURES

Figure: 1 Multiple perspectives on cloud computing (Prentice, 2010).....	11
Figure 2: Multiple perspectives on cloud computing (Prentice, 2010).....	12
Figure 3: Cloud computing services .....	19
Figure 4: Cloud Taxonomy (Open Crowd, 2010).....	20
Figure 5: Community Cloud (Dustin Amrhein et al., 2010) .....	22
Figure 6: Public Cloud (Dustin Amrhein et al., 2010).....	23
Figure 7: Hybrid Cloud (Dustin Amrhein et al., 2010).....	24
Figure 8: Development and design of entire processing stages to authorize certificates.....	28
Figure 9: Cloudle prototype architecture (Yogeesh A.C et al., 2012) .....	30
Figure 10: Two step verification service for iCloud.....	31
Figure 11: user authentication model.....	32
Figure 12 CAM Architecture model ( Jaejung Kim* and Seng-phil Hong et al., 2012).....	33
Figure 13: Agile Life Cycle for development process .....	39
Figure 14: Architectural Design in cloud.....	42
Figure 15: application MVC flow chart.....	46
Figure 16: Activity Diagrams showing interaction for students, employer and prototype. ....	49
Figure 17: Sequence Diagram for MVC .....	50
Figure 18: Entity Relationship Diagram .....	53
Figure 19: Process Flow diagram.....	54
Figure 20: Modified Conceptual Framework Using Codeigniter .....	56
Figure 21: The Angani Cloud Datacenter Dashboard.....	58

## LIST OF TABLES

Table 1:Cloud definitions Adapted from Luis et, al., (2009).....	16
Table 2: Database schema.....	53

## **LIST OF ACCRONYMS**

API -Application Programming Interface

ASP -Application Service Provision

CA- Certificate Authority

CAM -Consolidated Authentication Model

HPC -High performance computing

IaaS - Infrastructure as-as-a service

IEEE -Institute of Electrical and Electronics Engineering

IJATER -International Journal of Advanced Technology & Engineering Research

MVC -Model- View -Controller

NIST -National institute of Standards and Technology

PaaS -Platform –as-a-service

PDAs -Personal Digital Assistant

PHP -Hypertext Preprocessor

PKI -Public Key Infrastructure

R&D -Research and Development

SaaS -Software-as-a=service

SD -Smart Device

SLAs -Service Level Agreements

SOA -Service Oriented Architecture

SP -Service Provider

## **CHAPTER ONE     INTRODUCTION**

### **1.1     Background**

Verification is the process of establishing the truth, accuracy, or validity of something such as the verification of official documents. Most of applicants falsify their educational credentials. What's more, industry experts cite academic fraud as the most common lie on resumes. This poses the greatest danger to organization. This has been accelerated by applicants who falsify the information. The risks involved of not verifying applicants' includes, greater recruiting and replacement costs, increased employee turnover, compromised business performance, embarrassment and negative impact to your organization's reputation, declining market value, cost customers and revenue and civil and criminal liability.

Globally, most of the institutions and organizations rely on use traditional paper verification methods to verify the documents presented to them. These organizations and institution do not have the capacity to verify the document presented to them instantly. One of the problems we have in traditional paper based is that people and especially recruiters and employers find difficult in knowing the validity of documents such as academic certificates presented to them because there is no way they can authenticate those documents instantly. In the current scenario most of the organization does not have the capacity to instantly authenticate the documents presented. Traditional identity information verification and validation processes were developed in a "paper" transaction world.

According to Association of Certified Fraud Examiners, 41% of applicants lie about education. It is estimated that resume fraud costs employers approximately \$600 billion annually.

According to ADP Screening Index, 45% of employment, education and/or credential reference checks reveal discrepancies in the applicant's information.

According to Wall Street Journal 34% of all application forms contain misrepresentations about the applicants' experience, education, and ability to perform essential job functions.

Career Builder 49% of the 3,100 hiring managers surveyed caught a job applicant fabricating some part of his/her resume.

American Psychological Association: According to a recent study, 67% of job applicants' resumes in the U.S

While global trends indicate an increase in falsification of academics fraud, local conditions in Kenya have had such a challenge to verify these academic certificates. This means that people continues to falsify document without been easily detected due to inadequate detection tools and methods used.

Several studies have been made towards developing models to verify and authorize certificates in government sectors. According to International Journal of Advanced Technology & Engineering Research (IJATER) Yogesh A.C, Roopashree H.R, Anjan punith B.G and Rajesh.B designed and developed a model to authorize certificates in government sectors using cloud computing environments. University of Grants Commission in India developed an e-certification/verification for online.

This disturbing decline in ethics, which touches everyone from recent graduates to seasoned executives, has serious implications for all organizations. Several actions can be taken by businesses to protect themselves. First, employers must independently check prospective employees' backgrounds. Second, those with questionable backgrounds or who lie on their resumes should be considered high fraud risk individuals. Third, every effort must be made to avoid hiring those with criminal backgrounds.

**The motivation came** as a result of reading Daily Nation where the chairman of IEBC Isaac Hassan said that “**we do not have any mechanism of authenticating certificate instantly**”. I saw this as a problem and now took initiative to come up with a prototype which when open to public can be used to solve the problem of verifying academic certificates of member of parliament and anybody wishing to verify in our country at large.

To overcome and minimize this problem we need a secure automated verification method. One of the existing methods is the accessing of documents online and verification and authenticity via a secure hosted website. This study proposes a model for academic certification based academic certification based on cloud computing environment. The proposed prototype works on the basis of cloud computing. Here the application is placed or installed and hosted in the cloud. The cloud computing is chosen because it provides and deliver application via internet which are accessed

from web browsers by using devices such as laptop, mobile, desktop etc. User can access through online by using website tools or web browser. The database will be hosted in the cloud in which verifications of academic certificates can be instantly verified. To do this we ensure that the data integrity and security is enhanced in the cloud.

For security issues for cloud computing. Cloud computing is not secure by nature. Security in the cloud is often intangible and less visible, which inevitably creates a false sense of security and anxiety about what is actually secured and controlled. The off-premises computing paradigm that comes with cloud computing has incurred great concern on the security of data especially the integrity and confidentiality of data as cloud service providers may have confidentiality of data as cloud service providers may have complete control on the cloud computing infrastructure that underpins the services[14].

Several things can be done with cloud computing. Cloud computing environment can be set up to enable sharing of resources.

We ensure the data integrity and security is enhanced. In cloud computing, hardware, software and services are used by many users. The role of identity and authorizations is to ensure that only authorized persons may use the system. Access to all the IT prototypes or services must be made secure by identifying and authenticating the users or IT prototypes seeking access[6].

## **1.2 Problem statement**

Verification of certificates is a major concern in organization, academic institutions, recruiters and employers. Employers have been experiencing a high alarming rate of fake certificates. This is as a result of production of fake certificates. Firstly the traditional paper based prototype of verification contributes to production of fake certificates which poses a difficulty in knowing the validity of such academic certificates presented to them because there is no way they can authenticate them instantly. Secondly, modern technology and the rise of the internet have undoubtedly contributed to the wide-spread trend of educational fraud and fake degrees, accuracy and convenience.

Cloud computing is a technology that can be used to solve the problem of speed, accuracy and create convenient based on the following:-

- **On Demand Self-Service:** allows for provisioning of computing resources automatically as needed.
- **Broad Network Access:** access to cloud resources is over the network using standard mechanisms provided through thin or thick clients in a heterogeneous manner
- **Resource Pooling:** the vendors' resources are capable of being pooled to serve multiple clients using a multi-tenant model, with different physical and virtual resources in a dynamic way. The pooling and assigning of resources is done based on the changing needs of clients or consumers. Example of resources include; computation capabilities, storage and memory.
- **Rapid Elasticity:** allows for rapid capability provisioning, for quick scaling out and scaling in of capabilities. The capability available for provisioning to the client seems to be unlimited and that it can be purchased as demanded.
- **Measured Service:** allows monitoring, control and reporting of usage. It also allows for transparent between the provider and the client

### 1.3 What Are the Risks

The risks of not verifying applicants' education credentials include:

- Greater recruiting and replacement costs
- Increased employee turnover
- Compromised business performance
- Embarrassment and negative impact to your organization's reputation
- Declining market value
- Lost customers and revenue
- Civil and criminal liability



### **1.5 Objectives of the study**

The following are the objectives of the proposed research project:-

1. Research on the various clouding computing platforms and models
2. Review the methods used for certificate verification in current systems
3. Develop a prototype for academic certificate verification and hosted on cloud computing environment.

### **1.6 Research questions**

The use of cloud computing poses significant questions which form part of the proposed project study:

1. Which are the various models of cloud computing appropriate for certificate verification?
2. Which methods are currently used for academic certificate verification?
3. What method and technology may be used to develop and deploy academic certificate verification on the cloud?

### **1.7 Research hypothesis**

The following hypothesis is put forward: The verification prototype based on cloud environment will provide more reliable and trustworthy services.

### **1.8 Significance of the study**

When the project goes online the following benefit will be realized:-

- Recruiters and employers receive the benefit because the system gives the opportunity to authenticate the certificates.
- Help the recruiting agencies in verification academic certificates held by an individual.
- Verification Software reduces instances of academic fraud. Improves fraud detection.

## 1.9 Contributions of the study

The design and development of a prototype for an academic certification based on cloud computing service will help in contribution to the body of knowledge in cloud computing.

## 1.10 Justification of using Cloud computing

Cloud computing has a number of characteristics that distinguishes it from other computing paradigms. The essential characteristics that forms the bases of justification for using cloud computing are listed below:

- 1) **On Demand Self-Service:** allows for provisioning of computing resources automatically as needed.
- 2) **Broad Network Access:** access to cloud resources is over the network using standard mechanisms provided through thin or thick clients in a heterogeneous manner. For example through Smartphone's, mobile phones and laptop computers.
- 3) **Resource Pooling:** the vendors' resources are capable of being pooled to serve multiple clients using a multi-tenant model, with different physical and virtual resources in a dynamic way. The pooling and assigning of resources is done based on the changing needs of clients or consumers. Example of resources include; computation capabilities, storage and memory.
- 4) **Rapid Elasticity:** allows for rapid capability provisioning, for quick scaling out and scaling in of capabilities. The capability available for provisioning to the client seems to be unlimited and that it can be purchased as demanded.
- 5) **Measured Service:** allows monitoring, control and reporting of usage. It also allows for transparent between the provider and the client.
- 6) Cloud computing is available in 24hrs and stakeholders can use it at any time.

### 1.11 Project scope

Cloud computing is a new area that is not fully adopted in many institutions and organizations. Cloud computing technology can be used to solve problems whose solution will be of use to those institutions and organization.

This study will concentrate on the development of a prototype for academic certificates verifications and point out how it can be hosted in cloud computing environment. The product/Output is a software product called vericert. Vericert is a system for verifying academic certificates. It is available for anyone or any organization that wishes to establish the veracity of academic documents presented to them by any candidate seeking a job.

### 1.12 Definitions of important terms

**Cloud:-** the word cloud (also phrased as "the cloud") is used as a metaphor for "*the Internet*," so the phrase *cloud computing* means "a type of Internet-based computing," where different services -- such as servers, storage and applications -- are delivered to an organization's computers and devices through the Internet.

**Grid** Globally distributed units with different operating prototypes and hardware being capable of processing a large amount of data collaboratively.

**Virtualization** in computing is a term that refers to the various techniques, methods or approaches of hybrid cloud creating a virtual (rather than actual) version of something, such as a virtual, operating prototype (OS).

**Clusters** A computer cluster consists of a set of loosely connected computers that work together so that in many respects they can be viewed as a single prototype.

**Hypervisors:** In computing, a hypervisor or virtual machine manager (VMM) is a piece of computer software, firmware or hardware that creates and runs virtual machines.

VMware is an American software company that provides cloud and virtualization software and services.

Cloud Hosting a type of hosting where the client leases virtualized, dynamically scalable infrastructure on as – needed bases.

**Cloud computing** is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet). The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in prototype diagrams

**Virtual Box** is a general-purpose full virtualizer for x86 hardware.

**Elastic computing** is the use of computer resources which vary dynamically to meet a variable workload

**Hybrid cloud** A is a cloud computing environment in which an organization provides and manages some resources in-house and has others provided externally.

**A computer cluster** consists of a set of loosely connected *computers* that work together so that in many respects they can be viewed as a single prototype.

**Cloud Database** A database accessible to clients from the cloud and delivered to users on demand via the Internet from a cloud database provider's servers.

## **CHAPTER TWO    LITERATURE REVIEW**

### **2.1    Introduction**

The purpose of this chapter is to show the connection between what is proposed for study with the existing knowledge, previous studies, or contemporary practice with relevant citation of other scholars work with respect to the problem. The advent of cloud computing in recent years has sparked interest from different stakeholders of Information Technology (IT) and Computer science, such as academicians, business organizations and institutions. With its promise of a new economic model for the Computing/Communication and Information Technology (ICT) department of business organization, cloud computing brings about a shift in the way organization invest in their IT resources. The new economic model removes the need for the organization to invest a substantial sum of money for purchase of limited IT resources that are internally managed, but rather the organization can outsource its IT resource requirements to a cloud computing service provider and pay per use. This new computing paradigm called cloud computing has also brought challenges to the organization seeking to adopt it. The challenges that are raised are: trust, security, legal, compliance and organizational challenge. These challenges are closely linked to trust .This chapter provides the background material for the remainder of this thesis. The first section provides the definition of cloud computing, a brief history of cloud computing, underlying technologies, service and delivery models offered by cloud computing and the benefits of using cloud computing. Second section talk about authorization and certification.

### **2.2    Cloud Computing**

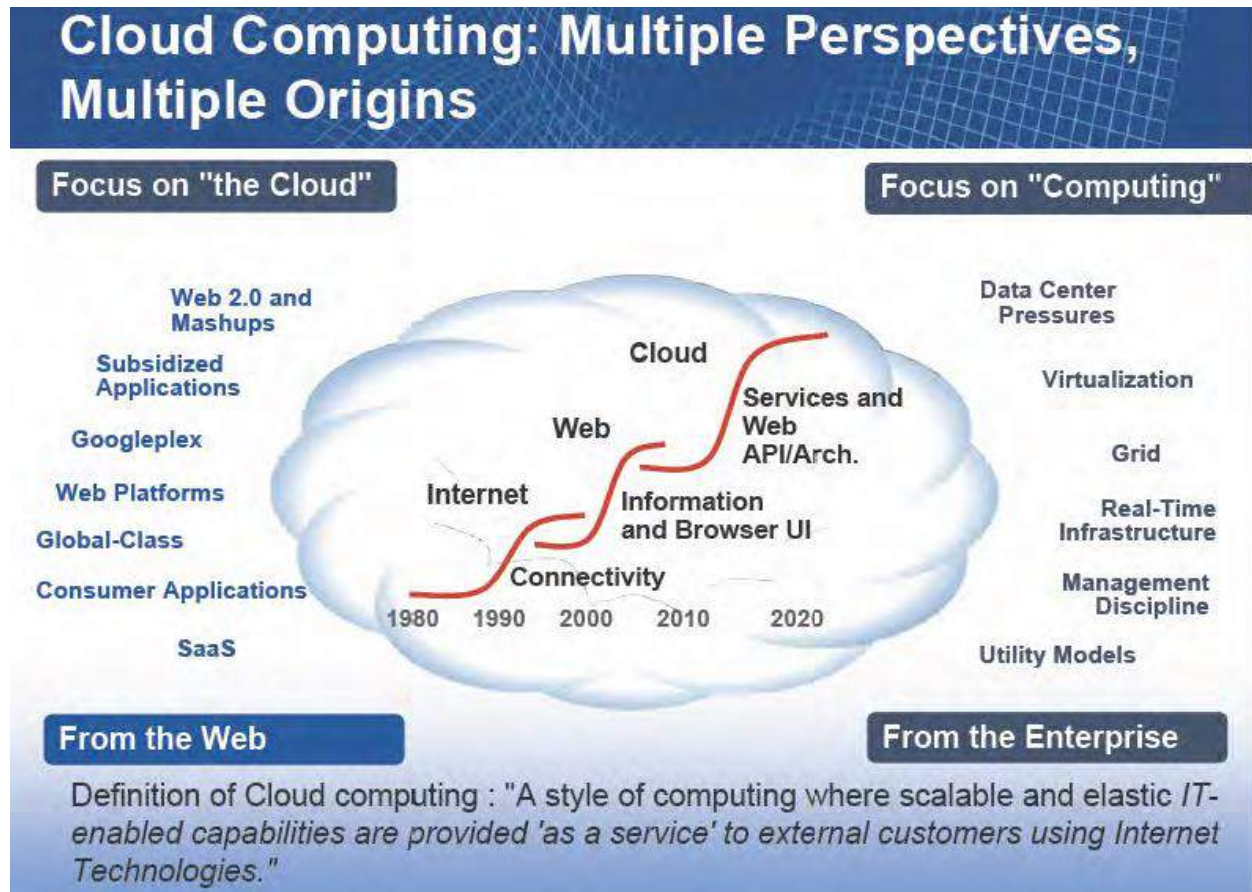
Without a doubt, the advent of cloud computing in recent years has sparked an interest from different stakeholders, business organizations, institutions and government agencies. This interest is fuelled by the promised new economic model of cloud computing which brings a shift from heavy IT infrastructure invest for limited resources that are internally managed and owned to pay per use for IT infrastructure owned by a service provider. Also, it promises scalability and on-demand provisioning of resources. However the term cloud computing is fairly new since its emergence in the computing world (Luis et al., 2008). Although the term is new, its concepts are

not new. Cloud computing borrows terms and concepts from other computing paradigms such as utility computing, grid computing, service oriented architecture among others (Luis et al., 2008, Wang and Laszewski, 2008, Geelan, 2009, Buyya et al., 2008). This shows that cloud computing has been in existence in different forms since the beginning of computing, and it can be traced back to early sixties. In the sixties time sharing and utility computing emerged. This project failed because it was far ahead of its time. There was no public Internet, lack of communication technology and high speed processing and storage capacities. It was during this era that, time sharing and multitasking – operating prototypes technology emerged. These technology were pre-cursors of cloud computing (Wang and Laszewski, 2008). The seventies witnessed the mainframe era and with a company like Tymeshare Inc. renting out storage space and processing power via the telephone line (Bhattacharjee, 2009). The Eighties saw the advent of personal computers, while the nineties saw the dot-com bubble and the advent of grid computing. Grid computing aimed at linking and enabling the sharing of computing resources, while the dot-com bubble led to the emergence of datacenters. Yet these datacenters were not fully utilized, and this led to the virtualization technology, and thus the birth of modern day cloud computing (Bhattacharjee, 2009). The first attempt at cloud computing were in 1999 when Marc Andreessen founded the Cloud company which was to “*build the web’s next power play: custom-designed, infinitely scalable sites that blast off a virtual assembly line*” (Sheff, 2003). The company intended to be a managed service provider. It was the first company to offer services which are now called Software as a Service (SaaS) using an Infrastructure as a Service model (IaaS) (Sheff, 2003). The company does not exist today. In 2000 Microsoft launched web services as SaaS offering, followed in 2001 by IBM with their Autonomic Computing Manifesto (Kephart and Chess, 2003, IBM, 2001) and in 2007 collaboration between IBM and Google launched research in cloud computing (Lohr, 2007).

### **2.2.1 Cloud Definition**

Cloud computing has been defined differently by different industry experts and researchers alike. Larry Ellison founder of Oracle says “*we’ve defined cloud computing to include everything that we already do... I don’t understand what we would do differently in the light of cloud computing other than change the wording of some of ours ads*” (Farber, 2008). Richard Stallman founder of the Free Software Foundation and creator of the operating prototype GNU says “*it’s stupidity.*

*It's worse than stupidity: it's a marketing hype campaign"* (Johnson, 2008). These comments are representative of how different experts look at cloud computing. Figure 1 shows the different contributors and perspective of cloud computing paradigm. Figure 2.1: Shows multiple perspectives on cloud computing (Prentice, 2010)



**Figure: 1 Multiple perspectives on cloud computing (Prentice, 2010)**

The Gartner consulting propose a definition as follows "A style of computing where scalable and elastic IT-related capabilities are provided as-a-service using Internet technologies to multiple external customers" (Plummer et al., 2009). The National Institute of Standards and Technology (NIST) defines cloud computing as " a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., network, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is

composed of five essential characteristics and three service models and four deployment models” (Mel and Grance, 2009b, Mel and Grance, 2009a).

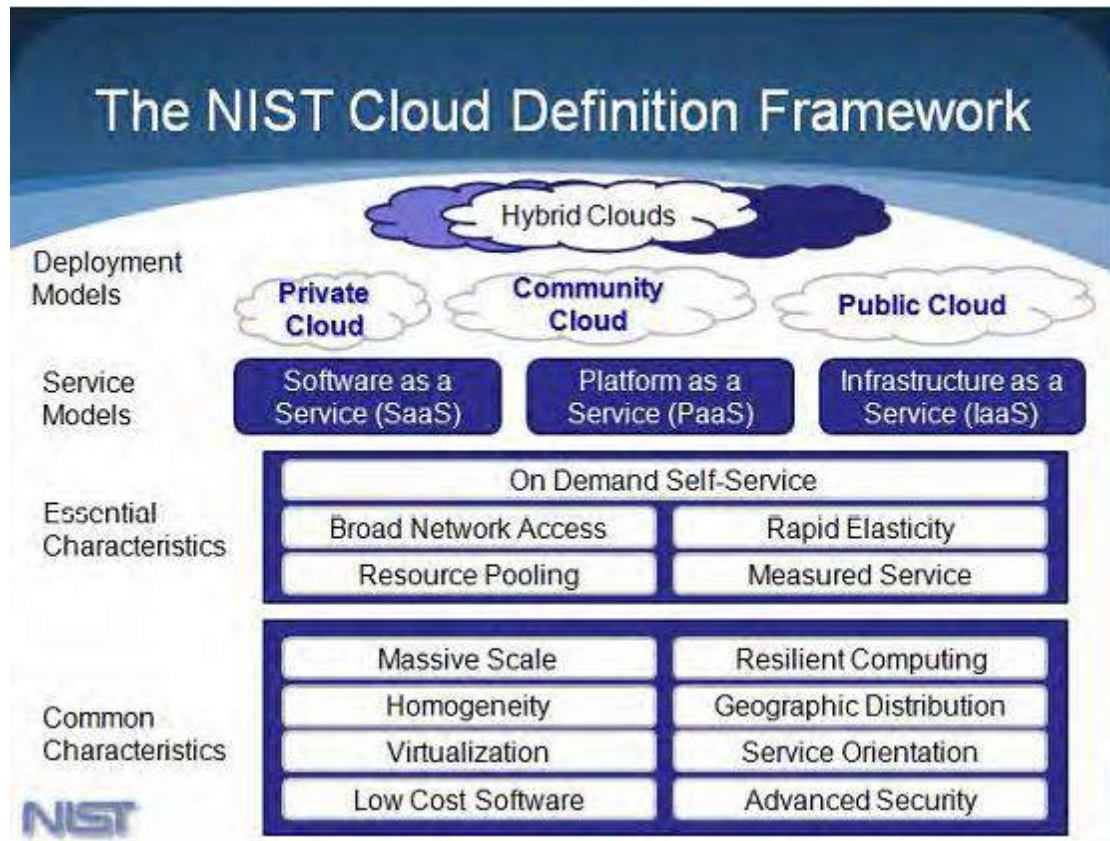


Figure 2: shows the framework of the NIST definition of cloud computing

### Figure 2: Multiple perspectives on cloud computing (Prentice, 2010)

The European Network and Information Security Agency (ENISA) has defined cloud computing as “on-demand service model for IT provision, often based on virtualization and distributed computing technologies” (Catteddu and Hogben, 2009). However the first academic definition of cloud computing was offered by Ramnath Chellapa in 1997 where he defined the term cloud as “a computing paradigm where the boundaries of computing will be determined rationale rather than technical” (Chellapa, 1997).

Other common academic and scholarly definitions are as follows: according to (Buyya et al., 2008) cloud computing is “a type of parallel and distributed prototype consisting of collection of interconnected and virtualized computers that are dynamically provisioned and present as on or



*more unified computing resource based on service-level agreements established through negotiation between service provider and customer*". Another common academic definition defines cloud computing as *"a set of network enabled services, providing scalable, QoS guaranteed, normally personalized, inexpensive computing platforms on demand, which could be accessed in a simple and pervasive way"* (Wang and Laszewski, 2008), while Luis et, al., (2009) proposes the following definition *"cloud are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the infrastructure provider by means of customized SLAs"*. These different definitions show the varied understanding of what cloud computing is from the different perspectives of different stakeholders such as; academicians, architects, consumers, developers, engineers and managers (CSA, 2009). Table 2-1 provides an excerpt of cloud definitions that are currently available as summarized by Luis et, al., (2009) and adapted by the author.

<b>Author/Reference</b>	<b>Year</b>	<b>Definition/Excerpt</b>
M. Klems (Geelan, 2009)	2008	<i>"you can scale your infrastructure on demand within minutes or even seconds, instead of days or weeks, thereby avoiding under-utilization(idle servers) and over utilization (blue screen)of in-house resources"</i> .
P. Gaw (Geelan, 2009)	2008	<i>"refers to the bigger picture...basically the broad concept of using the internet to allow people to access technology enabled services"</i> .
R. Buyya (Buyya et al., 2008)	2008	<i>"a type of parallel and distributed prototype consisting of collection of interconnected and virtualized computers that are dynamically provisioned and present as on or more unified computing resource based on service-level agreements established through negotiation between service provider and customer"</i> .
R. Cohen (Geelan, 2009)	2008	<i>"for me the simplest explanation for cloud computing is</i>

		<i>describing it as, 'internet centric software'. This new cloud computing software model is a shift from traditional single tenant approach to software development to that of scalable, multi-tenant, multiplatform, multi-network, and global".</i>
J. Kaplan (Geelan, 2009)	2008	<i>"a broad array of web-based services aimed at allowing users to obtain a wide range of functional capabilities on a 'pay-as-you-go' basis that previously required tremendous hardware/software investment and professional skills to acquire".</i>
D. Gourlay (Geelan, 2009)	2008	<i>"cloud will be the next transformation over the next several years, building off of the software models that virtualization enabled"</i>
D. Edwards (Geelan, 2009)	2008	<i>"...what is possible when you leverage web scale infrastructure (application and physical) in an on-demand way. ...anything as a service... all terms that couldn't get it done. Call it 'cloud' and everyone goes bonkers".</i>
B. De Haff (Geelan, 2009)	2008	<i>"the 'cloud' model initially focused on making hardware layer consumable as on demand compute and storage capacity. ... to harness the power of the cloud, complete</i>
B. Keppes (Geelan, 2009)	2008	<i>"put cloud computing is the infrastructural paradigm shift that enables the ascension of SaaS".</i>
K. Sheynkman (Geelan, 2009)	2008	<i>"the 'cloud' model initially focused on making hardware layer consumable as on demand compute and storage capacity. ... to harness the power of the cloud, complete application infrastructure needs to be easily configured, deployed, dynamically scaled and managed in these virtualized hardware environments".</i>

O.Sultan (Geelan, 2009)	2008	<i>“... in a fully implemented Data center 3.0 environment, you can decide if an app is run locally (cook at home), in someone else’s data center (take-out) and you can change your mind on the fly in case you are short on data center resources (pantry is empty) or you having environmental/facilities issues (too hot to cook)”.</i>
K.Harting (Geelan, 2009)	2008	<i>“cloud computing overlaps some of the concepts of distributed, grid and utility computing, however it does have its own meaning if contextually used correctly. Cloud computing really id accessing resources and services needed to perform functions with dynamically changing needs”.</i>
J. Pritzker (Geelan, 2009)	2008	<i>“cloud tend to be priced like utilities... i think is a trend not a requirement”.</i>
T. Doerksen (Geelan, 2009)	2008	<i>“cloud computing is... the user friendly version of grid computing”.</i>
T. von Eicken (Geelan, 2009)	2008	<i>“... outsourced, pay-as-you-go, on-demand, somewhere in the internet”.</i>
M. Sheedan (Geelan, 2009)	2008	<i>“... ‘cloud pyramid’ to help differentiate the various cloud offerings out there... top: SaaS; middle: PaaS; bottom: IaaS”.</i>
A. Ricadela (Geelan, 2009)	2008	<i>“... cloud computing projects are more powerful and crash proof than Grid prototypes developed even in recent years”</i>
I. Wladawsky Berger (Geelan, 2009)	2008	<i>“... the key thing we want to virtualize or hide from the user is complexity. ...with cloud computing our expectation is that all that software will be virtualized or hidden from us and taken care of by prototypes and /or professionals that are somewhere else – out there</i>

		<i>in the cloud”.</i>
G. Gruman and E. Knorr	2008	<i>“cloud is all about: SaaS... utility computing... Web services... PaaS... Internet integration... commerce platforms...”.</i>
Gartner(Plummer et al., 2009)	2009	<i>“A style of computing where scalable and elastic IT-related capabilities are provided as-a-service using Internet technologies to multiple external customers</i>

**Table 1: Cloud definitions Adapted from Luis et, al., (2009)**

### **Cloud definitions Adapted from Luis et, al., (2009)**

After a thorough review of existing cloud computing definitions and the computing paradigms from which cloud computing borrows terms and concepts, in this study we define cloud computing We shall adopt the America National Institute of Standards and Technology (NIST)’s definition of the cloud. According to NIST (2011), Cloud computing is *“A pay-per-use model for enabling available convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”* The following sub-section highlights the essential and common characteristics of cloud computing paradigm.

### **2.2.2 Cloud Computing Characteristics**

Cloud computing has a number of characteristics that distinguishes it from other computing paradigms. These characteristics can be categorized as essential characteristics and common characteristic. The NIST has identified five essential characteristics (Plummer et al., 2009) and eight common characteristics of cloud computing (Grance, 2010, Mel and Grance, 2009a).The essential characteristics are:

**On Demand Self-Service:** allows for provisioning of computing resources automatically as needed.

**Broad Network Access:** access to cloud resources is over the network using standard mechanisms provided through thin or thick clients in a heterogeneous manner. For example through Smartphone's, mobile phones and laptop computers.

**Resource Pooling:** the vendors' resources are capable of being pooled to serve multiple clients using a multi-tenant model, with different physical and virtual resources in a dynamic way. The pooling and assigning of resources is done based on the changing needs of clients or consumers. Example of resources include; computation capabilities, storage and memory.

**Rapid Elasticity:** allows for rapid capability provisioning, for quick scaling out and scaling in of capabilities. The capability available for provisioning to the client seems to be unlimited and that it can be purchased as demanded.

**Measured Service:** allows monitoring, control and reporting of usage. It also allows for transparent between the provider and the client. In conjunction with the essential characteristics as identified by NIST, there are other cloud computing characteristics (GNi, 2009, Miller, 2008, Luis et al., 2008, Vouk, 2008, Grance, 2010). These characteristics are such as: massive scale availability of computing and storage capabilities, homogeneity, use of virtualization technology, resilient computing, and pay-as you go model. Low or no up-front IT infrastructure costs, geographical distribution of clouds, low overhead costs for IT and administration personnel. These characteristics make cloud computing attractive to business organizations and government agencies. The next sub-section looks on the different technologies that underlies cloud computing.

### 2.2.3 Cloud Computing Technologies

In this section cloud computing is reviewed from a technology point of view. Improvement in technology and in particular virtualization have contributed greatly in the advancement of cloud computing. Other technology of cloud computing include utility computing, grid computing, parallel computing and service oriented architecture (Mel and Grance, 2009b, Luis et al., 2008, Vouk, 2008, Wang and Laszewski, 2008), thus cloud computing is combination of many different technologies.

The technologies that underpin the advent of cloud computing are: *grid computing*, virtualisation, parallel computing, service oriented architecture (SOA), the Internet, autonomic prototype computing, Web services, web application frameworks and open source software

These are Web 2.0, Software as a Service, utility computing, service level agreements, open standards, data portability and accessibility (Mel and Grance, 2009b). These technologies and business models prepared the platform for cloud computing for offering such capabilities such as: the representation of computation, storage as logical entities through virtualization (Bhattacharjee, 2009, Vouk, 2008); this enables the creation of multiple instances of the virtual machines based on the physical machine or storage for use by multiple users (Buyya et al., 2008, Wang and Laszewski, 2008). Service oriented architecture and web services enables offering of cloud computing services as web services accessible via the Internet, also SOA makes it possible for cloud services to be available in multiple platforms (Wang and Laszewski, 2008); grid computing offered to cloud the capabilities for resource sharing, heterogeneity and ability to decentralize resource control (Luis et al., 2008). Since cloud computing services are web application or web based application accessed via the Internet, Web 2.0 provides cloud computing with capabilities of improved connectivity and interaction between web applications. This makes access to cloud computing services by users more efficient and easy (Wang and Laszewski, 2008). These technologies are the key technologies underpinning the evolution and success of cloud computing. This is because these technologies paved the way for the platform from which cloud computing is launched. They provided the technology and infrastructure that cloud computing relies on. They also provided the theoretical and practical experiences which cloud computing capitalizes on for its success and adoption in business organisations. The next subsection describes the delivery and deployment models used in cloud computing in offering its services.

Cloud computing has evolved through a number of phases which include grid and utility computing, application service provision (ASP), and Software as a Service (SaaS).

#### **2.2.4 Cloud Service Models**

There are three common service models for offering cloud computing services. These models are Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructures- as -Service (IaaS) (CSA, 2009).

- **Software as a Service (SaaS).** The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser

(e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating prototypes, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

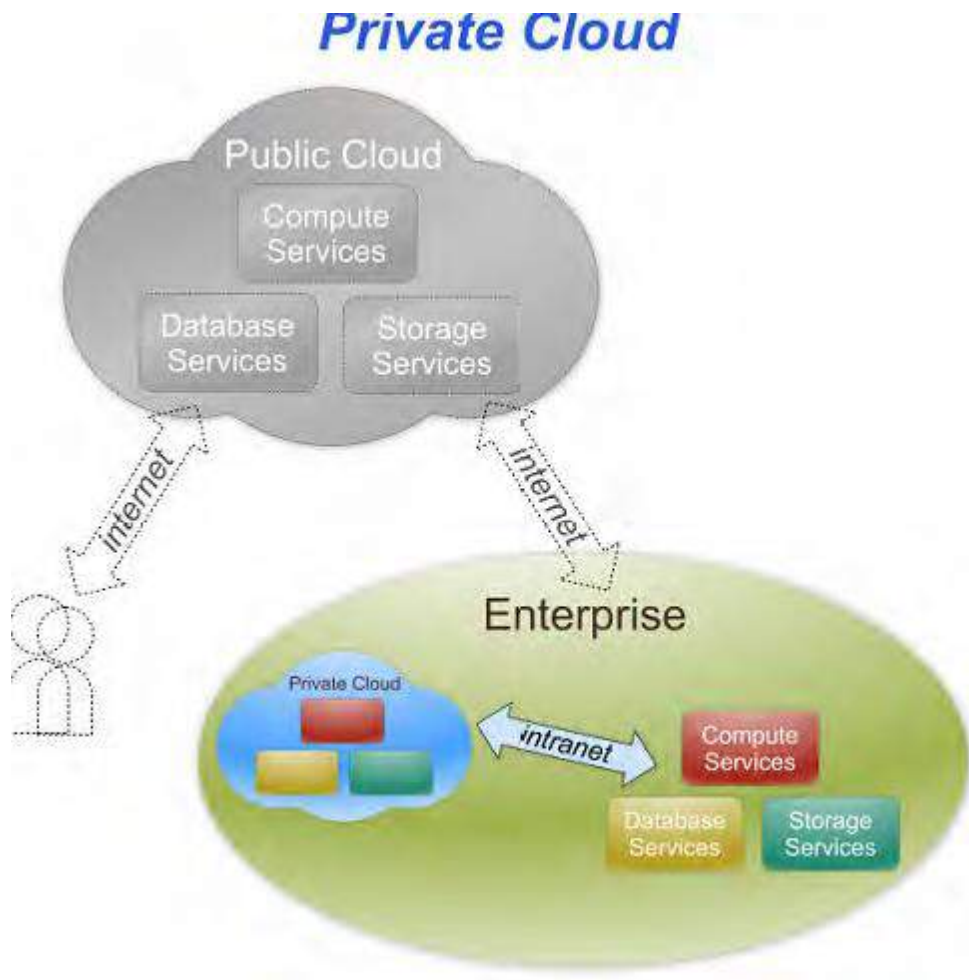
- **Platform as a Service (PaaS).** The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming not manage or control the underlying cloud infrastructure including network, servers, operating prototypes, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.
- **Infrastructure as a Service (IaaS).** The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating prototypes and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating prototypes, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).



**Figure 3: Cloud computing services**

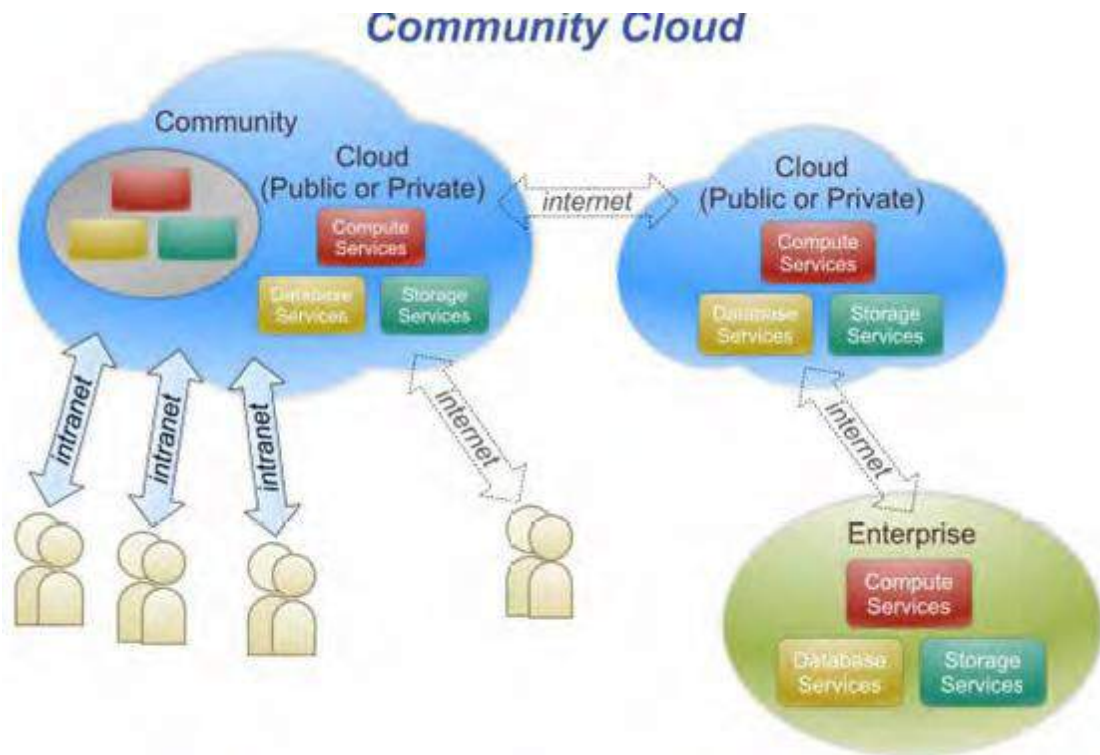






**Figure 5: Private Cloud (Dustin Amrhein et al., 2010)**

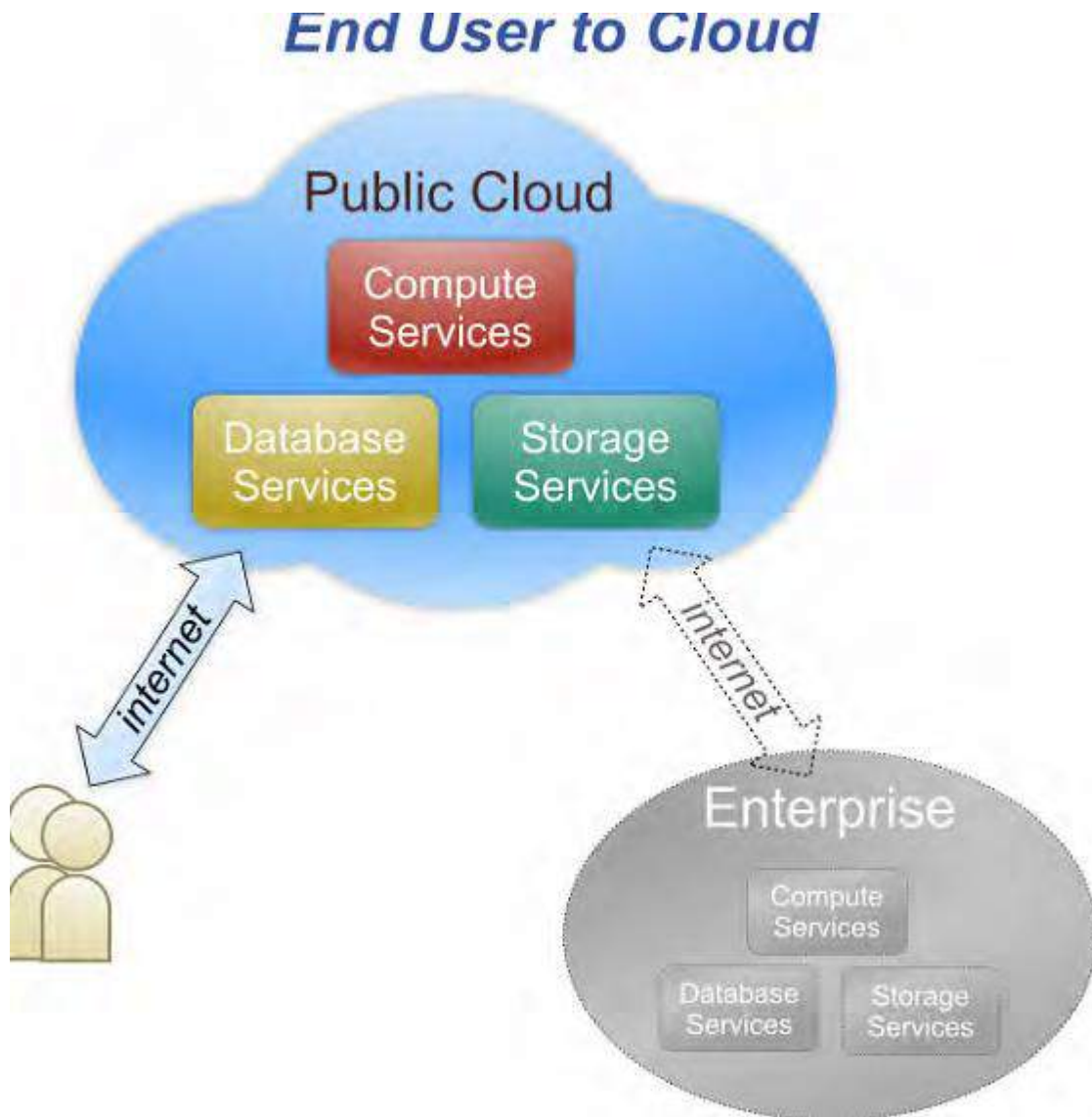
- **Community cloud.** The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.



**Figure 5: Community Cloud (Dustin Amrhein et al., 2010)**

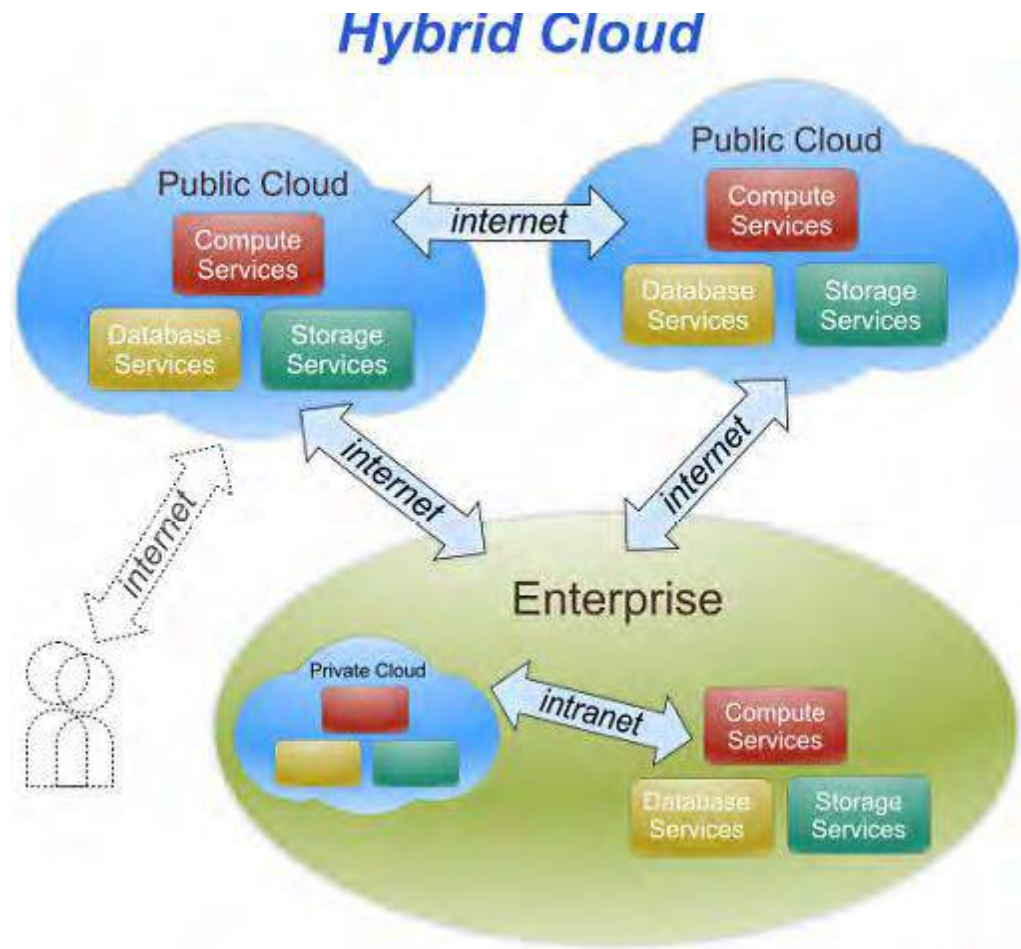
**Public cloud.** The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some

combination of them. It exists on the premises of the cloud provider.



**Figure 6: Public Cloud (Dustin Amrhein et al., 2010)**

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



**Figure 7: Hybrid Cloud (Dustin Amrhein et al., 2010)**

### 2.2.6 Cluster Computing

A computer cluster consists of a set of loosely connected computers that work together so that in many respects they can be viewed as a single prototype. The components of a cluster are usually connected to each other through fast local area networks, each node (computer used as a server) running its own instance of an operating prototype. Computer clusters emerged as a result of convergence of a number of computing trends including the availability of low cost microprocessors, high speed networks, and software for high performance distributed computing.

Clusters are usually deployed to improve performance and availability over that of a single computer, while typically being much more cost-effective than single computers of comparable speed or availability.

### **2.2.7 Virtualization Technology**

Virtualization is the simulation of the software and/or hardware upon which other software runs. This simulated environment is called a virtual machine (V2.2.5). There are several software's that are used to create virtual machines and are called hypervisors. In this study XenServer is used as a hypervisor. The guest operating system created is Ubuntu12.04 (64bit) and one virtual central processing unit.

### **2.2.8 Cloud computing features**

The summary of the features of Cloud Computing described by Abah Joshua and Francisca N. Ogwueleka(2012) is:

- Cloud Computing is a new computing paradigm.
- Infrastructure resources (hardware, storage and prototype software) and applications are provided in everything-as-a-service (XaaS) manner. When these services are offered by an independent provider or to external customers, Cloud Computing is based on pay-per-use business models.
- Main features of Clouds are virtualization and dynamic scalability on demand.
- Utility computing and SaaS are provided in an integrated manner, even though utility computing might be consumed separately.
- Cloud services are consumed either via Web browser or via a defined API.

### **2.2.9 Cloud computing characteristics**

There are five essential characteristics of Cloud Computing which explains their relation and difference from the traditional computing. These are;

- On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
- Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick

client platforms (e.g., mobile phones, laptops, and personal digital assistants (PDAs)).

- **Resource pooling.** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the subscriber generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
- **Rapid elasticity.** Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- **Measured Service.** Cloud prototypes automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

## **2.3 Authentication and Authorization methods**

### **2.3.0 Introduction**

An authentication and authorization plug-in model for a cloud computing environment enables cloud customers to retain control over their enterprise information when their applications are deployed in the cloud. The cloud service provider provides a pluggable interface for customer security modules. When a customer deploys an application, the cloud environment administrator allocates a resource group (e.g., processors, storage, and memory) for the customer's application and data. The customer registers its own authentication and authorization security module with

the cloud security service, and that security module is then used to control what persons or entities can access information associated with the deployed application.

### **2.3.1           PKI on clouds**

PKI plays a vital role when it comes to building trust on cloud computing services. Some aspects that PKI brings to cloud computing are briefly listed below:

- **Security**

When documents of confidential nature are to be communicated over the cloud, security is of paramount importance. Since PKI ensures secured signing by making use of digital signatures with a digital ID that can be accessed exclusively by that user, it implies comprehensive protection.

- **Reliability**

Reliability offered by a service is a telltale of its capabilities, seamless implementation and high level of security. With PKI, review of quality, monitoring and development are aligned with cloud service, hence substantiating reliability.

- **Open communications**

Successful communication is directly associated with trust and cloud services are required to respond and acknowledge the digitally aware end-users in the desired manner and this is what the use of PKI offers. With several ways of communication available, it is the responsive and prompt communication PKI streamlines that makes the real difference.



### 2.3.2 Related Work on Verifications

Several researchers have used cloud computing for verification. According to YogeeeshA.C, Roopasharee H.R, anjan Punith B.G,Rajesh.B ,they developed a model for authorization of certificates in Government sectors using cloud computing Environment. They designed and developed a model where a user can request and administrator can authorize certificates through online several sectors. They used fifth generation cloud computing environments to maintain data. The application allows users to make a request to get certificates through online by filling user application form by attaching appropriate proof(voter id, Driving Licence,ration card etc. They authorize the certificates using digital signatures. They ensure data integrity and security using RSP algorithm.

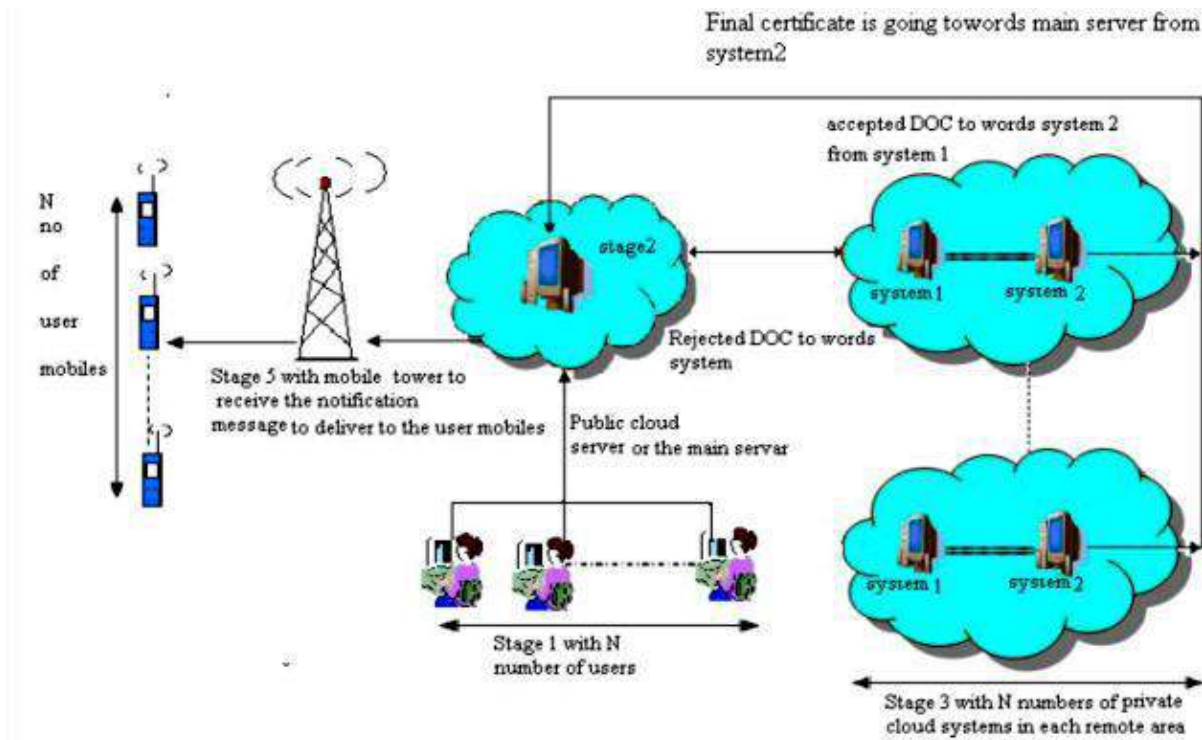


Figure 8: Development and design of entire processing stages to authorize certificates.



Explanation of each stage. The model works in five stages as explained below.

**Stage 1:** Main server is placed in public cloud which allows number of users to make request by filling user application forms in order to get certificates online.

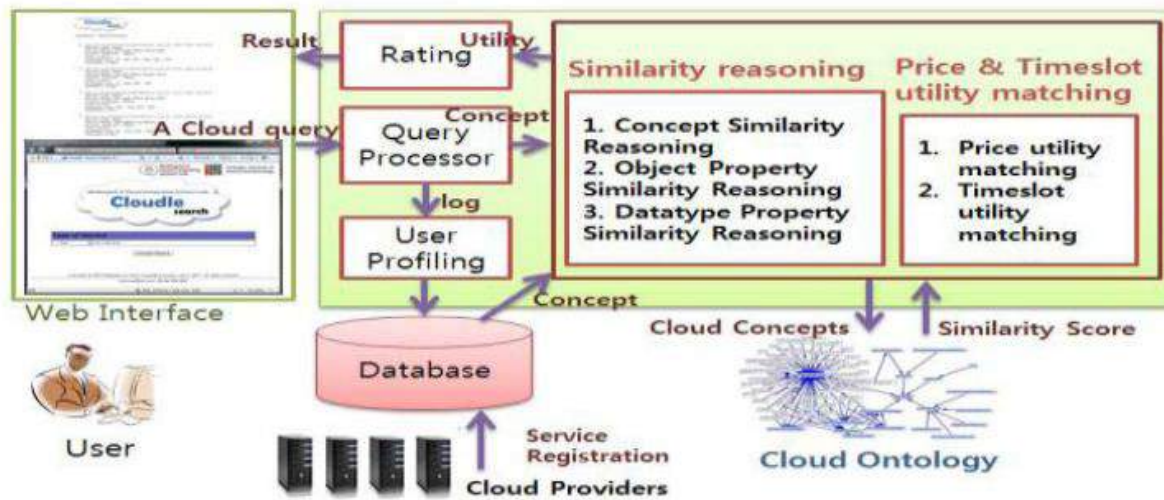
**Stage 2:** The uploaded document of user is present in the main public cloud server, which consist of all the uploaded documents of the users through the internet. The public cloud server facilitates to send the notification messages to the users about their document progress.

**Stage 3:** The village accountant (prototype 1) after accessing to the public cloud server he/she looks for uploaded document in order to verify, if the document is correct then the village accountant prepares a new document called FINAL CERTIFICATE consisting of user name, address and all required data for the certificate then it sends to thashildar prototype (prototype 2) in order to get signed to the income certificate. If the uploaded document is not correct then it is rejected by the village accountant and he guides the public cloud server to send a notification message to particular user i.e. —Your uploaded document is incorrect, please provide correct proof.

**Stage 4:** In this stage the signed income certificate is sends to the public cloud server and notification message send to the particular user i.e. Your income certificate is ready and collect by downloading in our website by providing the unique identity code.

**Stage 5:** In this stage the all notification messages from the public cloud server will be delivered to mobile tower then that message will be delivered to particular users mobile and the users also allowed replying their feedback.

The researchers used a cloud search engine for cloud computing prototype (Cloudle) [13] to search applications effectively by users and authorized persons.



**Figure 9: Cloudle prototype architecture (Yogeesh A.C et al., 2012)**

Cloud search engine run as follows. At first, users request send queries (application id and DOB) to the cloud Prototype through a web interface. After that the service discovery agent carries out five functionalities (1) Query processing, (2) User profiling, (3) Similarity Reasoning,(4) Price and timeslot utilities and (5) Rating

## iCloud

Apple has rolled out a new two-step verification service for iCloud and Apple ID users.

This security code can be sent via SMS or via the Find my iPhone iOS app .Users setup two-step authentication on their devices via the Apple ID website

Apple’s two-step verification is available in the U.S., U.K, Australia, Ireland, and New Zealand.

## How it works

This is a prototype that lets you inquire verification of your identity when you sign on to a new device. This will theoretically make it more difficult for people to use your Apple ID on devices other than your own, especially to make purchases. It involves entering your Apple ID on a new device and receiving a verification code that you use to confirm your identity via SMS. You’ll

also get a master Recovery Key that lets you gain access to your account if you lose your SMS device.

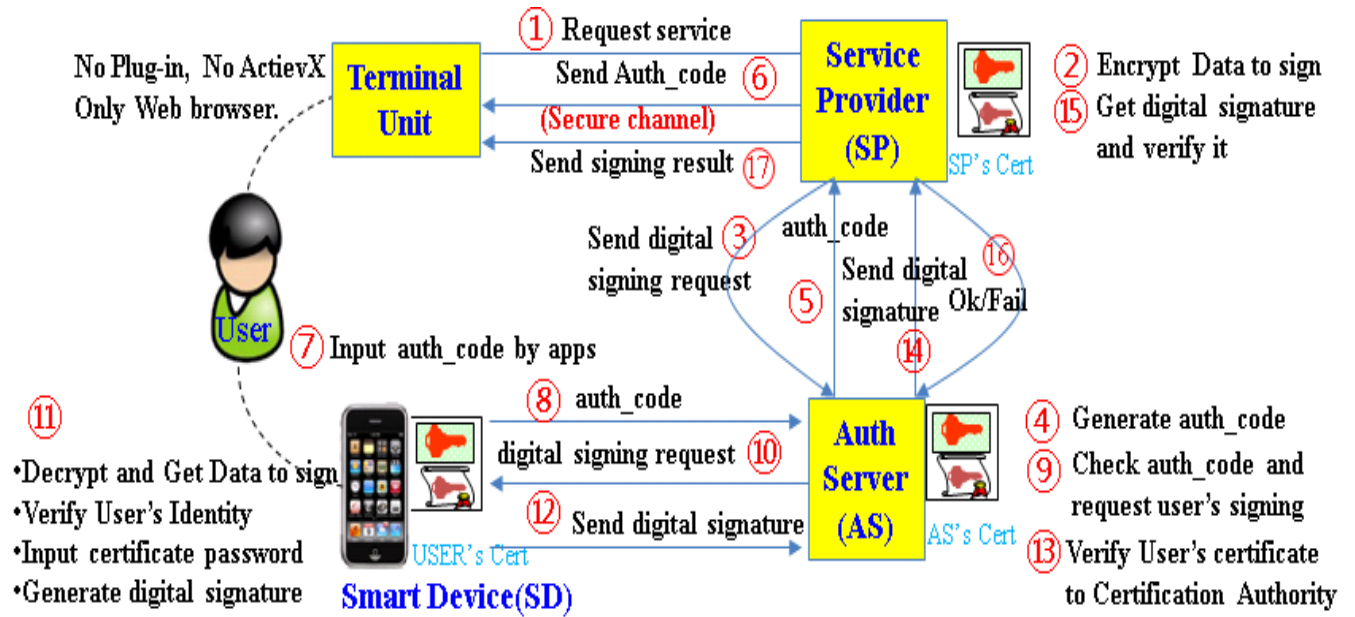


**Figure 10: Two step verification service for iCloud**

This work explains on how network coordinate prototypes can be used to verify the location of virtual cloud resources and detect geographical node movements, by being able to identify possible policy violations.

### **User authentication for mobile devices**

The current user authentication model as below is a model which enables user mobile devices to perform user authentication by using user certificate stored in the smart devices. This model does not need to install additional software such as plug-in or ActiveX in order to perform user authentication. It simply requires web browser such as Internet Explorer, Opera, Safari, Firefox, Chrome etc. Furthermore, this model is designed not to reveal the sensitive data such as digital signature information to Auth Server through end-to-end encryption which ensures its secure delivery between service provider and smart device as shown in the figure 2.3 below.

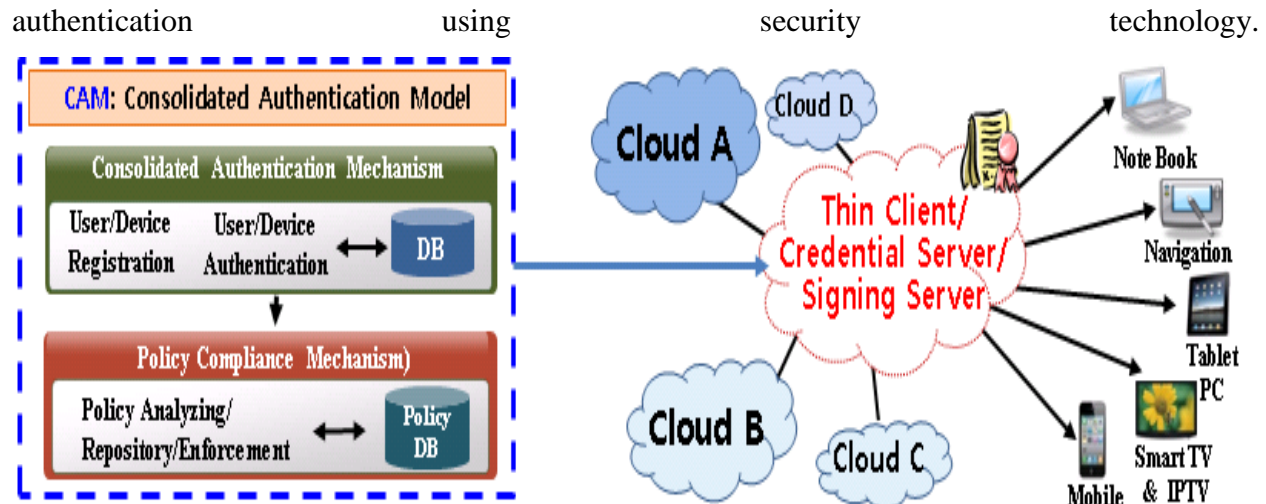


**Figure 11: user authentication model**

In this user authentication model, credentials are stored in a specific smart device to generate a digital signature. However, since cloud computing environments should support a variety of devices, a more efficient and secure user authentication model is required. In addition to that, tight security prototype needs to be equipped in dealing with the life cycle of personal information which ranges from collection, storage, use, transfer to disposal.

### Consolidated Authentication Model (CAM)

The CAM consists of consolidated authentication mechanism and policy compliance mechanism. The consolidated authentication mechanism is guaranteed to the use's consolidated



**Figure 12 CAM Architecture model ( Jaejung Kim\* and Seng-phil Hong et al., 2012)**

### Explanation

Client, Credential Server, Signing Server in framework perform the following roles. A Client uploads or downloads credentials from Credential Server through a variety of devices such as PC, smart pad, and smart phone and generates the digital signature from Signing Server. The Credential Server (CS) downloads secure credentials and uploads them from the client. The Credential Store is the repository for secured credentials. The Signing Server (SS) creates a digital signature by the Client's request. Credentials are information that can be used to establish the identity of an entity, or help that entity communicate securely. Credentials include such things as private keys.

### 2.3.3 Public Key Infrastructure in cloud computing

PKI is enabling computer to computer communications in The Cloud because it offers a cryptographically strong method of authentication which can be tied to the secure transport mechanism. There are several services that PKI is expected to provide to ensure its effective implementation. What makes PKI valuable for cloud computing is that it allows the use of digital signatures and encryption in multiple applications. At the same time, transparency is the most significant constraint on a public-key infrastructure which establishes that the cloud computing

can be used optimally only when the users are not required to understand how the keys and services are being managed by the PKI. A handful of areas that comes under the jurisdiction of PKI for providing the desired services of certificate and public key management are outlined below:

- Issuance of key certificates;
- Repository of certificates;
- Revocation of certificates;
- Support for backup and recovery;
- Assurance of non-repudiation of digital certificates;
- Automatic update of certificates and keys;
- Cross-certification service.

**3.0 Introduction**

This chapter shows how the research methods used is carrying out our research in line with the research questions. The aim is find out the appropriate design for verification, and establish what methods employers, recruiters and organizations use during verification of certificates.

The information obtained from the interview was used to influence in the development of the prototype for certificate verification. After interacting with the system and seeing how fast and easy it is to verify certificates most of user were willing and desiring to have such a system implemented.

The core of the study was aimed at gathering information from relevant institutions that that need to screen certificates.

**3.1 Target Population**

Target population is asset of elements that researcher focuses on (Orodho and Okombo), (2002).

The target population for this study was learning institution, organization, and recruiting agencies in the entire country. The data was collected in Nairobi region for the purposes of ease access and cost of the researcher. This formed a representative sample for the entire country. We used a stratified random sampling technique in selecting respondents from the population.

**3.2 Sampling Design**

A sample is part of large population(Orodho 2009).Sampling is a process of selecting a sub-set of cases in order to draw conclusions about the entire sets(Okombo and Tromp,2006).During the research, the study adopted was the stratified sampling technique since it was targeting specific groups of respondents. According to C.R Kothari, 2004, if a population from which a sample is to be drawn does not constitute a homogeneous group, stratified sampling technique is generally applied in order to obtain a representative sample.

### **3.3 Research Instruments for Data Collection**

This study employed primary method to collect data. Primary data are those collected for the first afresh and for the first time and thus happen to be original in character. For primary we used interviews, questionnaires.

#### **3.3.1 Questionnaires**

This study employed semi structured questionnaires for data collection. According to C.R. Kothari a questionnaire consists of a number of questions printed or typed in a define order on a form or set of forms.

The questionnaires developed as shown in Appendix I was dispensed to personnel in Recruiting agencies, Ministry of Education, Vetting organizations. The questionnaire touched on various methods of verifications and challenges involved in verifications. The respondent was given questionnaires which comprised of open and closed ended questions. These included Agree. Strongly Agree and Disagree.

#### **3.3.2 Personal interview**

While questionnaire were distributed to organization mentioned, personal interview were conducted in Examination and certificate issuing office. At Technical University of Kenya Senor Person in Certificate ate issuing was interviewed, Quality survey officer at Ministry of Education.Commandatant School of Signal and Director National Military Command Centre. This methodology assisted in obtaining further information on how verification is carried out and the problem experienced.

### **3.4 Data analysis Methods**

All the data collected needed to be analyzed as so as to be of relevant value. Editing, classification and analysis using graphs and charts was used. The collected data was saved as an excel document. It was then edited and classified accordingly so as to ensure significance and validity of the project conclusion.



### **3.5 Agile Methodology**

The methodology employed was Agile Methodology approach. Agile methodology is a software development process framework that adopts the iterative approach, open collaboration, and process adaptability throughout the life-cycle of the project. This iterative agile approach is more flexible and its short time-span iterations seek improvement for the project in small release, with minimal planning, rather than plan at length. This helps to minimize the overall risk, and allows the project to adapt to changes more quickly. There is also an emphasis on stakeholder involvement. Meaning at the end of each iteration, the stakeholder is consulted about the product and comments are noted.

Some benefits of iterative method are:

1. Early release, better stakeholders' feedback.
2. Review the project priorities and make changes to the requirements, functionalities, estimations, plans, and resources, as required.
3. Improves stakeholders' confidence and reduce uncertainties.
4. Useful to clarify requirements when there are uncertain scopes or changing requirements.
5. Constant feedback reduces the project risk.

The Manifesto of Agile Software Development follows:

1. Individual and interactions Over processes and tools
2. Working software Over comprehensive documentation
3. Customer collaboration Over contract negotiation
4. Responding to change Over following a plan

### **3.6 Reasons for using Agile Methodology**

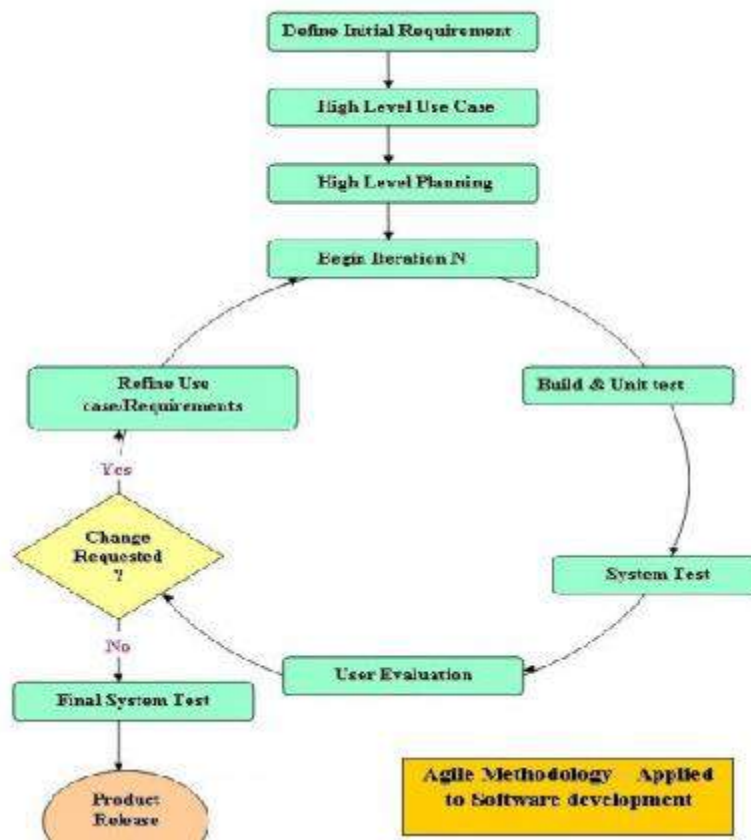
Agile development methodology attempts to provide many opportunities to assess the direction of a project throughout the development lifecycle. This is achieved through regular cadences of work, known as sprints or iterations, at the end of which teams must present a shippable increment of work. Thus by focusing on the repetition of abbreviated work cycles as well as the

functional product they yield, agile methodology could be described as "iterative" and "incremental." In waterfall, development teams only have one chance to get each aspect of a project right. In an agile paradigm, every aspect of development - requirements, design, etc. - is continually revisited throughout the lifecycle. When a team stops and re-evaluates the direction of a project every two weeks, there's always time to steer it in another direction.

The results of this "inspect-and-adapt" approach to development greatly reduce both development costs and time to market. Because teams can gather requirements at the same time they're gathering requirements, the phenomenon known as "analysis paralysis" can't really impede a team from making progress. And because a team's work cycle is limited to two weeks, it gives stakeholders recurring opportunities to calibrate releases for success in the real world. In essence, it could be said that the agile development methodology helps companies build the right product. Instead of committing to market a piece of software that hasn't even been written yet, agile empowers teams to optimize their release as it's developed, to be as competitive as possible in the marketplace. In the end, a development agile methodology that preserves a product's critical market relevance and ensures a team's work doesn't wind up on a shelf, never released, is an attractive option for stakeholders and developers alike.

The prototype will be developed using Unified Process modeling of Prototype Analysis and Design. The methodology is suited for development of the prototype due to its iterative and incremental approach. This methodology is suitable because it allows concurrent development of different modules.

.



**Figure 13: Agile Life Cycle for development process**

### 3.7 Ways the Cloud Enhances Agile Software Development

Cloud computing and virtualization let you create virtual machines and use of cloud-based services for project management, issue management and software builds with automated testing.

This, in turn, encourages agile development. An example is The Commonwealth Bank and Salesforce.com R&D are two examples of how agile software development teams are using cloud computing to accelerate development operations and achieve efficiency and effectiveness. Cloud computing and virtualization make it easy for agile development teams to seamlessly combine multiple development, test and production environments with other cloud services.

### 3.8 Verification process

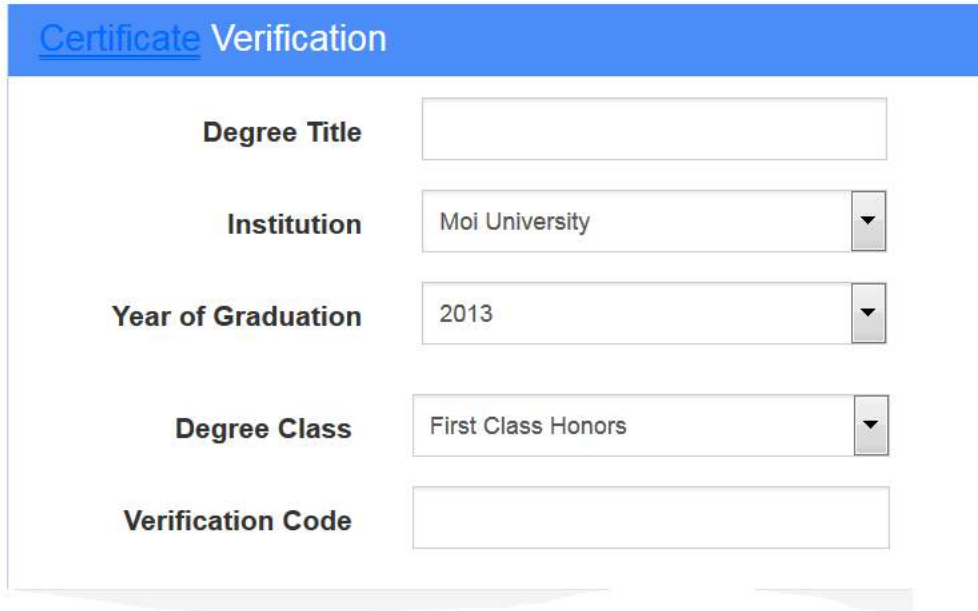
The certificate validation will require number of items pertaining the certificates in order to ensure the authenticity and validity. Unique numbers are used for identifying the owner's certificates. Form validation rules will be set to authenticate the data entered in the requesting form.

#### 3.9 How do you validate the certificate?

The validation is done by generating a unique code. The following are the parameters used for validation:

- 1) Degree Title
- 2) Name of institution
- 3) Year of Graduation
- 4) Degree Class
- 5) Verification code

The screen shot below illustrate the parameters required for verification.



The screenshot shows a web form titled "Certificate Verification" with a blue header. The form contains five input fields, each with a label to its left: "Degree Title" (a text box), "Institution" (a dropdown menu showing "Moi University"), "Year of Graduation" (a dropdown menu showing "2013"), "Degree Class" (a dropdown menu showing "First Class Honors"), and "Verification Code" (a text box).

#### Verification code

The unique code is generated when the certificate owner make request for it. Each certificate is provided with a unique verification code.

## **CHAPTER FOUR ANALYSIS, DESIGN AND IMPLEMENTATION**

### **4.1 ANALYSIS**

The analysis involves gathering considerable amount of information. System analyst obtains information from people who will use the system, either by interviewing them or by watching they work.

### **4.2 Functional Requirements**

These are the specific statements that prototype should provide and how it should react to particular inputs.

#### **1. The users**

Users shall be able to login

Users shall be able to sign up, create their account, login with their own username, request verification and receive the feedback.

#### **2. Administrator**

Administrator shall be able to login and manage the user's account and their privileges

#### **3. Institutions.**

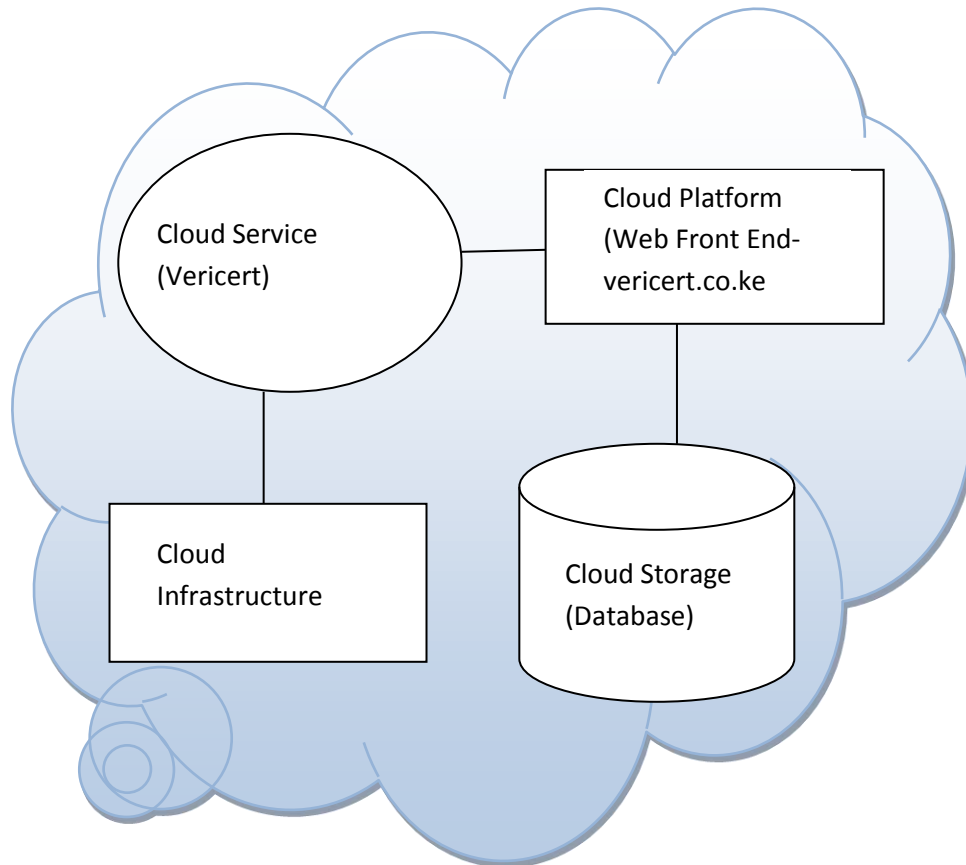
The system shall be able to login, register Institution, manage their institutions, add students, and upload the student's certificates and photos. The system shall allow institution to make request for verification and get reply.

### **4.3 Non-Functional Requirements**

1. The system shall be able search the database for academic certificates and give feedback.
2. The system shall provide appropriate viewers for the user to make request for verification.

#### 4.4 Architectural Design of the prototype

Cloud architecture, these prototypes architecture of the software prototypes involved in delivery of cloud computing, typically involves cloud components communicating with each other over a loose coupling mechanism such as messaging[11].



**Figure 14: Architectural Design in cloud**

#### **4.4.1 The role of each Components**

The following paragraph explains in details the role and functions of the Architectural Design in cloud shown in figure 15.

##### **Cloud Platforms**

Cloud platform services, also known as platform as a service (PaaS), deliver a computing platform as a service. It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layer. Cloud computing is becoming a major change in industry and one of the important is the shift to cloud platforms. Platforms let developers write applications that can run in the cloud or even use services provided by the cloud. In this study the platform will be provided to the users on internet. User can use the prototype without understanding the underlying technology.

##### **Cloud Storage Server**

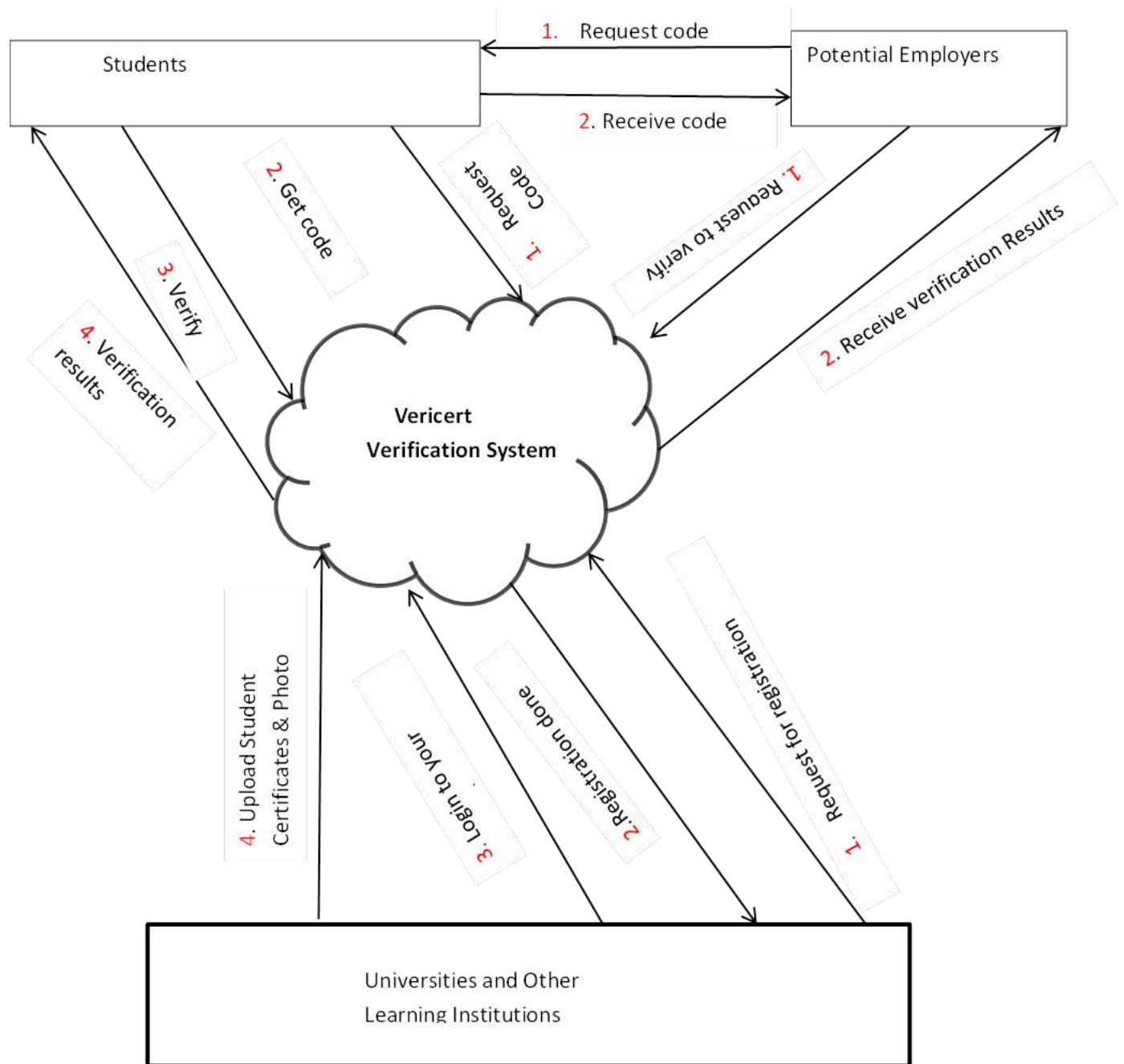
The servers' layer consists of computer hardware and/or computer software products that are specifically designed for delivery of cloud services, including multi-core processors, cloud-specific operating prototypes.

##### **Cloud infrastructure**

Cloud infrastructure services, also known as "infrastructure as service" (IaaS), deliver computer infrastructure, typically a platform virtualization environment as service, along with raw (block) storage and networking. Rather than purchasing servers, software, data resources as fully outsourced services. The cloud infrastructure proposed in this study will be private and public.

##### **Cloud Services**

Cloud application services or software as a service (SaaS) deliver a service over internet, eliminating the need to install and run application on the customer's own computers and simplifying maintenance and support. In this study the certificate verification will be provided.



**Figure 16: Conceptual High Level Model for the proposed prototype**

### Role of Each Component

The following explains the role and interactions of each component as shown in the conceptual High Level Model in figure 16.



- **VeriCert Verification system**

The Vericert Verification system is an application for academic certificate verification. It is hosted in cloud computing environment as SAAS. The service is available for:

- Employers
- Consultancies
- Institutions (Colleges, Universities) and
- Other similar organizations
- Recruiting agencies
- **Universities and other Learning institutions**

These are certificate issuing institution which issues academic certificates. They must first register with the owners of the system in order to get an account. After getting the account, they will now be able to register their institutions, add student's records and upload the students' photos. Only authorized persons from the registered institutions are allowed manage their institutions and upload student's records.

- **Potential Employers**

These are people or recruiting agencies that wishes to employ the certificate owner's .Their interaction with the system involves the following.

- i. The must get verifications code from the certificate owners
- ii. Make request for verification by entering registration number, name of institution, year of Graduation, degree class and verification code.

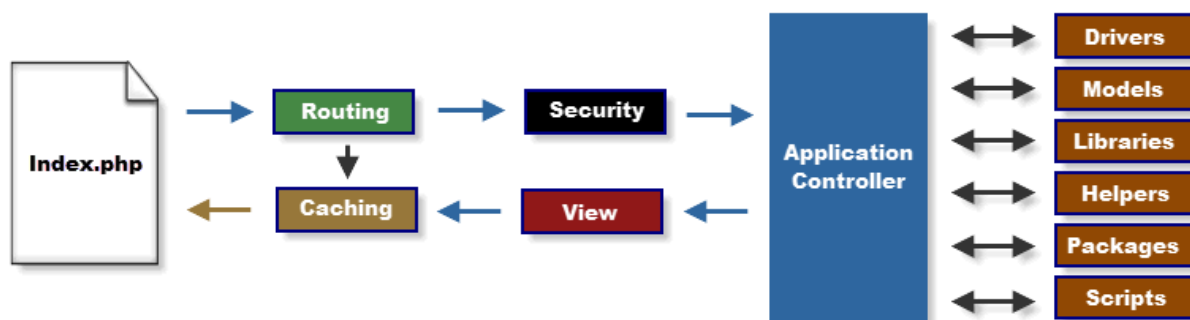
**Certificate owners ( Students).**

These are the owners of certificates who wish to verify them. The owner of certificate must first make request for code. The code is generated by the system upon request. The interaction with system involves

- i. Certificate owner makes request for the code to the system by entering registration number, name of institution, year of Graduation, degree class and certificate serial number.
- ii. The system reply by displaying the verification code which is valid for six month.
- iii. The certificate owner now uses the verification code for verification.

#### 4.5 Design Framework for Codeigniter

The VerifyCert system will be made up of a client side interface for the users. The resulting prototype will be based on the PHP Codeigniter framework that uses MVC (model-controller-view). It uses PHP programming language. The MVC Codeigniter application chart showing how data flows is illustrated below:-



**Figure 15: application MVC flow chart**

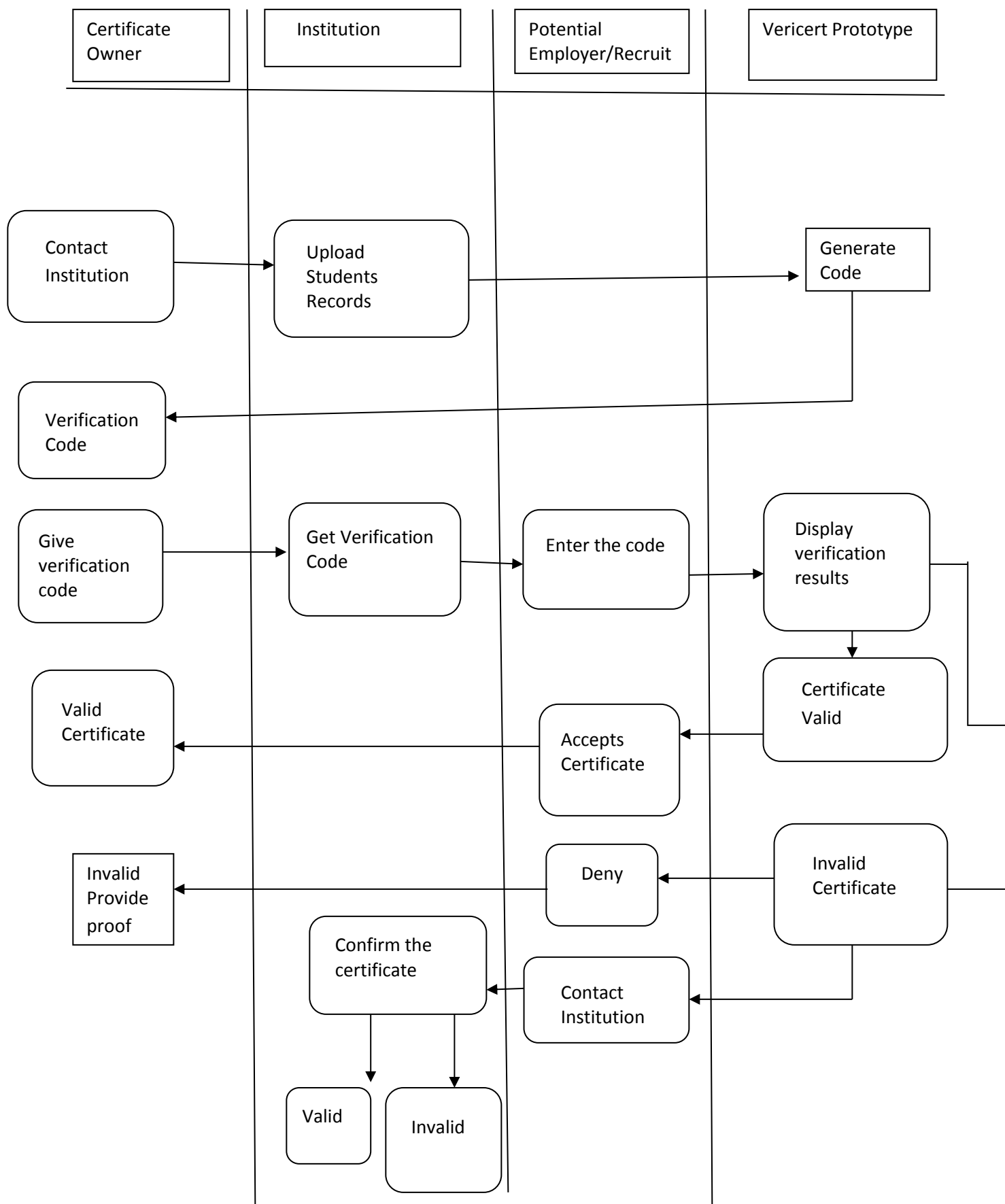


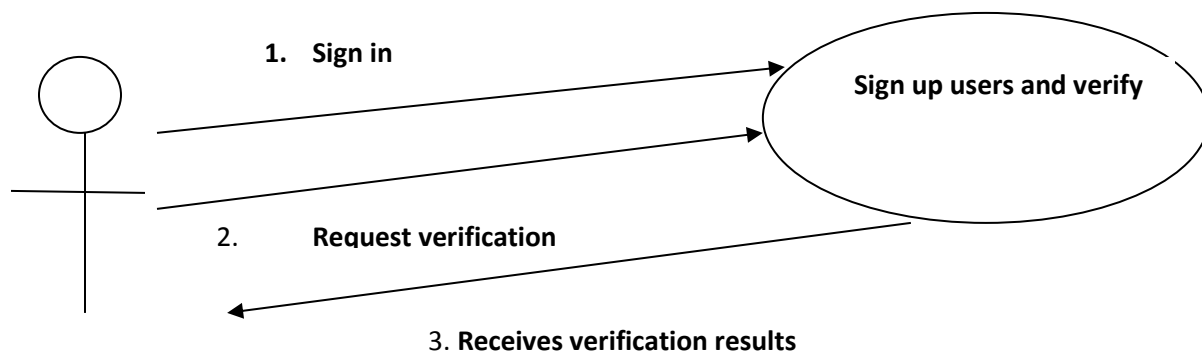
Fig17 Sequence interaction diagram

### Use case Scenarios

A case is a view of the functionality (or use) of a prototype from user's perspective .The use case scenarios mostly represents a particular instance of the prototype.

#### Use case 1

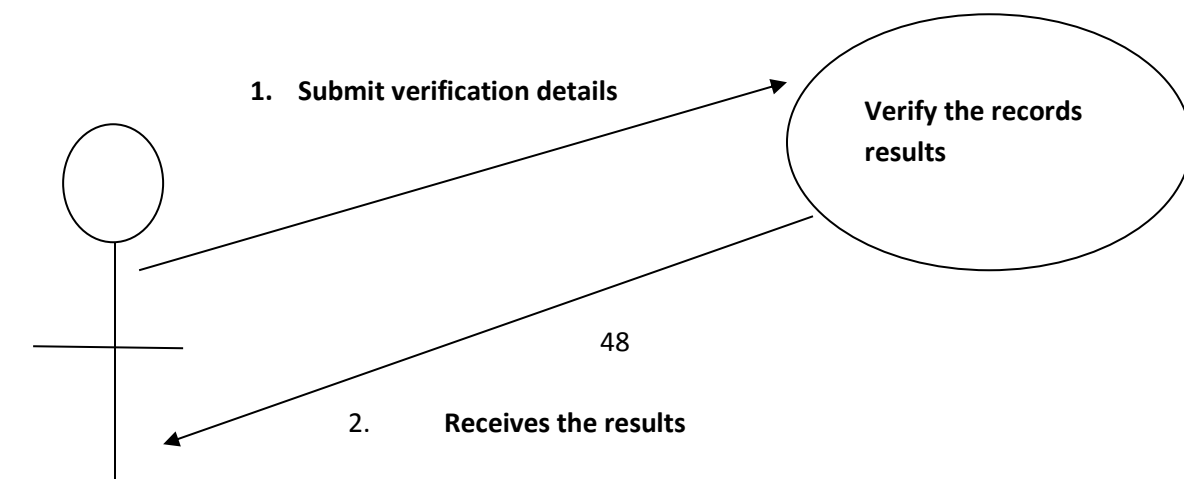
The user sign in the prototype and proceeds with verification. The user can either be students, recruiters, institution, and any other organization. When the users log in to the prototype they proceed to make request for verification.

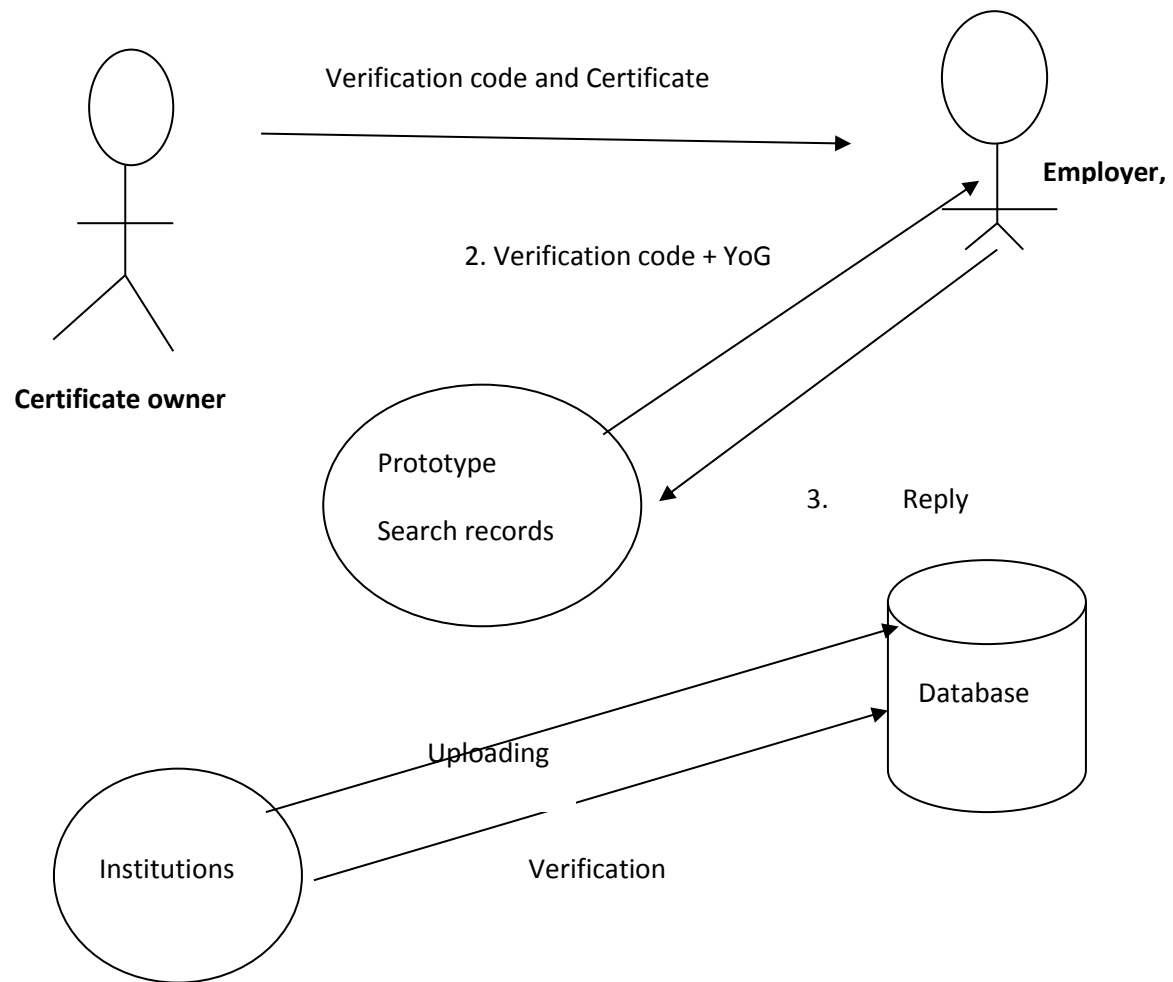


### Users signing and verifying

#### Use case 2

The entities who wish to make request for verification must submit to the prototype the name of Institution. Year of Graduation, verification code and course program.





**Figure 16: Activity Diagrams showing interaction for students, employer and prototype.**

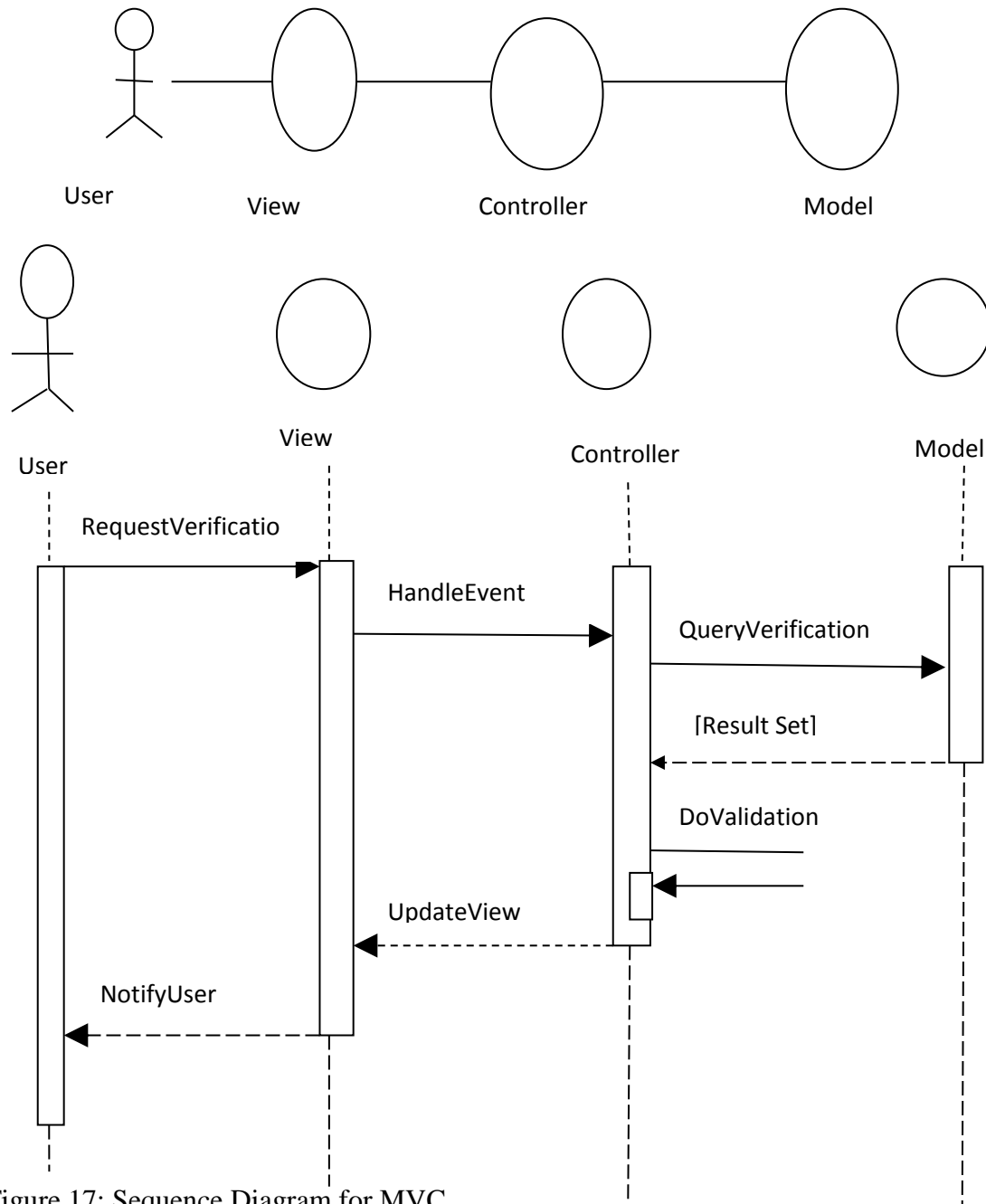


Figure 17: Sequence Diagram for MVC

User initiate a query requesting for verification and event is generated that is handles by the controller set information that is needed from the model, validates the information and passes back the results set to the view.

## 4.6 Database Design

The database that will be implemented in this study is based on relational database approach.

Data conceptual schema

The data required for the development of the vericert is illustrated below.

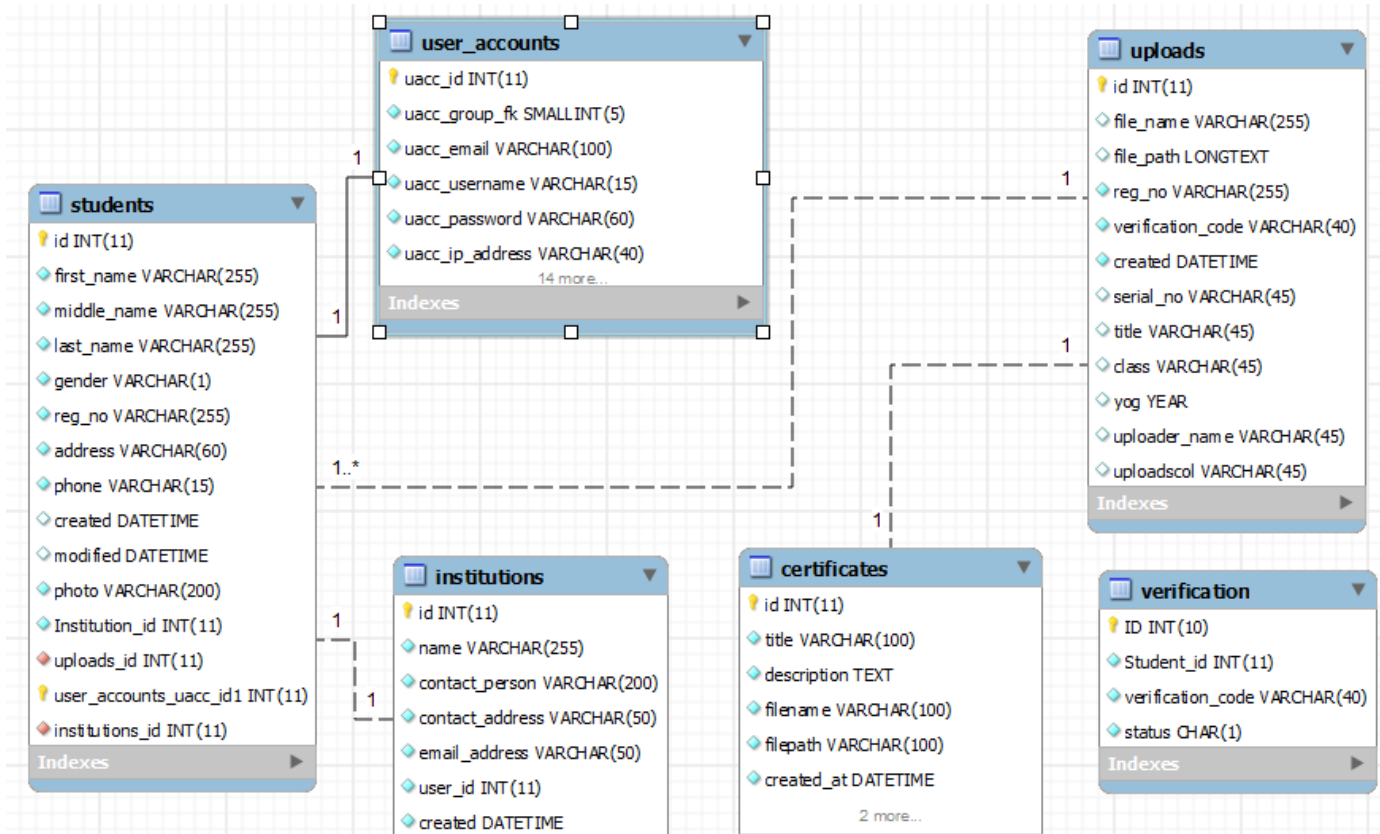
Table and Column set up

Table Name	Table fields	Data Type	Description
Students	Id	Int	Table primary Key
	First_Name	varchar(255)	User's First name
	Middle_Name	varchar(255)	User's middle name
	Last_Name	varchar(255)	User's last Name
	Gender	varchar(1)	Gender Type
	Reg_no	varchar(255)	Student's reg_no
	Address	varchar(255)	Student address
	Phone	varchar(255)	Student's phone
	Created	date time	
	Modified	date time	Dates student
	Photo	varchar(255)	information entered
	Institution_id	int(11)	Photo for the student
			Uniquely identifies institutions
Uploads	Id	Int	Table primary key
	First_Name	varchar(255)	First name
	File_name	varchar(255)	File name
	Reg_no		Student's reg no
	Verification_code	varchar(255)	Code for verification

	Created Serial no title Degree Class Year Of Graduation	varchar(40) date time varchar(255) varchar(255) varchar(255) year(4)	Time entered No for certificate Name of certificate E.g. First class, upper Year student graduated
User accounts	Uacc-id _pk Uacc_group- fk Uacc_username Uacc_password	Int varchar(15) varchar(15) varchar(15)	Table primary key The foreign he users login username The users login password
User_priviledges	Upriv-id Upriv_name Upri description	Int varchar(15) varchar(15)	Primary key User privileges What users can do
Institutions	Id Name phone Contact_address Email_addres	Int varchar(255) varchar(255) varchar(255) varchar(255)	Primary key Name of institution Person to contact contacts of institution email of institution

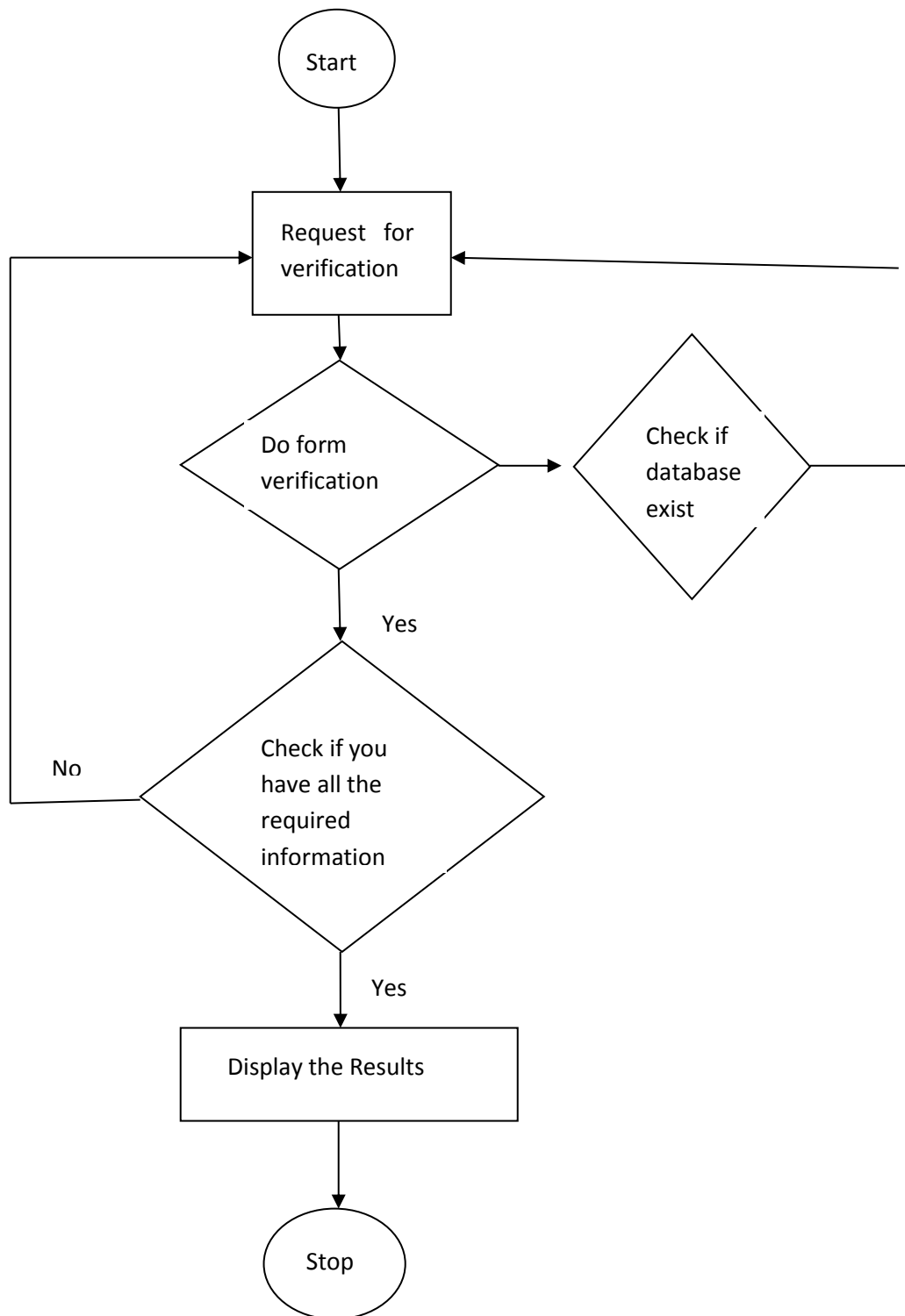


**Table 2: Database schema**



**Figure 18: Entity Relationship Diagram**

#### 4.7 Process flow diagram



**Figure 19: Process Flow diagram**

#### **4.8           Prototype Implementation**

The prototype is implemented using CodeIgniter Framework and PHP.

The prototype is developed using Codeigniter Framework and PHP.MySQL workbench creating Edit Relationship Diagrams and phpMyAdmin for database design using XAMMP server.

#### **4.9     Resource Needed**

Relational Database Management Prototypes (MySQL Database)

CodeIgniter Framework environment

Any Apache/PHP/MySQL

Laptop

Linux operating systems

Virtual machine

Xen hypervisor

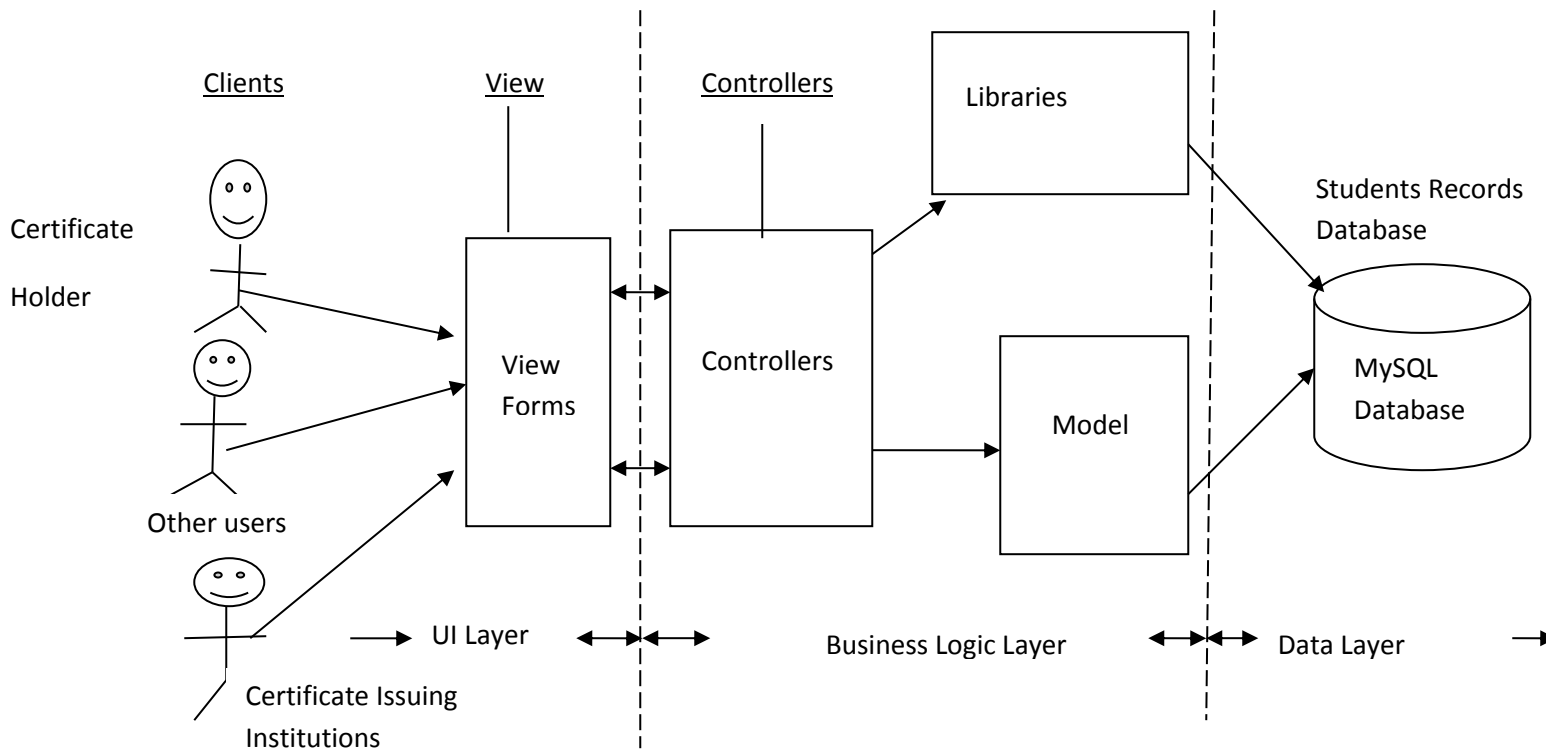
#### **4.10   Setting up the Environment**

In order to develop a PHP application in the cloud, the developer has to create an environment that will help in achieving this task. Setting Cloud Computing environment involve using a hypervisor to create quest operating system. The XenServer is used as a platform for virtualization. The application is installed in a virtual machine. The screen shot below show.

## 4.11 Modules in prototype

### Model-View-Controller

CodeIgniter is based on the Model-View-Controller development pattern. MVC is a software approach that separates application logic from presentation.

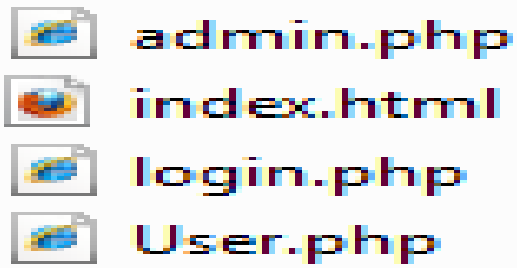


**Figure 20: Modified Conceptual Framework Using Codeigniter**

The components are briefly described below:-

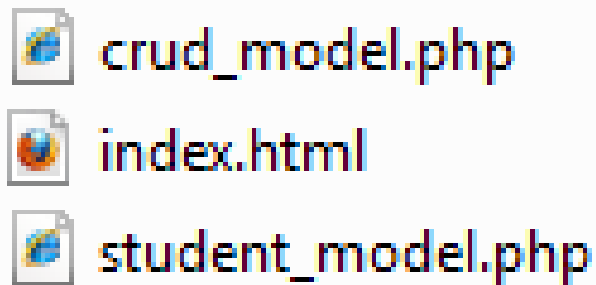
### Controller

The **Controller** serves as an intermediary between the Model and the View. In this design the controller `user.php`, `login.php` and `admin.php` is implemented.

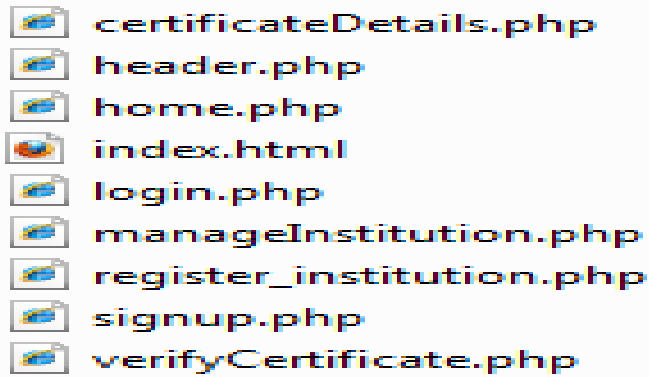


The **Model** represents your data structures. Typically your model classes will contain functions that help you retrieve, insert, and update information in your database.

The design model used are Student\_model.php



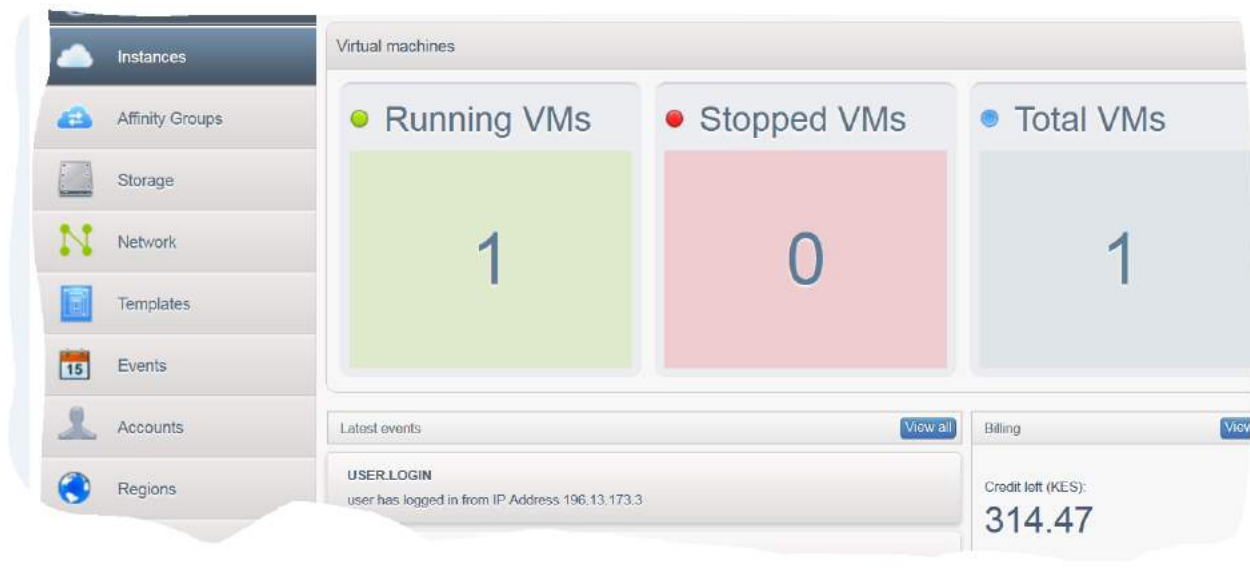
The **View** shows the information that is being presented to a user. In this design we have



#### 4.12 Process of implementing the private cloud

The process of implantations of cloud for this project involves the following

1. Setting up a cloud computing Environment
2. Setting up a virtual machine and selecting the datacenter that forms a cloud.
3. Creating an instance in this case the instance is called vericert
4. Creating an Template or ISO image containing bootable model for operating system.
5. Install the Ubuntu 12.04 (64bit)



**Figure 21: The Angani Cloud Datacenter Dashboard**

#### 4.14 Test Process

The main objective of the prototype is to be able to verify the student's records which have been uploaded to the database as true, valid and correct. Several students' records were uploaded to the database.

- The institutions uploads students records
- The unique verification code is generated
- The users make request to verify using the verification code
- Enter the year of graduation.

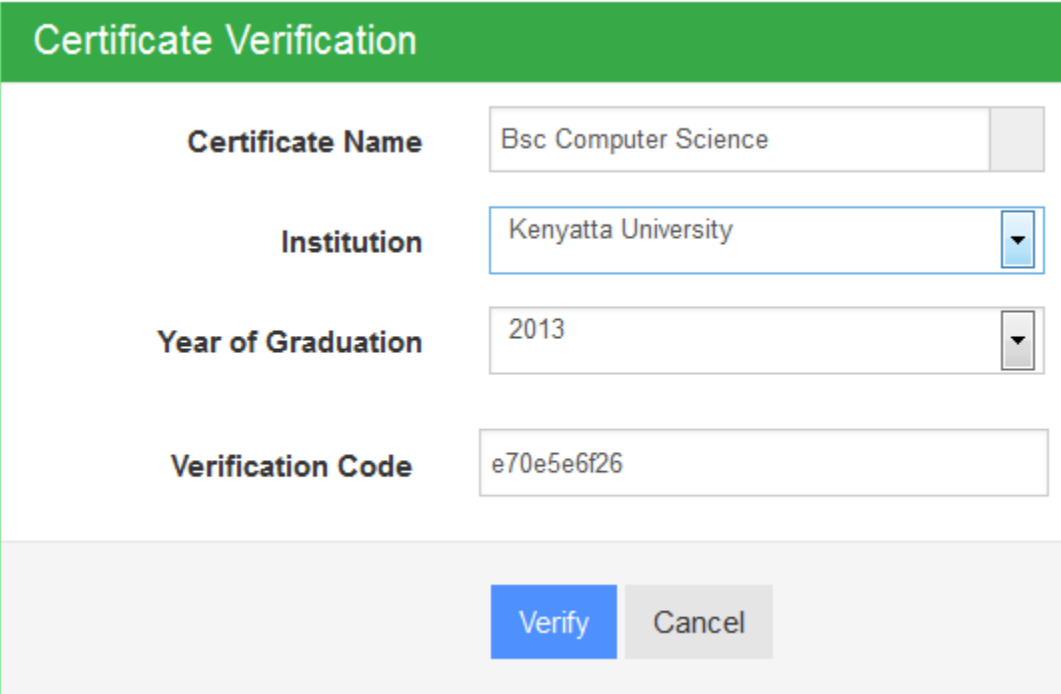
The following parameters were used to carry out the test:-

Student Name: Nicholas Manikin Muse

Verification code: **e70e5e6f26**

Year of graduation **2013**

In each of the institutions people were selected randomly to enter the record as student. The verification code was generated and used to test the verification.



The screenshot shows a web form titled "Certificate Verification" with a green header. The form contains four input fields: "Certificate Name" with the value "Bsc Computer Science", "Institution" with a dropdown menu showing "Kenyatta University", "Year of Graduation" with a dropdown menu showing "2013", and "Verification Code" with the value "e70e5e6f26". At the bottom of the form, there are two buttons: "Verify" (blue) and "Cancel" (grey).

Certificate Verification	
Certificate Name	Bsc Computer Science
Institution	Kenyatta University
Year of Graduation	2013
Verification Code	e70e5e6f26
<div>Verify Cancel</div>	

## Screen Shows verification Tests results

Certificate verification successful. Owner is Nicholas Mwaniki Musee.



Nicholas  
Mwaniki Musee

### Certificate Details

[View Certificate](#)

Owner	Nicholas Mwaniki Musee
Institution	JKUAT
Serial No.	KB 1845
Registration No.	MAC_2008
Programme	Bsc Computer Information Systems
Class	Second Class Upper Division
Gender	Male
Year of Graduation	2010



**5.0 Introduction**

The implemented VeriCert system was evaluated to ascertain that it met the proposed objectives.

The objectives include:-

1. Research on the various clouding computing platforms and models
2. Review the documents for verification in current systems
3. Develop a prototype for academic certificate verification and host it on cloud computing environment.

The purpose of system evaluation was to get user view on the system functionalities, perception on the usability and the attitude towards the adoption of cloud computing.

- The following parameters were evaluated:-
- Usability,
- Satisfaction,
- Ease of learning
- Speed
- Accuracy
- Convenient
- perception

On the other hand the project also sought to develop a prototype based in cloud computing environment and the research was required on the various cloud computing platforms and models.

The system evaluation was conducted with potential users selected who included learning institutions, recruiting agencies.

The information required during evaluation was get user acceptance of the system and how they perceive it in solving the problems experienced in academic certification verification.

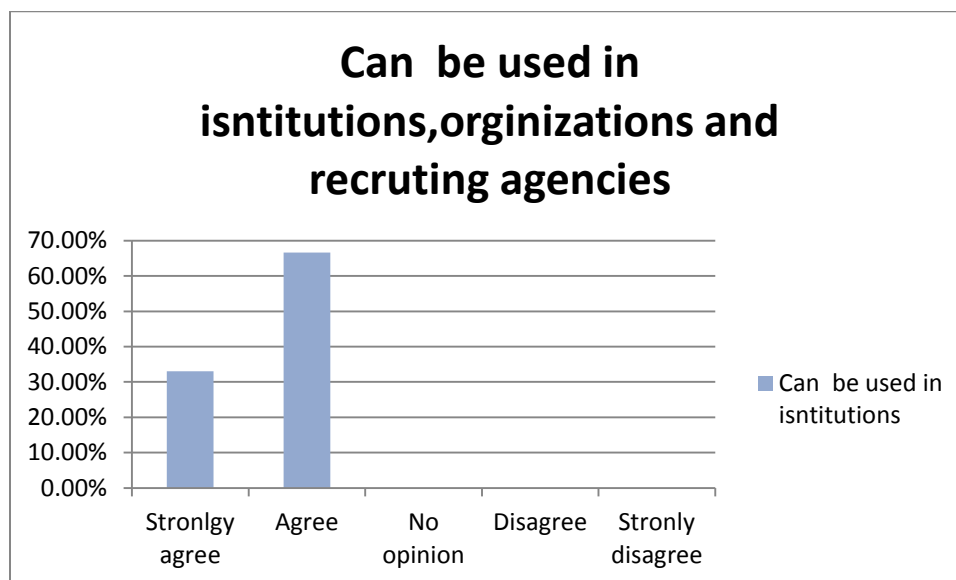
During evaluation, the questionnaires were used to collect data for the user's attitude towards a usability of the prototype. The participants were required to rate their agreement with statements' ranging from strongly agree to strongly disagree. Most of the evaluating groups recommended the system to be implemented in learning institutions and recruiting agencies.

Microsoft Excel was used to capture and analyze the final results using bar graphs.

67% had positive intentions of using the prototype, agreed to recommend the prototype to be used in learning institutions, organizations and recruiting agencies with 33% strongly agreeing.

The outcomes presented below are a summary of questionnaires responses (attached in the appendix) from users who participated in the testing of the prototype

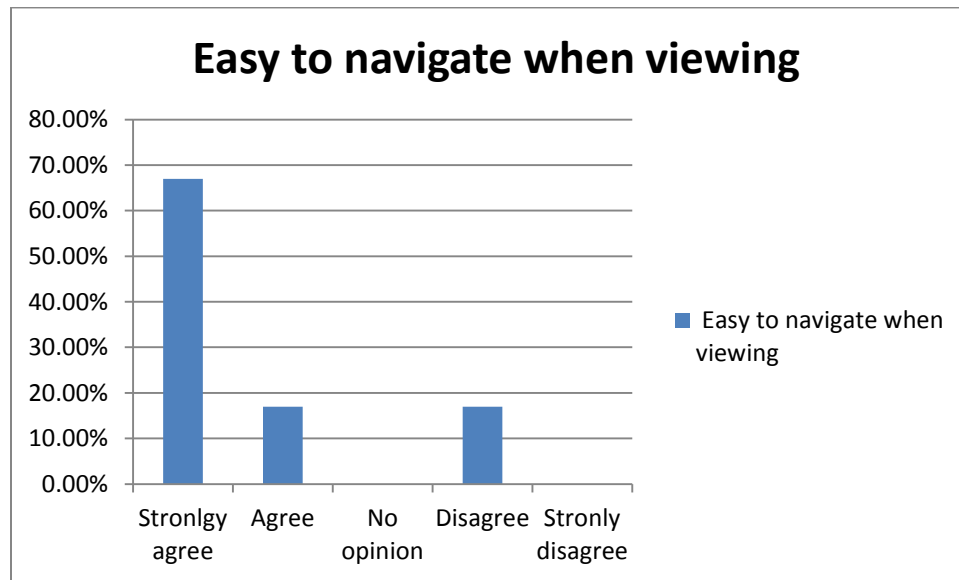
## 5.1 Results



### Graph 1 Satisfaction Results

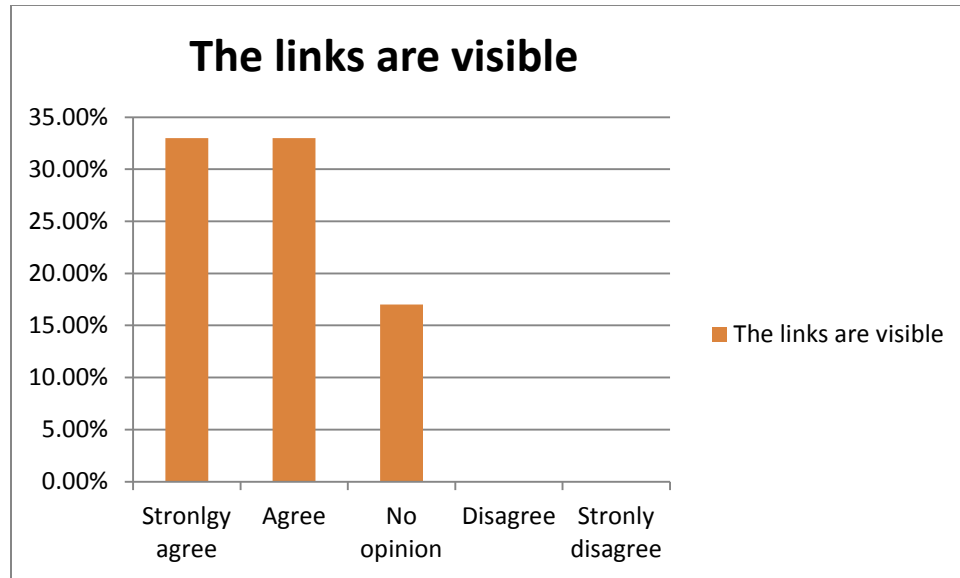
67% strongly agreed that the prototype was easy to navigate when viewing.

18% disagreed that the prototype was not easy to navigate.



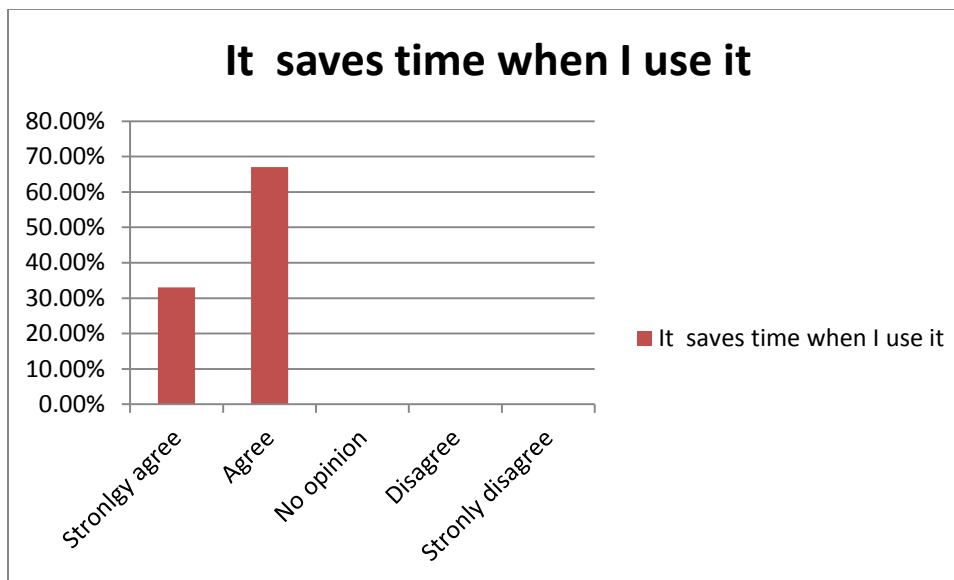
### Graph 2 Navigation

33% strongly agreed and 33% agreed that links were visible with 16% having no opinion.



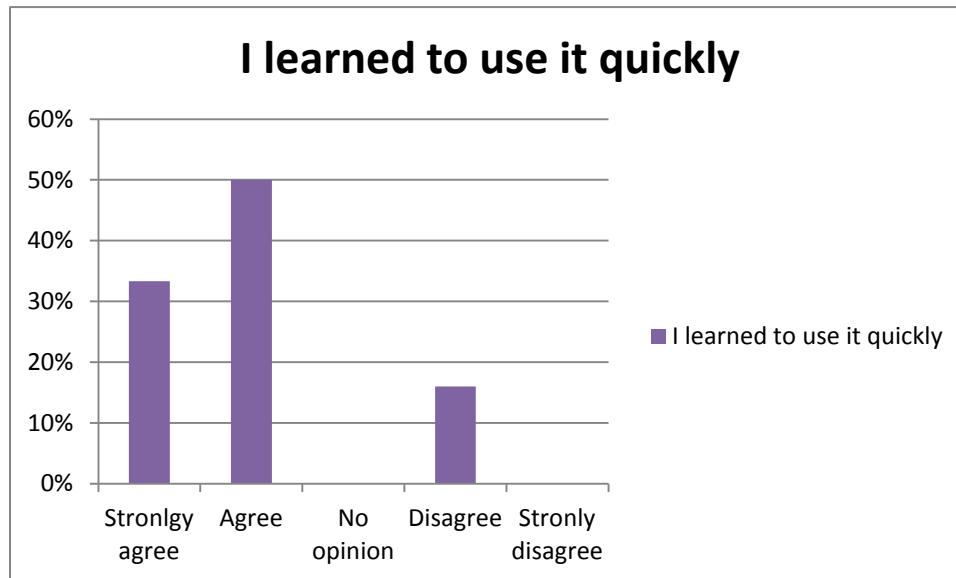
Graph 3 Link Visibility

68% agreed that the prototype saves time in doing their work. Agreed that they were able to accomplish activities more quickly than before.



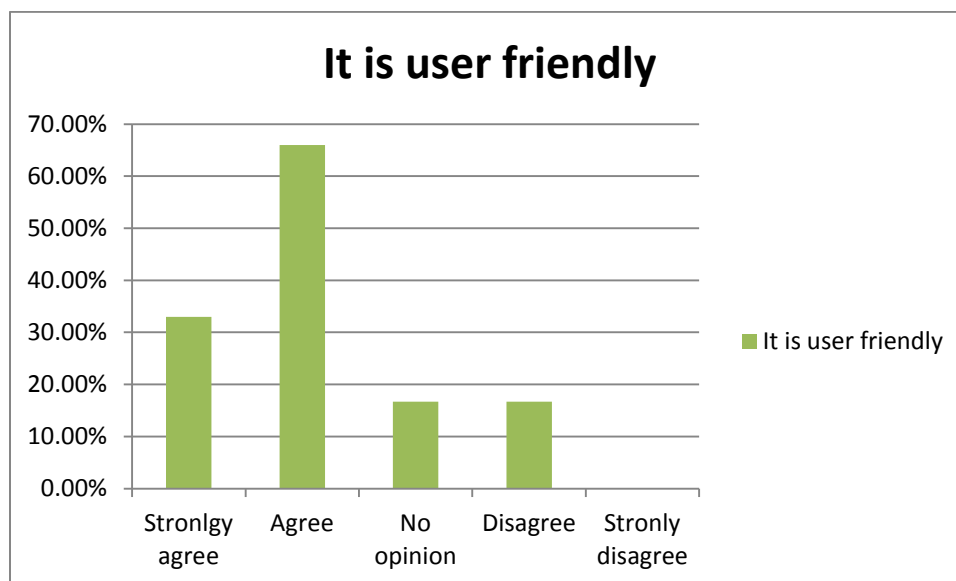
Graph 5 Usefulness

50% indicated that it was easy to learn the prototype while 17% indicated that it was not easy to learn and needed time to be trained.



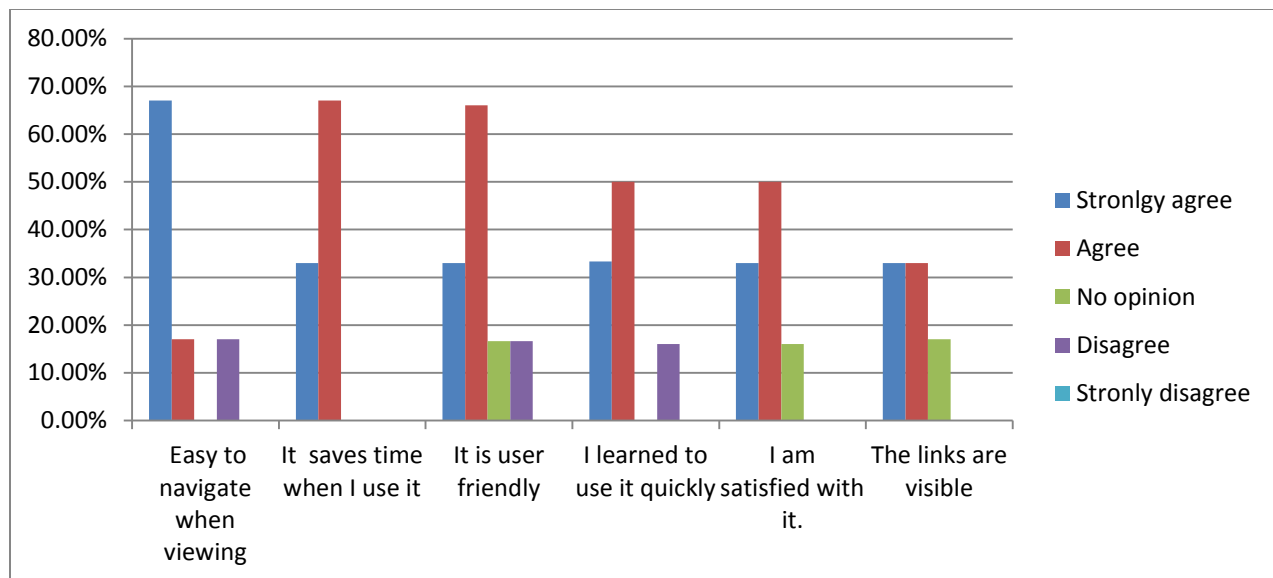
**Graph 6 Ease of learning**

67% agreed that it was user friendly while 10% had no opinion.

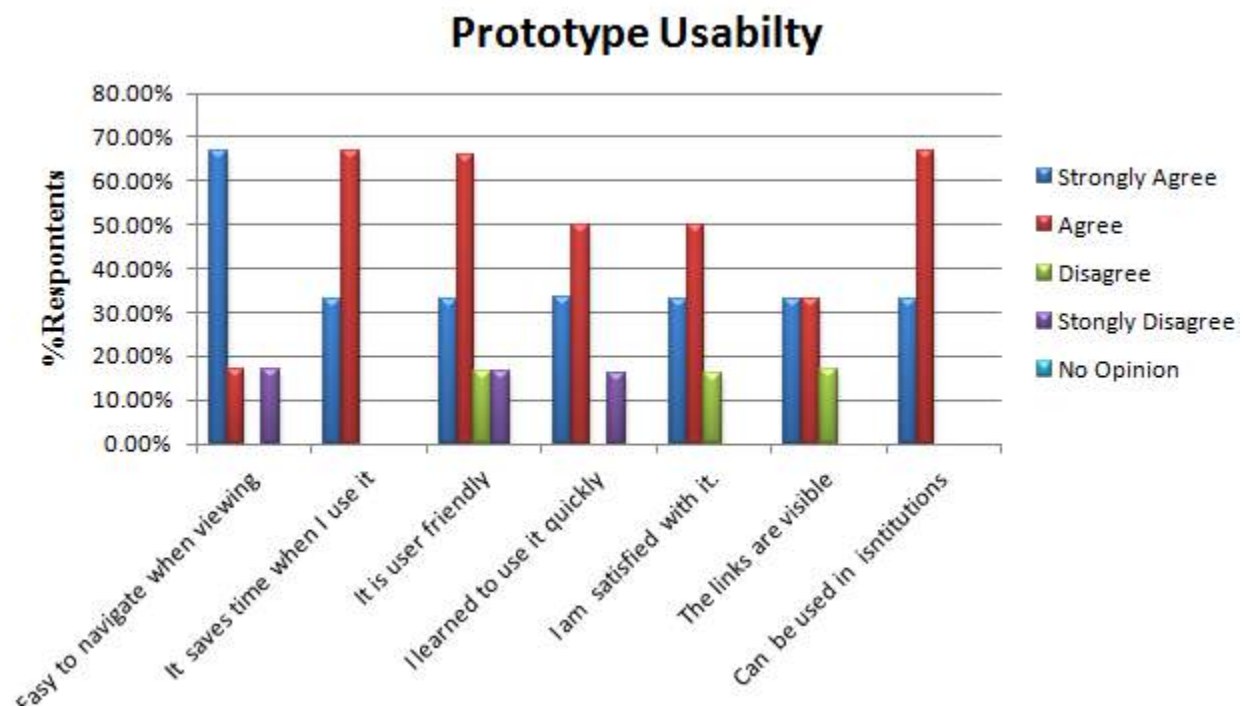


**Graph 7 Ease of Use**

The overall rating graph showing all the respondents.



**Graph 8 Overall Usability measurements**



## **CHAPTER SIX CONCLUSION AND RECOMMENDATIONS**

### **6.0 Introduction**

This research work is an effort towards elimination of fake certificates in learning institutions. As discussed in the introduction chapter of this study, verification of academic certificates is one of the important research areas today. This work contributes towards solving problems in academic fraud. A part of this work focused on the application of the proposed prototype as proof of concept. In our proof of concept the prototype was able to verify the student's academic details as they are in the database which was uploaded by the learning institutions.

### **6.1 Achievements**

The following were achieved as per the objectives set in chapter one

#### **Objective 1**

Research on the use of cloud computing platforms and models

Research of related work on cloud computing was achieved. Several cloud computing models were discussed in literature review.

#### **Objective 2**

Develop a prototype for certificates verification and hosting on cloud environment.

The prototype was developed using the Code igniter PHP framework and hosted in cloud computing environment. Field test was done at various institutions, University of Nairobi, Technical University of Kenya, and School Of signal, National Military Communication Centre and Recruiting agencies.

- We implemented a Vericert prototype as proof of concept. The implemented VeriCert prototype targeted the recruiters, employers as the primary users.
- Advances can be made to adopt cloud computing to provide verifications as a service.

## **6.2 Finding**

According to the evaluation and test carried out it was concluded that this study has shown that verification of academic certification is necessary.

Various institutions of higher learning, organizations were identified .The results suggested that the prototype was helpful in verification of academic certificates. It showed that organizations attitude and perceived usefulness both directly drive the usage intention.

The finding highlighted that institutions, organizations and recruiting agencies have the ability and willing to use this technology.

## **6.3 Challenges and limitations**

Installation of datacenter in a cloud computing environment is quite expensive.

Cloud computing is still a new technology which is not fully adopted in Kenyan market.

## **6.5 Data collection method**

The main challenge was unwillingness of the user to provide information of how they verify their certificates. It was considered as very sensitive and confidential data. After talking at length with the users some agreed and others refused completely.

## **6.6 Recommendation**

Based on experience during the research, we would like to recommend that more research be done in cloud computing and a lot of literature review done for related work.

After successfully implementing and testing the project prototype, in order to realize the intended purpose of the study we recommend the prototype to be adopted by:-

1. Cloud computing providers
2. Higher learning institutions
3. Organizations and recruiting agencies



## **6.7 Future Work**

To enhance this system and to increase the usability of the overall solution in learning institutions and organization the needs certificate verification the following items may be considered for future implementation;

First and foremost as part of continuation for this project, lots of future work is ahead for the full implementation and deployment cloud computing environment as Software as a Service; hence inclusion in the cloud computing would add more value to the research.

Secondly, development for a wider scope should be incorporated into the whole project to ensure that the solution is all rounded.

Lastly the solution should be tailored and security mechanism implemented well so that it will build more trust to the targeted market/users. Security measures to be included are as follows:

1. Public key to be issued to the users of the system
2. Authentication of all devices that will be used to connect to the cloud databases
3. Institutions to be verified before they use the system by certification authority.
4. All the email used to be verified
5. All the device connecting to the cloud must first registered and then authenticated.
6. All the academic certificates to have sealed verification code which when scanned will provide link to the academic database.
7. Authenticate the IP address to ascertain that they are tied up with the institutions hosting the academic database.

## **6.8 Conclusion**

From my research, I can clearly state that cloud computing technology and its' application has been taken with a lot of seriousness globally and I have no doubt that my research has as well contributed positively towards the uptake of this novel technology. It's my hope that when the whole system is developed and implemented the problems of having fake certificate will be greatly reduced.

## 7.0 REFERENCES

1. Borko Furht, Armando(2010). Handbook of Cloud Computing.
2. Dry Ashish Rastogi (2010) *International Journal of Computer Applications* (0975 – 8887) Volume 9– No.7.
3. Deep Mann and Inderveer Chana (2012). Heterogeneous Workload Consolidation for Efficient Management of Data Centers in Cloud Computing. *International Journal of Computer Applications* 50(10):13-17,
4. Foster, I., Zhao, Y., Raicu, I., and Lu, S. (2008). Cloud Computing and Grid Computing 360-Degree Compared in Grid Computing Environments Workshop. 2008. GCE'08. pp. 1-10. N
5. Grumman, G., & Knorr, E. (2008). What Cloud Computing Really Means.
6. Federal Office for Information security”Security Recommendations for cloud computing Providers(Minimum information security requirements)”,White paper, Section 114 Security Management and IT-Grundschutz,p.O Box 20 03 63,53133 Bonn
7. Furht, B., & Escalante, A. (. (2010). Handbook of Cloud Computing.
8. Furht, B., & Escalante, A. (. (2010). Handbook of Cloud Computing. New York: Springer.
9. John Wiley & Sons(2012) *Server Virtualization For Dummies®*, Oracle Special Edition
10. Khmelevsky, Y., & Voytenko, V. (2010). Cloud Computing Infrastructure Prototype for University Education and Research. Proceedings of the 15th Western Canadian Conference on Computing Education. Kelowna, Canada: ACM.
11. Katzan, H. (2010). The Education Value of Cloud Computing. *Contemporary Issues in Education Research*, 3 (2), 37-42. Behrend, T. S., Wiebe, E. N., London, J. E., & Johnson, E. C. (2011). D Morh, Copmutational Yanuarius Department of Electrical Engineering, National Taiwan University of Science and Technology.
12. Mel, P., & Grance, T. (2009). The NIST Definition of Cloud Computing. Retrieved 2 11, 2011,NIST Information Technology Laboratory:
13. Mobile cloud computing Service Based on Heterogeneous Wireless. Ber
14. Ontology and Search Engine for cloud computing Prototype, Proceedings of 2011 International Conference on Prototype Science and Engineering,Macau,China-June 2011

15. P. Thomas Harnessing (2012). Cloud Computing for Teaching and Learning: Strategies for Design and Implementation (pp. 147-158).
16. Par deep Kumar,Vivek Kumar Sehgal,Durg Sigh Chauhan,P.K “Effective Ways of Secure, Private and Trusted cloud Computing Environment” ,International Journal of Computer Science Issues(IJCSI),ISSN(Online) Vol.8 8,Issues 3,No.2,pp. 412-421,May 2011
17. Murley, D. (2009). Law Libraries in the Cloud. *Law Library Journal*, 101:2 (15), 249-254.
18. Rittinghouse, J. W., & Ransomed, J. F. (2010). *Cloud Computing Implementation, Management, and Security*. New York: Taylor and Francis Group.
19. Steinder, M. , Whaley, I. , Carrera, D. & Gaweda, I. , and Chess, D. M. (2007). Server virtualization in autonomic management of heterogeneous workloads. In *Integrated Network Management*. pp. 139-148.
20. Sultan, N. (2010). Cloud computing for education: A new dawn? *International Journal of Information Management*, 30, 109–116.
21. Spínola, M. (2009). The Five Characteristics of Cloud Computing. Retrieved March 2011, from *Cloud Computing Journal*
22. Sergeant, D. M. (2009) the five defining characteristics of cloud computing.
23. Vouk, M. A. (2008). Cloud Computing – Issues, Research and Implementations. *Journal of Computing and Information Technology*, 4, 235–246.

## 8.0 APPENDICES

### 8.1 APPENDIX 1: QUESTIONNAIRE

Date.....

Dear Sir/Madam

You are invited to participate in a research study investigating the implementation of **a prototype for academic certificate verification** using a cloud computing Technology. Verification of certificates is a major concern in organizations, academic institutions, recruiting agencies and employers. They all have been experiencing high alarming rate of fake certificates. The prototype seeks to simplify academic verifications for potential employers and organizations that regularly screen certificates. Most of the organizations and academic institutions use traditional verification methods to verify the certificates presented to them. These organizations and institution do not have the capacity to verify the certificate presented to them instantly. One of the problems we have in traditional method is that people and especially recruiters and employers find difficult in knowing the validity of documents such as academic certificates presented to them because there is no way they can authenticate those certificate instantly.

The questions are therefore designed to collect data to help in the implementation of the prototype for academic certificate verification.

If you agreed to participate you will be required to fill out a simple survey that takes apro 10-15 minutes of your time.

The information gathered from this study will help in further research in the contribution of academic knowledge.

The information collected through your participation will be used for an academic requirement and may be published in a professional journal presented in a professional meeting.

Thank you

1. What methods do you use to confirm that the certificates offered by the institutions are not fake?
2. What challenges/problems do you face when verifying the certificates?
3. What are the particular or unique parameters that identify particular certificates belongs a certain institution?
4. Have you ever had any cases of faked certificate?
5. If yes (Q4) how have you been solving such cases of those faked certificates?
6. How many departments does the verification of certificates go through?
7. Do you have any automated prototype for online certificate verification?
  - A. Yes ☐
  - ☐
  - B. No
8. State the current level of interest in cloud computing technology
  - A. High ☐
  - B. Low ☐  
☐
  - C. Others
9. Which statement best describe the importance of cloud computing in your IT department.
  - A. Good ☐
  - B. Best ☐
  - C. Excellent ☐
  - D. Others ☐

10. Do you think cloud computing technology will help solve your problem/challenges you indicated in question 2?

11. How important is convenience when choosing this type of product?

i. Very important ☐

ii. Moderately important ☐

iii. Slightly important ☐

iv. Not at all important ☐

12. . Overall, are you satisfied with your experience using our new product?

i. Neither satisfied ☐

ii. Satisfied with it, ☐

iii. Dissatisfied with it ☐

iv. Not at all important ☐



13. Do you recommend the adoption of cloud computing technology in your organization as a higher Learning institution?

i. Yes ☐

ii. No ☐

14. Do you recommend the adoption of online verification prototype in higher Learning institution?

iii. Yes

☐

iv. No

☐

Name of Organization/Institution .....

Contact Address .....

Signature .....

Date .....

## 8.2 APPENDIX 2 USER INTERFCES

### i. Login

**Vericert** [Home](#) [Create Account](#) [About ▾](#)

## User Login

**Registered Users**

Email or Username:

Password:

Remember Me:☐

Login:

**New Users**

New users can register for an account.



- ii. Account registration.

**Vericert** [Home](#) [Create Account](#) [About ▾](#)

## Register Account

### Personal Details

**First Name:\***

**Last Name:\***

### Contact Details

**Phone Number:\***

**Subscribe to Newsletter:**

☐

### Login Details

**Email Address:\***

**Username:\***

**Password policy:**  
Password length must be more than 8 characters in length.  
Only alpha-numeric, dashes, underscores, periods and comma characters are allowed.

iii. Verification screen

**Certificate Verification**

<b>Certificate Name</b>	<input type="text" value="Bsc Computer Science"/>
<b>Institution</b>	<input type="text" value="Kenyatta University"/>
<b>Year of Graduation</b>	<input type="text" value="2013"/>
<b>Verification Code</b>	<input type="text" value="e70e5e6f26"/>

## Institution Registration

Institution Registration		
<b>General Information</b>		
<b>Institution Name</b>		
<input type="text" value="Institution Name"/>		
<b>Phone No.</b>	<b>Contact Address</b>	
<input type="text" value="Phone No."/>	<input type="text" value="Contact Address"/>	
<b>Contact Person Details</b>		
<b>Fist Name</b>	<b>Last Name</b>	
<input type="text" value="First Name"/>	<input type="text" value="Last Name"/>	
<b>Phone No.</b>	<b>Email</b>	
<input type="text" value="Phone No."/>	<input type="text" value="Email"/>	
<b>Login Details</b>		
<b>Username</b>	<b>Password</b>	<b>Re-enter Password</b>
<input type="text" value="Username"/>	<input type="text" value="Password"/>	<input type="text" value="Re-enter Password"/>
		<input type="button" value="Submit"/> <input type="button" value="Cancel"/>

### 1.3 APPENDIX 3 SOURCE CODE SAMPLE

#### Login

```
function _validate_login () {

    $query = $this->db->get_where ("user_accounts", array ('uacc_username' => $this->input-
    >post ('username'),

        'uacc_password' => md5 ($this->input->post ('password'))));

    if ($query->num_rows () > 0) {

        $row = $query->row ();

        $this->session->set_userdata ('user_id', $row->uacc_id);

        $this->session->set_userdata ('username', $row->first_name . ' ' . $row->last_name);

        $this->session->set_userdata('email', $row->uacc_email);

        $q = $this->db->get_where("institutions", array('contact_id' => $row->uacc_id));

        if ($q->num_rows() > 0) {

            $row = $q->row ();

            $this->session->set_userdata('is_institution', true);

            $this->session->set_userdata('institution_name', $row->name);

            $this->session->set_userdata('institution_id', $row->id);

        }

        Return TRUE;

    } else

        return FALSE;
```

```
}
```

## Verification Function

```
public function verifycert () {

    $this->load->model ('student_model');

    //loading method for verify

    if ($this->student_model->verify_cert_count () > 0) {

        $data['verification'] = $this->student_model->verify_certificate();

        $reg_no      =      $this->student_model->fetch_student_vericode      ($this->input->post
('verification_code'));

        $data      ['student']      =      $this->student_model->fetch_student_code($this->input-
>post('verification_code')); //changes

        $data['student'] = $this->student model->fetch_student_reg($reg_no); //i need to change
this code

        $data['institution']      =      $this->crud_model->get_institution_name($this->input-
>post('institution'));

        //$data['row']= $this->student_model->verify_cert_count();

        $this->load->view('certificateDetails', $data);

    } else {

        $this->session->set_flashdata ('verification message', 'Certificate verification failed.
Details for this certificate could not be found!');      $data ['institutions'] = $this->crud_model-
>get institutions ();
```

```
$this->load->view ('verify Certificate', $data);    }    } }.
```

### **Student Model**

```
class Student model extends CI_Model {
```

```
    var $certificatepath;
```

```
    var $photopath;
```

```
    var $content = "";
```

```
    var $date = "";
```

```
    function __construct() {
```

```
        // Call the Model constructor
```

```
        parent::__construct();
```

```
        $this->certificatepath = realpath(APPPATH . '../certificate_uploads');
```

```
        $this->photopath          =          realpath(APPPATH          .
```



