ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL SCIENCE

SCHOOL OF INFORMATION SCIENCE

GRADUATE PROGRAM IN INFORMATION SCIENCE

A Cloud Computing Framework for Ethiopian Banking Industry

BY: ALEMAYEHU ABERE MULU

June, 2014
ADDIS ABABA, ETHIOPIA

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A Cloud Computing Framework for Ethiopian Banking Industry

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Information Science

BY: ALEMAYEHU ABERE MULU

May, 2013

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Name and signature of members of the examining board,

Name Title Signature Date

1. --------------------------- --------- (Advisor) -----------------------Date----------
2. -------------------------- --------- (Examiner) ----------------------Date-----------
3. -------------------------- --------- (Examiner) ----------------------Date-----------
4---------------------------- -------- (Chair Person) -----------------Date-----------

DEDICATION

This thesis is dedicated to my late mother MelkamaBekele.

Acknowledgement

First of all, I would like to forward my gratefully and deepest thanks to the almighty God for his guidance, help, support and who added days to my age, Glory to God. Next, my heartfelt thanks go to my research advisors Dr.DerejeTeferi for his invaluable advice, patience and constructive criticisms of this work. Thirdly, I would like to thanks all intervieweesfrom IT staffs of the banks` (NBE, CBE, United&Dashen) for their honesty, suggestion and cooperation by giving interview.

I am thankful to my friends SeleshTefera, FerawoKassay, TadleTefera, TimkiteabeYacobe, Osman Taha, TesfayaDessi and Bezunehu, for their kindness and assistance during my thesis writing.

My special thanks goes to my father, AbereMulu, my brother, Yalemezewod and Yohannes, my sister Almaz, for their encouragement and support. My heartfelt & deepest gratitude also goes to my lovely wife Tigist (TG) and son Ezana (Chuloya). I wouldn't have finished this thesis without their support and love.

Finally, I would like to thank everyone at the College of Natural Science, Department of Information Science, AAU, who has encouraged and assisted me throughout the completion of this thesis.

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List of Acronyms

AAU -------Addis Ababa University
API ------- Application Programming Interface
APIs -------Application Programming Interfaces
ATM-------Automated Teller Machine
AWS ------Amazon Web Service
AWS ------Amazon Web Service
CBE------..Commercial Bank of Ethiopia
CBS------ .Core Banking Solution
CPU -------Central Processing Unit
CRM ------Customer Relation Management
CSP -------Cloud Service Provider
DB ------- Database
DBs ------.Database Systems
EBI------ .Ethiopian Banking Industry
EBIHC ---Ethiopian Banking Industries Hybrid Cloud
EBIPC ---Ethiopian Banking Industries Private Cloud
EBIs------Ethiopian Banking Industries
EC2 ------Elastic Compute Cloud
ERP ------Enterprise Resource Planning
GUI ------Graphical User Interface
IaaS ------Infrastructure as a Service
IBM ------International Business Machine
ICT -------Information Communication Technology
ICTs -----Information Communication Technologies

IT ------- Information Technology
NBE----- National Bank of Ethiopia
OS -------Operating System
OSS -----Open Source Software
PaaS -----Platform as a Service
POS-------Point Of Sale
QoS ------Quality of Service
S3 ------- Simple Storage Service
SaaS -----Software as a Service
SLA ------Service Level Agreement
SOA ------Service Oriented Architecture
SQL ------Structured Query Language
UK ------- United Kingdom
US ------- United States
USD------.United States Dollar
VM -------Virtual Machine
VMs ------Virtual Machines
VPC ------Virtual Private Cloud
VPN ------Virtual Private Network
SLA ------Service Level Agreement

Abstract

Acquisition and use of information technology affect banks` on every front of their business processes. Substantial, banks spend highinvestment on IT to position themselves for mergers or acquisitions, to simply protect their competitive advantages, or to expand geographical coverage into the marketplace. In today's difficult business and economic climate challenged by complex and changing customer and line of business needs, banksare confront problems in providing necessary IT supports to deliver services to customers, partners, and employees anytime, on their preferred device, through the optimum channel.The objective of this research work is to find an alternative solution for acquisition and use of information technology to deliver efficient, flexible and scalable IT services for leveraging Ethiopian Banking Industries from innovative technologies.

Interview and a concise survey on cloud computing were used as the research methodology for this study. Interview was selected for information acquisition method from the selected IT managers of banks. On the other hand a concise survey of concerning literatures on the existing state-of-the-art in Cloud provisioning, management and securitywere conducted. The overall system architecture and its elements that form collaborative Cloud infrastructures in banking

sectors, and best practices on cloud-based service implementations from the early adopter banks in the world also explored in this study.

The advantages of cloud computing for banking sectors, the limitations of current ICT usages in EBI were briefly discussed in this research paper. Also, an alternative solution to the current ICT utilizationslimitations in EBI is given. The study proposed Hybrid Cloud Computing model. The result shows that the proposed cloud computing service framework can have a capabilities for reducing IT investment cost and management complexity, efficient IT utilization for delivering banking services andimprove collaboration among partners. When the proposed framework implemented it could have significant importance to EBI.

Keywords: Cloud Computing, Ethiopian Banking Industries

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Chapter One

Introduction

1.1. Background

The growth of high speed networks and computing power is making possible to process different banking services or applications in microseconds undreamed of in the past. These rapid explosions of technology are changing the banking industries from paper and branch banks to digitized and networked banking services (Wakeham, 2010). Delivering banking services on this networked environment are more convenient and effective than ever before. Expanding the geographical coverage of digitized and networked banking services are the mainstreams for banks to deliver QoS to customers (NBE, 2012). In developing countries, the cost of expanding the geographical coverage of digitized and networked banking services to customers would be difficult for a single bank. In this environment, banks would start to collaborate to pool non-differentiated activities using private cloud computing within a closed group of banks in a similar way to telecommunication sharing network infrastructure (Sardet, 2012). These bundling could provide shared services that interact with customers in more engaging ways while simultaneously freeing banks from the burden of routine transactions. Thus, when the transaction volumes decline these collaboration could enables banks to stop duplicating investment, industrialize their security processes for economies of scale, gain new service options and have immediate access to the latest apps. These collaborative private clouds could even be hybrid cloud powered by a third-party, increasing the benefits of cost and flexibility (Sardet, 2012). .

Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (NIST, 2012). By deploying IT infrastructure and services over the network, an organization can purchase these resources on an as-needed basis and avoid the capital costs of software and hardware. With cloud computing, IT capacity can be adjusted quickly and easily to accommodate changes in demand. While remotely hosted,

managed services have long been a part of the IT landscape, a heightened interest in cloud computing is being fueled by ubiquitous networks, maturing standards, the rise of hardware and software virtualization, and the push to make IT costs variable and transparent (Sewale, 2012).Cloud computing delivers: Infrastructure as a Service (IaaS), platform as a Service (PaaS), and Software as Services (SaaS), which are made available as subscription-based services in a pay-as-you-go model and other essential features to customers (NIST, 2012).
Cloud computing uses the internet to deliver remotely hosted applications, data, and infrastructure services as a new business model for ICT services. The cost for services are typically billed on a recurring, pay-as-you-go basis, cloud solutions require no end-user infrastructure other than client devices equipped with a browser and reliable web access (Furht, 2010). And since most cloud solutions are hosted in service provider data centers/third-party servers (equipped with processors that deliver excellent performance, strong I/O characteristics, low energy consumption, and robust virtualization assistance), banks can scale them up on the fly, without having to invest time and money in procuring and provisioning new computing resources and maintenance costs (Armbrust et al., 2009).

The new business and technological model, such as cloud computing technology will enable banks to create new base of competition, new streamlined business process and improved customer service environments (Ryan, 2012). Cloud computing enables newer banks to have low cost startups by allowing them to rent resources offered by cloud providers/matured infrastructure legacy banks instead of having their own sets (Sardet, 2012). Thus banking industries in Ethiopia would take advantage of cloud computing as a tactical solution to face seasonal peaks without spending big sums to acquire resources that will be idle for most of the time. Operational expenses including salaries and energy costs are equally reduced. Cloud allows banks to share their infrastructure to provide integrated channel services to the whole customers. All these will reduce costs, setup time, installation/upgrade hassles and gives high scalability.
Therefore Cloud technology offers secure deployment options that could help banks develop new customer experiences, enable effective collaboration and improve speed to market, deploy new applications more quickly, trim development costs, and achieve greater agility. Thus, all while increasing IT efficiency through cloud-based services.

1.2. Statement of the Problem and its Justification

In any financial services institutions, IT infrastructure and support are constantly facing cost pressures, while computing needs and amount of data are ever increasing. These increasing IT usages enforce banks to invest million dollars for procuring computing resources and re-procuring when computing needs and business data are increased over time. Cloud computing has generated a tremendous amount of interest and excitement in recent years as it gives a new and useful way to address IT challenges across and beyond financial services (Ryan, 2012).Banks would needs to transform their current ICT service delivery systems and the manner in which their product offerings, channels and customer serviceto enable effective collaboration and improve speed to market with reduced ICT infrastructures investment costs. Banks also would starts to collaborate with partners or third party IT service provider to share IT resources for supporting and providing common banking services to their customers on a security rich environment(Sardet, 2012).

Cloud-based services could be provided by different IT companies which have large datacenters and huge software infrastructures with skilled manpower who can run the datacenter (Nayro, 2012). Amazon, IBM, Google, Azure, and many other IT organizations provide various IT services such as infrastructure as a service, platform as a service and software as a service to consumers. Virtually customers could deploy and run their data or applications on the providers IT infrastructures or public cloud without the need to procure that infrastructures, and pay for the infrastructure they are used (Raoj& Reddy, 2011). This might reduce infrastructure investment cost and its management complexities to banks. However, banks would not be willing to put their data/application on the external public clouds because of fear of risks on customer data privacy, security and confidentiality issues that might be brought from using it.

Banks in Ethiopia are working in a highly controlled and regulated environment, while their customer data are the main assets to run the business securely. Deploying and running the banking services on the public cloud infrastructure would bring unauthorized access from the banks private datacenter that could leads conflict from the financial policy of the country and customers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to

the affected customer. Additionally, the existing telecommunication infrastructure in Ethiopia would bring latency problems for deploying and running the banking system on the public cloud. Transferring data to and from the cloud would have high latency than when transferring data to and from an in-house datacenter.

Currently, many banks in Ethiopia are including self-service and mobile applications into their mix of offerings across staffed and automated channels.Banks in Ethiopia have already using the CORE banking solutions at their enterprise level IT infrastructure. These services provided by a group of networked channels such as: branches, ATMs, POS, phone &etc.This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw or transfer the deposited money from any of the bank's member channels throughout the country.Also the existing core banking solution used by banks are suitable for integrating the data between banks and cloud provider for cloud computing deployment model (Sardat, 2012).Since cloud computing can play a significant role in banks efforts to reinvent its business and operating models (Nikam et al., 2012).

IT capital expenses typically include enterprise software licenses, servers and networking equipment are more expensive and harder to forecast than routine IT operating expenses(Sardat, 2012). With cloud applications, there is no longer a need to build hardware, install software or pay dedicated software license fees. Adopting cloud services allows EBIs to shift costs from capital to operational or from fixed to variable. The bank pays for what it needs when it needs it. This pay-per-use model is more flexible and eliminates the need for significant capital expenditures. Cloud offers more than just IT scalability; it allows a bank to scale their business operations. By allowing for rapid provisioning of resources without scale limitations, using cloud technology enables a company to benefit from economies of scale without needing to add more servers(Nikam et al., 2012).

Moreover, the success of the cloud implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009).In developing cloud computing strategy and infrastructure, it is important to keep security in mind. It needs to understand which delivery models are appropriate based on security and trust requirements with connecting systems. Then assessing the security requirements for banking industries such as: governance,

architecture, applications and assurance to develop the cloud computing framework also an important consideration in this study.

Therefore, the cloud computing framework developed for all banks in this study were designed to support a secure and cost effective electronic services sharing between customers, banks and cloud services providers, facilitating smooth collaboration and integration. However, developing cloud-based applications requires new approaches. Because without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011).But, in the best of my knowledge there was no research conducted on a cloud computing framework to cloud-based application for banking industries in Ethiopia.

Hence, the aim of this study was to answer the following three research questions.

1. Is the current ICT usage strategy efficient in EBI?
2. Do we need to change the current ICT service delivery strategy deployed in EBI?
3. Could cloud computing model be an alternative solution for efficient ICT service provisioning strategy for EBI?

1.3. Objective of the Study

1.3.1. General objective

The general objective of this study was to examine existing ICT infrastructure and usage in Ethiopian banking industries and to develop an integrated cloud computing framework for Ethiopian banking industries.

1.3.2. Specific objective

The specific objective of the study is:

- ✓ To Review cloud computing related literatures to understand various cloud services, deployment models and framework development methods.

- ✓ To examine the current ICT infrastructure and usage strategy and efficiency in Ethiopian banking industries.
- ✓ To explore the potential benefits of Cloud Computing in banking sectors.
- ✓ To examine the necessity of Cloud Computing for Ethiopian banking industries.
- ✓ To compare the cost effectiveness of using cloud computing technology in Ethiopian banking industries.
- ✓ To develop an integrated cloud-based service architectural framework model that can be placed in a moderate place and can provide cloud service for different bank.
- ✓ To identify and recommend future research directions for further investigation on the benefits of Cloud Computing in bank industry.

1.4. Significance of the study

This research could allow the Ethiopian banking industries to consider alternative ways of deploying ICT infrastructures for an efficient and effective customer service delivery. The study would give new insights to the Ethiopian banking industries and other financial sectors on how to invest ICT budgets on their institution. The Proposed Hybrid cloud computing model and the presented implementation plan could be used as a baseline for the physical realization of the cloud. Additionally the study could be used as a baseline for further studies of this newly emerged ICT utilization strategy to be considers in different governmental and nongovernmental organizations of Ethiopia. The proposed Cloud Computing framework could also be used as a baseline for Ethiopian banking industries ICT managerial on how the cloud computing would be implemented and used in banking institutions.

1.5. Scope and limitation of the Study

The main intent of the study is to examine the current ICT service delivery strategies to support Ethiopian banking industries, to consider cloud computing in the field of banking

specifically in Ethiopian banking industries and propose a Cloud Computing framework that could be used as a baseline for implementation of Cloud Computing in Ethiopian banking industries. This study does not consider the development of cloud service implementation prototype. This work focus on examining and analyzing the current ICT usage in Ethiopian banking industries, exploring possible cloud service frameworks for banking sector and developing an integrated cloud-based service framework.

1.6. Organization of the Thesis

The rest of this study is organized as follows: Chapter two covered related literatures on the basic concept of cloud computing: service types, tools, deployment models, cloud computing adoption strategy, cloud challenges and benefits for banking industry; different publications about CBE existing ICT usages; and related works done on cloud based service frameworks locally and abroad in order to understand how it is implemented or used in banking sectors.Chapter three describes the research methodology and strategy that aims to identify the potential cloud solutions that could be provided to banking industries. It begins by describing exploratory research approaches. Primary data collection and analysis technique were described as information acquisition method. Validity and reliability requirements also identified. Chapter four presents the results of the interview described in chapter three. The data collection method utilized was the semi structured interview that provided both control and direction through a list of question under interview.In Chapter five, backgrounds of a framework for building the proposed Cloud Computing Framework for EBI, the detail elements of the proposed cloud computing framework, the architectural components of the proposal for implementing a framework are given. Additionally, technological requirement identification for EBI also presented. What design is better for EBI, why the specific design was selected for EBIs also discussed. Finally in chapter six conclusions about the research and suggestions for future research direction were presented.

Chapter Two

Literature Review

This chapter reviews the different literatures that are related to the objective of the study. Literatures covered in this section are the basic concept of cloud computing: service types, tools, deployment models, cloud computing adoption strategy, cloud challenges and benefits for banking industry; different publications about CBE existing ICT usages; and related works done on cloud based service frameworks locally and abroad in order to understand how it is implemented or used in banking sectors.

2.1. Cloud Computing

Over the last few years, many IT professionals, business managers, and researchers have started to talk about a new phenomenon called cloud computing. Each of these groups defined cloud computing

differently according to their understanding of its offerings. Although there was no agreement about what precisely constituted cloud computing, it still offered a promising paradigm that could enable businesses to face market volatility in an agile and cost-efficient manner (Qusay F. Hassan, 2011).

Regarding its relations to other pre-existing computing models, cloud computing can be used in principle to deliver computing services, including grid computing services, high-performance computing services, etc. This does not imply that cloud computing is a replacement for grid computing, high-performance computing, or any other pre-existing computing model. Instead, cloud computing should be thought of as a new business model that aims at service delivery in a highly scalable and highly flexible manner. The difference between cloud computing and other pre-existing computing models can be better demonstrated by ways of using the service and deployment models and its key enabling technologies of virtualization.

Recently a group of domain-specific experts have proposed definitions that aim at abstracting common characteristics of the cloud and cloud computing. Here are four representative definitions quoted from Gartner, US National Institute of Standards and Technology(NIST), EU commission Expert Group, and Berkeley Institute (cited in TeciRes project research group: Xiaoyu Chen, Gary B. Wills, Lester Gilbert, David Bacigalupo, 2010)

"The term 'cloud computing' refers to any computing capability that is delivered as a service over the internet. While there is no authoritatively accredited definition of the concept, one of the most frequently used defamations is the one given by Gartner, who describe cloud computing as 'a style of computing where massively scalable IT-related capabilities are provided as a service' across the internet to multiple external customers"(Gartner). "A cloud is an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality of service" (EU commission Expert Group).

"Cloud computing refers to both the applications delivered as services over the internet and the hardware and systems software in the data center that provides those services. The services themselves have long been referred to as Software as a Service (SaaS), so we use that term. The data center hardware and software is what we will call a cloud" (Berkeley Institute).

"Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (US National Institute of Standards and

Technology, NIST). The following figure can better demonstrate the definitions of cloud computing.

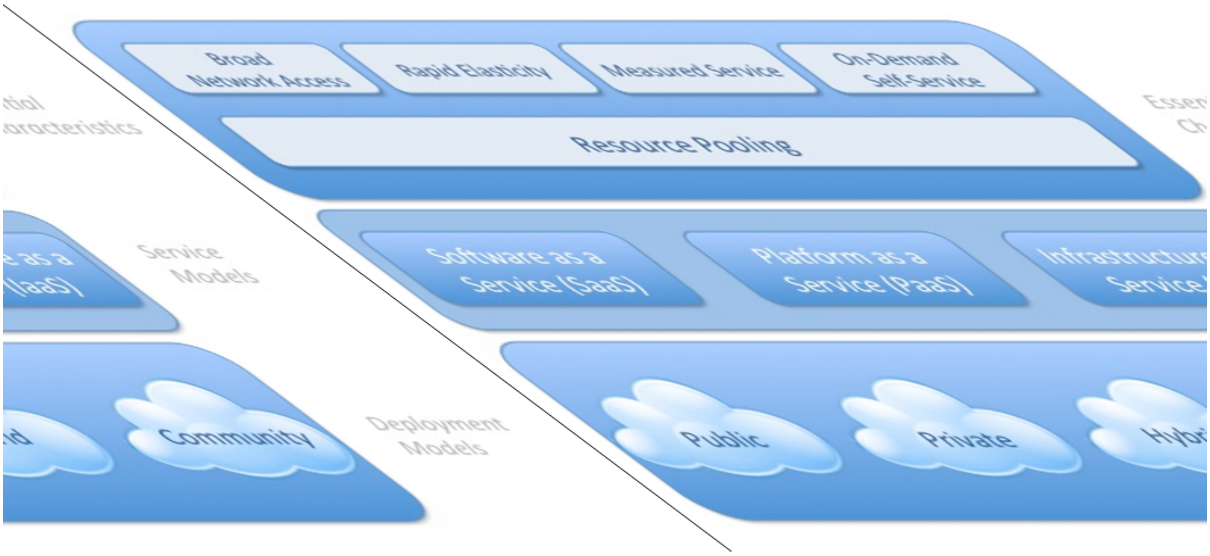


Figure.1. Visual model for cloud computing working definition (source NIST)

2.2. Characteristics of Cloud Computing

According to US National Institute of Standards and Technology (NIST) and Sun Microsystems, Inc (2009), cloud services exhibit the following essential characteristics that demonstrate their relation to, and differences from, traditional computing approaches:

On-demand

A consumer can unilaterally provision computing capabilities such as server time and network storage as needed automatically, without requiring human interaction with a service provider. Instead of requiring a long-term contract for services with an IT organization or a service provider, clouds work on needed model where an application may exist to run a job for a few minutes or hours, or it may exist to provide services to customers on a long-term basis.

Broad network access

Cloud capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs) as well as other traditional or cloud-based software services. Cloud computing extends the existing trend of making services available over the network. Virtually business organization can make available different applications to their internal and external customers using web based interfaces. While enterprises are well aware of the ability to secure communications using Secure Socket Layer (SSL) encryption along with strong authentication, bootstrapping trust in a cloud computing environment requires carefully considering the differences between enterprise computing and cloud computing. When properly architected, Internet service delivery can provide the flexibility and security required by enterprises of all sizes.

Resource Pooling

The provider's computing resources (such as: storage, processing, network bandwidth, and virtual machines) are pooled to serve multiple consumers using a multi-tenant model, thus, different physical and virtual resources dynamically assigned and reassigned according to consumer demand. Even private clouds tend to pool resources between different parts of the same organization.

Rapid Elasticity

Cloud allows the dynamic integration and extraction of computing resources. Cloud services are available for provisioning, often appear to be unlimited and can be purchased in any quantity at any time. Elasticity is an essential core feature of cloud systems and circumscribes the capability of the underlying infrastructure to adapt to changing. This cloud capability allows service users to create an elastic environment that can expand and contract based on the workload and target performance parameters. In general, it is assumed that changes in the resource infrastructure needs are announced first to the middleware manager and then that such changes can be maintained automatically.

Measured service

Cloud system automatically control and optimize resource usage by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, or active user accounts). Resource usage can be monitored, controlled, and reported to providing transparency for both the provider and consumer of the service. Based on this metering and accounting capability of cloud computing, users pay

only for service they are used. Thus, billing is based on resource consumptions such as CPU hours used, volume of data moved, or gig bytes of data used.

Virtualization

It is an essential technological characteristic of clouds which hides the technological complexity from the user and enables enhanced flexibility (through aggregation, routing and translation). More concretely, virtualization supports the following features:

- ✓ Ease of use: through hiding the complexity of the infrastructure (including management, configuration etc.) virtualization can make it easier for the user to develop new applications, as well as reduces the overhead for controlling the system.
- ✓ Infrastructure independency: in principle, virtualization allows for higher interoperability by making the code platform independent.
- ✓ Flexibility and Adaptability: by exposing a virtual execution environment, the underlying infrastructure can change more flexible according to different conditions and requirements (assigning more resources, etc.).
- ✓ Location independence: services can be accessed independent of the physical location of the user and the resource.

2.3. Cloud Computing Service Model

Cloud computing means using IT infrastructure as a service — and that service may be anything from renting raw hardware to using third-party APIs. Cloud service models offer financial institutions the option to move from a capital intensive approach to a more flexible business model that lowers operational costs. In practice, cloud service providers tend to offer services that can be grouped into three categories: SaaS, PaaS, and IaaS. These categories group together the various layers illustrated in Figure 2, with some overlap.

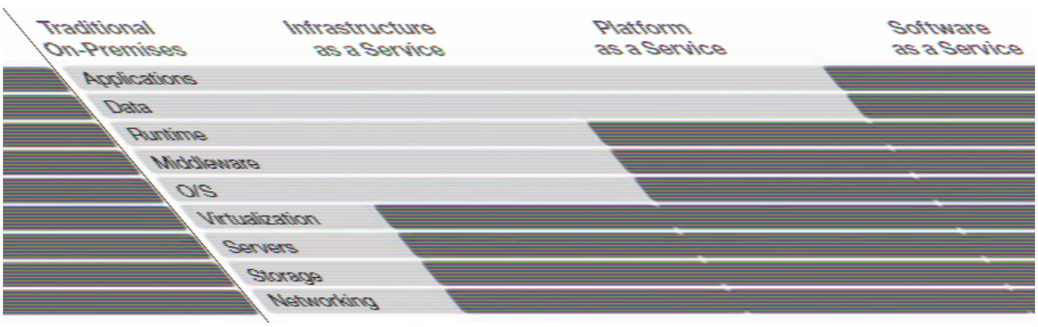


Figure.2. cloud based service layers

2.3.1. Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) refers to making available basic computing resources (storage, processing, and networking) as a service (RuiEsteves, 2011). Under this forms of delivery, organizations can access computing infrastructures from a cloud provider instead of the traditional purchase of physical servers and software needed to set up a datacenter (Maurice Nyaoro, 2012). Infrastructure as a Service (IaaS) allows the customer to run software (both systems and applications), to store data, and to transfer an existing workload to the cloud with limited control at lower total infrastructure cost.

For infrastructure as a Service, the provider maintains the storage, database, message queue or other middleware, or the hosting environment for virtual machines; while user can uses that service with the capabilities to control the operating system, storage, deployed applications and possibly networking components such as firewalls and load balancers, but not the cloud infrastructure beneath them (Raoj& Reddy, 2011).

According to Raoj& Reddy (2011) IaaS operates on a "Pay as you go" model ensuring that the users pay for only what they are using. To operate on this model, IaaS providers offer almost unlimited instances of servers to customers and make cost-effective use of the hosting hardware through virtualization. While the user can buy the infrastructure according to their requirements at any particular point of time instead of buying the infrastructure that might not be used for months and very costly if purchased completely. Thus dynamic scaling, usage based pricing, reduced costs and access to superior IT resources are some of the benefits of IaaS. Examples of IaaS provider: Mossol/Rackspace, AmazonS3, GoGrid&Fexiscode).

2.3.2. Software as a Service (SaaS)

Software as a service (SaaS) is a way of delivering applications over the internet as a service, where the web browser is often the interface for delivery (Bhattachariee, 2009). Instead of installing, maintaining and managing complex software and hardware task, SaaS allows to simply accessing application via the internet (Raoj& Reddy, 2011). The consumer uses an application without having hardware or software to buy, install, maintain, update, and manage the infrastructure on which the applications running. SaaS applications run on a SaaS provider's servers and the provider manages access to the application, including

security, availability, and performances using open standards apply at the application level (Raoj& Reddy, 2011).

According to Raoj& Reddy (2011) this types of cloud computing delivers a single application through the browser to thousands of customers using a multitenant architecture. Thus SaaS eliminates upfront investment in servers or software licensing for users and reduce the costs to manage access to the application compared to conventional hosting.

2.3.3. Platform as a Service (PaaS)

Platform as a Service (PaaS) provides an environment upon which the customer can use to build and deploy cloud applications. These applications may be for use by the customer or offered as a service to others. Building applications using PaaS means that they are inherently cloud-enabled and the PaaS provider also provides the service upon which these applications run (Bhattachariee, 2009).

In the traditional model of software development applications are written in one environment, tested in another environment and deployed elsewhere ((Maurice Nyaoro, 2012). PaaS is a combination of a development platform and a solution stack, delivered as a service on demand. It provides infrastructure on which software developers can build new applications or extend existing ones without the cost and complexity of buying and managing the underlying hardware and software and provisioning hosting capabilities (Raoj& Reddy, 2011).

Platform as a Service (PaaS) layer incorporates all the environments used for development or for run time support, not being directly accessible by the final user (RuiEsteves, 2011). The consumer uses a hosting environment for their applications and controls the applications that run in the environment (and possibly has some control over the hosting environment), but does not control the operating system, hardware or network infrastructure on which they are running.

2.4. Cloud Computing Deployment Model

Regardless of the service model utilized (SaaS, PaaS, or IaaS) there are four deployment models for cloud services, such as:

2.4.1. Public cloud services

Public cloud or external cloud describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet via web applications/web services, from an off-site third-party provider who shares resources and bills on a fine-grained utility computing basis (VenkateRao J. et.al. 2011). The

cloud services are available for anyone to subscribe and to use in a pay-as-you-go manner. A public cloud customer can access these services over the internet from a third-party provider who may share computing resources with many customers.

The public cloud model is widely accepted and adopted by many enterprises because the leading public cloud vendors as Amazon, Microsoft and Google, have equipped their infrastructure with a vast amount of data centers, enabling users to freely scale and shrink their rented resources with low cost and little management burden (B. Furht, 2010). Security and data governance are the main concern with this approach. Sharing applications and infrastructure with unknown co-tenants can lead to concerns over data security and data leakage. If a public cloud is implemented with performance, security, and data locality in mind, the existence of other applications running in the cloud should be transparent to both cloud architects and end users (Sewale, 2012).

2.4.2. Private cloud service

A Private Cloud, or internal cloud, is used when the cloud infrastructure, proprietary network or data center, is operated solely for company or government departments who prefer to keep their data in a more controlled and secure environment, and serves customers within the business fire-wall (B. Furht, 2010). The private cloud allows organizations to outsource the management of their IT infrastructure while retaining tighter control over the location and management of the resources. The price to pay for this is that the costs are likely to be higher because there is less potential for economy of scale, and resilience may be lower because of the limit on service resources available (Larry Ryan, 2012).

The difference between a private cloud and a public cloud is that in a private cloud-based service, data and processes are managed within the organization without the restrictions of network bandwidth, security exposures and legal requirements that using public cloud services might entail (VenkateRao J. et.al. 2011). Isolation is one of the key techniques for ensuring security and, while in the public cloud applications and data exist in a shared environment, the private cloud offers greater isolation by dedicating resources to a particular customer.

2.4.3. Community cloud service

The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, or compliance considerations) (CSA, 2009). In a community cloud, several enterprises with similar requirement can share their

infrastructures, thus increasing their scale while sharing the cost (Wikipedia – Cloud Computing, 2010). Another form of community cloud may be established by creating a virtual data center from virtual machines instances deployed on underutilized users machines (Briscoe &Marinos, 2009). A community cloud provides many of the benefits of scale of the public cloud, while retaining greater control over compliance and data privacy.

Community cloud services already exist, but under a different name – for example NHSmail, the national e-mail and directory service available to NHS staff in England and Scotland, is effectively software-as-a-service with a community deployment model. As regards security, NHSmail is accredited to government "restricted" status, and is the only NHS e-mail service that is secure enough for the transmission of confidential patient information.

2.4.4. Hybrid Cloud service

The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds) (CSA, 2009). Hybrid Cloud is a composition of the two types of cloud (private and public) where, a private cloud is able to maintain high services availability by scaling up their system with externally provisioned resources from a public cloud when there are rapid workload fluctuations or hardware failures (B. Furht, 2010).

In the Hybrid cloud, many enterprises would prefer to keep their critical data and applications within their own control to ensure security firewall, while hosting the less critical ones on a public cloud. Under this cloud deployment model users typically outsource non-business critical information and processing to the public cloud, while keeping business-critical services and data in their control (VenkateRao J. et.al. 2011). A hybrid cloud can be delivered by a federated cloud provider that combines its own resources with those of other providers. Thus hybrid cloud delivery model encompasses provisioning all components and services that are required to deploy services (e.g. Hardware, network services, operating systems, databases, middleware, applications, and third party service provisioning). The following figure summarizes the cloud computing deployment model with potential governance of the cloud.

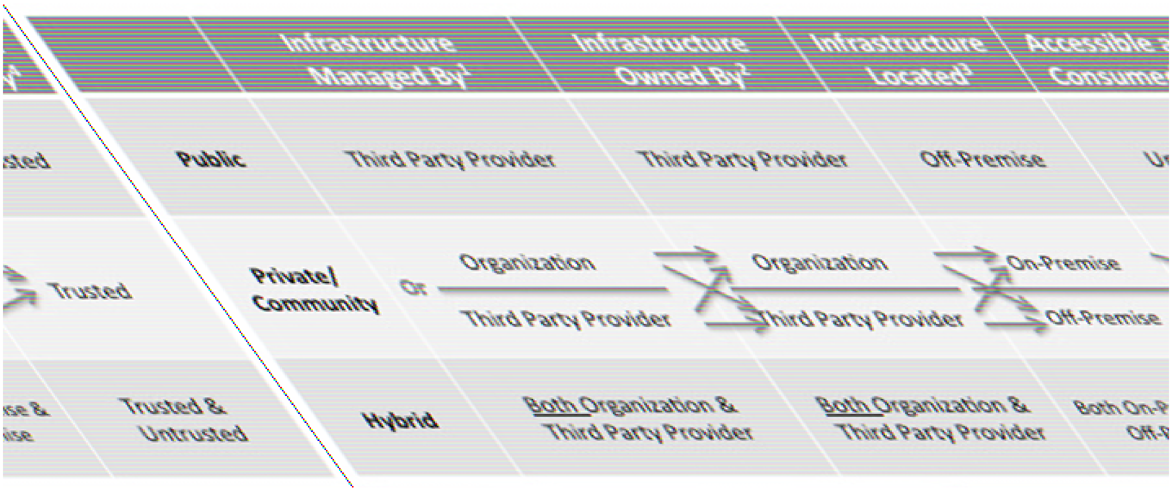


Figure.3. cloud computing deployment model

As a figure 3 shows computing infrastructure are managed and owned by third party providers, third party providers/organizations and both third party providers and organizations through different cloud service deployment models public, private and hybrid clod respectively. Infrastructures can be located as off-premise, off-premise/ on-premise and both off-premise and on-premise ways. Finally Infrastructures can be consumed by un-trusted (authorized to consume some/all services but are not logical extension of the organization), trusted (part of an organization legal policy umbrella including employees, contractors, and business partners) and both un-trusted and trusted consumers of the cloud services.

2.5. Cloud Computing Benefits for Banks

Cloud computing can help financial institutions to improve performance in a number of ways. Cloud based service have many benefits to the provider and to the consumer of cloud services. For the purpose of the study cloud benefits for banks will be discus under this topic.

Cloud computing can enable banks to turn a large up-front capital expenditure into a smaller, ongoing operational cost (including salaries and energy costs). Cloud allows banks to reduce the heavy investments in new hardware and software to expand internal IT infrastructures, while it allows customers to pick and choose the services required on a pay-as-you-go basis offered by cloud providers. This elasticity gives adopters two main advantages over on-

premises models. First, it frees organizations from spending high up-front costs on IT resources that may not be fully utilized in the future. Second, it allows them to face occasional spikes by flexibly adding more resources at whatever time needed (Aarti Singh et al., 2012).

Cloud computing enables emerging market banks to have low cost startups by allowing them to rent resources offered by cloud providers or by establishing collaboration with matured infrastructure legacy banks instead of having their own sets. While, large enterprises can take advantage of cloud computing as a tactical solution to face seasonal peaks without spending big sums to acquire resources that will be idle for most of the time (Qusay F. Hassan, 2011).
With cloud computing, the provider is responsible for managing the technology. Cloud computing also provides a high level of redundancy and back-up at lower price than traditional managed solutions (B. Furht, 2010). Thus, financial firms can gain a higher level of data protection, fault tolerance, and disaster recovery

Cloud-based operating models enhance business agility and focus. Cloud is operating in a flexible way to develop new products within shorter development cycle and with less capital investment (Aarti Singh et al., 2012).With on-premises, organizations spend much time and effort to setup and run IT resources. Conversely, cloud computing put all these complexities on provider sides enabling clients to easily operate hardware and software appliances (Qusay F. Hassan, 2011). Cloud computing also allows businesses to move non-critical services to the cloud, including software patches, maintenance, and other computing issues (AbhinarGarg, 2011). As a result, firms can focus more on the business of financial services, not on IT. This also supports a faster and more efficient response to the needs of technological and business solutions.

Additional, cloud enables banks to contribute on green IT development. Financial service sectors can use cloud computing to transfer financial services on a virtual environment that will reduces the energy consumption and carbon footprint comes from setting up of a physical infrastructure

2.6. ICT and Banks Transformation

2.6.1. Role of ICT in the Banking Ecosystem

A bank is a financial institution and a financial intermediary that accepts deposits and channels those deposits into lending activities, either directly by loaning or indirectly through capital markets. A bank is the connection between customers that have capital deficits and customers with capital surpluses. Due to their influence within a financial system and the economy, banks are highly regulated in most countries. Most banks operate under a system known as fractional reserve banking where they hold only a small reserve of the funds deposited and lend out the rest for profit (Wikipedia – Bank, 2013).

The 21st century will bring about an all-embracing convergence of computing, communications, information and knowledge. The growth of high speed networks and computing power is making possible to process different applications in microseconds undreamed of in the past. The rapid explosion of technology is changing the banking industries from paper and branch banks to digitized and networked banking services. (Giacomo&Brunzel, 2010). This explosion of technology is changing the banking industry from paper and branch banks to' digitized and networked banking services (Ostergaard, 2010). It has already changed the internal accounting and management systems, and the service delivery systems of banks used to interact with their customers. Delivering banking products and services using this system can be more convenient and effective than ever before. All over the world, banks are still struggling to find a technological solution to meet the challenges of a rapidly-changing environment (Ryan, 2012). It is clear that this new technology is changing the banking industry forever. Banks with the ability to invest and integrate information technology dominates in the highly competitive global market.

Advances in technology are allowing for delivery of banking products and services more conveniently and effectively than ever before. Rapid access to critical information and the ability to act quickly and effectively will distinguish the successful banks of the future. The bank gains a vital competitive advantage by having a direct marketing and accountable customer service environment and new, streamlined business processes (Gardachew, 2010). Thus the advantages accruing from computerization are three-directional - to the customer, to the bank and to the employee.

2.6.2. Challenges in the Present Banking Ecosystem

There are different challenges available in the current banking ecosystem that demands continual technological change and high investment costs. According to MCsuresh (2010) and VMware (2011) some of the challenges that are directly related to ICT infrastructures needs are:

- ✓ Rapid geographical expansion of banking market has forced banks to replace their off-line systems by an on-line system linking the branches to the head office through the telecommunications network.

- ✓ The need for restructuring banks processes in order to reduce staff expenses which constitute a large part of the operating costs and a heavy burden on operating profitability.

- ✓ Incompatibility of the old systems with the strategic necessity of integrating new technologies like ATMs, telebanking, etc. in order to provide the high quality services to the customers and competing on an equal foot with the foreign banks.

- ✓ Competition through technology enforces banks to offer the entire range of services like telebanking, ATMs and others collaboratively. These require banks to respond very actively in the marketplace in introducing new products and services bundling.

- ✓ Banking services demanded a more dynamic banking web site with real-time transaction processing and rich functionality without limitations for service to be slow or unavailable.
- ✓ The rapidly changing computing needs such as comprehensive customer transaction history requires large and increasing transaction-data storages, and high-performance computing capacity needs for running complex algorithms and a high number of computations.

- ✓ Lack of proper planning for the development of any new applications. A computerization plan is the basis for implementing successful information technology solutions. To be relevant, these plans have to be linked closely to organizational strategies, objectives, priorities and processes.

This leads to very high investment cost for building and maintaining infrastructure to ensure high availability at any demand level (i.e. maintaining more dynamic banking web sites, large storage needs, high performance computing needs, and etc.). Providing innovative services, cost reduction through capital expenditure control, and improving the customer experience are challenging in these context.

More frequent need for risk analysis adds to the loads on in-house systems, forcing increased capacity and increased capital investment costs. A multi-sourced infrastructure allows faster resources provisioning than building in-house HPC infrastructure (VMware, 2011). Building in-house HPC infrastructure has the limitations to provide flexibility to schedule necessary simulations when business requires it, not just when internal resources are available. Additionally, there are lacks of mechanism for on-demand scaling solution that can enable superior customer experience and capacity. Therefor banks need to upgrade or change their internal datacenters during peak load times of the market. This leads very high investment to procure and provision the infrastructures.

Additionally, in developing countries telecommunications infrastructure is the greatest obstacle to real time electronic banking in the banking sector. Telecommunications in the banking sector is a major factor to the success or failure of any application or service. The result of such situation is a delay in implementing new services and products like remote banking, electronic funds transfer, and real time bank information systems (MCsuresh, 2010). This has also an effect on the reliability of the services already implemented like ATMs. In order to face this challenge, banks began studying the feasibility of installing a private telecommunications network. This network will also be used to connect the ATMs machines which will thus function on-line. However there are problems to obtaining a license from monopolized telecommunications market, high cost of equipment to installing and lack of coordination between banks.

2.6.3. Challenges for Adopting Cloud Computing

Banking industries operate within a highly competitive and finely regulated environment. Therefore all of the service aspects are influenced not only by business considerations but also by the compliance requirements. Innovations, so far, have been evaluated, customized, adopted, deployed and managed inside the enterprise – security, control, reliability & governance have always been managed internally. Since, Cloud based services attempt to

take the functional, technology and operational aspects of the business out of the enterprise, these considerations significantly influences the adoption (SarfrazBrohi et al. 2011). Thus, According to Staten et al. (2008) for cloud-based services to be ready for enterprise to consume, it must pass from the early-adopter phase to early majority. Early majority is depicted by a sufficient volume of customers using the services for business-critical purpose. The major reasons that continue to hinder the level of adoption of this new computing infrastructure acquisition paradigm are: performance bottlenecks due to use of HTTP protocols and bandwidth issues; increased threats of single point of failure; customer data lock-in; concerns over data privacy and security; lack of frequently used tools; and the switching costs of migrating from in-house IT infrastructure (Nyaoro, 2012). The following sections discus some of major challenges to adopt cloud computing by presenting possible ways to tackle them.

Performance bottlenecks

The latency encountered when transferring data to and from the cloud is higher than when transferring data to and from an in-house datacenter (Nyaoro, 2012). With applications continuing to become more data intensive latency becomes a big concern. Bhattacharjee (2009) states that one of the key causes of this latency problem is that the architecture being used for data interchange in the cloud relies on the traditional get/post mechanism of the HTTP protocol which was not designed for the dynamic user interfaces supported by the cloud. Nevertheless, Bhattacharjee (2009) suggest that a probable solution could be realized through use of multiple geographically dispersed datacenters. This should widen and shorten the channel between the user and cloud service provider.

Data confidentiality, privacy and trust

This is the commonly cited reasons for organizations apathy towards the cloud. For starters, the non-uniform structure of legislations across the world characterized largely by the United States` Patriot Act makes enterprises unwilling to move their data into the cloud. Cloud providers are trying to work around this by building data centers in more parts of the world but this only solve the aspects of legislation.

The second concern of security is whether the cloud environment can be made as secure as that for most in-house IT environment. Ambrust et al. (2009) downplays this by stating that use of well-understood technologies such as encryption, Virtual LAN and network middle boxes could easily make data in the cloud as secure as that an a local datacenter.

Thirdly, there is the difficulty of winning consumer trust. How can cloud adopters trust their cloud computing providers not to disclose their data to competitor or alter their data? The end user perspective of trust makes this a highly subjective property. According to (Savola, Juhola, &Uusitalo, 2010) the most important aspects that enforce trust in the cloud are good level of security and privacy. One of the best ways of achieving this is through cutting off the semantic link of the data to the owner while presenting the cloud provider with the capability to properly and reliably charge for the usage of its cloud resources (Jensen, Schage, &Schwenk, 2010). The provider can solve this through use of cryptographic solutions based on ring and group signature to create an accounting scheme that ensures a user`s anonymity and guarantees authenticity of service requests (Jensen et al., 2010).

Switching costs

Organizations that are contemplating moving to the cloud face a dilemma on whether to discard their IT investments-such as that used on setting up their local datacenter at a discount and opt for the cloud (Nyaoro, 2012). To migrate to the cloud organizations have to be prepared to incur not only the cost of migrating data and application but also the cost of restructuring their organizations to fit new computing paradigm (Bhattacharjee, 2009). To mitigate against this the large cloud providers could leverage their economies of scale to offer competitive prices that will entice organizations to encounter these switching costs.

2.7. Cloud System Controlling Wings

2.7.1. Security for Cloud Computing

Security controls in cloud computing are, for the most part, no different than security controls in any IT environment. However, because of the cloud service models employed, the operational models, and the technologies used to enable cloud services, cloud computing may present different risks to an organization than traditional IT solutions (CSA, 2009).

According to CSA (2009) study, an organization's security posture is characterized by the maturity, effectiveness, and completeness of the risk-adjusted security controls implemented. These controls are implemented in one or more layers ranging from the facilities (physical security), to the network infrastructure (network security), to the IT systems (system security), all the way to the information and applications (application security). Additionally controls are implemented at the people and process levels, such as separation of duties and change management, respectively.

The security responsibilities of both the provider and the consumer greatly differ between cloud service models. Amazon’s AWS EC2(one of the leading cloud service provider) infrastructure as a service offering, as an example, includes vendor responsibility for security up to the hypervisor, meaning they can only address security controls such as physical security, environmental security, and virtualization security. The consumer, in turn, is responsible for security controls that relate to the IT system (instance) including the operating system, applications, and data.

The inverse is true for Salesforce.com’s (the known cloud service vender on software service offering) customer resource management (CRM) SaaS offering. Because the entire ‘stack’ is provided by Salesforce.com, the provider is not only responsible for the physical and environmental security controls, but it must also address the security controls on the infrastructure, the applications, and the data. This alleviates much of the consumer’s direct operational responsibility.

The deployment and consumption modalities of cloud should be thought of not only within the context of ‘internal’ vs. ‘external’ as they relate to the physical location of assets, resources, and information; but also by whom they are being consumed by; and who is responsible for their governance, security, and compliance with policies and standards. Cloud Computing Security helps customers regain visibility and control through its end-to-end coverage for securing private, hybrid and public clouds.

IaaS is the foundation of all cloud services, with PaaS building upon IaaS, and SaaS in turn building upon PaaS. In SaaS environments the security controls and their scope are negotiated into the contracts for service; service levels, privacy, and compliance are all issues to be dealt with legally in contracts. In an IaaS offering, while the responsibility for securing the underlying infrastructure and abstraction layers belongs to the provider, the remainder of the stack is the consumer’s responsibility. PaaS offers a balance somewhere in between, where securing the platform itself falls onto the provider, but securing the applications developed against the platform and developing them securely, both belong to the consumer.

Understanding the relationships and dependencies between Cloud Computing models and how they are deployed is critical to managing Cloud Computing security risks posture of an organization.

2.7.2. Self-service management capabilities of cloud systems

The key feature of a self-managing cloud system is dynamic capacity planning, which is underpinned by monitoring and accounting services. Capacity planning hides complex infrastructural tasks from users by automatically scaling in and out virtualized resource instances in order to enforce established SLA commitments (TeciRes project research group: Xiaoyu Chen, Gary B. Wills, Lester Gilbert, David Bacigalupo, 2010).
Monitoring is an import technological aspect in cloud computing. Monitoring is a lower-level service that aims at providing real-time system performance information. With a monitoring service, CSPs can measure performance and availability of the overall cloud system. The monitoring service can also be used by users to measure the performance of provisioned virtual machines, and to determine whether new virtual machines need to be started. Monitoring processes can take place at the service level and provide information for SLA management.

In a cloud system, everything is metered and accounted. Metered usage information provides for flexible pricing and charging in a public cloud environment. Historic usage information together with monitoring information is critical to automate capacity planning and ensured agreed QoS.

Cloud users can use self-service API (allowing developers take care of scalability and autonomic capabilities themselves) for capacity planning, or self-management API (that allows developers to call auto-scaling and autonomic capabilities provided by CSPs) facilities for dynamic resource provisioning by specifying high-level policies, rules, or SLAs. In the latter case, the burden of capacity planning shifts to the Cloud providers' side. For CSPs, well-defined strategies of capacity planning are critical to successful business. Nevertheless, users may use utility functions to combine different QoS metrics and maximize their usage of paid Cloud services.

One of the key characteristics that distinguish cloud computing from standard enterprise computing is that the infrastructure itself is programmable. Instead of physically deploying

servers, storage, and network resources to support applications, developers specify how the same virtual components are configured and interconnected, including how virtual machine images and application data are stored and retrieved from a storage cloud. They specify how and when components are deployed through an API that is specified by the cloud provider.

An analogy is the way in which File Transfer Protocol (FTP) works: FTP servers maintain a control connection with the client that is kept open for the duration of the session. When files are to be transferred, the control connection is used to provide a source or destination file name to the server, and to negotiate a source and destination port for the file transfer itself. In a sense, a cloud computing API is like an FTP control channel: it is open for the duration of the cloud's use, and it controls how the cloud is harnessed to provide the end services envisioned by the developer. And unlike the FTP protocol, cloud APIs are not yet standardized, so each cloud provider has its own specific APIs for managing its services.

2.8. The Future of Cloud Computing in Banking

The rapidly changing customer relationship management task, the emerging generation of cloud based socially-driven money management tools, the emerging collaborative cloud based service sharing in to joint venture, scale of IT infrastructure, and competitors' pressure will influence cloud computing adoption for banking industries in the future (Emmanuel Sardet, 2012).

The relationship between consumers and their providers of banking services and products are rapidly changing from time to time. Consumers' migrations to digital, mobile and contactless payments will affect the buying habits, channels and customer services in all markets, and will impact all consumer-facing industries. Cloud computing will make these services more convenient, more accessible, easier to use, and more personalized to the individual's needs and lifestyle.

Currently many banks are focusing to advance the IT stacks at all level on IaaS and/or SaaS, having virtualized their infrastructure and started to use SaaS for undifferentiated activities. Additionally banks will continue to ramp up effort to win customers not just from banks, but from others to respond the competitor pressures in order to avoid disintermediation by investing in capabilities around social media, analytics, and targeted product and service bundling. Banks can take the same approach with their own systems and processes. Scale of IT infrastructure will also influence cloud computing adoption. Newer and smaller banks built on client/server architectures have less overlapping legacy systems and infrastructure,

and will therefore be quicker to adopt cloud technology higher up the stack. Underscoring the fact that cloud computing adoption is not an all-or-nothing choice for newer and matured market banks.

Emerging market banks that have less systems infrastructure legacy than their counter parts in the market are enforced to invest on the infrastructure to compete in the banking market ecosystem. For those emerging market banks too small to invest alone in a cloud-based core banking infrastructure, they may choose to form a consortium to leverage a shared cloud. Banks can compete either as ecosystem leader, if they are matured or as a participant in the ecosystem if they are an emerging market bank.

Collaboratively banks can pool non- differentiated activities in to joint venture using private clouds with in a closed group banks. These JVs could provide shared services that interact with customers in more engaging ways while simultaneously freeing banks from the burden of routine transactions. Collaborative JVs could also be suited to areas that are integral to core banking but not differentiators with customers, such as security. By turning security into a service that is shared with other banks and operated via a joint venture private cloud, banks could stop duplicating investment, industrialize their security processes for economies of scale, gain new service options and have immediate access to the latest applications. These collaborative private clouds could even be “hybrids” powered by a third-party, increasing the benefits of cost and flexibility.

According to Emmanuel Sardet (2012), in the foreseeable future, cloud computing will be omnipresent. No industry can afford to ignore it. But its impact will vary in every case. Competition, collaboration, and convergence will impact future banking products, services and technologies.

2.9. Ethiopian Banking Industries

2.9.1. Overview of Ethiopian Banking Industries

The history of the use of modern money in Ethiopia can be traced back more than 2000 years (Pankhrust 1968 cited in Gedey1990, and Simeneh 2012). Modern banking in Ethiopia was introduced in 1905. At the time, an agreement was reached between the Ethiopian Emperor Minelik II and a representative of the British owned National Bank of Egypt to open a bank

which led to Bank of Abyssinia inaugurated in Feb.16, 1906 by the Emperor himself. In the 30's the bank was bought by the Ethiopian government and the State Bank of Ethiopia and was established by a proclamation issued in august 1942. Twenty six year later, Bank of Abyssinia was legally replaced by Bank of Ethiopia shortly after Emperor Haile Selassie came to power. The new Bank, Bank of Ethiopia (http://www.nbe.gov.et/), was a purely Ethiopian institution and was the first indigenous bank in Africa. This bank was later disintegrated to two different banks forming the National Bank of Ethiopia and the Commercial Bank of Ethiopia. (Lulseged, 2005)

These days Ethiopian banking sector comprises a central bank (National Bank of Ethiopia), three public and over sixteen private owned banks. The common banking functions provided by public and private banks in Ethiopia are deposit mobilization, credit allocation, money transfer and safe custody.

The Ethiopian banking industry as a whole has a network of 1289 branches at the end of the fiscal period ended in June 2012, which is not enough compared to the size of the country (1.1milion square km) and number of population (above 80 million) and this shows that the number of population being served by a single branch stood at around 62,063.6 (NBE, 2012)..

With such scattered branch network and disintegrated working system it is hard to ensure efficient flow of financial resources, efficient usages of ICT infrastructure, customer satisfaction, and optimize the contributions of the entire financial system to the development processes. Money banks in Ethiopia are too late to move with technological advancement used in the rest of the world and they are not integrated with each other for rendering non differentiated banking services for all customers of the bank in Ethiopia.

The banking system has developed well over the years in terms of its geographical coverage, deposit mobilization and credit expansion. Commercial Bank of Ethiopia is the largest, controlling the majority assets of the industry followed by Construction & Business Bank, Dashen Bank, Awash International Bank and etc. Hence, the share of private banks branch network was 47.6 percent at the end of 2011/12.

2.9.2. Current ICT usage Practice in Ethiopian Banking Industries

Many banks in Ethiopia have already using the digitized and networked banking services at enterprise level IT infrastructure. Banks invest millions of dollar for fulfilling the changing

computing needs to deliver the banking services consistently in the market at enterprise level individually. These modern e-banking technologies used to provide banking services for customers are ATMs, Debit cards, Credit cards, Tele banking, Internet banking, Mobile banking and others technologies.

Recently, Core Banking Systems are applied in many private and public banks of Ethiopia. The use of core banking solutions is expected to achieve a nationwide electronic payment system according to the central bank`s targets (NBE, 2012). CORE ("centralized online real-time environment".) banking is services provided by a group of networked bank branches. Bank customers may access their funds and other simple transactions from any of the member branch/channel offices/computing devices by accessing the application from centralized data centers. This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw the deposited money from any of the bank's branches throughout the country. Thus, using core banking technology bank`s provide banking services (including cash withdrawals, bill payments, fund transfer, mobile top up, balance inquiry, and etc.) available across multiple inter-connected channels like ATMs, Internet banking, and branches. Example, customers` of Commercial Banks of Ethiopia can access various banking services from any channels of CBE located anywhere at any time.

Cooperation among banks is the best strategy to improve electronic card payment system in Ethiopia. Recently, three private commercial banks - Awash International Bank S.C., Nib International Bank S.C and United Bank S.C. – have deployed an ATM network called Fettan ATM network. Fettan ATM is installed in ATM machines and POSs across Ethiopia (Gardachew, 2010). The customers of the member banks can have an access from all service channels of the banks across the country. On the other side through collaboration between Zemen Bank and Dashen Bank under the “Q-Link” network the customers of Zemen and Dashen Banks are both able to benefit from a total network of more than 100 ATMs at locations throughout Addis Ababa and several regional cities. This collaboration marked as a significant cooperation between competing banks in Ethiopia, which others should be encouraged to follow (Zemen Bank, 2013). There is no single bank in Ethiopia that can afford the infrastructures to provide extensive geographical coverage and access. Additionally, the first ever electronic banking gateway was signed between Ethiopian Commodity Exchange (ECX) and Dashen Bank and CBE (Dashen, 2012). The electronic

banking system being developed with both banks is designed to give a secure electronic data sharing gateway between clients, banks and ECX, facilitating a smooth transaction.

However, low level of internet penetration and poorly developed telecommunication infrastructure, high cost of internet compered to developed countries, limitations of collaboration among banks to share resources, high rate of ICT illiteracy, security issues, lake of trained personnel, the changing computing needs and other related factors are the key challenges in the current ICT usages of Ethiopian Banking Sectors (Gardachew, 2010). Lack of up-to-date plan for ICT service delivery strategy can be considered as a limitation for banks` to fully harvest the opportunities presented by the latest technology.

Certainly the banking industry in Ethiopia is in a developing stage and therefore there is an all immediate need to embark on capacity building arrangements and modernize the banking system by employing the state of the art technology being used anywhere in the world. Continual improvement and advancement of technology would assist banks` for harvesting the actual and expected benefits of ICT. Developing a framework for adopting new technologies that are well applicable in the developed country banking market has been helpful in selecting the right tracks to profitable ICT adoption strategy.

2.10. Cloud Computing for Ethiopian Banking Sector

Literatures indicate that many financial institutions including banking sector are shifting their ICT paradigm from traditional data centers to centralize and distributed one for the improvement of services with lower costs and better efficiency. In Ethiopia, banking service development and rendering quality of service that can meet customer needs has suffered by high investment cost to ICT infrastructures and the rapidly changing computing needs. In Ethiopia, banking industries are being expanding in a very high speed across the country. Currently there are 19 private and public banks with their many branch offices/automated channels.

Without quality customer service distributing branches by itself cannot give the solution we seek for customer satisfaction, profitability, cost reduction, overall growth of the bank specifically, and economic development and poverty reduction of the country as a whole through banking service. Banking service should be supported through up-to-date technologies and new market models. Many Banking sectors in Ethiopian has been investing

millions of dollars every year to support their banking service by technology. However due to struggling economy and technological limitation it is not able to supply full ICT infrastructure requirements recently applicable in the civilized world. As it has been discussed in the previous sections this infrastructure requirements can be solved using cloud computing strategy .i.e. implementing a central Hybrid Cloud computing infrastructure that can be used by all banks.

The Proposed Ethiopian Banking Industries Hybrid Cloud (EBIHC) combines private and EBIs clouds. The private cloud is implemented and managed by each banks. Every computing resource (such as servers, connections, storage, and related tools necessary to build an application environment) that can be shared by multiple bank branches will be placed at EBIHC and then it will be available to all hosted bank service channels. This can be an attractive option for Ethiopian Banking Industries for cost savings, ease of scaling-in and scaling-out computing resources, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move. Therefore the proposed EBIHC cloud system will reduce duplicated cost by provisioning computing resources in a very affordable way that are necessary to build an application environment on-demand by renting base rather than procuring resources for extending the performance of internal infrastructure.

The proposed EBIHC can have an interface from each Ethiopian Banking Industries Private Cloud (EBIPC) to local Cloud Service Providers. The hybrid cloud interface creates a connection between private clouds and public clouds. By deploying Hybrid cloud computing model, the fear of privacy and other related security issues can be avoided, since critical and sensitive data could be owned by the bank responsible bodies.

The proposed EBIHC can improve collaborative work between banks through sharing infrastructures. This presents new streamlined business process and new bases of competition among matured banks and emerging market banks. Emerging market banks generally have less systems and infrastructure legacy than their counterparts in mature markets, making it easier for them to adopt cloud models by paying fewer service charges for the matured market banks. At the same time, banking innovation in emerging markets is being accelerated by faster economic growth and distinctive social needs. Therefor emerging market banks can use mature market ICT infrastructure and service channels without investing the

infrastructure from scratch with some level of service charge agreement; in other side mature market banks have an opportunity for expanding their business and earning revenue from the new service.

2.11. Cloud Computing Adoption Strategy for Banks

Cloud computing has caused more debate than many other recent technological advancements. Regardless, there has been a tremendous rise in its adoption by financial services firms over the last couple of years. Without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011). The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009). Also, in order to have success, the cloud strategy must be aligned with the banks strategy. The prominent cloud adoptions strategies that are agreed in many experts and organizations have included the following phases as illustrated in the figure below.

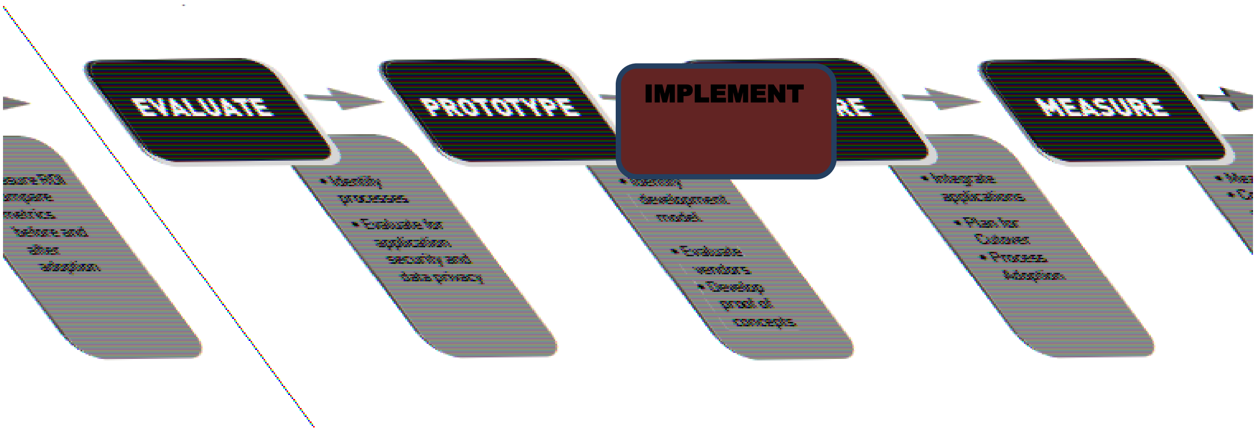


Figure.4. Cloud Adoption Strategy

Phase I: Evaluate

The development of a successful cloud strategy starts with thorough evaluation of current business processes and applications and identifying those that can be moved to a cloud. The phase consists in developing the knowledge base by participating at seminars, conferences,

discussions with the suppliers and consulting the most recent researches in the field. The success of the phase depends on the allocation of sufficient resources for research, for understanding how Cloud Computing functions in different banking industries in the world as a benchmark, the benefits and risks, policies and the best usage practices of Cloud Computing. The research is conducted by a team formed mainly of IT staff who permanently communicates with the users of the solution regarding the objectives, the progress, costs and benefits of the Cloud Computing solution.

The processes and applications should be evaluated from the banks point of view of the IT needs, structure and usage. The service oriented architecture represents the base for understanding the data, services, processes and applications that may be migrated or need to be maintained within the banks, so as to observe the security policy. With respect to the IT needs, their structure and usage, the analysis may start from the categories of users who interact with the present IT infrastructure and their necessities. Additionally, privacy requirements when the information is stored on a cloud, peak load hours, architecture constraints and such legal requirements as the physical location of hardware, which will decide applicable legal jurisdiction and laws of country, and other important points, should be identified in this phase.

Phase II: Prototype

In the Prototype phase, particular processes are selected and the type of deployment model, including public, private or a hybrid cloud, is decided. Plus, strategies for storing data with different security requirements and complexities are developed. Some of the key decisions focus on where the most sensitive data should be located and how less sensitive data will be processed. This phase also includes the evaluation of cloud vendors based on data and architectural parameters. Proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability are completed. Choosing the right vendor involves understanding what each one can offer and how their offerings align with the firm's requirements.

Phase III: Implement

Once the deployment model is decided and cloud vendors are chosen, the implementation phase begins. In this phase, applications are deployed on cloud. Several factors are kept in mind during this phase, including migration and cutover planning, as well as the adoption and operational management of the new process.

Phase IV: Measure

Finally, an organization should spend considerable time measuring the ROI achieved and fine-tuning the adoption process. In this phase, ROI is measured considering the objectives and feedback is collected from end users. The output of this phase is fed back into the evaluation process to fine-tune the next roll-out.

2.12. Related works

Cloud adoption frameworks are developed to predict what customers might do with cloud, based on the frameworks cloud based service implementations are developed and deployed to validate customer predictions from the cloud services. This section describes the available literatures on best practices of cloud-based service implementations and framework development works for cloud-based service adoption strategy in the banking sector.

BBVA, one of the largest financial institutions in the world, announces today that it is adopting Google's cloud-based collaboration and communication suite Google Apps for Business to increase productivity and drive innovation. Over 35,000 BBVA workers in Spain will initially use the productivity tools integrated in to the Google Apps suite including: Gmail with Google Chat, Google Calendar, Google Docs, Google Groups, Google Sites and Google Video. By the end of 2012 BBVA expects to migrate 110,000 employees in over 26 countries to Google Apps.

BBVA chose Google Apps to increase efficiency and to help its workers collaborate more easily, regardless of location. BBVA's new global intranet is the main technology project that will be transformed thanks to Google's collaboration tools such as Google Talk, Google Sites and Google Docs, changing it from a corporate communications and process management site to a place where all employees will be able to share, contribute and manage knowledge globally. Integrating the Google Apps for Business suite with our own tools will allow us to introduce a new way of working where employees have access to all the information they need with just one click, no matter where they are, and can reap the benefits of using advanced collaboration tools. In addition, BBVA will create a social network to improve communication and explore new ways of working. BBVA will now join the four million businesses worldwide which are using Google's enterprise solutions to embrace technological change, and open the door to constant innovation, collaboration and cost savings.

Accenture (2012) describes the Citigroup and Banks of America practices for using cloud services to communicate with customers using social media. Citigroup has implemented various social media strategies to communicate better with its customers, including a blog that actively seeks questions and comments from customers, a YouTube channel, and a service that will allow customers to talk to bank staff through Twitter or other social media. Bank of America uses Twitter as a customer service and advice tool, and reports that

customers find it a faster and more effective way of getting the help they need than traditional customer service channels.

IBM Academy of Technology (2010) conducted 110 case studies and examines those survey findings: where clients are with cloud computing, what challenges they face, how they are benefiting from their existing implementations and where they expect to be in the future. According to IBM Academy of Technology survey findings from the cases studied on financial institutions show that: Firstly, IT efficiencies, consumer interfaces featuring ease of use, and new charging models are the primary motivations for client cloud implementations.Secondly, conversely, security concerns, pricing strategies, system complexity, rapid technology advancements of cloud capabilities, gaps in standardization and a lack of clear value propositions are seen as the biggest inhibitors to cloud computing. Thirdly, integrated vendor offerings combined with ongoing support (applying best practices) are in high demand.

IBM sales and distribution also identifies the successful cloud implementation works (such as cloud desktop, cloud collaboration, cloud analytics, cloud storage, and etc.) in the banking and financial services industry across the world.

Some of the organizations are: (1), a global Japanese bank was concerned that it would suffer security and business continuity risks if the H1N1 virus were to spread to pandemic levels. The 34,000-employee bank is deploying an IBM private cloud to centralize management of desktops using an enterprise-class data center rather than at the user stations. This change gives the bank greater remote flexibility without sacrificing control. (2), a central European bank facilitated continuous, standardized operations and enabled employees across its distributed branches to quickly access trading and banking systems through a security-rich cloud infrastructure. (3), a subsidiary of a large European bank designed a new sales platform based on an application package, which enables tellers to enter data into the system only once, instead of entering it up to 20 times for different applications. The new platform also gives the bank a 360-degree view of customer data, which when combined with embedded artificial intelligence can help generate more sales. (4), a Chinese financial services organization reduced system management costs, speed up deployment for resource requests, standardized software configuration for each deployment request and improved the tracking of system resource usage by implementing a cloud computing solution to deliver powerful provisioning capabilities that simplify system management and maintenance.

AbhinavGarg (2011) conducted a study on how cloud computing is applicable to the financial services industry and provide an approach for adoption by a financial services firm. He was start the study by introducing cloud computing and its characteristics. Then he outline the common challenges that different financial services firms that are more in a regulated and

security-sensitive environment have faced while implementing cloud computing like data privacy, compliance, availability, lack of standards, etc.

The study discusses the factors that make cloud computing an attractive option for a financial services firm. This factors are perceived cost savings, ease of scaling-in and scaling-out, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move are all critical consideration factors that can drive financial services firms to adopt cloud computing.

Additionally, the study suggest a cloud computing readiness approach, which can be adopted by firms to make sound decisions around their approach to—and readiness for—cloud computing. These approaches are: first evaluating current business processes and applications and identifying those that can be moved to a cloud. Second prototype the particular processes that are selected and the type of deployment model, including public, private or a hybrid cloud is decided. Plus, strategies for storing data with different security requirements and complexities are developed. Third implement the application and deployed on the cloud. Fourth measure the ROI achieved and fine-tuning the adoption process.

Finally the study concludes that hybrid clouds with the appropriate allocation of data and applications are recommended where data secrecy is more important. Cloud Computing is a promising paradigm for delivering computing utilities as services. Just as personal computers and servers shook up the world of mainframes and minicomputers or as smart phones and tablets revolutionized the mobile commerce industry, cloud computing is bringing similar far-reaching changes to the licensing and provisioning of infrastructure and to methodologies for application development, deployment and delivery. Some firms have already realized the benefits of cloud computing, which include scalability, cost savings and time to market. Firms that are still looking to leverage the cloud should begin by moving nonrevenue generating and non-core systems to the cloud. And, they should consider developing a comprehensive cloud strategy to move core applications to the cloud.

Chapter Three

Research Methodology

The main aim of this chapter was to design the methodology to carry out the study, which included: determining design strategy for the study including a conceptual framework, defining the deliverables, and articulating the methodology. The requirements to this study were: developing the knowledge base about the state of the problem and the importance of its solution to define the problem; developing the knowledge base about the state of the problem and current solutions to identify the requirements; the knowledge of theory that brought to bear in a solution to design the proposed cloud computing framework; and developing evaluation tool to measure the performance of the resulting framework. Thus the instruments used to develop the knowledge base to the study requirements were data collection using interview and review of relevant literature including similar studies.

3.1. Research design

The research method used in this study is based on the design science paradigm in IS research (Nunamaker et al., 1990; Walls et al., 1992; Hevner et al., 2004). The design science research is a prescription-driven and problem-solving paradigm that seeks to create viable artifacts in the form of a construct, a model, a method, or an instantiation (design artifacts) which provide solutions for management problems (Hevner et al., 2004; Gregor and Jones, 2007; van Aken, 2004).The study focused to use a consensus building approach to produce the framework based on well-accepted elements of the DSRM process, which contains four phases discussed below (Peffers et al., 2007).

i. Problem identification and motivation

This phase includes defining the knowledge of the state of the problem and the importance of its solution. Researchers begun by defining the specific research problem and justify the value of a solution by conducting interview and rigorous analysis of literatures on cloud computing adoption in the banking sector. Since based on the problem definition the researchers atomize the problem conceptually to capture its complexity for developing the proposed cloud computing framework that can effectively provide a solution. The value of the solution also justified to motivate the researcher and the audience of the research to pursue the solution and to accept the results and to understand the reasoning associated with the researcher's understanding of the problem.

ii. Define the objectives for a solution

This phase aims at to identify or drive the requirements for developing the proposed cloud computing framework from knowledge of the state of problems and current solutions. The researchers infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible to align with the bank's requirements. The qualitative objectives are used, which described how a proposed framework is expected to support solutions to problems not hitherto addressed. The researcher used the conceptual framework to inferred objectives rationally from the problem specification. In order to develop the study conceptual framework, researchers started with the literature review to gather relevant requirements and aspects of existing Cloud frameworks.

iii. Design and development

Conceptually, a design research artifact can be any designed object (models, frameworks or instantiations) in which a research contribution is embedded in the design. This phase includes determining the artifact's desired functionality and its architecture and then creating the actual artifact. The knowledge of theory that can be brought to bear in a solution is required to move from objective of a solution to design and development of the proposed framework.

Based on the required knowledge of a solution identified in phase one and two with the literature review and expert interviews analysis to develop the proposed framework:

particular processes are selected; the type of deployment model is decided; strategies for storing data with different security requirements and complexities are developed; and proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability are completed. After determining the framework functionality and its architecture, the proposed collaborative cloud computing framework for EBIs with the implementation plan to deploy application on the cloud could be developed.

iv. Evaluation

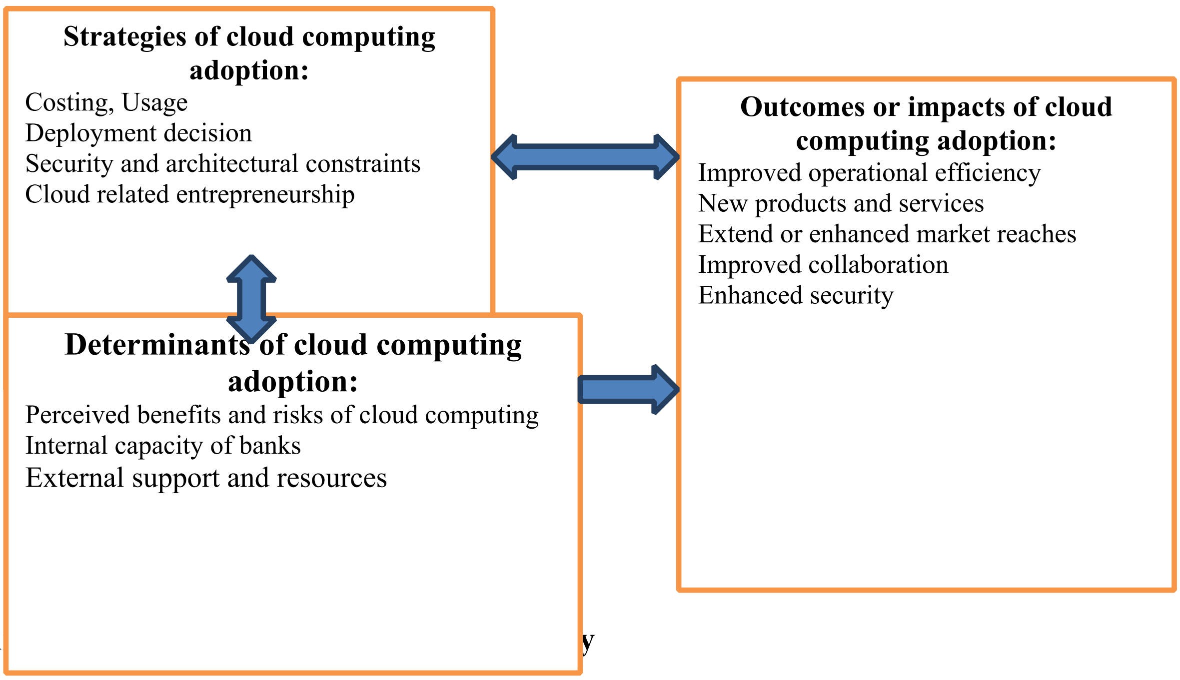
This phase aims to Observe and measure how well the framework supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the framework in the demonstration. It requires knowledge of relevant metrics and analysis techniques. Depending on the nature of the problem venue and the artifact, this study took the qualitative evaluation analysis techniques which include: a comparison of the proposed framework functionality with the solution objectives from activity two above, objective qualitative performance measures, such as business impacts, extents of actual use and user satisfaction. Conceptually, such evaluation could include any appropriate empirical evidence or logical proof. At the end of this activity the researchers can decide whether to iterate back to step three to try to improve the effectiveness of the artifact or to continue on to communication and leave further improvement to subsequent projects. The nature of the research venue may dictate whether such iteration is feasible or not.

3.2. Conceptual Framework for the study

A conceptual framework used in this study was to limit the scope of the relevant data required in the DSRM process phases discussed above by focusing on specific variables and defining the specific viewpoint (framework) that the researcher took in analyzing and interpreting the data to be gathered, understanding concepts and variables according to the given definitions, and building knowledge by validating or challenging theoretical assumptions (Herbert, Asher and William, 2006). Many researchers have been used different frameworks in the study of adopting new technological innovation. Among frameworks that have been developed based on the past studies that are well received framework in the context of innovation adoption by organizations and have been used in many studies are discussed below.

Tornatzky and Fleischer (1990) proposed the Technology-organization-Environment framework (TOE) for studying the likelihood of adoption success of technology innovations. According to Tornatzky and Fleischer (1990), technology adoption within an organization is influenced by factors pertaining to the technological context, the organizational context, and the external environment. While, Kshetri (2010) proposed a framework that explains contexts, mechanisms and processes associated with the development of the cloud industry in the developing world in terms of three inter-connected flows: determinants, cloud related performances and impacts of the cloud. Based on this, the researcher modified this framework and created a more relevant framework for this study by integrating ideas from the two frameworks.

Figure 3.1 shows the resulting conceptual framework that was used to carry out the baseline study on cloud computing for EBIs. The direction of arrows shows an element of causal effect which could either be one directional or bi-directional.



Figu **y**

As shown in in figure 3.1 the conceptual framework for this study consisted three elements including: determinants of cloud computing adoption which used to describe the key factors for cloud computing adoption, strategies of cloud computing which used to describe the deployment strategies for cloud computing adoption, and outcomes of cloud computing

adoption which used to describe the values created by cloud computing adoption. The elements of concepts in figure 3.1 are discussed below.

3.2.1. Determinants of cloud computing adoption

The aim of this element in the framework was to assess the key factors that affect cloud related performance and its outcomes or impacts from its adoption. It contained three components that could affect the adoption: Perceived benefits and risks of cloud computing that refers to adopter's perception of cloud computing attributes,internal capacity of banks that refers to the organization's characteristics that influence its ability to adopt and use of cloud computing, and External support and resources that refers to the external environment in which an organization operates and its condition for supporting the development of cloud computing. For each context, various factors have been identified from the literature but only those that are considered relevant for cloud computing adoption are included in the framework. Details of determinants considered in this element are discussed below.

a) Benefits of cloud computing

This aims to evaluating whether there are sufficient benefits to warrant on cloud computing adoption for banks. For successful cloud computing adoption, the study needed to go through evaluating: operational, financial, CRM and strategic efficiency of using cloud computing for supporting banking services by comparing with the existing IT services provisioning. The current banks preference or innovation culture needed to be analyzed to determine whether it is supportive towards the process of adopting cloud computing or not. These is vital for referring typical characteristics of cloud computing technology considered in technology adoption studies, which include relative advantages (perceived benefits), and relative disadvantages (perceived risks), based on the assumption of Roger's diffusion of innovation (Rogers 2003).

b) Internal capacity

It aims at determining whether the banks has within it sufficient internal resources and appropriate procedures necessary for the successful selection and implementation of cloud computing. Standard compliances such as development and structure of related industries with the considerations of e-government service availability and strong demand strengthen

forward linkages and bandwidth provision with horizontal linkage. For example, cloud computing is IT infrastructure provisioned over the internet, this means that for an organization to adopt this technology it would require good internet connection or bandwidth, where good determined by the bank's core activity and the services that it would acquire from the cloud.

Internal resources also look at: the technological capacity and financial constraints necessary to making the switch from traditional computing to cloud computing. There is also need to evaluate the organizations current policy on IT with the considerations of availability, flexibility, and effectiveness to meet the needs of this new paradigm. While the market situations need to be assessed with the considerations of availability, readiness and dominance of certain actors in the market.

The development of a successful cloud strategy starts with thorough evaluation of current business processes and applications and identifying those that can be moved to a cloud. The evaluation consists in developing the knowledge base by reviewing recent literature in the field and interviewing banks IT staffs who permanently communicates with the users of the solution regarding the objectives, the progress, costs and benefits of the Cloud Computing solution.

c) External environment

It aims to evaluate the external environment, support and resources, particularly if in-house resources and support are lacking. To assess the external environment, the researchers needed to acquire the knowledge about how Cloud Computing functions in different banking industries in the world through considering: benefits, risks, strategies, and the best usage practices of Cloud Computing. There is also needed to evaluate the technologies deployed by service provider with the considerations of reliability, investment cost, agility, usability, availability of the technology and sustainability that affect cloud related performance and its outcomes or impacts from its adoption. Here the researchers look at: data security, number of operating systems and application supported, training and back end support, provider reputation, SLAs guaranteed and so on. At the end of this stage the researchers typically able to have an answer to the question of which cloud provider it should subscribe to.

3.2.2. Strategies of cloud computing adoption

It aims to assess the strategies of cloud computing development for banks or various actors that are instrumental in delivering the outcomes or impacts of cloud computing adoption based on the evaluation on determinants of cloud computing adoption and its outcomes. Strategies look at: costing, usage, deployment decisions and cloud related security and architectural requirements.

The researchers needed to used the available service oriented architecture that represents the base for understanding the data, services, processes and applications that may be migrated or need to be maintained within the banks, so as to observe the security policy. With respect to the IT needs, structure and usage, the analysis started from the categories of users who interact with the present IT infrastructure and their necessities. Additionally, privacy requirements when the information is stored on a cloud, peak load hours, architecture constraints and such legal requirements as the physical location of hardware, which decide applicable legal jurisdiction and laws of country, and other important points, identified in this stage.

In this context, particular processes are selected and the type of deployment model is decided; strategies for storing data with different security requirements and complexities are developed; and proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability that can align with the bank's requirements completed. After the deployment model and cloud vendors option are decided, the proposed cloud computing framework for EBIs developed.

3.2.3. Outcomes or impacts of cloud computing adoption

This aims to evaluate the values created by the cloud or benefits, which are the ultimate objectives that decision makers want to accomplish. Outcomes or impacts of cloud computing adoption includes: improved operational efficiency, new products and services, extend or enhanced market reaches, improved collaboration, enhanced security and Job creation. Finally, the outcomes are measured by considering the objectives and feedbacks collected from end users using qualitative measurement analysis techniques.

3.3. Instrument design

In order to develop the knowledge base about the current state of IT need, structure and usage in Ethiopian Banking Industries the researchers used a qualitative research approach. This approach was selected because this study aims at to investigate existing IT infrastructure, understand what is happening, and find alternative solution from an operational point of view.The contribution of qualitative studies is normally based on its ability to present a new way to investigate existing phenomena, understand what is happening, and find new phenomena and perspectives from an operational point of view (Koskinen et al., 2005). Hirsjärvi et al. (2009) describe qualitative research with three key characteristics. First, qualitative methods such as interview are used. Second, inductive reasoning is employed, which means that diverse analysis of the data and revelation of unexpected things are essential for formulating a problem and developing the working framework from an operational point of view. Second, purposive sampling is used in data collection, which means that the best suitable respondents are chosen in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations.

3.3.1. Sampling method

Sample designs are basically of two types: non-probability sampling and probability sampling. Probability sampling is based on the concept of random selection, whereas non-probability sampling is 'non-random' sampling. Under probability sampling design, every item of the universe has an equal chance of inclusion in the sample. Under non-probability sampling each item in the population has of being included in the sample (Kothari, 1990).

Purposive sampling was used for data collection in this study, which means that the best suitable respondents were chosen from different banks in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations (Kothari, 1990). Under this sampling the organizers of the inquiry purposively choose the particular units of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be typical or representative of the whole. According to Kothari (1990), in purposive sampling, personal element has a great chance of entering into the selection of the sample. The investigator may select a sample which shall yield results favorable to his point of view. Accordingly different persons including IT experts and ICT managers from different banks were selected for interviews. The criteria for selecting

interviewees were their position of authority due to formal position or expertise and knowledge in some specific area to this study. Also the criteria to select the banks were their status of maturity in the market and infrastructure legacy with regulator of the market by categorizing them in to: matured infrastructure legacy banks, less infrastructure legacy banks and regulator bank. The following table shows the organization of the sample and population for the study.

Banks Status	**No. of Selected Banks**	**Name of Selected Banks**	**No. of respondents selected**
Matured infrastructure legacy banks	2	Commercial Bank of Ethiopia	2
		Dashen Bank	2
Less infrastructure legacy banks	2	Addis International Bank	2
		Enat Bank	2
Regulator bank	1	National Bank of Ethiopia	2
Total	5		10

3.3.2. Data Collection and Analysis Technique

- Data collection

Research differs in a number of aspects but they do have some commonalities. One of the common aspects is the need to collect data. Data collection can be derived from a number of methods, which include interviews, focus groups, surveys, telephone interviews, field notes, taped social interaction, questionnaires, and from various publications. Data collected to this study could be a base to understand and identify the banks IT needs, structure and usages.

Data collection consists of either primary or secondary data. Primary data is information that is collected a fresh by the researcher to answer his current research questions. There are several methods of collecting primary data; it can obtain either through observation or through direct communication with respondents in one form or another or through personal interviews (David & Sutton, 2004; Saunders et al., 2009; Sekaran&Bougie, 2010).

Secondary data is use of information already collected by someone else. Secondary data may either be published data or unpublished data. Usually published data are available in various publications of the organizations, governments, researchers, individuals, and others sources of published information. The sources of unpublished data are many; they may be found in diaries, letters, unpublished biographies and autobiographies and also may be available with scholars and research workers, trade associations, and other public/private individuals and organizations. The already available data should be used by the researcher only when the data are reliable, suitable and adequate (Kothari, 1990).

The decision of which information acquisition method to use depends on the research goals and the advantages and disadvantages of each method relative to those goals. Because it is worth remembering that one method of data collection is not inherently better than another method (Nyaora, 2012). This research has preferred to use primary data for different reasons. Firstly, primary data is up to date/fresh, and this is vital where the research is looking at issues in an environment with a rapidly changing landscape such as the cloud computing environment. This original data is important for identifying the real requirements of banks. Secondly, scarcity of finding secondary data that are suitable for this study; because cloud computing is an emerging technology in the developing country.

For the purpose of this study interviewing the best suitable respondents selected through purposive sampling are used as information acquisition method. Interview was selected as the information acquisition method because as Hirsjärvi et al. (2009) and Hirsjärvi and Hurme (2008) argue, it is good method when working with unknown or less explored topic and when predicting answers beforehand is difficult. They also argue that interview is good method because it makes possible to expand the information, clarify desired answers, and get illustrative examples. This method was used to develop the knowledge base to identify the requirements for cloud based service provisioning strategy and its elements for constructing cloud based service framework for EBIs.

Hirsjarvi and Hurme (2008) define interview by suggesting that interviewer’s task is to mediate picture of respondent’s thoughts, opinions, experiences, and feelings. Interviews are a systematic way of talking and listing to people (Nyaoro, 2012). The researcher often uses

open questions to obtain responses from the interviewee, who is the primary data for the study. There are many types of interviews, which include: structured interviews, semi-structured interviews and unstructured interviews (Sauders et al., 2009).

In structured interview the aim is for all interviewees to be given exactly the same context of questioning so that their replies can be aggregated. Questions tend to be closed ended, pre-coded, or of fixed choice. Structured interviews make probing a problem area difficult because they introduce some rigidity to the interview (Corbetta, 2003). Nevertheless, the common format utilized within this types of interview makes it easier to code, analyze and compare data (David & Sutton, 2004).

Semi-structured interviews, on the other hand, are non-standardized and are frequently used in qualitative analysis. The interviewer does not do the research to test a specific hypothesis. Instead he has a list of key themes, issues, and questions to be covered (David & Sutton, 2004). Semi-structured interviews give the researcher flexibility to establish own style of conversation depending on the direction of the interview (Corbetta, 2003). This flexibility enables probing, which is a way for the interview to explore new path which are not initially considered (Gray, 2004).

The unstructured interview or in-depth interview takes a further step towards a more open discussion where no predetermined question is needed. The interviewee is encouraged to speak freely about events, behavior, and beliefs, with reference to the subject. The problem with this is that the researcher may not know what to look for or what direction to take the interview especially if his interviewers are inexperienced. Respondents may talk about irrelevant and inconsequential issues and also it may be difficult to code and analyze the data. The unstructured interview would be highly disadvantageous for this research especially when one considers the limited research time and resource that study's offer.

After carefully understanding each types of interview method semi-structure interview method was selected for this study because it is most suitable considering the nature of the subject. Semi-structured interviews give the researcher flexibility to establish own style of conversation depending on the direction of the interview. This flexibility was important to

obtain rich information systematically from the interview about the subject. Interview questions were adopted from (Sewale, 2012).

Interviews were conducted between April 15 and April 25, 2014 and responses were obtained from all selected informants. The objectives and concepts of the study were briefly explained for interviewees. Each informant was interviewed individually by the researcher.

- **Analysis Technique**

After interviewing all selected informants, the collected data are analyzed and summarized for better understanding of the current ICT need, structure and usage. Interpretation, description, classification, and/or combining of the data are few standardized analysis techniques for qualitative data (Jaatmaa, 2010). The procedure followed in this study was: using the interview to collect data, describing the data, grouping the issues, and interpreting what is happening. In terms of analysis the research deploys the following approach: results and findings from the interview will be described and analyzed, findings from the interview would be compered and contrasted to relevant literature review findings.

The analysis made based on the finding of the literatures and the data collected from the interview for presenting the requirements to constructing the framework intended in this study. Analysis of business requirements through comparisons of information obtaining from primary data with relevant literature finding was necessary to fulfill the gap in current research. The survey of concerning literature happens to be the most simple and fruitful method of formulating precisely the research problem or developing framework (Kothari, 1990). According to Kothari (1990), researcher may review two types of literature: the conceptual literature concerning the concepts and theories, and the empirical literature consisting of studies made earlier which are similar to the one proposed. In this study literatures on concepts of cloud computing including similar studies were reviewed. Accordingly interview and review of relevant literature are employed for this study to develop the knowledge bases required for developing the proposed cloud computing framework.

3.4. Reliability and Validity

The concept of validation refers to the determination of the correctness of the system with respect to user needs and requirements. Validation criteria include comparisons with known

past cases, comparison against exert performance, comparison against theoretical possibilities.

The quality of a research refers to its reliability and validity. In qualitative research validity refers to the appropriateness of the choices in terms of research strategy and data collection and analysis techniques (Jaatmaa, 2010). Validity means consistency of description and its explanation and interpretation (Uusitalo, 1991).

The question templates used to conduct the semi-structured interview coupled with interview findings and discussion could be used by other researchers to validate the findings.Readily available literatureswere carefully selected from the authenticated sources. Consistent practices were applied to the interpretation and explanation of findings.

Reliability also refers to repeatability of a study, i.e., ability to deliver non-random results. This research is reliable because it used valid strategies and techniques appropriate to the research objectives (Nyaoro, 2012). It has a detailed record of research plan and its implementation. The purpose of the research and the use of the collected data were discussed to the interviewees to collect unbiased response.

Finally, the outcomes are measured by considering the objectives and feedbacks collected from users using qualitative measurement analysis techniques, which described how a proposed framework is expected to support solutions to problems not hitherto addressed.

Chapter Four

Findings and Discussion

This chapter presents the results of the interview described in chapter three. The data collection method utilized was the semi structured interview that provided both control and direction through a list of question under interview. Respondents were ICT managers` and senior staff who have an authority to decide which direction banks takes with regard to adopting new IT infrastructure or not. Interviewees were selected randomly from five different banks ICT department using purposive sampling. Ten interviewees from NBE, CBE, Dashen, Addis International and Enate bank were interviewed. Accordingly, results are discussed in this chapter by grouping the issues and comparing the interview findings from relevant literature findings.

4.1. Structure for Cloud Computing Development

There are many factors associated with cloud computing developments, which include benefits with the adoption of cloud computing, reasons which leads development of the system, and outcomes which affects the decisions for implementing the cloud system. In case of Ethiopian banking industries, many commercial0banks using the conventional IT systems based on the “hosted applications model” and don’t have access to take advantage from the new business and technological model i.e. cloud computing IT model. Both models have several features in common; fundamentally their difference is from the business model standpoint (ITU, 2012).

The difference between cloud computing and the existing computing models in EBIs can be better demonstrated by ways of using the service and deployment models and its key enabling technologies of virtualization. ITU, 2012 studies indicated that the major differences between the two modes lies in the fact that, in the case of cloud, responsibility for security is entirely a matter for the cloud computing provider, whereas in the “hosted applications” mode, that responsibility is shared between the owner of the application and the host.

On the other hand Nyaoro (2012) discussed that, under cloud computing IT model, organizations can access computing infrastructures from a cloud provider instead of the traditional purchase of physical servers and software needed to set up a datacenter. Also Armburst et.al. (2009) studies demonstrated that Cloud computing IT model allows the dynamic integration and extraction of computing resources based on the workload and target performance parameters needed by banks, while billing is based on resource consumptions such as CPU hours used, volume of data moved, or gig bytes of data used.

Additionally, Garg (2011)observed the following reasons which may be considered as an attractive option for a financial service institutions for the use of cloud computing.The factors that make cloud computing an attractive options for financial service institutions are perceived cost savings, ease of scaling-in and scaling-out, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move. These critical factors can drive EBIs to adopt and implement cloud computing. Moreover, the main components that can needed to be analyzed for the development of cloud computing framework for EBIs regarding with determinants, strategies and outcomes of cloud computing development were presented as follows.

4.1.1. Determinants of cloud computing

4.1.1.1. Benefits and Risks of Cloud computing

The issues raised in this study in relation with the potential benefits of cloud computing banks gained from adoption it and the potential risk which hinder banking industries from the adoption of new technological innovations.

In Ethiopia, banking services are provided on a group of networked banking channel services to the dedicated customers from a single bank infrastructure. In this context, for expanding the geographical coverage of these banking services, banks need to distribute the channels with the necessary resources (human, financial, computing and etc.). Distributing branch offices and installing ATMs to expand the market coverage of the banking services needed high investment costs to acquire hardware and software infrastructure to support it. This does not protect the investment costs of ICT or it does not the financial efficiency of banks.

When the market reaches at the peak time or computing needs changed, banks also need to procure and install the required IT infrastructures to support the banking operation. This does

not provide a flexibility to respond to fluctuations of market supply and demand, because resources are procured and installed in a fixed time interval.

Customers wants to access any banking services everywhere and anytime nearer to their places without access limitations from any banks available in Ethiopia. But in case of EBIs, the dedicated customers to the specifics banks access only from banks channel they are registered. So customers needed to search bank`s channels, this wastes customers time and money, while reduces their satisfaction. Employees also loaded by large routine transaction volumes, this leads high customer traffic to access the banking services from the branches and limiting the access. Improving operational, financial and CRM efficiency using ICT is the strategy of all banks in Ethiopia. However, because of the above factors banks do not address their strategic efficiency. The overarching and most disruptive impacts of cloud computing will be how redefines the relationship between consumers and their providers of banking products and services. Cloud computing will make these services more convenient, more accessible, easier to use, and more personalized to the individual needs and lifestyle (Sardat, 2012).

One of the basic barrier a firm faces, while adopting technological innovation is the perceived risks. The major reasons that continue to hinder the level of adoption of this new computing infrastructure acquisition paradigm are: performance bottlenecks due to use of HTTP protocols and bandwidth issues; increased threats of single point of failure; customer data lock-in; concerns over data privacy and security; lack of frequently used tools; and the switching costs of migrating from in-house IT infrastructure (Nyaoro, 2012).

Without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011). The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009). Garg (2011) suggest that data privacy, compliance, availability, lack of standards, etc. are the common challenges of implementing cloud computing in a more regulated and security-sensitive financial service institutions.

Moreover, all of the bank manager's participated in this study were asked whether security issue is raised with the use of technological facility in the banking industries, and all of them stated that security is the main concern that hinders our bank to use technological facilities.

The finding indicated that fear of security risks is main barriers if banks used external resources to adopt and implement cloud solutions to support electronic banking for EBIs. In the case of using mobile banking, ATM and POS, security risk affects banks' decision to use external public cloud service providers. Banks do not trust the technology provided by external cloud service providers.

The respondents asked whether banks will decided to use IT resource and support from external public cloud provider to support electronic banking services with greater cost saving and flexibility, and largest number of respondent were agreed on the issue, however fear of risk is one of the factor that hinder the use of external cloud vendor resources and support for EBIs. Similarly the result from the interview revealed that lack of confidence with the security issue is considered as barrier for using external cloud vendor resources and support. This result were consistent with the findings of Garg (2012) in which all indicted that, technological barriers, such as security risk as hindrance factor for the adoption of cloud computing.

Also the result indicated that lack of trust on the use of technological facility provided by external cloud service providers is another factor that can hinder adoption of technological innovation by Ethiopian banking industries. This result confirms the finding of Sarfraz and Brohi et al. (2011) which suggests; the greatest challenge among the banking sector is winning the trust of customers in the issue of security or perceived security risk as a key inhibitor in the adoption of cloud computing. Also Savola, Juhola, &Uusitalo (2010) indicated that there is the difficulty of winning consumer trust, and they suggested that the most important aspects that enforce trust in the cloud are good level of security and privacy.

4.1.1.2. Internal Capacity of Banks

One of the basic issue related with internal capacity assessment to develop cloud computing for EBIs is, the availability of financial as well skilled human resource to implement the system. In this study costs related with the use of E-banking instrument and technical or managerial skills required to implement E-banking system were considered as organizational factors.

Through the years, the value of ICT is increasing for general purpose computing and industry specific computing in banks. Many banks in Ethiopia have already using the digitized and

networked banking services at enterprise level IT infrastructure. Also they are investing millions of dollar for fulfilling the changing computing needs to deliver the banking services consistently in the market, mostly at enterprise level/individually.

Core Banking Systems are applied in many private and public banks of Ethiopia. The use of core banking solutions is expected to achieve a nationwide electronic payment system according to the central bank`s targets. CORE ("centralized online real-time environment".) banking is services provided by a group of networked bank such as: branches, ATMs, POS, phone &etc. This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw or transfer the deposited money from any of the bank's member branches throughout the country. User computing devices used as banking service channels are interconnected with the centralized server or datacenter of bank`s using virtual private network telecom infrastructure.

Moreover, the IT manager of CBE, indicated that: ‘Our bank were aggressively doing on the provision of high quality service to customers by employing different technological innovation, for example the bank purchase CORE banking system software, which offers service to customers more than the sophisticated ATM machine. It would enable banks to provide Internet banking to deliver product/service to customers. It helps customers to view their balances, transfer funds, and pay bills online. Banks could also offer mobile banking services through which customers can check their balance and transfer funds by short message service (SMS), as well as phone banking to check balances and make account inquires by phone.

Thus the cloud computing performance and features have an attractive option to allocate the required resources to implement cloud computing, because the existing core banking solution implemented in many banks in Ethiopia are suitable for integrating the data among them through cloud collaboration or hybrid cloud deployment model (Sardat, 2012).

Similarly the result shows that recently banks and their customers are familiar with the different IT based service provided through ATM, Internet banking, telephone and mobile phone, relatively technical and managerial skills on the use of technological innovation are available. And also this availability of skills and the suitability of the existing core banking solution are considered as favorable input to adopt and implement cloud computing solution for EBIs.

In general, supporting E-banking service such as internet banking, mobile banking and others using cloud computing model achieves greater total cost saving and simplifying the management of IT complexity when compared with the existing IT model to support banking system.

Limitations of ICT Investment and Usage

All Respondents agreed that high investment cost on IT infrastructures, inefficient use of IT resources, lack of collaboration among banks to share IT resources, internet bandwidth inconsistency, the changing computing needs which bear compatibility problems and other related factors were the key challenges in the current ICT usages of Ethiopian Banking Sectors. Lack of up-to-date plan for ICT service delivery strategy also considered as a limitation for banks` to fully harvest the opportunities presented by the latest technology.

The result shows that in regarding to the existing cost incurred on ICT infrastructure to support the non-core and core banking services (different E-banking system like internet/online banking and mobile banking) many respondents did not agreed about its efficiency. The suggestions from all respondents on cloud indicated that, 'compared with the existing IT system to support banking services, using cloud computing in banking industry is efficient to perform banking activities at lower costs. This finding is consistent with the studies of Aarti Singh et al. (2012) which suggested that cloud computing gives adopters two main advantages over: First, it frees them from spending high up-front costs on IT resources that may not be fully utilized in the future, Second, it allows them to face occasional spikes by flexibly adding more resources at whatever time needed.

Respondents agreed on the insufficiency of the current ICT infrastructure investment and usage suggested that banks needed to improve the banking services by employing the state of the art technology being used anywhere in the world. They also suggested that continual improvement and advancement of technology would assist banks` for harvesting the actual and expected benefits from ICT. However, some experts in the banking industry speculate that underdeveloped telecommunications infrastructure may hinder the visibility and practicality of the CORE banking system.

4.1.1.3. External Environment

In principle cloud service is provisioned over the internet to multiple users on as needed and pay as you go model in the world. When we evaluate the external public cloud providers that can provide resource and support to banks in Ethiopia the different prerequisites are under consideration in this study which included: their ability to provide cloud service(IaaS, PaaS and SaaS) required by banks, favorability of their pricing model, the ability to meet high security, trust and privacy measurement standards, the adequacy SLA commitment for banks, availability of alternative cloud providers, availability of data movement from one provider to another provider in terms of time and resource, latency issues, and switching cost.

On the other side the availability of legal frame works, the maturity of national ICT infrastructure, competitive pressure and government support which can affect the adoption of technological innovation in Ethiopian banking industry also analyzed in this study. The result obtained from interview and literatures regarding those issues were presented in the following sections.

i. Legal and Regulatory Framework

National Electronic payments systems, mobile and agent banking system currently covered in Ethiopian legal system, but it is not specifically covered how cloud computing model support E-banking systems. Such legal framework encourages and enhances the introduction of modern electronic payment instrument such as ATMs, credit and debit cards, mobile/telephone/internet banking.

All respondents were agreed that there is no specific legal frame works in Ethiopia to adopt and implement cloud computing. Likewise, respondents were agreed that the differences on banking regulation in different country will have impact on the adoption of new technological innovation such as cloud computing. Similarly, An interview conducted with one of the bank supervision manager at national bank of Ethiopia (NBE) also prove that, Ethiopia does not have special rule on the use of cloud computing or it is not yet included in the banking regulation.

The promotion of cloud computing is an important matter for policymakers and regulators worldwide, since the cloud computing holds out distinct benefits for governments, companies, service providers, industry and research. To enable full enjoyment of these benefits, a coherent regulatory framework guaranteeing transparency, data protection and

respect for data integrity has to be established (ITU, 2012). So the availability of an adequate legal structure and security framework on cloud computing implementation could also encourage the use of cloud computing to support banking services in Ethiopia.

However there is no specific legal framework for the adoption of cloud computing standardized with other countries regulation at central bank. Cross-country legal and regulatory differences will have impact on the adoption of cloud computing in the banking sector that support e-banking services like, ATM, internet banking, mobile banking and Point of sale terminals (POS). These may hinders the use of external cloud service provider for EBIs. Moreover, the result from the interview about legal framework on implementation of cloud computing revealed that lack of legal frame works that meets on cross country legal and regulatory difference is considered as barriers faced by banking industries for the adoption of cloud model to support E-banking system in Ethiopia.

ii. Regulation of Mobile and Agent Banking Services in Ethiopia

Recently the government (NBE) established a clear set of legal framework on the use of technology in banking industry. NBE encourages and enhances banks to focus on technological innovation competition rather than traditional bases of retail bank competition.
The National Bank of Ethiopia is responsible for ensuring that financial institutions are delivering mobile and agent banking services without compromising the safety and soundness of the financial system of the country. Based on this the researchers have been reviewed the Regulation of Mobile and Agent Banking Services (NBE, No. FIS /01/2012)**.**
The use of technology and innovative financial service delivery channels such as mobile devices and agents have significant contribution in deepening financial service accessibility to the wider section of the population at an affordable price. This regulation stated that the use of alternative and innovative financial services delivery channels are essential to encourage and enhance savings mobilization. The minimum standards set by NBE for risk management and customer protection on the delivery of mobile and agent banking services reviewed in this study are:

Modes of Business Conduct

Mobile and agent banking service shall be carried out only within the geographical boundary of Ethiopia and with only Ethiopian Birr within financial institutions that are licensed by the National Bank are allowed to engage in mobile banking services.

Any person who is engaged in valid and lawful business or commercial activity within Ethiopia can be an agent of a financial institution. However, i) a foreign person or entity that is fully or partially owned by foreign nationals ii) religious entity which is faith based and iii) not for profit such as non-government organizations whose applicable law prohibits from engaging in profit making business shall not be an agent of any financial institution.

System Technology

The technology used for delivery of mobile and agent banking services must be secure and should at least ensure the following, which shall be part of the technology risk management program of a financial institution:

User Risk: User awareness on their information security including how to secure Personal Identification Number (PIN) and other security features.

Infrastructure and Software Application Risk: Information security standard, PIN and user authentication, Financial and non-financial data storage, availability of services and backup, Confidentiality of user information, Data and transaction integrity, maintenance of audit trails,, and authorization controls.

Communication Media Risks: Communication protocol risks, Data storage risks, and Availability and quality of service

Agent and Third Party Service Provider Risks: Data Encryption and message integrity, Data storage and backup, Physical and logical access to system, and authenticity and non-reputability of communication

Business Continuity Plan: Availability of services, Disaster recovery site, Standardize way of the data center, Redundancy of network communication, and antivirus protection.

Interface Feature of the Application: The system should be open (need to have a feature of interoperability with other system in any file format.

iii. ICT Infrastructure

Despite the recent improvements made by Ethiopian government on the national infrastructure, the overall ICT infrastructure in Ethiopia created an opportunity for many banks to introduce and expand networked and digitized banking systems rapidly. Card-based payment systems in Ethiopia have been growing fast in recent years. Many banks in Ethiopia

have introduced wider use of debit or ATM cards. The studies of ITU (2012) stated that the level maturity in telecommunication infrastructure is one of the basic elements in the development of cloud computing.

The result shows that ICT infrastructure in Ethiopia for internet access is relatively favorable to use online banking service, which indicated that the current development and improvement strategy of the government for the available and new ICT infrastructure in the country considered as driver to use E-banking system through cloud computing model.

Similarly, an interview result from the CBE E-payment manager indicates that the occasional inconsistency of telecommunication network service is a major obstacle for all banks in Ethiopia to effectively deliver some services such as internet banking, mobile banking and others. However some respondents agreed that the current government effort on improvement of national infrastructure, it will encourage banks to adopt different technological innovation. Therefore, one of the major obstacle factor for adopting external cloud providers resources and support identified in this study is the current maturity level of ICT infrastructure which might create latency problems for transferring data to and from the cloud stakeholder.

iv. Competition

As it is stated in different cloud computing literature, competitive pressure is considered as driver for the adoption of cloud computing in developed country. Respondents from Addis and Enat bank ICT managers were agreed with the idea that the current competitive pressure among newer and old banks in Ethiopian banking sectors is considered as factors for the rapid growth of using innovative technologies. The finding consistent with the studies of Sardat (2012) indicated that cloud computing can help to increase the pace of innovation, specifically for emerging market banks by allocating them to deploy new products quickly and at low cost which allows them to compete more effectively with matured banks whose deployment process in enterprise datacenter can be significantly longer. Thus cloud enables those banks to provide new services and products or to speed the market easily which can be various electronic banking services.

On the other hand an interview conducted with IT managers and experts of NBE confirms that, the central bank enforces and encourages the banks to work collaboratively by integrating their services to improve the speed and efficiency of banking market in Ethiopia.

4.1.2. Strategies for Cloud Computing Development

This section aims to evaluate the essential strategies such as security, legal and architectural requirements for cloud computing deployment and delivery for EBIs. The study of Garg (2011) stated that without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems.

Cloud-based services can be provided by IT companies which have large datacenters and huge software infrastructures with skilled manpower who can run the datacenter. Such cloud service providers are Amazon, IBM, Google, Azure, and others, which provide various IT services such as IaaS, PaaS and SaaS to consumers (Armbrust, 2012). Virtually customers can deploy and run their data or applications on the providers IT infrastructures without the need to invest on IT infrastructures, pay for that infrastructure they are used. This might reduce infrastructure investment cost and its management complexities to enterprises. However, the result shows that banks would not be willing to put their data/application on the external public clouds because of fear of risks on customer data privacy, security and confidentiality issues that might be brought from using it.

Moreover, the regulations covered in the national payment system and mobile and agent banking services limits the third party IT service provider to those only working in Ethiopia. Since processing financial data abroad the country is a difficult issue because of these regulatory framework and various concerns of security risks brings from using external public cloud service providers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer.

On the other hand the existing maturity level of telecommunication infrastructure in Ethiopia would create latency problems for deploying and running the banking system on the public cloud. Transferring data to and from the cloud has high latency than when transferring data

to and from an in-house datacenter. Respondents agreed that high bandwidth internet is required as a basis for providing cloud computing services. These security, legal, and architectural requirements identified above indicated that developing cloud computing infrastructure with external cloud service providers in case of Ethiopia does not present the success we seek from cloud computing.

Additionally, the respondents were asked to suggest about cloud deployment and service delivery suitable for banks. The objectives of the study and the main concepts of cloud computing were briefly discussed with interviewees before conducting the interview. So many of them were recognized the concept of cloud computing such as its service and deployment and delivery model. Accordingly, respondents suggested that hybrid and private deployment models have better role in the banking markets and the availability of IaaS, PaaS and SaaS in the cloud system are essential to provide and meet any demand levels of IT services for banks. Also many respondents agreed that cloud computing have new technological alternatives to produce, develop and deliver IT services than the current ICT investment and usages in banks. They also saw cloud computing as an easier, faster, cheaper and more flexible way to sell and buy all stacks of IT services. Finally, respondents suggested that before goes to investing in the cloud computing references of banks that have successfully implemented cloud-based solutions and are still operating it could be considered.

Therefore, based on the discussions covered in this chapter about cloud benefits, internal capacity of banks for cloud computing development and external environment the researchers decided to select hybrid delivery model that can be formulated between banks and NBE for provisioning cloud based services.

4.1.3. Outcomes of Cloud Computing Adoption

The findings of the interview indicate that the existing ICT investment and usage in Ethiopia Banking Industries were insufficient. Very high IT investment cost, network and internet bandwidth problem and lack of collaboration between banks were the major challenges.

While improving QoS, facilitating collaboration among competing banks, efficiency of ICT usage, and reducing both capital and operating expenses on ICT investment were the main driving forces to adopt alternative IT solutions. And also the major factors that affect cloud computing adoption in Ethiopian Banking Industries identified in this study were: efficiency of ICT investment and usage, increased collaboration with partners for opening new channels and markets, and reduced organizational burden of installing and managing resources in infrastructure and platforms. While the security issues (such as data privacy, confidentiality and etc.), the evolving financial regulations, and poorly developed telecommunication infrastructure are the main barriers for cloud computing adoption. In the following sub section the finding are discussed in each category.

4.2. Requirements for Cloud Computing Framework

Legal and security frameworks are identified, the decisions of cloud computing deployment and delivery model completed and here the architectural requirements to develop cloud computing frameworks that can be independent from the specific cloud service model (SaaS, PaaS, IaaS) are identified below based on legal, security, and architectural consideration of cloud computing for Ethiopian banking industries. These cloud computing framework requirements can be used as evaluation criteria to the final output (Repschlaeger, Zarnekow, Stefan and Turowski, 2011).

i. Service and Cloud management

This includes aspects necessary for the Cloud management and the maintenance of the relationship between customer and provider. Provider management contains support and contact information of the provider. This criterion considers all facts regarding support and customer service, e.g. which support is offered and under which conditions. Service management includes all activities necessary to control and manage the obtained Cloud services which are subsumed in this criterion, e.g. monitoring of services and volume control via APIs.

ii. Costs

It is characterized through monetary aspects like small capital commitment or low acquisition costs and consists of three requirements: pricing model, payment and service charging. Payment and pricing models are shaped by monetary considerations regarding the decision of EBIs and NBE. The payment opportunities include the possible payment method (e.g. credit

card or bank transfer), the time of payment (pre-paid or post-paid) and which level of granularity is priced (e.g. 1 MB, 100 MB or 1 GB steps). Service charging defines how the service is charged (volume based, time based, account based) and the available booking concept, e.g. pay per use, subscription fee, market based prices (spot pricing).

iii. IT Security and Compliance

It summarizes everything related to protection and safety and is composed of the following requirements: datacenter protection, network protection, operations protection and IT compliance. IT compliance is separated into the proposed provider requirements for privacy (e.g. encryption of data) and compliance (e.g. location of data center). Communication security refers to the provided infrastructure and focuses on the communication protection via secure cryptographic protocols and dedicated firewall settings. Operations protection includes the access management and role concept related to the used services. Furthermore, it can provide a multi-tenancy and firewall protected infrastructure, including virus protection systems.

iv. Reliability and Trustworthiness

It describes how certain the bank can be that the service from the Cloud has the guaranteed availability. The proposed cloud framework includes the requirements: reliability, trustworthiness and service level agreements. Trustworthiness characterizes the proposed cloud provider infrastructure including performance and service transparency (e.g. reports, service description), market experience, the number of customers or the annual revenue. Availability and liability include the probability that service commitments and promises can be met by the provider, based on indicators like the service availability, accessibility to several internet service providers and the liability agreements including penalties if the guaranteed service level is not met.

v. Flexibility

It describes the ability to respond quickly to changing capacity requirements and competition pressure. It included the requirements: interoperability, portability, delivery model, and automatization degree. Provisioning and set-up time are subsumed under the associated flexibility advantage of Cloud Computing. Resources, for instance, can be allocated and de-allocated as required. The provisioning time is shorter compared to traditional outsourcing and the set-up time to get in contact with the provider (e.g. register or set up a new account) is shorter as well. Interoperability and scalability comprise all features regarding the maximal

number of available resources (e.g. user accounts, instances, functions, services) which can be used simultaneously. Additionally the interoperability describes the integration between services of banks and the provider. The browser compatibility is important especially on the SaaS level, whereas the development environment is of high relevance on the PaaS level. Contract flexibility and renewal of contract both represent the commitment between the bank and the provider and defined contract automatisms based on the directives of NBE.

vi. Scope and Performance

It covers the functionality and performance of the Cloud service and the requirements consists of service characteristics, service optimizing, hardware, and performance. Usability and customizability refer to the usability and adaptability of the surface of the web portal, the user interacts with. The Usability mainly represents the structure and the ease of use following the self-service concept. Regarding individual preferences predefined templates, editable user views and function settings can be configured by the user. Add-on services describe additionally bookable services like storage, database services, communication services (e.g. collaboration, messaging) or security services.

Chapter Five

Cloud- Based Service for EBIs

5.1. Backgrounds of the Framework

5.1.1. Identifying Cloud Services and Deployment Models

For identifying the required cloud computing solutions that can be provided to EBIs`, the researcher started by analyzing the requirements of bank by means of interview and looking at other financial institutions best cloud service experience and best practice. The analysis

process was based on interviewing Information System directors from selected banks, reviewing best cloud service experience and practices of business companies and financial institution around the world as described in chapter four. Following the results of the analysis the researcher identifies the potential cloud services such as IaaS, PaaS and SaaS, while hybrid cloud delivery/deployment model are proposed for EBIs. The proposed cloud types and deployment model that could best meets banks functional, service, security, and regulatory requirements are discussed in the next sub sections.

5.1.1.1. Hybrid Delivery Model for Ethiopian Banking Industries

Several cloud deployment models are now available to banks and other financial services firms, including (Ryan, 2012): Firstly, the public cloud infrastructure, which is made available to the general public or a large industry group and is owned by an organization providing cloud services.Secondly, the private cloud infrastructure, which is operated and managed solely for an organization or it may be managed by a third party and mayexist on premises or off premises. Thirdly, a hybrid cloud is a composition of two or more cloud environments, in which an organization provides and manages some resources in-house and has others provided externally through a public or community cloud.

By considering the knowledge derived from the literatures and the banks intention from the interview result the researcher decided to propose a hybrid cloud delivery model for EBIs. The researcher also decided to form Ethiopian-based cloud service provider to formulate a secured cloud environment for hybrid cloud model. The formulation of a hybrid model, then, is based on a range of variables, including security and data concerns; the evolving financial services regulatory environment; and a specific institution's application and infrastructure requirements (Ryan, 2012).

The proposed hybrid cloud model will have a capabilities to combine cloud and non- cloud IT infrastructures such as private, shared, and traditional IT with in banks, in which banks provides and manages some resources in-house and has others provided externally through a local cloud service provider in security rich environments.

The proposed hybrid delivery approach allows banks to accelerate speed-to-market by better aligning IT and the business itself. This strategy instills greater agility, which enables banks to better respond to new opportunities and competitive challenges. By integrating traditional IT and private cloud-based services with the new local cloud service provider, this hybrid

approach protects current investments in EBIs. By leveraging flexible sourcing and usage-based pricing, it can help to reduce both capital and operating expenses of banks. This hybrid cloud formulation will fortify vital risk and security management that were considered as the major barrios on cloud computing adoption from using external public cloud service provider in EBIs. Thus, it will mitigate the major barriers raised on cloud computing adoption in Ethiopian Banking Industries.

5.1.1.2. Identifying the Type of Cloud-Based Services

The cloud-based services were selected and identified by considering the needs of their uses on the cloud environment for EBIs. The following sections discuss the three types of cloud services.

Software as a Service (SaaS)

SaaS is one of the service deployment mechanisms which enable user's access different software from the cloud wherever they are, and whenever they need without installing it on their machine (Sewale, 2012). In SaaS users can access different software from the cloudIn SaaS users can access different software from the cloud: CRM, Email, Virtual Desktop, Office applications, Simulation software, Enterprise Resource Planning and different Business Information system applications, like core banking systems, finance systems, HRM system.

Platform as a Service (PaaS)

Platform as a Service delivers a solution stack, which is an integrated set of software that provides everything a developer needs to build an application for both software development and runtime (Bhattachariee, 2009).. The proposed hybrid cloud will offer developer tools as a service to build services, or data access and database services, or billing services on the cloud. The developers who seek to develop and run a cloud application for a particular platform can access these services using the interface presented to them. The developer interacts only with the platform through the proposed hybrid cloud interface, and the platform does what is necessary to manage and scale it to provide a given level of service. Using the cloud, developers do not need to physically install any specific services, solution stacks or databases on their machine. According to Raoj& Reddy (2011) PaaS provides the images to users where they can simply select these images and use them on a machine provided in a

cloud. The hybrid cloud provides the following services for PaaS users: solution stacks (Java, PHP and .NET), and Storages (database and file storage).

Infrastructure as a Service (IaaS)

IaaS is another mechanism to deliver computer hardware such as servers, networks, datacenter space and others, which allows cloud users to host/run their data/applications on the provider computing infrastructure (Esteves, 2011).. The proposed hybrid cloud delivers these infrastructures using virtualization or multi-tenancy architecture at one place to all distributed banks. Under this cloud service model, the provider manages and maintains the hosting and the development environments. By consuming IaaS cloud banks canreduce infrastructure cost and complexity through its capabilities of rapid provisioning, ability to scale up/down and pay only for what you use. The hybrid cloud provides the following services for IaaS users: physical machine, Virtual machine, OS-level virtualization, storage, network and etc.

5.1.2. The Proposed EBIs Cloud Services Provider

Analyzing the potential benefits and risks on cloud computing adoption for EBIs was one of the objectives of this study. These could be considered as a significant starting point for cloud system development effort. Thus this study presents the potential benefits and risks that could be brought from cloud computing adoption. The major factors that affect cloud computing adoption in Ethiopian Banking Industries identified in this study were: efficiency of ICT investment and usage, increased collaboration with partners for opening new channels and markets, and reduced organizational burden of installing and managing resources in infrastructure and platforms. While the security issues (such as data privacy, confidentiality and etc.), the evolving financial regulations, and poorly developed telecommunication infrastructure are the main barriers for cloud computing adoption.

Regulatory risk or the need to secure and protect customer data is a primary concern when evaluating and choosing any cloud-based solution. Ryan (2012) suggested that to select the best cloud model, banks need to consider several issues such as: assess the critical need for security, privacy, and control in a cloud environment, and evaluate the potential cloud solutions based on value, competencies, and risks to decide on building in-house or consuming an external cloud service. This implies that the choose of an appropriate cloud-based solution depends on: security and data concerns; the evolving financial services regulatory environment; and a specific bank's application and infrastructure requirements.

The interview results indicate that Ethiopian banking industries are working in a very highly restricted regulatory policy. Processing financial data abroad the country is a difficult issue because of these regulatory risks and security concerns brings from using external public cloud service providers. Banks also would not be willing to locate their data on external public cloud. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer. Thus the need to find an alternative local cloud service provider that could provide cloud-based solutions for EBIs than external cloud service providers were mandatory.

Through taking in to account the above issues we are discussed the researcher decided to propose Ethiopian-based cloud service provider that can provide the identified cloud services by deploying hybrid cloud model for EBIs. The proposed local cloud service provider will be formed and equipped with essential cloud technology infrastructure that can be provisioned as a service to banks based on their specific application/infrastructure requirements using cloud computing business model. This cloud provider will provide scalable, elastic and reliable resources to the users.

The cloud-based services offered by the proposed cloud service providers could be: (1) IaaS which deliver infrastructure resources includes servers, storage, operating systems, and networking. (2) SaaS which deliver domain-specific applications or services over the Internet including collaboration and communication tools, CRM, Office applications, and different Business Information system applications (like core banking systems, finance systems, HRM system). (3) PaaS which offer developer tools as a service to build services, or data access and database services including: solution stacks (Java, PHP and .NET), and Storages (database and file storage).

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Therefore, the proposed hybrid cloud model allows users to run the different workloads on the local cloud service provider infrastructure or platform services. These potential workloads that could run on that infrastructure/platform services to extend the performance of internal infrastructure/platform services are: development and test, storage, collaboration, desktop,

Webmail, self-service application development environments, ERP and virtualization (Gulla, 2013). Additionally, users will consume the local provider platform services such as: database as a service, middleware as a service, software as a service and software lifecycle as a service.

5.2. Building the Framework

The existing Information communication technology investment and usages in Ethiopia Banking Industry were described as insufficient based on the interview results and the ICT usage practices of other banking industries in the developed world reviewed in this study. Bank is a financial institution and a financial intermediary that accepts deposits and channels those deposits into payment activities, either by loaning to others or withdrawing to depositors. Building an efficient ICT investment and usage strategy to support these activities by leveraging EBIs from recent technological model i.e. cloud computing IT model for ensuring QoS was the main intention of this study.Using this model all channels of EBIs are interconnected with each other virtually and customers can access various banking services from any channels available anywhere through cloud interface. These virtual banking Services helps to solve limitations of the current ICT usage in EBIs. The following figure shows a high level cloud-based service delivery architecture for the proposed Ethiopian Banking Industries Cloud system based on cloud computing model with cloud interface layer to facilitate the interactions among banks from the provider and the cloud service partners to all banks.

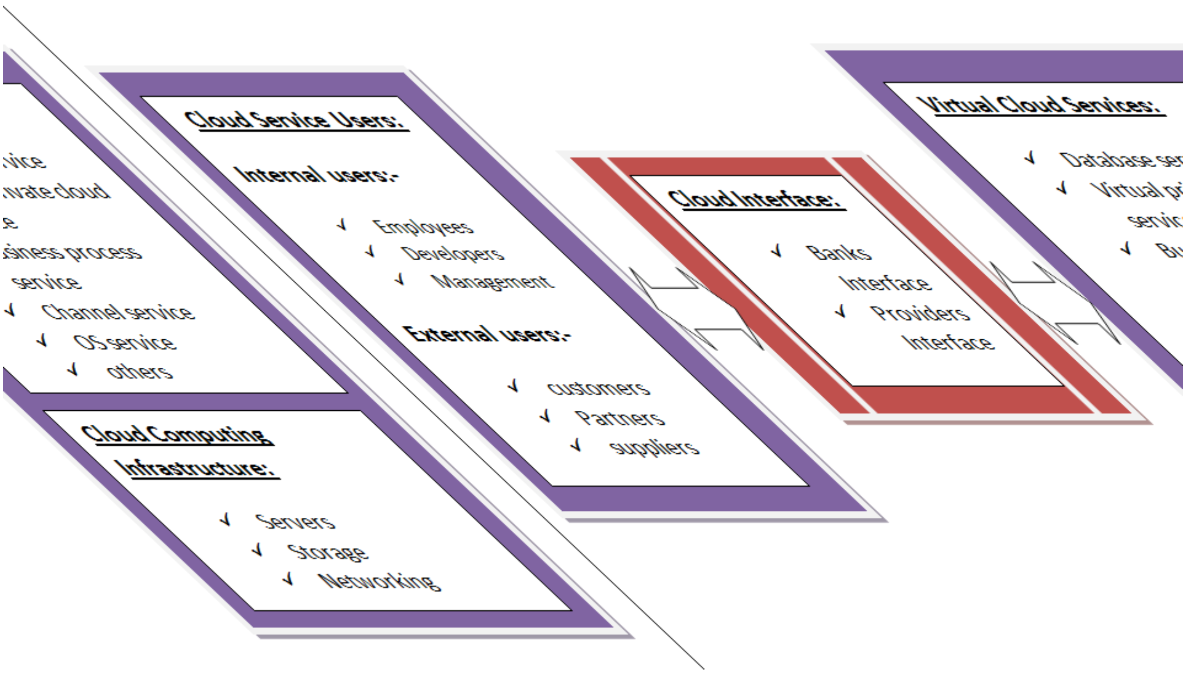

Figure 4.1: High level cloud based service delivery architecture

Virtually the cloud services can be deployed and run on the proposed service provider physical IT infrastructures. Users of cloud services are employees, customers, joint ventures/partners, and others users of the bank. EBIHC have an interface for both banks private cloud and the local service provider cloud. Users can store their data and access virtual machine instances (software containers) on cloud computing infrastructure easily. Users can create virtual machine image, launch the required services and terminate the virtual machines through cloud interface. In cloud, computing resources will not exit but functions by creating virtual version of an IT resource such as OS, a server, Storage Device and Network Resource on rent base when needed (Ryan, 2012)..

Based on the identified cloud services and the selected Cloud model discussed in the framework background, the researchers proposed a collaborative cloud computing architectural framework for EBIs. The following figure shows the proposed Ethiopian Banking Industry Cloud framework.

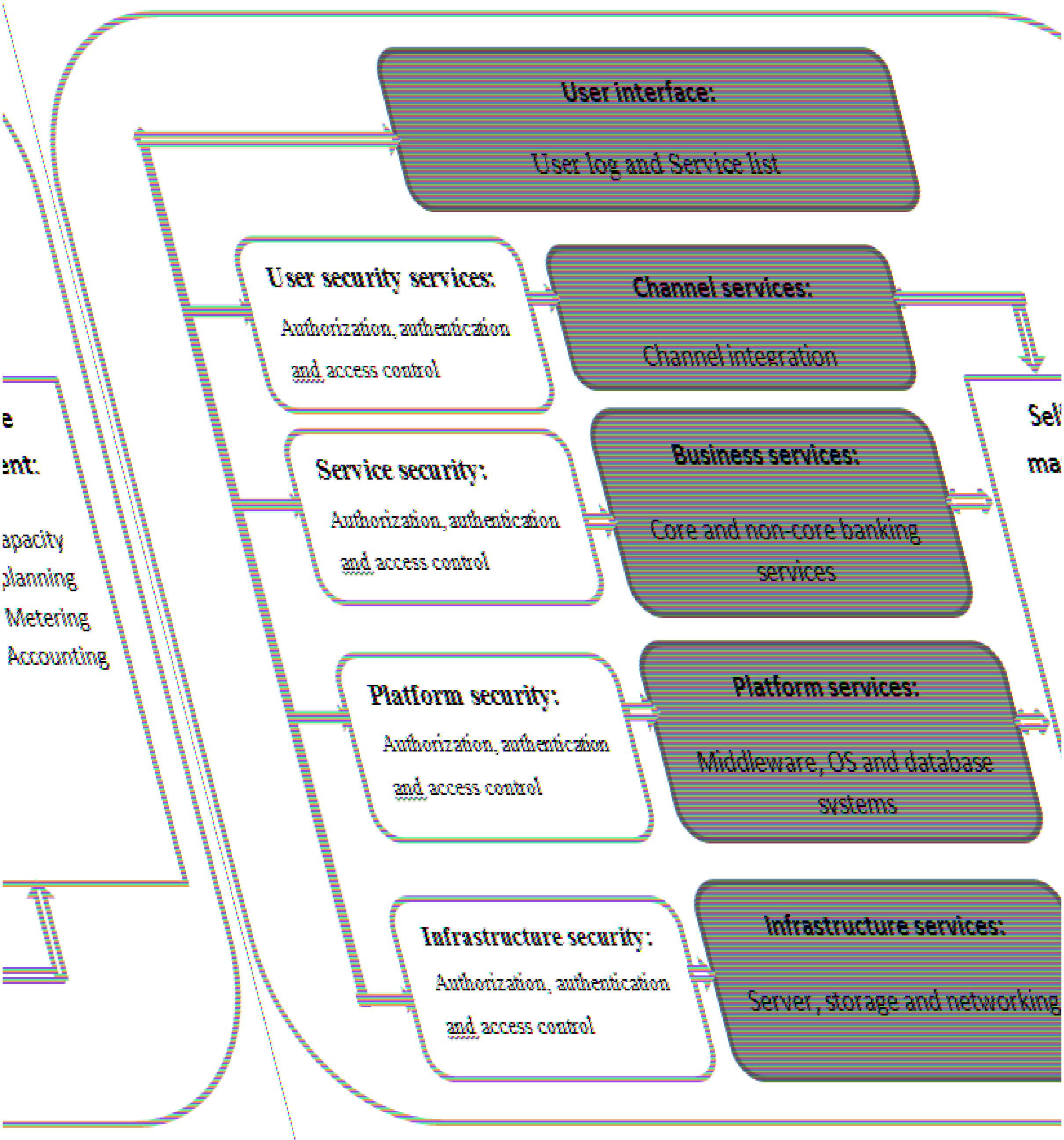
User interface:
User log and Service list
User security services:
Authorization, authentication and access control
Channel services:
Channel integration
Service security:
Authorization, authentication and access control
Business services:
Core and non-core banking services
Platform security:
Authorization, authentication and access control
Platform services:
Middleware, OS and database systems
Infrastructure security:
Authorization, authentication and access control
Infrastructure services:
Server, storage and networking
Metering
Accounting

Figure 4.2: A collaborative cloud computing architectural framework for EBI

The proposed framework illustrated in the above figure contains five cloud service layers (interface, channel service, Business service, platform service and Infrastructure service). The following sections discuss the five service layers of the proposed framework.

5.2.1. Interface layer

This layer acts as an interface between the user and the Cloud content. Access to each cloud services are protected by the proposed security framework. This allows users to access the cloud services in a security rich environment. The User Interface layer contains two important components. The first one is user log which provides an access path to specific cloud services, and the second is a service list which provides the list of the available services on the cloud environment.

5.2.2. Channel Services Layer

The services offered in this layer are channel integration toward a single architecture that supports all channels (ATM, branch, call center, mail, mobile, online, telephone, video, etc.), for delivering a consistent customer experience, common banking services, and information across all channels. The proposed framework provides a user security services to protect unauthorized access from unwanted users. Using this service EBIs can share their channels to provide common banking services collaboratively.

5.2.3. Business Services Layer

The business Services offered in this layer includes core bank services (corporate and retail banking, wealth management, treasury management, risk management and compliance, trading, etc.), as well as noncore services as a hosted application on the cloud environment. Banks may build, operate and manage their core banking services internally, while they can consume other business services offered by the proposed local service provider based on their needs.

5.2.4. Platforms Service Layer

This layer provides access to application hosting and development environments including middleware technology, operating systems, programing languages, database systems and other platform services on a security rich cloud environment. Users are able to build more sophisticated systems and distributed DBs using this application hosting and development environments.

5.3.5. Infrastructure Service Layer

This layer offers infrastructure services including servers, storage, and networking on the cloud environment. The users can consume the services virtually without buying managing it from the proposed EBIs infrastructure service providers. Customer can use these computing resources to run software (both operating systems and applications) and to store data. This layer is often called IaaS.

Additionally, the proposed framework includes security modules and self-service management module. The framework has the security services in each cloud services. First, user Security Services which is included in the framework to control unauthorized access from channels. Second, service security which allows to protects the business services or application from unwanted users. Third, Platform Security services which allows the hosted application/business process run on the platform securely. Fourth, the security module also includes the infrastructure securities that are the building blocks for delivering any cloud based services securely.

The real-time system performance information can be monitored on self-service management module. The local CSPs can measure performance and availability of the overall cloud system. The monitoring service can also be used by users to measure the performance of provisioned virtual machines, and to determine whether new virtual machines need to be started. In a cloud system, everything is metered and accounted. Metered usage information provides for flexible pricing and charging in cloud environment. Historic usage information together with monitoring information is critical to automate capacity planning and ensured agreed QoS.

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5.3. Implementation Plan for the Proposed Framework

The proposed framework`s i.e. EBIHC which are described in the previous sections are promising for efficient utilization of ICT investment and usage of EBIs. In such a situation, the framework needs an implementation plan to deploy cloud-based solution for EBIs. The hybrid Cloud model, which combines the internal IT infrastructure with the proposed local Cloud service provider, was proposed. The next figure shows the general layouts of the hybrid Cloud computing model proposed for Ethiopian Banking Industries.

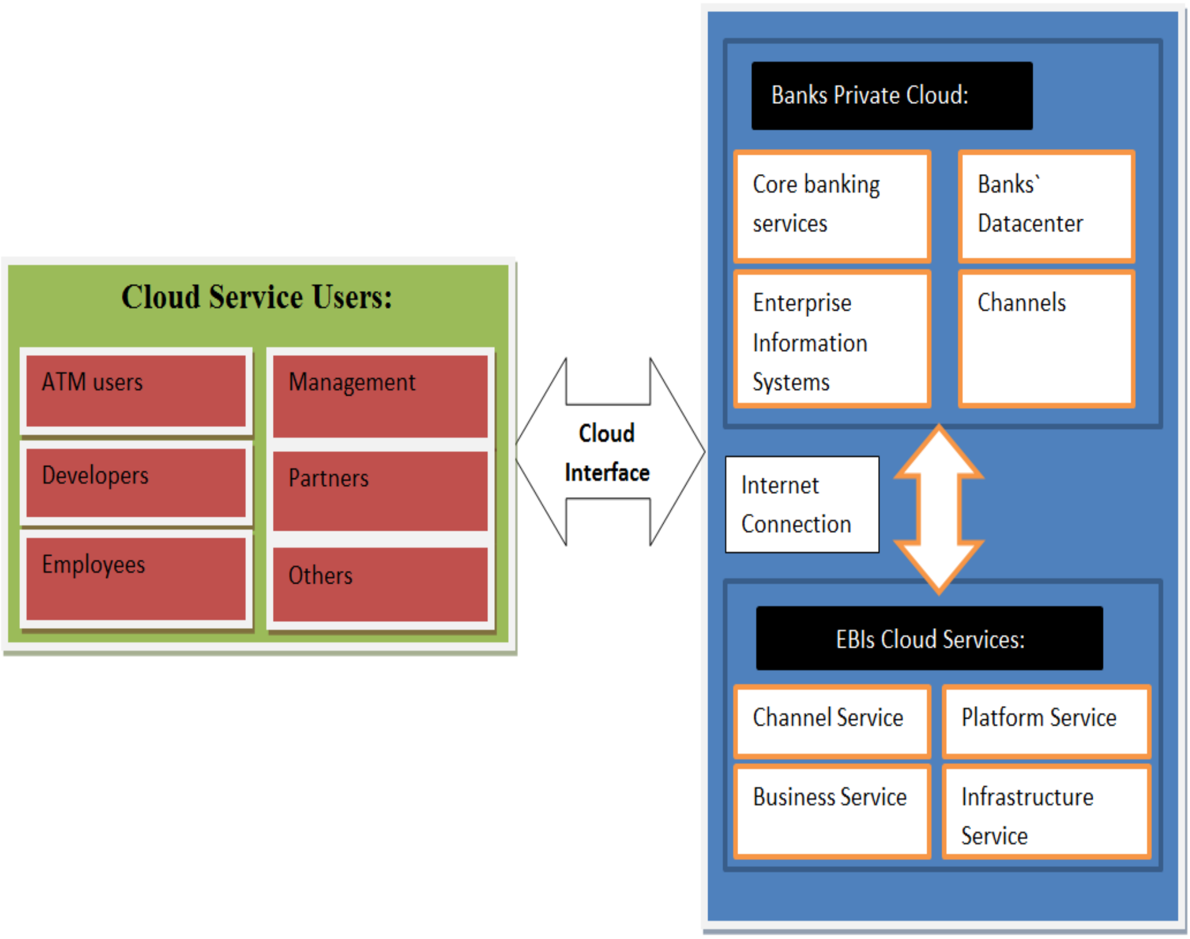

Figure 4.3: The general layouts of a hybrid Cloud for Ethiopian Banking Industries

The figure above shows the general layouts how the user can use computing resource using the central hybrid cloud from providers. The proposed hybrid cloud model could have an interface for both the private cloud and the EBIs cloud. Using this interface cloud users and provider could operate on the hybrid cloud environment. Banks private cloud and EBIs cloud would be combined using internet connection. The cloud service users might be banking service users or cloud administrators.

The following steps illustrate the mechanisms for operating in the cloud environment:

1. The user submits a service request using the EBIHC interface on their devices such as ATMs`, mobile, workstations and etc.
2. The user request would be checked to verify authorization of access to the requested services.
3. If the user is unauthorized to access the requested services, the system will reject the user's request or the request will be sent to the virtual infrastructure manager to redirect the request to the appropriate location.
4. If the user is authorized (users information is available in cloud datacenter) to access the requested service, the system will establish a connection between the requested service from the cloud (EBIs or private) and the user.
5. When the user accomplish their tasks/accessed the required service from the cloud they can terminate the application they was used. The system also terminate the application/services if the users don`t access the services on the time limited to access that service, and the user can submit the request again to the cloud.

To operate in the cloud efficiently each cloud services should be protected on the security framework. As we have seen in the above step accessing any cloud services on the virtual cloud environment is secured.

Developing hybrid cloud model needs to made changes on the existing IT infrastructure for efficient hybrid cloud delivery strategy. So Banks need to standardize their enterprise level IT infrastructures through the proposed EBIs cloud for easy integration of their IT infrastructure

to the cloud. Then they can extend the performance their enterprise level IT infrastructure using EBIs cloud computing environments when computing needs are increased and internal infrastructures are incapable to provide the computing requirements. These will utilize the current Ethiopian Banking Industries IT investment and usage. After a standardized private cloud is established using the proposed EBIs cloud, the cloud provided a manageable hybrid Cloud for the banks. Thus, banks will increase their IT infrastructure efficiency by extending their datacenter and computing power using provider infrastructure without buying additional computing resources when the changing storage and high performance computing power need increased. The proposed hybrid Cloud architecture formulates through combining the proposed EBIs and banks internal IT infrastructure/private cloud using internet connection. The several elements included to formulate a hybrid cloud for delivering the requested service are illustrated in the following figure. The following figure illustrates the proposed EBIHC hybrid Cloud implementation architecture:

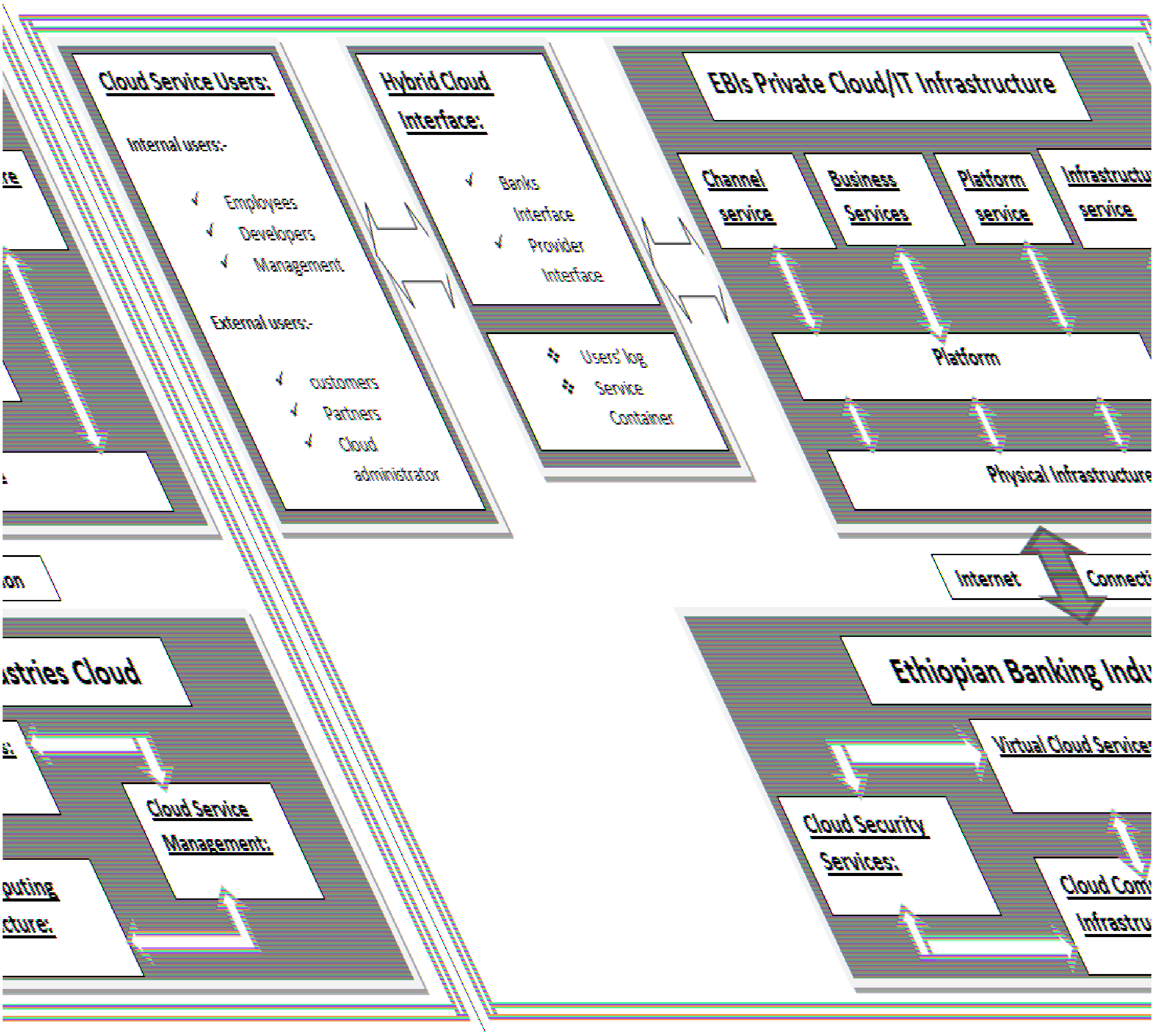

Figure 4.4: The proposed Hybrid Cloud Implementation Architecture for EBIs

There are four elements included in the hybrid cloud implementation architecture such as: cloud users, user interface, internal IT infrastructure/private cloud and the proposed EBIs cloud with their respected cloud services. First, the user interface element contains two services to manage the cloud user's access privileges control and business service delivery. Next, the internal IT infrastructure/private clouds of banks contain four services that can provide all IT services to deploy and use banking services. Finally, proposed EBIs cloud contains four services such as: virtual cloud services, infrastructure services, security services and self-service management that could offer as a service to banks on demand. The following list discusses the proposed hybrid cloud arrangements:

Cloud users: cloud users might be identified as business service users, channel services users, platform users or infrastructure users. Channel service users are customers, partners, employees and others, those who will access the hosted banking services through channels. The proposed hybrid delivery model supports all channels using a single architecture for integrating them. Then banks business services might be hosted on their internal datacenter or on the provider datacenter to be accessible for authorized users through integrated channels. Platform users are mainly developers who will develop applications using cloud development platform environments. Platform service provider offer different platforms to developers on demand. The physical infrastructures of the banks` will be virtualized using virtual private cloud services or internet connection by developers.

User interface: The users' access mode is identified in this element. The system administrator/cloud coordinator will create users type and access privileges. The created users might be customers, employees, administrators, managements and others and their access privileges are determined based on their priority to access the system. User logs are one of the security services included in the interface, which is important for controlling and checking the authorizations of users to access the services. This is mainly responsible for checking the track of the authorizations users and its access mode which is selected for them. Users' information such as access modes, user passbook account, card password, providers` account, user type, and so on are verified using the information stored about the user for access permission in the cloud datacenter. Additionally different business services are listed on the cloud container with specific details about business services to users on the interface. Such business services might be core banking services and other enterprise information

systems. So the authorized users who are verified by the cloud security services can access the services they required using these secure interface service.

The internal IT infrastructure/private clouds: contains four services that can provide all IT services to deploy and use banking services.Banks` private Cloud would be built on the available infrastructure and standardized by the proposed EBIs cloud facilities. Then the physical infrastructures of the banks` will be virtualized using internet connection. An infrastructure service provides IT resource from the Infrastructure resources to the infrastructure service users. The private cloud also contains the platform services which will work and manage the platforms to enable development and deployment of applications and programs with the abilities to access proposed cloud resources and platforms. The platform services provide platforms from the platform container to the platform service users. These infrastructure and platform resources would be offered from the private cloud or provider cloud.

Platforms would be connected to the service container to integrate the platform services with different business services. Then the business service provides access to platforms, so users can use one of the deployed/hosted applications on the platform through platform services. Additionally, Platforms would be connected to all channels to integrate the platform services with channel services. So channel users can access the hosted banking services on the platform.

The proposed EBIs cloud: To build the proposed EBIs cloud large datacenter, large scale software infrastructure and technical manpower to run these datacenter would be required. After having the required infrastructure EBIs cloud provides virtual cloud services on the top of its physical IT infrastructure for banks in Ethiopia. EBIs platform services would allow scalable deployment of applications by providing a web service through which a user can boot virtual machine image to create a virtual machine or an instance containing any cloud services desired. The virtual cloud services offered by EBIs cloud are database services, virtual private cloud services, business services, channel services, operating system services, compute and storage services, and others. The sample virtual cloud services offered by EBIs cloud were presented below.

Storage services: EBIs cloud provides online storage services using a web interface. Customers can access raw computing power from virtual servers or virtual machine instances. And also banks can store and access their data on EBIs cloud storage spaces on-demand. Various information or data would be deployed, stored and accessed by users.

Operating system services: The proposed EBIs cloud will offers a variety of operating systems in image form; the cloud users can operate and perform multiple tasks on the available operating system images. This will facilitate the users to operate their tasks in different operating systems according to their task requirements and compatibility.

Database services: Under cloud-based database service, users can run databases on a cloud computing platform independently, using a virtual machine image, or they can purchase access to a database service, maintained by a cloud database service provider i.e. EBIs cloud. In these cloud environment database developers can create relational databases; link different databases from diverse locations implement and maintain relational databases, and retrieve information using different database languages like, Oracle application or Structured Query Language (SQL) with PHP to connect the databases in the Internet.

Networking services: User can create and launch EBIs cloud resources using a virtual network. By using this virtual networking environment, customers will select their own IP address range, create subnets, configure route tables and network gateways.

Additionally, the proposed EBIs cloud also contains self-service interfaces for on-demand provisioning and management (i.e. start, stop, reboot, and destroy) of virtual services, and self-management interfaces for auto-scaling and other automatable management facilities.

5.4. Evaluation of the Framework

i. Data Privacy, Security and Regulations

Many respondents from the selected banks appreciate the relevance of the proposed cloud solutions. Data privacy and security regulations in many countries including Ethiopia prohibit the storage and processing of customer data outside national borders.Banks are also wary of the potentially disastrous impact of a serious breach of security or privacy, or of even a brief outage in areas such as ATM operations, fraud monitoring or credit card processing. To comply with the rules which prohibit customer data to be passed beyond national borders and the fear of risks banks wary, the options of local cloud service provider considered in this study have positive feedback from respondents.

Interoperability and scalability comprise all features regarding the maximal number of available resources which can be used simultaneously from the cloud system. This capability of the system allows easy data and service integration between banks and provider. In the proposed framework all banks IT infrastructures can be virtualized using internet connection, then using the platform data and applications integrated and made available to end users. In this situation,Platform and infrastructure security focuses on the communication protection via secure cryptographic protocols and dedicated firewall settings. While channel and business protection includes the access management and role concept related to the used services.

The proposed framework supports the data privacy requirements of the banks through the technics of data encryption and they know the physical location of the datacenter. The use of well-understood technologies such as data encryption, the network middle ware manager,which are included in the proposed framework, couldeasily make data in the cloud as secure as that banksdatacenter. This meets the concern of security raised by banks whether the cloud environment can be made as secure as that for most in-house IT environment.

The proposed cloud computing framework security posture is characterized by the effectiveness, and completeness of the risk-adjusted security controls implemented. These controls are adjusted in all layers of the proposed framework ranging from channel (channel security), to business (application security), platform (platform security), and infrastructure (infrastructure security). Additionally controls are adjusted at the people and process levels, such as separation of duties and change management, respectively. These characteristics of the framework facilitate secure cloud deployment and delivery systems for Ethiopian banking industries.

ii. Business Impacts

The cloud computing system being developed for all banks in this study were designed to support a secure electronic services sharing between customers, banks and cloud services providers, facilitating smooth collaboration and integration.

The use of cloud system minimizes the risks inherent in purchasing physical IT infrastructures. When pushing an application out to the cloud, scalability and the risks of purchasing too much or too little IT infrastructure becomes the cloud providers' issues. In a growing number of cases, the cloud provider has such a massive amount of infrastructures that it can be absorb the growth and workload spikes of banks, reducing the financial risks they face.

These capabilities of cloud computing helps banks to reduce the cost to enter new market, because infrastructure is rented, not purchased, the cost is controlled, and the capital investment can be zero. Also applications are developed more by assembly than programing. Moreover, cloud computing can help to increase the pace of innovation, specifically for emerging market banks by allocating them to deploy new products quickly and at low cost which allows them to compete more effectively with matured banks whose deployment process in enterprise datacenter can be significantly longer. Thus cloud enables those banks to provide new services and products or to speed the market easily which can be various electronic banking services.

Cloud computing improves easy collaboration between banks in which customers of the collaborated bank` can interact with the shared system in a more engaging way than before. Customers' ability to access the banking services are improved, they can access the banking services anywhere and anytime from any channels of banks in Ethiopia and with their available devices. Thus customers can easily access the banking services based on their experience, digitally or manually from the branch offices or automated devices, simultaneously banks will reduce duplicated investments and freeing them from routine transaction.

Example: if we consider the concepts ofsynergy to enable effective collaboration and speed to market, banks can improve the operational efficiency or greater total cost saving for production of banking services and speed to market or expanding the geographical coverage easily.

Providing electronic banking services within a single bank infrastructure is not more efficient than providing it within a total network of the whole bank infrastructures. Assume that the total network of digital banking channels (i.e. ATM, POS) for production of banking services within individual banks such as: CBE, Dashien Bank, Addis International Bank, Enat Bank,

70, 40, 15, and 10 respectively. Then providing the banking services using 135 total networks of ATMs and POS of the whole banks distributed in different geographical area are more efficient than using a total network of ATMs and POS within such individual bank infrastructure.

In summary, the above evaluations criteriadiscussed related to the performances of protection and safety of the proposed cloud computing framework which included: channel service protection, business service protection, platform protection and infrastructure protection, while the outcomes of cloud computing for business efficiency brought positive feedbacks from the respondents.

Chapter Six

Conclusion and Recommendation

6.1. Conclusion

The development of fundamental techniques that integrate Ethiopian Banking Industries existing IT infrastructure with the proposed EBIs clouds in a collaborative fashion would be critical to enable composition and deployment of elastic application services for banks. That was the main aim of this research work. For developing cloud-based services framework`s for Ethiopian Banking Industries the study started by understanding the banks requirements

through interview, cloud service models and cloud-based service delivery alternatives, and evolutionary options of today's maturing cloud solutions. And also the study discusses the potential benefits and limitations of cloud computing to banking sectors, and the cloud adoption strategy suitable to banks.

The study indicates that processing financial data abroad the country were theproblematic issue because of the evolving financial regulatory and security concerns brings from using external public cloud service providers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer. Due to this consideration researchers decided to proposed Ethiopian-based cloud service provider to formulate a secured cloud environment for banks.

The research shows that hybrid cloud computing modelwould be the main form of cloud adoption forEthiopian Banking Sectors. The proposed hybrid cloud provides a benefit for blending banks IT infrastructure with the proposed EBIs cloud depending on the sensitivity of banks data and applications in each process, and the degree of business criticality and differentiation.By integrating traditional IT and private cloud-based services with the new local cloud service provider, this hybrid approach protects current investments in EBIs.

The resulting framework facilitates collaboration between banks, quality of services and assist new comers in to the market. The different components of the proposed framework offer powerful capabilities to address both services and resources management. This will provide enhanced degrees of scalability, flexibility, and simplicity for management and delivery of services in the clouds. Thus the proposed framework in this study used as a blue print for implementing actual cloud-based services in EBI that can ensure secure services collaboration among banks and cloud service providers.

6.2. Recommendation

Although the results of this study are promising, further work needs to be done in order to realize the proposed framework to Ethiopian Banking Industries. The proposed framework should be implemented on the selected business process and tested with iterative feedback

reflection from the users so that the proposed framework will be modified based on the feedback before the framework`s full implementation in all banks business process.

Cloud computing literature is still in its infancy. The scope of current literature is fairly narrow and thereby future research should consider cloud computing from less charted and novel perspectives. As this study revealed, cloud computing paradigm has still many aspects that should be understood better before it can evolve to the mainstream of enterprise IT. Some suggestions and future research directions are presented next.

- ✓ Developing framework`s for banks on enhancing the security architecture of virtual data centers in Cloud Environment. Researchers might focus on providing security in cloud that protects the data in the Cloud Environment.
- ✓ Future studies can carry out on exploring business models of cloud computing services. Researchers will assess the different cloud business models and their differences according to business model ontology. In particular, it should be analyzed what different capabilities different business models require from the services provider.
- ✓ Exploring the changes in risk sharing model between services provider and banks`/other customer that cloud computing paradigm necessarily inflicts. The implications of changing customer on pricing should be carefully reviewed in order to ensure cloud computing’s viability from services provider viewpoint.
- ✓ Exploring the critical issues in selecting cloud service providers, cloud-based service delivery model, and cloud computing deployment model (Private & hybrid). In particular, it should be analyzed by describing the strength and weakness from service provider to cloud-based service delivery and deployment model for financial institutions.

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Appendix

Interview Questions:

1) What are the ICT services and supports that are provided for internal and external users of the bank by your office?

A. For internal users, employees and management staff?

B. For external users, customers, partners and suppliers?

2) Do you think these services are enough to achieve your mission and vision, in improving quality service to customers, reducing cost and IT complexity, optimizing ICT usage efficiently, dynamic scalability of resources, increasing competitive advantage and modernizing your company?

3) What are the limitations in providing an efficient ICT services?

4) What are the feedbacks of the users about your ICT service? Positive and negative

5) What is the yearly budget for the ICT department of the bank?

6) Does your bank have an ICT policy based on country ICT policy and legal framework for new technology adoption? Do you know them?

6) What is your suggestion in formulating a new paradigm for providing ICT services and supports in the bank? And if possible suggest your own solution from the current technology trends?

7) As an ICT manager, what do you think is best strategy to provide ICT services for Banks to support with the current economic, business and legal context of Ethiopia?

8)If an integrated cloud computing infrastructure is to be built in EBI that could be used by all banks in Ethiopia to provide ICT services, what will be your reaction to this strategy, what kind of services do you think your bank will benefit from the cloud-based technology?

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June, 2014

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A CLOUD COMPUTING FRAMEWORK FOR ETHIOPIAN BANKING INDUSTRY

A Thesis Submitted in Partial Fulfillment of the
Requirement for the Degree of
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Name Title Signature Date

1. ------------------------- --------- (Advisor) ----------------------Date----------

2. ------------------------- --------- (Examiner) ---------------------Date-----------

3. ------------------------- --------- (Examiner) ---------------------Date-----------

4--------------------------- -------- (Chair Person) ----------------Date----------
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DEDICATION

This thesis is dedicated to my late mother MelkamaBekele.

Acknowledgement

First of all, I would like to forward my gratefully and deepest thanks to the almighty God for his guidance, help, support and who added days to my age, Glory to God. Next, my heartfelt thanks go to my research advisors Dr.DerejeTeferi for his invaluable advice, patience and constructive criticisms of this work. Thirdly, I would like to thanks all intervieweesfrom IT staffs of the banks` (NBE, CBE, United&Dashen) for their honesty, suggestion and cooperation by giving interview.

I am thankful to my friends SeleshTefera, FerawoKassay, TadleTefera, TimkiteabeYacobe, Osman Taha, TesfayaDessi and Bezunehu, for their kindness and assistance during my thesis writing.

My special thanks goes to my father, AbereMulu, my brother, Yalemezewod and Yohannes, my sister Almaz, for their encouragement and support. My heartfelt & deepest gratitude also goes to my lovely wife Tigist (TG) and son Ezana (Chuloya). I wouldn't have finished this thesis without their support and love.

Finally, I would like to thank everyone at the College of Natural Science, Department of Information Science, AAU, who has encouraged and assisted me throughout the completion of this thesis.

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List of Figures

List of Acronyms

AAU -------Addis Ababa University
API ------- Application Programming Interface
APIs -------Application Programming Interfaces
ATM-------Automated Teller Machine
AWS ------Amazon Web Service
AWS ------Amazon Web Service
CBE------..Commercial Bank of Ethiopia
CBS------ .Core Banking Solution
CPU -------Central Processing Unit
CRM ------Customer Relation Management
CSP -------Cloud Service Provider
DB ------- Database
DBs ------.Database Systems
EBI------ .Ethiopian Banking Industry
EBIHC ---Ethiopian Banking Industries Hybrid Cloud
EBIPC ---Ethiopian Banking Industries Private Cloud
EBIs------Ethiopian Banking Industries
EC2 ------Elastic Compute Cloud
ERP ------Enterprise Resource Planning
GUI ------Graphical User Interface
IaaS ------Infrastructure as a Service
IBM ------International Business Machine
ICT -------Information Communication Technology
ICTs -----Information Communication Technologies

IT ------- Information Technology
NBE----- National Bank of Ethiopia
OS -------Operating System
OSS -----Open Source Software
PaaS -----Platform as a Service
POS-------Point Of Sale
QoS ------Quality of Service
S3 ------- Simple Storage Service
SaaS -----Software as a Service
SLA ------Service Level Agreement
SOA ------Service Oriented Architecture
SQL ------Structured Query Language
UK ------- United Kingdom
US ------- United States
USD------.United States Dollar
VM -------Virtual Machine
VMs ------Virtual Machines
VPC ------Virtual Private Cloud
VPN ------Virtual Private Network
SLA ------Service Level Agreement

Abstract

Acquisition and use of information technology affect banks` on every front of their business processes. Substantial, banks spend highinvestment on IT to position themselves for mergers or acquisitions, to simply protect their competitive advantages, or to expand geographical coverage into the marketplace. In today's difficult business and economic climate challenged by complex and changing customer and line of business needs, banksare confront problems in providing necessary IT supports to deliver services to customers, partners, and employees anytime, on their preferred device, through the optimum channel.The objective of this research work is to find an alternative solution for acquisition and use of information technology to deliver efficient, flexible and scalable IT services for leveraging Ethiopian Banking Industries from innovative technologies.

Interview and a concise survey on cloud computing were used as the research methodology for this study. Interview was selected for information acquisition method from the selected IT managers of banks. On the other hand a concise survey of concerning literatures on the existing state-of-the-art in Cloud provisioning, management and securitywere conducted. The overall system architecture and its elements that form collaborative Cloud infrastructures in banking

sectors, and best practices on cloud-based service implementations from the early adopter banks in the world also explored in this study.

The advantages of cloud computing for banking sectors, the limitations of current ICT usages in EBI were briefly discussed in this research paper. Also, an alternative solution to the current ICT utilizationslimitations in EBI is given. The study proposed Hybrid Cloud Computing model. The result shows that the proposed cloud computing service framework can have a capabilities for reducing IT investment cost and management complexity, efficient IT utilization for delivering banking services andimprove collaboration among partners. When the proposed framework implemented it could have significant importance to EBI.

Keywords: Cloud Computing, Ethiopian Banking Industries

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Chapter One

Introduction

1.1. Background

The growth of high speed networks and computing power is making possible to process different banking services or applications in microseconds undreamed of in the past. These rapid explosions of technology are changing the banking industries from paper and branch banks to digitized and networked banking services (Wakeham, 2010). Delivering banking services on this networked environment are more convenient and effective than ever before. Expanding the geographical coverage of digitized and networked banking services are the mainstreams for banks to deliver QoS to customers (NBE, 2012). In developing countries, the cost of expanding the geographical coverage of digitized and networked banking services to customers would be difficult for a single bank. In this environment, banks would start to collaborate to pool non-differentiated activities using private cloud computing within a closed group of banks in a similar way to telecommunication sharing network infrastructure (Sardet, 2012). These bundling could provide shared services that interact with customers in more engaging ways while simultaneously freeing banks from the burden of routine transactions. Thus, when the transaction volumes decline these collaboration could enables banks to stop duplicating investment, industrialize their security processes for economies of scale, gain new service options and have immediate access to the latest apps. These collaborative private clouds could even be hybrid cloud powered by a third-party, increasing the benefits of cost and flexibility (Sardet, 2012). .

Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (NIST, 2012). By deploying IT infrastructure and services over the network, an organization can purchase these resources on an as-needed basis and avoid the capital costs of software and hardware. With cloud computing, IT capacity can be adjusted quickly and easily to accommodate changes in demand. While remotely hosted,

managed services have long been a part of the IT landscape, a heightened interest in cloud computing is being fueled by ubiquitous networks, maturing standards, the rise of hardware and software virtualization, and the push to make IT costs variable and transparent (Sewale, 2012).Cloud computing delivers: Infrastructure as a Service (IaaS), platform as a Service (PaaS), and Software as Services (SaaS), which are made available as subscription-based services in a pay-as-you-go model and other essential features to customers (NIST, 2012).
Cloud computing uses the internet to deliver remotely hosted applications, data, and infrastructure services as a new business model for ICT services. The cost for services are typically billed on a recurring, pay-as-you-go basis, cloud solutions require no end-user infrastructure other than client devices equipped with a browser and reliable web access (Furht, 2010). And since most cloud solutions are hosted in service provider data centers/third-party servers (equipped with processors that deliver excellent performance, strong I/O characteristics, low energy consumption, and robust virtualization assistance), banks can scale them up on the fly, without having to invest time and money in procuring and provisioning new computing resources and maintenance costs (Armbrust et al., 2009).

The new business and technological model, such as cloud computing technology will enable banks to create new base of competition, new streamlined business process and improved customer service environments (Ryan, 2012). Cloud computing enables newer banks to have low cost startups by allowing them to rent resources offered by cloud providers/matured infrastructure legacy banks instead of having their own sets (Sardet, 2012). Thus banking industries in Ethiopia would take advantage of cloud computing as a tactical solution to face seasonal peaks without spending big sums to acquire resources that will be idle for most of the time. Operational expenses including salaries and energy costs are equally reduced. Cloud allows banks to share their infrastructure to provide integrated channel services to the whole customers. All these will reduce costs, setup time, installation/upgrade hassles and gives high scalability.
Therefore Cloud technology offers secure deployment options that could help banks develop new customer experiences, enable effective collaboration and improve speed to market, deploy new applications more quickly, trim development costs, and achieve greater agility. Thus, all while increasing IT efficiency through cloud-based services.

1.2. Statement of the Problem and its Justification

In any financial services institutions, IT infrastructure and support are constantly facing cost pressures, while computing needs and amount of data are ever increasing. These increasing IT usages enforce banks to invest million dollars for procuring computing resources and re-procuring when computing needs and business data are increased over time. Cloud computing has generated a tremendous amount of interest and excitement in recent years as it gives a new and useful way to address IT challenges across and beyond financial services (Ryan, 2012).Banks would needs to transform their current ICT service delivery systems and the manner in which their product offerings, channels and customer serviceto enable effective collaboration and improve speed to market with reduced ICT infrastructures investment costs. Banks also would starts to collaborate with partners or third party IT service provider to share IT resources for supporting and providing common banking services to their customers on a security rich environment(Sardet, 2012).

Cloud-based services could be provided by different IT companies which have large datacenters and huge software infrastructures with skilled manpower who can run the datacenter (Nayro, 2012). Amazon, IBM, Google, Azure, and many other IT organizations provide various IT services such as infrastructure as a service, platform as a service and software as a service to consumers. Virtually customers could deploy and run their data or applications on the providers IT infrastructures or public cloud without the need to procure that infrastructures, and pay for the infrastructure they are used (Raoj& Reddy, 2011). This might reduce infrastructure investment cost and its management complexities to banks. However, banks would not be willing to put their data/application on the external public clouds because of fear of risks on customer data privacy, security and confidentiality issues that might be brought from using it.

Banks in Ethiopia are working in a highly controlled and regulated environment, while their customer data are the main assets to run the business securely. Deploying and running the banking services on the public cloud infrastructure would bring unauthorized access from the banks private datacenter that could leads conflict from the financial policy of the country and customers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to

the affected customer. Additionally, the existing telecommunication infrastructure in Ethiopia would bring latency problems for deploying and running the banking system on the public cloud. Transferring data to and from the cloud would have high latency than when transferring data to and from an in-house datacenter.

Currently, many banks in Ethiopia are including self-service and mobile applications into their mix of offerings across staffed and automated channels.Banks in Ethiopia have already using the CORE banking solutions at their enterprise level IT infrastructure. These services provided by a group of networked channels such as: branches, ATMs, POS, phone &etc.This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw or transfer the deposited money from any of the bank's member channels throughout the country.Also the existing core banking solution used by banks are suitable for integrating the data between banks and cloud provider for cloud computing deployment model (Sardat, 2012).Since cloud computing can play a significant role in banks efforts to reinvent its business and operating models (Nikam et al., 2012).

IT capital expenses typically include enterprise software licenses, servers and networking equipment are more expensive and harder to forecast than routine IT operating expenses(Sardat, 2012). With cloud applications, there is no longer a need to build hardware, install software or pay dedicated software license fees. Adopting cloud services allows EBIs to shift costs from capital to operational or from fixed to variable. The bank pays for what it needs when it needs it. This pay-per-use model is more flexible and eliminates the need for significant capital expenditures. Cloud offers more than just IT scalability; it allows a bank to scale their business operations. By allowing for rapid provisioning of resources without scale limitations, using cloud technology enables a company to benefit from economies of scale without needing to add more servers(Nikam et al., 2012).

Moreover, the success of the cloud implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009).In developing cloud computing strategy and infrastructure, it is important to keep security in mind. It needs to understand which delivery models are appropriate based on security and trust requirements with connecting systems. Then assessing the security requirements for banking industries such as: governance,

architecture, applications and assurance to develop the cloud computing framework also an important consideration in this study.

Therefore, the cloud computing framework developed for all banks in this study were designed to support a secure and cost effective electronic services sharing between customers, banks and cloud services providers, facilitating smooth collaboration and integration. However, developing cloud-based applications requires new approaches. Because without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011).But, in the best of my knowledge there was no research conducted on a cloud computing framework to cloud-based application for banking industries in Ethiopia.

Hence, the aim of this study was to answer the following three research questions.

1. Is the current ICT usage strategy efficient in EBI?
2. Do we need to change the current ICT service delivery strategy deployed in EBI?
3. Could cloud computing model be an alternative solution for efficient ICT service provisioning strategy for EBI?

1.3. Objective of the Study

1.3.1. General objective

The general objective of this study was to examine existing ICT infrastructure and usage in Ethiopian banking industries and to develop an integrated cloud computing framework for Ethiopian banking industries.

1.3.2. Specific objective

The specific objective of the study is:

- ✓ To Review cloud computing related literatures to understand various cloud services, deployment models and framework development methods.

- ✓ To examine the current ICT infrastructure and usage strategy and efficiency in Ethiopian banking industries.
- ✓ To explore the potential benefits of Cloud Computing in banking sectors.
- ✓ To examine the necessity of Cloud Computing for Ethiopian banking industries.
- ✓ To compare the cost effectiveness of using cloud computing technology in Ethiopian banking industries.
- ✓ To develop an integrated cloud-based service architectural framework model that can be placed in a moderate place and can provide cloud service for different bank.
- ✓ To identify and recommend future research directions for further investigation on the benefits of Cloud Computing in bank industry.

1.4. Significance of the study

This research could allow the Ethiopian banking industries to consider alternative ways of deploying ICT infrastructures for an efficient and effective customer service delivery. The study would give new insights to the Ethiopian banking industries and other financial sectors on how to invest ICT budgets on their institution. The Proposed Hybrid cloud computing model and the presented implementation plan could be used as a baseline for the physical realization of the cloud. Additionally the study could be used as a baseline for further studies of this newly emerged ICT utilization strategy to be considers in different governmental and nongovernmental organizations of Ethiopia. The proposed Cloud Computing framework could also be used as a baseline for Ethiopian banking industries ICT managerial on how the cloud computing would be implemented and used in banking institutions.

1.5. Scope and limitation of the Study

The main intent of the study is to examine the current ICT service delivery strategies to support Ethiopian banking industries, to consider cloud computing in the field of banking

specifically in Ethiopian banking industries and propose a Cloud Computing framework that could be used as a baseline for implementation of Cloud Computing in Ethiopian banking industries. This study does not consider the development of cloud service implementation prototype. This work focus on examining and analyzing the current ICT usage in Ethiopian banking industries, exploring possible cloud service frameworks for banking sector and developing an integrated cloud-based service framework.

1.6. Organization of the Thesis

The rest of this study is organized as follows: Chapter two covered related literatures on the basic concept of cloud computing: service types, tools, deployment models, cloud computing adoption strategy, cloud challenges and benefits for banking industry; different publications about CBE existing ICT usages; and related works done on cloud based service frameworks locally and abroad in order to understand how it is implemented or used in banking sectors.Chapter three describes the research methodology and strategy that aims to identify the potential cloud solutions that could be provided to banking industries. It begins by describing exploratory research approaches. Primary data collection and analysis technique were described as information acquisition method. Validity and reliability requirements also identified. Chapter four presents the results of the interview described in chapter three. The data collection method utilized was the semi structured interview that provided both control and direction through a list of question under interview.In Chapter five, backgrounds of a framework for building the proposed Cloud Computing Framework for EBI, the detail elements of the proposed cloud computing framework, the architectural components of the proposal for implementing a framework are given. Additionally, technological requirement identification for EBI also presented. What design is better for EBI, why the specific design was selected for EBIs also discussed. Finally in chapter six conclusions about the research and suggestions for future research direction were presented.

Chapter Two

Literature Review

This chapter reviews the different literatures that are related to the objective of the study. Literatures covered in this section are the basic concept of cloud computing: service types, tools, deployment models, cloud computing adoption strategy, cloud challenges and benefits for banking industry; different publications about CBE existing ICT usages; and related works done on cloud based service frameworks locally and abroad in order to understand how it is implemented or used in banking sectors.

2.1. Cloud Computing

Over the last few years, many IT professionals, business managers, and researchers have started to talk about a new phenomenon called cloud computing. Each of these groups defined cloud computing

differently according to their understanding of its offerings. Although there was no agreement about what precisely constituted cloud computing, it still offered a promising paradigm that could enable businesses to face market volatility in an agile and cost-efficient manner (Qusay F. Hassan, 2011).

Regarding its relations to other pre-existing computing models, cloud computing can be used in principle to deliver computing services, including grid computing services, high-performance computing services, etc. This does not imply that cloud computing is a replacement for grid computing, high-performance computing, or any other pre-existing computing model. Instead, cloud computing should be thought of as a new business model that aims at service delivery in a highly scalable and highly flexible manner. The difference between cloud computing and other pre-existing computing models can be better demonstrated by ways of using the service and deployment models and its key enabling technologies of virtualization.

Recently a group of domain-specific experts have proposed definitions that aim at abstracting common characteristics of the cloud and cloud computing. Here are four representative definitions quoted from Gartner, US National Institute of Standards and Technology(NIST), EU commission Expert Group, and Berkeley Institute (cited in TeciRes project research group: Xiaoyu Chen, Gary B. Wills, Lester Gilbert, David Bacigalupo, 2010)

"The term 'cloud computing' refers to any computing capability that is delivered as a service over the internet. While there is no authoritatively accredited definition of the concept, one of the most frequently used defamations is the one given by Gartner, who describe cloud computing as 'a style of computing where massively scalable IT-related capabilities are provided as a service' across the internet to multiple external customers"(Gartner). "A cloud is an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality of service" (EU commission Expert Group).

"Cloud computing refers to both the applications delivered as services over the internet and the hardware and systems software in the data center that provides those services. The services themselves have long been referred to as Software as a Service (SaaS), so we use that term. The data center hardware and software is what we will call a cloud" (Berkeley Institute).

"Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (US National Institute of Standards and

Technology, NIST). The following figure can better demonstrate the definitions of cloud computing.

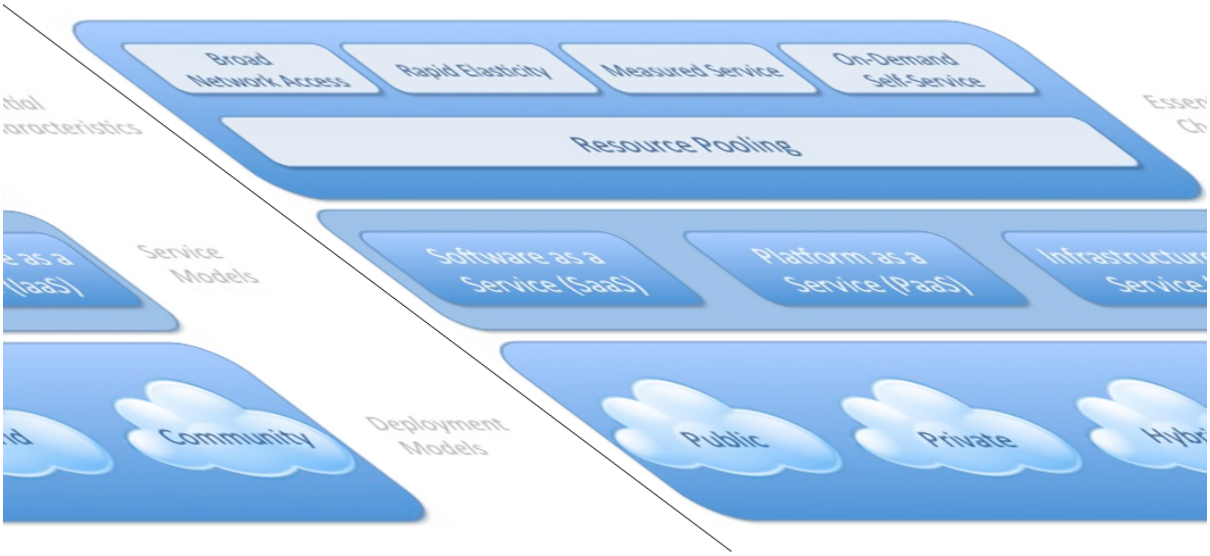


Figure.1. Visual model for cloud computing working definition (source NIST)

2.2. Characteristics of Cloud Computing

According to US National Institute of Standards and Technology (NIST) and Sun Microsystems, Inc (2009), cloud services exhibit the following essential characteristics that demonstrate their relation to, and differences from, traditional computing approaches:

On-demand

A consumer can unilaterally provision computing capabilities such as server time and network storage as needed automatically, without requiring human interaction with a service provider. Instead of requiring a long-term contract for services with an IT organization or a service provider, clouds work on needed model where an application may exist to run a job for a few minutes or hours, or it may exist to provide services to customers on a long-term basis.

Broad network access

Cloud capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs) as well as other traditional or cloud-based software services. Cloud computing extends the existing trend of making services available over the network. Virtually business organization can make available different applications to their internal and external customers using web based interfaces. While enterprises are well aware of the ability to secure communications using Secure Socket Layer (SSL) encryption along with strong authentication, bootstrapping trust in a cloud computing environment requires carefully considering the differences between enterprise computing and cloud computing. When properly architected, Internet service delivery can provide the flexibility and security required by enterprises of all sizes.

Resource Pooling

The provider's computing resources (such as: storage, processing, network bandwidth, and virtual machines) are pooled to serve multiple consumers using a multi-tenant model, thus, different physical and virtual resources dynamically assigned and reassigned according to consumer demand. Even private clouds tend to pool resources between different parts of the same organization.

Rapid Elasticity

Cloud allows the dynamic integration and extraction of computing resources. Cloud services are available for provisioning, often appear to be unlimited and can be purchased in any quantity at any time. Elasticity is an essential core feature of cloud systems and circumscribes the capability of the underlying infrastructure to adapt to changing. This cloud capability allows service users to create an elastic environment that can expand and contract based on the workload and target performance parameters. In general, it is assumed that changes in the resource infrastructure needs are announced first to the middleware manager and then that such changes can be maintained automatically.

Measured service

Cloud system automatically control and optimize resource usage by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, or active user accounts). Resource usage can be monitored, controlled, and reported to providing transparency for both the provider and consumer of the service. Based on this metering and accounting capability of cloud computing, users pay

only for service they are used. Thus, billing is based on resource consumptions such as CPU hours used, volume of data moved, or gig bytes of data used.

Virtualization

It is an essential technological characteristic of clouds which hides the technological complexity from the user and enables enhanced flexibility (through aggregation, routing and translation). More concretely, virtualization supports the following features:

- ✓ Ease of use: through hiding the complexity of the infrastructure (including management, configuration etc.) virtualization can make it easier for the user to develop new applications, as well as reduces the overhead for controlling the system.
- ✓ Infrastructure independency: in principle, virtualization allows for higher interoperability by making the code platform independent.
- ✓ Flexibility and Adaptability: by exposing a virtual execution environment, the underlying infrastructure can change more flexible according to different conditions and requirements (assigning more resources, etc.).
- ✓ Location independence: services can be accessed independent of the physical location of the user and the resource.

2.3. Cloud Computing Service Model

Cloud computing means using IT infrastructure as a service — and that service may be anything from renting raw hardware to using third-party APIs. Cloud service models offer financial institutions the option to move from a capital intensive approach to a more flexible business model that lowers operational costs. In practice, cloud service providers tend to offer services that can be grouped into three categories: SaaS, PaaS, and IaaS. These categories group together the various layers illustrated in Figure 2, with some overlap.

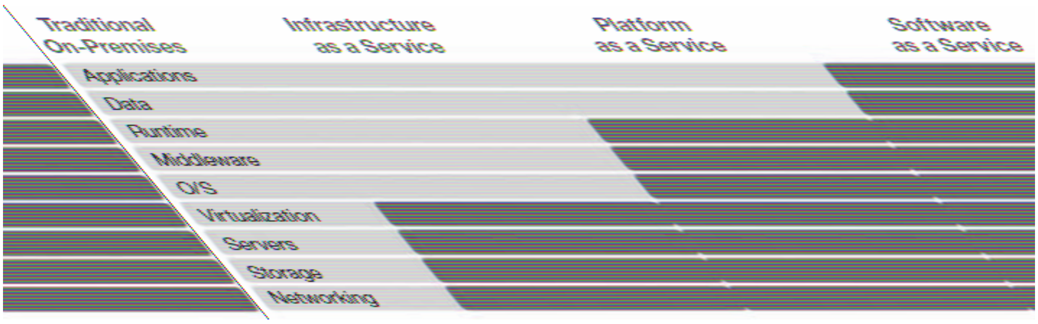


Figure.2. cloud based service layers

2.3.1. Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) refers to making available basic computing resources (storage, processing, and networking) as a service (RuiEsteves, 2011). Under this forms of delivery, organizations can access computing infrastructures from a cloud provider instead of the traditional purchase of physical servers and software needed to set up a datacenter (Maurice Nyaoro, 2012). Infrastructure as a Service (IaaS) allows the customer to run software (both systems and applications), to store data, and to transfer an existing workload to the cloud with limited control at lower total infrastructure cost.

For infrastructure as a Service, the provider maintains the storage, database, message queue or other middleware, or the hosting environment for virtual machines; while user can uses that service with the capabilities to control the operating system, storage, deployed applications and possibly networking components such as firewalls and load balancers, but not the cloud infrastructure beneath them (Raoj& Reddy, 2011).

According to Raoj& Reddy (2011) IaaS operates on a "Pay as you go" model ensuring that the users pay for only what they are using. To operate on this model, IaaS providers offer almost unlimited instances of servers to customers and make cost-effective use of the hosting hardware through virtualization. While the user can buy the infrastructure according to their requirements at any particular point of time instead of buying the infrastructure that might not be used for months and very costly if purchased completely. Thus dynamic scaling, usage based pricing, reduced costs and access to superior IT resources are some of the benefits of IaaS. Examples of IaaS provider: Mossol/Rackspace, AmazonS3, GoGrid&Fexiscode).

2.3.2. Software as a Service (SaaS)

Software as a service (SaaS) is a way of delivering applications over the internet as a service, where the web browser is often the interface for delivery (Bhattachariee, 2009). Instead of installing, maintaining and managing complex software and hardware task, SaaS allows to simply accessing application via the internet (Raoj& Reddy, 2011). The consumer uses an application without having hardware or software to buy, install, maintain, update, and manage the infrastructure on which the applications running. SaaS applications run on a SaaS provider's servers and the provider manages access to the application, including

security, availability, and performances using open standards apply at the application level (Raoj& Reddy, 2011).

According to Raoj& Reddy (2011) this types of cloud computing delivers a single application through the browser to thousands of customers using a multitenant architecture. Thus SaaS eliminates upfront investment in servers or software licensing for users and reduce the costs to manage access to the application compared to conventional hosting.

2.3.3. Platform as a Service (PaaS)

Platform as a Service (PaaS) provides an environment upon which the customer can use to build and deploy cloud applications. These applications may be for use by the customer or offered as a service to others. Building applications using PaaS means that they are inherently cloud-enabled and the PaaS provider also provides the service upon which these applications run (Bhattachariee, 2009).

In the traditional model of software development applications are written in one environment, tested in another environment and deployed elsewhere ((Maurice Nyaoro, 2012). PaaS is a combination of a development platform and a solution stack, delivered as a service on demand. It provides infrastructure on which software developers can build new applications or extend existing ones without the cost and complexity of buying and managing the underlying hardware and software and provisioning hosting capabilities (Raoj& Reddy, 2011).

Platform as a Service (PaaS) layer incorporates all the environments used for development or for run time support, not being directly accessible by the final user (RuiEsteves, 2011). The consumer uses a hosting environment for their applications and controls the applications that run in the environment (and possibly has some control over the hosting environment), but does not control the operating system, hardware or network infrastructure on which they are running.

2.4. Cloud Computing Deployment Model

Regardless of the service model utilized (SaaS, PaaS, or IaaS) there are four deployment models for cloud services, such as:

2.4.1. Public cloud services

Public cloud or external cloud describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet via web applications/web services, from an off-site third-party provider who shares resources and bills on a fine-grained utility computing basis (VenkateRao J. et.al. 2011). The

cloud services are available for anyone to subscribe and to use in a pay-as-you-go manner. A public cloud customer can access these services over the internet from a third-party provider who may share computing resources with many customers.

The public cloud model is widely accepted and adopted by many enterprises because the leading public cloud vendors as Amazon, Microsoft and Google, have equipped their infrastructure with a vast amount of data centers, enabling users to freely scale and shrink their rented resources with low cost and little management burden (B. Furht, 2010). Security and data governance are the main concern with this approach. Sharing applications and infrastructure with unknown co-tenants can lead to concerns over data security and data leakage. If a public cloud is implemented with performance, security, and data locality in mind, the existence of other applications running in the cloud should be transparent to both cloud architects and end users (Sewale, 2012).

2.4.2. Private cloud service

A Private Cloud, or internal cloud, is used when the cloud infrastructure, proprietary network or data center, is operated solely for company or government departments who prefer to keep their data in a more controlled and secure environment, and serves customers within the business fire-wall (B. Furht, 2010). The private cloud allows organizations to outsource the management of their IT infrastructure while retaining tighter control over the location and management of the resources. The price to pay for this is that the costs are likely to be higher because there is less potential for economy of scale, and resilience may be lower because of the limit on service resources available (Larry Ryan, 2012).

The difference between a private cloud and a public cloud is that in a private cloud-based service, data and processes are managed within the organization without the restrictions of network bandwidth, security exposures and legal requirements that using public cloud services might entail (VenkateRao J. et.al. 2011). Isolation is one of the key techniques for ensuring security and, while in the public cloud applications and data exist in a shared environment, the private cloud offers greater isolation by dedicating resources to a particular customer.

2.4.3. Community cloud service

The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, or compliance considerations) (CSA, 2009). In a community cloud, several enterprises with similar requirement can share their

infrastructures, thus increasing their scale while sharing the cost (Wikipedia – Cloud Computing, 2010). Another form of community cloud may be established by creating a virtual data center from virtual machines instances deployed on underutilized users machines (Briscoe &Marinos, 2009). A community cloud provides many of the benefits of scale of the public cloud, while retaining greater control over compliance and data privacy.

Community cloud services already exist, but under a different name – for example NHSmail, the national e-mail and directory service available to NHS staff in England and Scotland, is effectively software-as-a-service with a community deployment model. As regards security, NHSmail is accredited to government "restricted" status, and is the only NHS e-mail service that is secure enough for the transmission of confidential patient information.

2.4.4. Hybrid Cloud service

The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds) (CSA, 2009). Hybrid Cloud is a composition of the two types of cloud (private and public) where, a private cloud is able to maintain high services availability by scaling up their system with externally provisioned resources from a public cloud when there are rapid workload fluctuations or hardware failures (B. Furht, 2010).

In the Hybrid cloud, many enterprises would prefer to keep their critical data and applications within their own control to ensure security firewall, while hosting the less critical ones on a public cloud. Under this cloud deployment model users typically outsource non-business critical information and processing to the public cloud, while keeping business-critical services and data in their control (VenkateRao J. et.al. 2011). A hybrid cloud can be delivered by a federated cloud provider that combines its own resources with those of other providers. Thus hybrid cloud delivery model encompasses provisioning all components and services that are required to deploy services (e.g. Hardware, network services, operating systems, databases, middleware, applications, and third party service provisioning). The following figure summarizes the cloud computing deployment model with potential governance of the cloud.

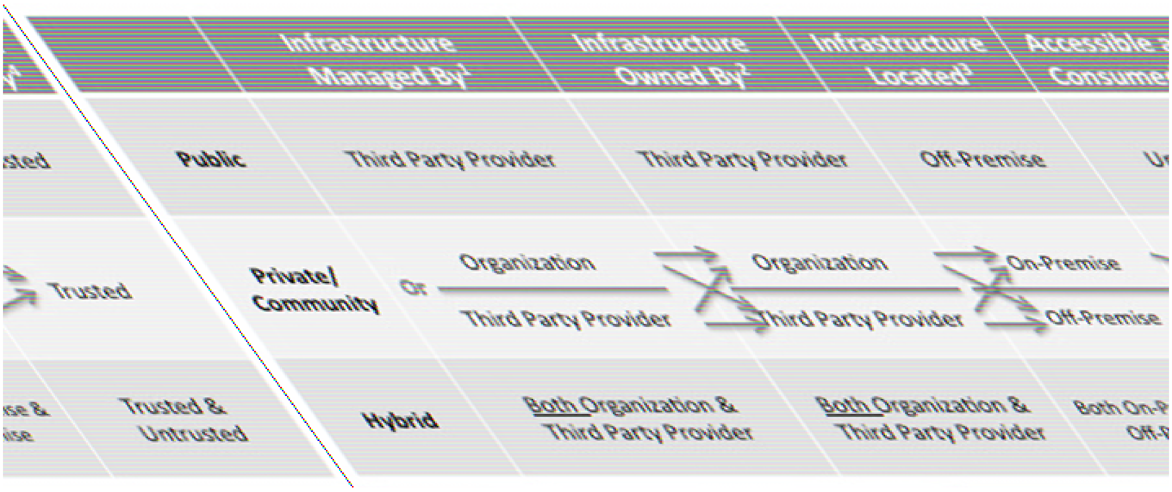


Figure.3. cloud computing deployment model

As a figure 3 shows computing infrastructure are managed and owned by third party providers, third party providers/organizations and both third party providers and organizations through different cloud service deployment models public, private and hybrid clod respectively. Infrastructures can be located as off-premise, off-premise/ on-premise and both off-premise and on-premise ways. Finally Infrastructures can be consumed by un-trusted (authorized to consume some/all services but are not logical extension of the organization), trusted (part of an organization legal policy umbrella including employees, contractors, and business partners) and both un-trusted and trusted consumers of the cloud services.

2.5. Cloud Computing Benefits for Banks

Cloud computing can help financial institutions to improve performance in a number of ways. Cloud based service have many benefits to the provider and to the consumer of cloud services. For the purpose of the study cloud benefits for banks will be discus under this topic.

Cloud computing can enable banks to turn a large up-front capital expenditure into a smaller, ongoing operational cost (including salaries and energy costs). Cloud allows banks to reduce the heavy investments in new hardware and software to expand internal IT infrastructures, while it allows customers to pick and choose the services required on a pay-as-you-go basis offered by cloud providers. This elasticity gives adopters two main advantages over on-

premises models. First, it frees organizations from spending high up-front costs on IT resources that may not be fully utilized in the future. Second, it allows them to face occasional spikes by flexibly adding more resources at whatever time needed (Aarti Singh et al., 2012).

Cloud computing enables emerging market banks to have low cost startups by allowing them to rent resources offered by cloud providers or by establishing collaboration with matured infrastructure legacy banks instead of having their own sets. While, large enterprises can take advantage of cloud computing as a tactical solution to face seasonal peaks without spending big sums to acquire resources that will be idle for most of the time (Qusay F. Hassan, 2011).
With cloud computing, the provider is responsible for managing the technology. Cloud computing also provides a high level of redundancy and back-up at lower price than traditional managed solutions (B. Furht, 2010). Thus, financial firms can gain a higher level of data protection, fault tolerance, and disaster recovery

Cloud-based operating models enhance business agility and focus. Cloud is operating in a flexible way to develop new products within shorter development cycle and with less capital investment (Aarti Singh et al., 2012).With on-premises, organizations spend much time and effort to setup and run IT resources. Conversely, cloud computing put all these complexities on provider sides enabling clients to easily operate hardware and software appliances (Qusay F. Hassan, 2011). Cloud computing also allows businesses to move non-critical services to the cloud, including software patches, maintenance, and other computing issues (AbhinarGarg, 2011). As a result, firms can focus more on the business of financial services, not on IT. This also supports a faster and more efficient response to the needs of technological and business solutions.

Additional, cloud enables banks to contribute on green IT development. Financial service sectors can use cloud computing to transfer financial services on a virtual environment that will reduces the energy consumption and carbon footprint comes from setting up of a physical infrastructure

2.6. ICT and Banks Transformation

2.6.1. Role of ICT in the Banking Ecosystem

A bank is a financial institution and a financial intermediary that accepts deposits and channels those deposits into lending activities, either directly by loaning or indirectly through capital markets. A bank is the connection between customers that have capital deficits and customers with capital surpluses. Due to their influence within a financial system and the economy, banks are highly regulated in most countries. Most banks operate under a system known as fractional reserve banking where they hold only a small reserve of the funds deposited and lend out the rest for profit (Wikipedia – Bank, 2013).

The 21st century will bring about an all-embracing convergence of computing, communications, information and knowledge. The growth of high speed networks and computing power is making possible to process different applications in microseconds undreamed of in the past. The rapid explosion of technology is changing the banking industries from paper and branch banks to digitized and networked banking services. (Giacomo&Brunzel, 2010). This explosion of technology is changing the banking industry from paper and branch banks to' digitized and networked banking services (Ostergaard, 2010). It has already changed the internal accounting and management systems, and the service delivery systems of banks used to interact with their customers. Delivering banking products and services using this system can be more convenient and effective than ever before. All over the world, banks are still struggling to find a technological solution to meet the challenges of a rapidly-changing environment (Ryan, 2012). It is clear that this new technology is changing the banking industry forever. Banks with the ability to invest and integrate information technology dominates in the highly competitive global market.
Advances in technology are allowing for delivery of banking products and services more conveniently and effectively than ever before. Rapid access to critical information and the ability to act quickly and effectively will distinguish the successful banks of the future. The bank gains a vital competitive advantage by having a direct marketing and accountable customer service environment and new, streamlined business processes (Gardachew, 2010). Thus the advantages accruing from computerization are three-directional - to the customer, to the bank and to the employee.

2.6.2. Challenges in the Present Banking Ecosystem

There are different challenges available in the current banking ecosystem that demands continual technological change and high investment costs. According to MCsuresh (2010) and VMware (2011) some of the challenges that are directly related to ICT infrastructures needs are:

- ✓ Rapid geographical expansion of banking market has forced banks to replace their off-line systems by an on-line system linking the branches to the head office through the telecommunications network.
- ✓ The need for restructuring banks processes in order to reduce staff expenses which constitute a large part of the operating costs and a heavy burden on operating profitability.
- ✓ Incompatibility of the old systems with the strategic necessity of integrating new technologies like ATMs, telebanking, etc. in order to provide the high quality services to the customers and competing on an equal foot with the foreign banks.
- ✓ Competition through technology enforces banks to offer the entire range of services like telebanking, ATMs and others collaboratively. These require banks to respond very actively in the marketplace in introducing new products and services bundling.
- ✓ Banking services demanded a more dynamic banking web site with real-time transaction processing and rich functionality without limitations for service to be slow or unavailable.
- ✓ The rapidly changing computing needs such as comprehensive customer transaction history requires large and increasing transaction-data storages, and high-performance computing capacity needs for running complex algorithms and a high number of computations.
- ✓ Lack of proper planning for the development of any new applications. A computerization plan is the basis for implementing successful information technology solutions. To be relevant, these plans have to be linked closely to organizational strategies, objectives, priorities and processes.

This leads to very high investment cost for building and maintaining infrastructure to ensure high availability at any demand level (i.e. maintaining more dynamic banking web sites, large storage needs, high performance computing needs, and etc.). Providing innovative services, cost reduction through capital expenditure control, and improving the customer experience are challenging in these context.

More frequent need for risk analysis adds to the loads on in-house systems, forcing increased capacity and increased capital investment costs. A multi-sourced infrastructure allows faster resources provisioning than building in-house HPC infrastructure (VMware, 2011). Building in-house HPC infrastructure has the limitations to provide flexibility to schedule necessary simulations when business requires it, not just when internal resources are available. Additionally, there are lacks of mechanism for on-demand scaling solution that can enable superior customer experience and capacity. Therefor banks need to upgrade or change their internal datacenters during peak load times of the market. This leads very high investment to procure and provision the infrastructures.

Additionally, in developing countries telecommunications infrastructure is the greatest obstacle to real time electronic banking in the banking sector. Telecommunications in the banking sector is a major factor to the success or failure of any application or service. The result of such situation is a delay in implementing new services and products like remote banking, electronic funds transfer, and real time bank information systems (MCsuresh, 2010). This has also an effect on the reliability of the services already implemented like ATMs. In order to face this challenge, banks began studying the feasibility of installing a private telecommunications network. This network will also be used to connect the ATMs machines which will thus function on-line. However there are problems to obtaining a license from monopolized telecommunications market, high cost of equipment to installing and lack of coordination between banks.

2.6.3. Challenges for Adopting Cloud Computing

Banking industries operate within a highly competitive and finely regulated environment. Therefore all of the service aspects are influenced not only by business considerations but also by the compliance requirements. Innovations, so far, have been evaluated, customized, adopted, deployed and managed inside the enterprise – security, control, reliability & governance have always been managed internally. Since, Cloud based services attempt to

take the functional, technology and operational aspects of the business out of the enterprise, these considerations significantly influences the adoption (SarfrazBrohi et al. 2011). Thus, According to Staten et al. (2008) for cloud-based services to be ready for enterprise to consume, it must pass from the early-adopter phase to early majority. Early majority is depicted by a sufficient volume of customers using the services for business-critical purpose. The major reasons that continue to hinder the level of adoption of this new computing infrastructure acquisition paradigm are: performance bottlenecks due to use of HTTP protocols and bandwidth issues; increased threats of single point of failure; customer data lock-in; concerns over data privacy and security; lack of frequently used tools; and the switching costs of migrating from in-house IT infrastructure (Nyaoro, 2012). The following sections discus some of major challenges to adopt cloud computing by presenting possible ways to tackle them.

Performance bottlenecks

The latency encountered when transferring data to and from the cloud is higher than when transferring data to and from an in-house datacenter (Nyaoro, 2012). With applications continuing to become more data intensive latency becomes a big concern. Bhattacharjee (2009) states that one of the key causes of this latency problem is that the architecture being used for data interchange in the cloud relies on the traditional get/post mechanism of the HTTP protocol which was not designed for the dynamic user interfaces supported by the cloud. Nevertheless, Bhattacharjee (2009) suggest that a probable solution could be realized through use of multiple geographically dispersed datacenters. This should widen and shorten the channel between the user and cloud service provider.

Data confidentiality, privacy and trust

This is the commonly cited reasons for organizations apathy towards the cloud. For starters, the non-uniform structure of legislations across the world characterized largely by the United States` Patriot Act makes enterprises unwilling to move their data into the cloud. Cloud providers are trying to work around this by building data centers in more parts of the world but this only solve the aspects of legislation.

The second concern of security is whether the cloud environment can be made as secure as that for most in-house IT environment. Ambrust et al. (2009) downplays this by stating that use of well-understood technologies such as encryption, Virtual LAN and network middle boxes could easily make data in the cloud as secure as that an a local datacenter.

Thirdly, there is the difficulty of winning consumer trust. How can cloud adopters trust their cloud computing providers not to disclose their data to competitor or alter their data? The end user perspective of trust makes this a highly subjective property. According to (Savola, Juhola, &Uusitalo, 2010) the most important aspects that enforce trust in the cloud are good level of security and privacy. One of the best ways of achieving this is through cutting off the semantic link of the data to the owner while presenting the cloud provider with the capability to properly and reliably charge for the usage of its cloud resources (Jensen, Schage, &Schwenk, 2010). The provider can solve this through use of cryptographic solutions based on ring and group signature to create an accounting scheme that ensures a user`s anonymity and guarantees authenticity of service requests (Jensen et al., 2010).

Switching costs

Organizations that are contemplating moving to the cloud face a dilemma on whether to discard their IT investments-such as that used on setting up their local datacenter at a discount and opt for the cloud (Nyaoro, 2012). To migrate to the cloud organizations have to be prepared to incur not only the cost of migrating data and application but also the cost of restructuring their organizations to fit new computing paradigm (Bhattacharjee, 2009). To mitigate against this the large cloud providers could leverage their economies of scale to offer competitive prices that will entice organizations to encounter these switching costs.

2.7. Cloud System Controlling Wings

2.7.1. Security for Cloud Computing

Security controls in cloud computing are, for the most part, no different than security controls in any IT environment. However, because of the cloud service models employed, the operational models, and the technologies used to enable cloud services, cloud computing may present different risks to an organization than traditional IT solutions (CSA, 2009).

According to CSA (2009) study, an organization's security posture is characterized by the maturity, effectiveness, and completeness of the risk-adjusted security controls implemented. These controls are implemented in one or more layers ranging from the facilities (physical security), to the network infrastructure (network security), to the IT systems (system security), all the way to the information and applications (application security). Additionally controls are implemented at the people and process levels, such as separation of duties and change management, respectively.

The security responsibilities of both the provider and the consumer greatly differ between cloud service models. Amazon's AWS EC2(one of the leading cloud service provider) infrastructure as a service offering, as an example, includes vendor responsibility for security up to the hypervisor, meaning they can only address security controls such as physical security, environmental security, and virtualization security. The consumer, in turn, is responsible for security controls that relate to the IT system (instance) including the operating system, applications, and data.

The inverse is true for Salesforce.com's (the known cloud service vender on software service offering) customer resource management (CRM) SaaS offering. Because the entire 'stack' is provided by Salesforce.com, the provider is not only responsible for the physical and environmental security controls, but it must also address the security controls on the infrastructure, the applications, and the data. This alleviates much of the consumer's direct operational responsibility.

The deployment and consumption modalities of cloud should be thought of not only within the context of 'internal' vs. 'external' as they relate to the physical location of assets, resources, and information; but also by whom they are being consumed by; and who is responsible for their governance, security, and compliance with policies and standards. Cloud Computing Security helps customers regain visibility and control through its end-to-end coverage for securing private, hybrid and public clouds.

IaaS is the foundation of all cloud services, with PaaS building upon IaaS, and SaaS in turn building upon PaaS. In SaaS environments the security controls and their scope are negotiated into the contracts for service; service levels, privacy, and compliance are all issues to be dealt with legally in contracts. In an IaaS offering, while the responsibility for securing the underlying infrastructure and abstraction layers belongs to the provider, the remainder of the stack is the consumer's responsibility. PaaS offers a balance somewhere in between, where securing the platform itself falls onto the provider, but securing the applications developed against the platform and developing them securely, both belong to the consumer.

Understanding the relationships and dependencies between Cloud Computing models and how they are deployed is critical to managing Cloud Computing security risks posture of an organization.

2.7.2. Self-service management capabilities of cloud systems

The key feature of a self-managing cloud system is dynamic capacity planning, which is underpinned by monitoring and accounting services. Capacity planning hides complex infrastructural tasks from users by automatically scaling in and out virtualized resource instances in order to enforce established SLA commitments (TeciRes project research group: Xiaoyu Chen, Gary B. Wills, Lester Gilbert, David Bacigalupo, 2010).
Monitoring is an import technological aspect in cloud computing. Monitoring is a lower-level service that aims at providing real-time system performance information. With a monitoring service, CSPs can measure performance and availability of the overall cloud system. The monitoring service can also be used by users to measure the performance of provisioned virtual machines, and to determine whether new virtual machines need to be started. Monitoring processes can take place at the service level and provide information for SLA management.

In a cloud system, everything is metered and accounted. Metered usage information provides for flexible pricing and charging in a public cloud environment. Historic usage information together with monitoring information is critical to automate capacity planning and ensured agreed QoS.

Cloud users can use self-service API (allowing developers take care of scalability and autonomic capabilities themselves) for capacity planning, or self-management API (that allows developers to call auto-scaling and autonomic capabilities provided by CSPs) facilities for dynamic resource provisioning by specifying high-level policies, rules, or SLAs. In the latter case, the burden of capacity planning shifts to the Cloud providers' side. For CSPs, well-defined strategies of capacity planning are critical to successful business. Nevertheless, users may use utility functions to combine different QoS metrics and maximize their usage of paid Cloud services.

One of the key characteristics that distinguish cloud computing from standard enterprise computing is that the infrastructure itself is programmable. Instead of physically deploying

servers, storage, and network resources to support applications, developers specify how the same virtual components are configured and interconnected, including how virtual machine images and application data are stored and retrieved from a storage cloud. They specify how and when components are deployed through an API that is specified by the cloud provider.

An analogy is the way in which File Transfer Protocol (FTP) works: FTP servers maintain a control connection with the client that is kept open for the duration of the session. When files are to be transferred, the control connection is used to provide a source or destination file name to the server, and to negotiate a source and destination port for the file transfer itself. In a sense, a cloud computing API is like an FTP control channel: it is open for the duration of the cloud's use, and it controls how the cloud is harnessed to provide the end services envisioned by the developer. And unlike the FTP protocol, cloud APIs are not yet standardized, so each cloud provider has its own specific APIs for managing its services.

2.8. The Future of Cloud Computing in Banking

The rapidly changing customer relationship management task, the emerging generation of cloud based socially-driven money management tools, the emerging collaborative cloud based service sharing in to joint venture, scale of IT infrastructure, and competitors' pressure will influence cloud computing adoption for banking industries in the future (Emmanuel Sardet, 2012).

The relationship between consumers and their providers of banking services and products are rapidly changing from time to time. Consumers' migrations to digital, mobile and contactless payments will affect the buying habits, channels and customer services in all markets, and will impact all consumer-facing industries. Cloud computing will make these services more convenient, more accessible, easier to use, and more personalized to the individual's needs and lifestyle.

Currently many banks are focusing to advance the IT stacks at all level on IaaS and/or SaaS, having virtualized their infrastructure and started to use SaaS for undifferentiated activities. Additionally banks will continue to ramp up effort to win customers not just from banks, but from others to respond the competitor pressures in order to avoid disintermediation by investing in capabilities around social media, analytics, and targeted product and service bundling. Banks can take the same approach with their own systems and processes. Scale of IT infrastructure will also influence cloud computing adoption. Newer and smaller banks built on client/server architectures have less overlapping legacy systems and infrastructure,

and will therefore be quicker to adopt cloud technology higher up the stack. Underscoring the fact that cloud computing adoption is not an all-or-nothing choice for newer and matured market banks.

Emerging market banks that have less systems infrastructure legacy than their counter parts in the market are enforced to invest on the infrastructure to compete in the banking market ecosystem. For those emerging market banks too small to invest alone in a cloud-based core banking infrastructure, they may choose to form a consortium to leverage a shared cloud. Banks can compete either as ecosystem leader, if they are matured or as a participant in the ecosystem if they are an emerging market bank.

Collaboratively banks can pool non- differentiated activities in to joint venture using private clouds with in a closed group banks. These JVs could provide shared services that interact with customers in more engaging ways while simultaneously freeing banks from the burden of routine transactions. Collaborative JVs could also be suited to areas that are integral to core banking but not differentiators with customers, such as security. By turning security into a service that is shared with other banks and operated via a joint venture private cloud, banks could stop duplicating investment, industrialize their security processes for economies of scale, gain new service options and have immediate access to the latest applications. These collaborative private clouds could even be “hybrids” powered by a third-party, increasing the benefits of cost and flexibility.

According to Emmanuel Sardet (2012), in the foreseeable future, cloud computing will be omnipresent. No industry can afford to ignore it. But its impact will vary in every case. Competition, collaboration, and convergence will impact future banking products, services and technologies.

2.9. Ethiopian Banking Industries

2.9.1. Overview of Ethiopian Banking Industries

The history of the use of modern money in Ethiopia can be traced back more than 2000 years (Pankhrust 1968 cited in Gedey1990, and Simeneh 2012). Modern banking in Ethiopia was introduced in 1905. At the time, an agreement was reached between the Ethiopian Emperor Minelik II and a representative of the British owned National Bank of Egypt to open a bank

which led to Bank of Abyssinia inaugurated in Feb.16, 1906 by the Emperor himself. In the 30's the bank was bought by the Ethiopian government and the State Bank of Ethiopia and was established by a proclamation issued in august 1942. Twenty six year later, Bank of Abyssinia was legally replaced by Bank of Ethiopia shortly after Emperor Haile Selassie came to power. The new Bank, Bank of Ethiopia (http://www.nbe.gov.et/), was a purely Ethiopian institution and was the first indigenous bank in Africa. This bank was later disintegrated to two different banks forming the National Bank of Ethiopia and the Commercial Bank of Ethiopia. (Lulseged, 2005)

These days Ethiopian banking sector comprises a central bank (National Bank of Ethiopia), three public and over sixteen private owned banks. The common banking functions provided by public and private banks in Ethiopia are deposit mobilization, credit allocation, money transfer and safe custody.

The Ethiopian banking industry as a whole has a network of 1289 branches at the end of the fiscal period ended in June 2012, which is not enough compared to the size of the country (1.1milion square km) and number of population (above 80 million) and this shows that the number of population being served by a single branch stood at around 62,063.6 (NBE, 2012)..

With such scattered branch network and disintegrated working system it is hard to ensure efficient flow of financial resources, efficient usages of ICT infrastructure, customer satisfaction, and optimize the contributions of the entire financial system to the development processes. Money banks in Ethiopia are too late to move with technological advancement used in the rest of the world and they are not integrated with each other for rendering non differentiated banking services for all customers of the bank in Ethiopia.

The banking system has developed well over the years in terms of its geographical coverage, deposit mobilization and credit expansion. Commercial Bank of Ethiopia is the largest, controlling the majority assets of the industry followed by Construction & Business Bank, Dashen Bank, Awash International Bank and etc. Hence, the share of private banks branch network was 47.6 percent at the end of 2011/12.

2.9.2. Current ICT usage Practice in Ethiopian Banking Industries

Many banks in Ethiopia have already using the digitized and networked banking services at enterprise level IT infrastructure. Banks invest millions of dollar for fulfilling the changing

computing needs to deliver the banking services consistently in the market at enterprise level individually. These modern e-banking technologies used to provide banking services for customers are ATMs, Debit cards, Credit cards, Tele banking, Internet banking, Mobile banking and others technologies.

Recently, Core Banking Systems are applied in many private and public banks of Ethiopia. The use of core banking solutions is expected to achieve a nationwide electronic payment system according to the central bank`s targets (NBE, 2012). CORE ("centralized online real-time environment".) banking is services provided by a group of networked bank branches. Bank customers may access their funds and other simple transactions from any of the member branch/channel offices/computing devices by accessing the application from centralized data centers. This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw the deposited money from any of the bank's branches throughout the country. Thus, using core banking technology bank`s provide banking services (including cash withdrawals, bill payments, fund transfer, mobile top up, balance inquiry, and etc.) available across multiple inter-connected channels like ATMs, Internet banking, and branches. Example, customers` of Commercial Banks of Ethiopia can access various banking services from any channels of CBE located anywhere at any time.

Cooperation among banks is the best strategy to improve electronic card payment system in Ethiopia. Recently, three private commercial banks - Awash International Bank S.C., Nib International Bank S.C and United Bank S.C. – have deployed an ATM network called Fettan ATM network. Fettan ATM is installed in ATM machines and POSs across Ethiopia (Gardachew, 2010). The customers of the member banks can have an access from all service channels of the banks across the country. On the other side through collaboration between Zemen Bank and Dashen Bank under the “Q-Link” network the customers of Zemen and Dashen Banks are both able to benefit from a total network of more than 100 ATMs at locations throughout Addis Ababa and several regional cities. This collaboration marked as a significant cooperation between competing banks in Ethiopia, which others should be encouraged to follow (Zemen Bank, 2013). There is no single bank in Ethiopia that can afford the infrastructures to provide extensive geographical coverage and access. Additionally, the first ever electronic banking gateway was signed between Ethiopian Commodity Exchange (ECX) and Dashen Bank and CBE (Dashen, 2012). The electronic

banking system being developed with both banks is designed to give a secure electronic data sharing gateway between clients, banks and ECX, facilitating a smooth transaction.

However, low level of internet penetration and poorly developed telecommunication infrastructure, high cost of internet compered to developed countries, limitations of collaboration among banks to share resources, high rate of ICT illiteracy, security issues, lake of trained personnel, the changing computing needs and other related factors are the key challenges in the current ICT usages of Ethiopian Banking Sectors (Gardachew, 2010). Lack of up-to-date plan for ICT service delivery strategy can be considered as a limitation for banks` to fully harvest the opportunities presented by the latest technology.

Certainly the banking industry in Ethiopia is in a developing stage and therefore there is an all immediate need to embark on capacity building arrangements and modernize the banking system by employing the state of the art technology being used anywhere in the world. Continual improvement and advancement of technology would assist banks` for harvesting the actual and expected benefits of ICT. Developing a framework for adopting new technologies that are well applicable in the developed country banking market has been helpful in selecting the right tracks to profitable ICT adoption strategy.

2.10. Cloud Computing for Ethiopian Banking Sector

Literatures indicate that many financial institutions including banking sector are shifting their ICT paradigm from traditional data centers to centralize and distributed one for the improvement of services with lower costs and better efficiency. In Ethiopia, banking service development and rendering quality of service that can meet customer needs has suffered by high investment cost to ICT infrastructures and the rapidly changing computing needs. In Ethiopia, banking industries are being expanding in a very high speed across the country. Currently there are 19 private and public banks with their many branch offices/automated channels.

Without quality customer service distributing branches by itself cannot give the solution we seek for customer satisfaction, profitability, cost reduction, overall growth of the bank specifically, and economic development and poverty reduction of the country as a whole through banking service. Banking service should be supported through up-to-date technologies and new market models. Many Banking sectors in Ethiopian has been investing

millions of dollars every year to support their banking service by technology. However due to struggling economy and technological limitation it is not able to supply full ICT infrastructure requirements recently applicable in the civilized world. As it has been discussed in the previous sections this infrastructure requirements can be solved using cloud computing strategy .i.e. implementing a central Hybrid Cloud computing infrastructure that can be used by all banks.

The Proposed Ethiopian Banking Industries Hybrid Cloud (EBIHC) combines private and EBIs clouds. The private cloud is implemented and managed by each banks. Every computing resource (such as servers, connections, storage, and related tools necessary to build an application environment) that can be shared by multiple bank branches will be placed at EBIHC and then it will be available to all hosted bank service channels. This can be an attractive option for Ethiopian Banking Industries for cost savings, ease of scaling-in and scaling-out computing resources, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move. Therefore the proposed EBIHC cloud system will reduce duplicated cost by provisioning computing resources in a very affordable way that are necessary to build an application environment on-demand by renting base rather than procuring resources for extending the performance of internal infrastructure.

The proposed EBIHC can have an interface from each Ethiopian Banking Industries Private Cloud (EBIPC) to local Cloud Service Providers. The hybrid cloud interface creates a connection between private clouds and public clouds. By deploying Hybrid cloud computing model, the fear of privacy and other related security issues can be avoided, since critical and sensitive data could be owned by the bank responsible bodies.

The proposed EBIHC can improve collaborative work between banks through sharing infrastructures. This presents new streamlined business process and new bases of competition among matured banks and emerging market banks. Emerging market banks generally have less systems and infrastructure legacy than their counterparts in mature markets, making it easier for them to adopt cloud models by paying fewer service charges for the matured market banks. At the same time, banking innovation in emerging markets is being accelerated by faster economic growth and distinctive social needs. Therefor emerging market banks can use mature market ICT infrastructure and service channels without investing the

infrastructure from scratch with some level of service charge agreement; in other side mature market banks have an opportunity for expanding their business and earning revenue from the new service.

2.11. Cloud Computing Adoption Strategy for Banks

Cloud computing has caused more debate than many other recent technological advancements. Regardless, there has been a tremendous rise in its adoption by financial services firms over the last couple of years. Without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011). The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009). Also, in order to have success, the cloud strategy must be aligned with the banks strategy. The prominent cloud adoptions strategies that are agreed in many experts and organizations have included the following phases as illustrated in the figure below.

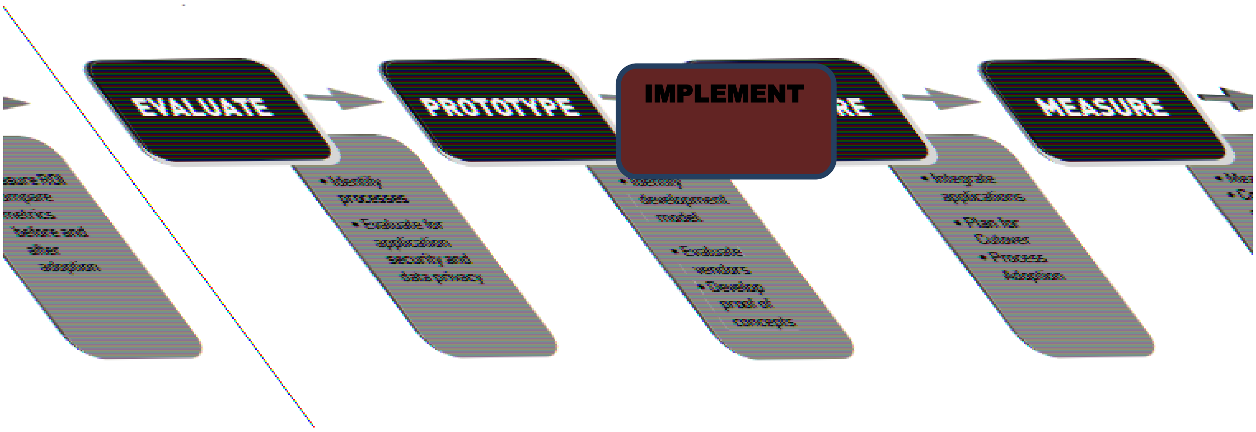


Figure.4. Cloud Adoption Strategy

Phase I: Evaluate

The development of a successful cloud strategy starts with thorough evaluation of current business processes and applications and identifying those that can be moved to a cloud. The phase consists in developing the knowledge base by participating at seminars, conferences,

discussions with the suppliers and consulting the most recent researches in the field. The success of the phase depends on the allocation of sufficient resources for research, for understanding how Cloud Computing functions in different banking industries in the world as a benchmark, the benefits and risks, policies and the best usage practices of Cloud Computing. The research is conducted by a team formed mainly of IT staff who permanently communicates with the users of the solution regarding the objectives, the progress, costs and benefits of the Cloud Computing solution.

The processes and applications should be evaluated from the banks point of view of the IT needs, structure and usage. The service oriented architecture represents the base for understanding the data, services, processes and applications that may be migrated or need to be maintained within the banks, so as to observe the security policy. With respect to the IT needs, their structure and usage, the analysis may start from the categories of users who interact with the present IT infrastructure and their necessities. Additionally, privacy requirements when the information is stored on a cloud, peak load hours, architecture constraints and such legal requirements as the physical location of hardware, which will decide applicable legal jurisdiction and laws of country, and other important points, should be identified in this phase.

Phase II: Prototype

In the Prototype phase, particular processes are selected and the type of deployment model, including public, private or a hybrid cloud, is decided. Plus, strategies for storing data with different security requirements and complexities are developed. Some of the key decisions focus on where the most sensitive data should be located and how less sensitive data will be processed. This phase also includes the evaluation of cloud vendors based on data and architectural parameters. Proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability are completed. Choosing the right vendor involves understanding what each one can offer and how their offerings align with the firm’s requirements.

Phase III: Implement

Once the deployment model is decided and cloud vendors are chosen, the implementation phase begins. In this phase, applications are deployed on cloud. Several factors are kept in mind during this phase, including migration and cutover planning, as well as the adoption and operational management of the new process.

Phase IV: Measure

Finally, an organization should spend considerable time measuring the ROI achieved and fine-tuning the adoption process. In this phase, ROI is measured considering the objectives and feedback is collected from end users. The output of this phase is fed back into the evaluation process to fine-tune the next roll-out.

2.12. Related works

Cloud adoption frameworks are developed to predict what customers might do with cloud, based on the frameworks cloud based service implementations are developed and deployed to validate customer predictions from the cloud services. This section describes the available literatures on best practices of cloud-based service implementations and framework development works for cloud-based service adoption strategy in the banking sector.

BBVA, one of the largest financial institutions in the world, announces today that it is adopting Google's cloud-based collaboration and communication suite Google Apps for Business to increase productivity and drive innovation. Over 35,000 BBVA workers in Spain will initially use the productivity tools integrated in to the Google Apps suite including: Gmail with Google Chat, Google Calendar, Google Docs, Google Groups, Google Sites and Google Video. By the end of 2012 BBVA expects to migrate 110,000 employees in over 26 countries to Google Apps.

BBVA chose Google Apps to increase efficiency and to help its workers collaborate more easily, regardless of location. BBVA's new global intranet is the main technology project that will be transformed thanks to Google's collaboration tools such as Google Talk, Google Sites and Google Docs, changing it from a corporate communications and process management site to a place where all employees will be able to share, contribute and manage knowledge globally. Integrating the Google Apps for Business suite with our own tools will allow us to introduce a new way of working where employees have access to all the information they need with just one click, no matter where they are, and can reap the benefits of using advanced collaboration tools. In addition, BBVA will create a social network to improve communication and explore new ways of working. BBVA will now join the four million businesses worldwide which are using Google's enterprise solutions to embrace technological change, and open the door to constant innovation, collaboration and cost savings.

Accenture (2012) describes the Citigroup and Banks of America practices for using cloud services to communicate with customers using social media. Citigroup has implemented various social media strategies to communicate better with its customers, including a blog that actively seeks questions and comments from customers, a YouTube channel, and a service that will allow customers to talk to bank staff through Twitter or other social media. Bank of America uses Twitter as a customer service and advice tool, and reports that

customers find it a faster and more effective way of getting the help they need than traditional customer service channels.

IBM Academy of Technology (2010) conducted 110 case studies and examines those survey findings: where clients are with cloud computing, what challenges they face, how they are benefiting from their existing implementations and where they expect to be in the future. According to IBM Academy of Technology survey findings from the cases studied on financial institutions show that: Firstly, IT efficiencies, consumer interfaces featuring ease of use, and new charging models are the primary motivations for client cloud implementations.Secondly, conversely, security concerns, pricing strategies, system complexity, rapid technology advancements of cloud capabilities, gaps in standardization and a lack of clear value propositions are seen as the biggest inhibitors to cloud computing. Thirdly, integrated vendor offerings combined with ongoing support (applying best practices) are in high demand.

IBM sales and distribution also identifies the successful cloud implementation works (such as cloud desktop, cloud collaboration, cloud analytics, cloud storage, and etc.) in the banking and financial services industry across the world.

Some of the organizations are: (1), a global Japanese bank was concerned that it would suffer security and business continuity risks if the H1N1 virus were to spread to pandemic levels. The 34,000-employee bank is deploying an IBM private cloud to centralize management of desktops using an enterprise-class data center rather than at the user stations. This change gives the bank greater remote flexibility without sacrificing control. (2), a central European bank facilitated continuous, standardized operations and enabled employees across its distributed branches to quickly access trading and banking systems through a security-rich cloud infrastructure. (3), a subsidiary of a large European bank designed a new sales platform based on an application package, which enables tellers to enter data into the system only once, instead of entering it up to 20 times for different applications. The new platform also gives the bank a 360-degree view of customer data, which when combined with embedded artificial intelligence can help generate more sales. (4), a Chinese financial services organization reduced system management costs, speed up deployment for resource requests, standardized software configuration for each deployment request and improved the tracking of system resource usage by implementing a cloud computing solution to deliver powerful provisioning capabilities that simplify system management and maintenance.

AbhinavGarg (2011) conducted a study on how cloud computing is applicable to the financial services industry and provide an approach for adoption by a financial services firm. He was start the study by introducing cloud computing and its characteristics. Then he outline the common challenges that different financial services firms that are more in a regulated and

security-sensitive environment have faced while implementing cloud computing like data privacy, compliance, availability, lack of standards, etc.

The study discusses the factors that make cloud computing an attractive option for a financial services firm. This factors are perceived cost savings, ease of scaling-in and scaling-out, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move are all critical consideration factors that can drive financial services firms to adopt cloud computing.

Additionally, the study suggest a cloud computing readiness approach, which can be adopted by firms to make sound decisions around their approach to—and readiness for—cloud computing. These approaches are: first evaluating current business processes and applications and identifying those that can be moved to a cloud. Second prototype the particular processes that are selected and the type of deployment model, including public, private or a hybrid cloud is decided. Plus, strategies for storing data with different security requirements and complexities are developed. Third implement the application and deployed on the cloud. Fourth measure the ROI achieved and fine-tuning the adoption process.

Finally the study concludes that hybrid clouds with the appropriate allocation of data and applications are recommended where data secrecy is more important. Cloud Computing is a promising paradigm for delivering computing utilities as services. Just as personal computers and servers shook up the world of mainframes and minicomputers or as smart phones and tablets revolutionized the mobile commerce industry, cloud computing is bringing similar far-reaching changes to the licensing and provisioning of infrastructure and to methodologies for application development, deployment and delivery. Some firms have already realized the benefits of cloud computing, which include scalability, cost savings and time to market. Firms that are still looking to leverage the cloud should begin by moving nonrevenue generating and non-core systems to the cloud. And, they should consider developing a comprehensive cloud strategy to move core applications to the cloud.

Chapter Three

Research Methodology

The main aim of this chapter was to design the methodology to carry out the study, which included: determining design strategy for the study including a conceptual framework, defining the deliverables, and articulating the methodology. The requirements to this study were: developing the knowledge base about the state of the problem and the importance of its solution to define the problem; developing the knowledge base about the state of the problem and current solutions to identify the requirements; the knowledge of theory that brought to bear in a solution to design the proposed cloud computing framework; and developing evaluation tool to measure the performance of the resulting framework. Thus the instruments used to develop the knowledge base to the study requirements were data collection using interview and review of relevant literature including similar studies.

3.1. Research design

The research method used in this study is based on the design science paradigm in IS research (Nunamaker et al., 1990; Walls et al., 1992; Hevner et al., 2004). The design science research is a prescription-driven and problem-solving paradigm that seeks to create viable artifacts in the form of a construct, a model, a method, or an instantiation (design artifacts) which provide solutions for management problems (Hevner et al., 2004; Gregor and Jones, 2007; van Aken, 2004).The study focused to use a consensus building approach to produce the framework based on well-accepted elements of the DSRM process, which contains four phases discussed below (Peffers et al., 2007).

i. Problem identification and motivation

This phase includes defining the knowledge of the state of the problem and the importance of its solution. Researchers begun by defining the specific research problem and justify the value of a solution by conducting interview and rigorous analysis of literatures on cloud computing adoption in the banking sector. Since based on the problem definition the researchers atomize the problem conceptually to capture its complexity for developing the proposed cloud computing framework that can effectively provide a solution. The value of the solution also justified to motivate the researcher and the audience of the research to pursue the solution and to accept the results and to understand the reasoning associated with the researcher's understanding of the problem.

ii. Define the objectives for a solution

This phase aims at to identify or drive the requirements for developing the proposed cloud computing framework from knowledge of the state of problems and current solutions. The researchers infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible to align with the bank's requirements. The qualitative objectives are used, which described how a proposed framework is expected to support solutions to problems not hitherto addressed. The researcher used the conceptual framework to inferred objectives rationally from the problem specification. In order to develop the study conceptual framework, researchers started with the literature review to gather relevant requirements and aspects of existing Cloud frameworks.

iii. Design and development

Conceptually, a design research artifact can be any designed object (models, frameworks or instantiations) in which a research contribution is embedded in the design. This phase includes determining the artifact's desired functionality and its architecture and then creating the actual artifact. The knowledge of theory that can be brought to bear in a solution is required to move from objective of a solution to design and development of the proposed framework.

Based on the required knowledge of a solution identified in phase one and two with the literature review and expert interviews analysis to develop the proposed framework:

particular processes are selected; the type of deployment model is decided; strategies for storing data with different security requirements and complexities are developed; and proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability are completed. After determining the framework functionality and its architecture, the proposed collaborative cloud computing framework for EBIs with the implementation plan to deploy application on the cloud could be developed.

iv. **Evaluation**

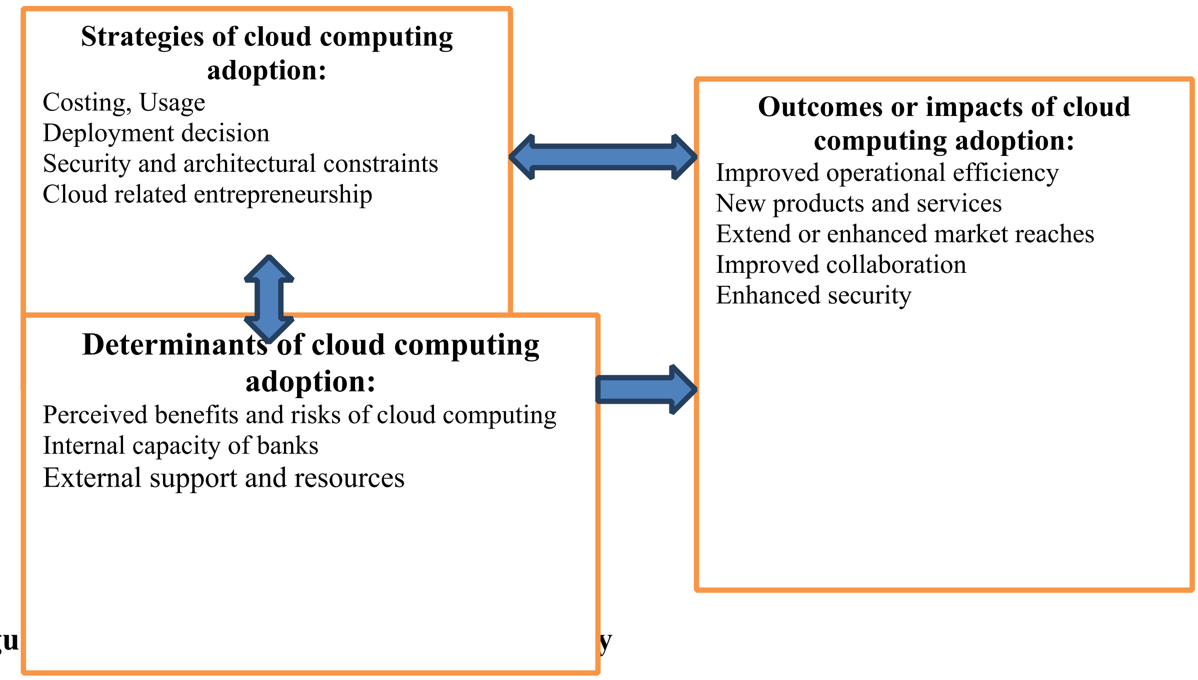
This phase aims to Observe and measure how well the framework supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the framework in the demonstration. It requires knowledge of relevant metrics and analysis techniques. Depending on the nature of the problem venue and the artifact, this study took the qualitative evaluation analysis techniques which include: a comparison of the proposed framework functionality with the solution objectives from activity two above, objective qualitative performance measures, such as business impacts, extents of actual use and user satisfaction. Conceptually, such evaluation could include any appropriate empirical evidence or logical proof. At the end of this activity the researchers can decide whether to iterate back to step three to try to improve the effectiveness of the artifact or to continue on to communication and leave further improvement to subsequent projects. The nature of the research venue may dictate whether such iteration is feasible or not.

3.2. Conceptual Framework for the study

A conceptual framework used in this study was to limit the scope of the relevant data required in the DSRM process phases discussed above by focusing on specific variables and defining the specific viewpoint (framework) that the researcher took in analyzing and interpreting the data to be gathered, understanding concepts and variables according to the given definitions, and building knowledge by validating or challenging theoretical assumptions (Herbert, Asher and William, 2006). Many researchers have been used different frameworks in the study of adopting new technological innovation. Among frameworks that have been developed based on the past studies that are well received framework in the context of innovation adoption by organizations and have been used in many studies are discussed below.

Tornatzky and Fleischer (1990) proposed the Technology-organization-Environment framework (TOE) for studying the likelihood of adoption success of technology innovations. According to Tornatzky and Fleischer (1990), technology adoption within an organization is influenced by factors pertaining to the technological context, the organizational context, and the external environment. While, Kshetri (2010) proposed a framework that explains contexts, mechanisms and processes associated with the development of the cloud industry in the developing world in terms of three inter-connected flows: determinants, cloud related performances and impacts of the cloud. Based on this, the researcher modified this framework and created a more relevant framework for this study by integrating ideas from the two frameworks.

Figure 3.1 shows the resulting conceptual framework that was used to carry out the baseline study on cloud computing for EBIs. The direction of arrows shows an element of causal effect which could either be one directional or bi-directional.



Figu **y**

As shown in in figure 3.1 the conceptual framework for this study consisted three elements including: determinants of cloud computing adoption which used to describe the key factors for cloud computing adoption, strategies of cloud computing which used to describe the deployment strategies for cloud computing adoption, and outcomes of cloud computing

adoption which used to describe the values created by cloud computing adoption. The elements of concepts in figure 3.1 are discussed below.

3.2.1. Determinants of cloud computing adoption

The aim of this element in the framework was to assess the key factors that affect cloud related performance and its outcomes or impacts from its adoption. It contained three components that could affect the adoption: Perceived benefits and risks of cloud computing that refers to adopter's perception of cloud computing attributes,internal capacity of banks that refers to the organization's characteristics that influence its ability to adopt and use of cloud computing, and External support and resources that refers to the external environment in which an organization operates and its condition for supporting the development of cloud computing. For each context, various factors have been identified from the literature but only those that are considered relevant for cloud computing adoption are included in the framework. Details of determinants considered in this element are discussed below.

a) Benefits of cloud computing

This aims to evaluating whether there are sufficient benefits to warrant on cloud computing adoption for banks. For successful cloud computing adoption, the study needed to go through evaluating: operational, financial, CRM and strategic efficiency of using cloud computing for supporting banking services by comparing with the existing IT services provisioning. The current banks preference or innovation culture needed to be analyzed to determine whether it is supportive towards the process of adopting cloud computing or not. These is vital for referring typical characteristics of cloud computing technology considered in technology adoption studies, which include relative advantages (perceived benefits), and relative disadvantages (perceived risks), based on the assumption of Roger's diffusion of innovation (Rogers 2003).

b) Internal capacity

It aims at determining whether the banks has within it sufficient internal resources and appropriate procedures necessary for the successful selection and implementation of cloud computing. Standard compliances such as development and structure of related industries with the considerations of e-government service availability and strong demand strengthen

forward linkages and bandwidth provision with horizontal linkage. For example, cloud computing is IT infrastructure provisioned over the internet, this means that for an organization to adopt this technology it would require good internet connection or bandwidth, where good determined by the bank's core activity and the services that it would acquire from the cloud.

Internal resources also look at: the technological capacity and financial constraints necessary to making the switch from traditional computing to cloud computing. There is also need to evaluate the organizations current policy on IT with the considerations of availability, flexibility, and effectiveness to meet the needs of this new paradigm. While the market situations need to be assessed with the considerations of availability, readiness and dominance of certain actors in the market.

The development of a successful cloud strategy starts with thorough evaluation of current business processes and applications and identifying those that can be moved to a cloud. The evaluation consists in developing the knowledge base by reviewing recent literature in the field and interviewing banks IT staffs who permanently communicates with the users of the solution regarding the objectives, the progress, costs and benefits of the Cloud Computing solution.

c) External environment

It aims to evaluate the external environment, support and resources, particularly if in-house resources and support are lacking. To assess the external environment, the researchers needed to acquire the knowledge about how Cloud Computing functions in different banking industries in the world through considering: benefits, risks, strategies, and the best usage practices of Cloud Computing. There is also needed to evaluate the technologies deployed by service provider with the considerations of reliability, investment cost, agility, usability, availability of the technology and sustainability that affect cloud related performance and its outcomes or impacts from its adoption. Here the researchers look at: data security, number of operating systems and application supported, training and back end support, provider reputation, SLAs guaranteed and so on. At the end of this stage the researchers typically able to have an answer to the question of which cloud provider it should subscribe to.

3.2.2. Strategies of cloud computing adoption

It aims to assess the strategies of cloud computing development for banks or various actors that are instrumental in delivering the outcomes or impacts of cloud computing adoption based on the evaluation on determinants of cloud computing adoption and its outcomes. Strategies look at: costing, usage, deployment decisions and cloud related security and architectural requirements.

The researchers needed to used the available service oriented architecture that represents the base for understanding the data, services, processes and applications that may be migrated or need to be maintained within the banks, so as to observe the security policy. With respect to the IT needs, structure and usage, the analysis started from the categories of users who interact with the present IT infrastructure and their necessities. Additionally, privacy requirements when the information is stored on a cloud, peak load hours, architecture constraints and such legal requirements as the physical location of hardware, which decide applicable legal jurisdiction and laws of country, and other important points, identified in this stage.

In this context, particular processes are selected and the type of deployment model is decided; strategies for storing data with different security requirements and complexities are developed; and proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability that can align with the bank's requirements completed. After the deployment model and cloud vendors option are decided, the proposed cloud computing framework for EBIs developed.

3.2.3. Outcomes or impacts of cloud computing adoption

This aims to evaluate the values created by the cloud or benefits, which are the ultimate objectives that decision makers want to accomplish. Outcomes or impacts of cloud computing adoption includes: improved operational efficiency, new products and services, extend or enhanced market reaches, improved collaboration, enhanced security and Job creation. Finally, the outcomes are measured by considering the objectives and feedbacks collected from end users using qualitative measurement analysis techniques.

3.3. Instrument design

In order to develop the knowledge base about the current state of IT need, structure and usage in Ethiopian Banking Industries the researchers used a qualitative research approach. This approach was selected because this study aims at to investigate existing IT infrastructure, understand what is happening, and find alternative solution from an operational point of view.The contribution of qualitative studies is normally based on its ability to present a new way to investigate existing phenomena, understand what is happening, and find new phenomena and perspectives from an operational point of view (Koskinen et al., 2005). Hirsjärvi et al. (2009) describe qualitative research with three key characteristics. First, qualitative methods such as interview are used. Second, inductive reasoning is employed, which means that diverse analysis of the data and revelation of unexpected things are essential for formulating a problem and developing the working framework from an operational point of view. Second, purposive sampling is used in data collection, which means that the best suitable respondents are chosen in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations.

3.3.1. Sampling method

Sample designs are basically of two types: non-probability sampling and probability sampling. Probability sampling is based on the concept of random selection, whereas non-probability sampling is 'non-random' sampling. Under probability sampling design, every item of the universe has an equal chance of inclusion in the sample. Under non-probability sampling each item in the population has of being included in the sample (Kothari, 1990).

Purposive sampling was used for data collection in this study, which means that the best suitable respondents were chosen from different banks in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations (Kothari, 1990). Under this sampling the organizers of the inquiry purposively choose the particular units of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be typical or representative of the whole. According to Kothari (1990), in purposive sampling, personal element has a great chance of entering into the selection of the sample. The investigator may select a sample which shall yield results favorable to his point of view. Accordingly different persons including IT experts and ICT managers from different banks were selected for interviews. The criteria for selecting

interviewees were their position of authority due to formal position or expertise and knowledge in some specific area to this study. Also the criteria to select the banks were their status of maturity in the market and infrastructure legacy with regulator of the market by categorizing them in to: matured infrastructure legacy banks, less infrastructure legacy banks and regulator bank. The following table shows the organization of the sample and population for the study.

Banks Status	**No. of Selected Banks**	**Name of Selected Banks**	**No. of respondents selected**
Matured infrastructure legacy banks	2	Commercial Bank of Ethiopia	2
		Dashen Bank	2
Less infrastructure legacy banks	2	Addis International Bank	2
		Enat Bank	2
Regulator bank	1	National Bank of Ethiopia	2
Total	5		10

3.3.2. Data Collection and Analysis Technique

- Data collection

Research differs in a number of aspects but they do have some commonalities. One of the common aspects is the need to collect data. Data collection can be derived from a number of methods, which include interviews, focus groups, surveys, telephone interviews, field notes, taped social interaction, questionnaires, and from various publications. Data collected to this study could be a base to understand and identify the banks IT needs, structure and usages.

Data collection consists of either primary or secondary data. Primary data is information that is collected a fresh by the researcher to answer his current research questions. There are several methods of collecting primary data; it can obtain either through observation or through direct communication with respondents in one form or another or through personal interviews (David & Sutton, 2004; Saunders et al., 2009; Sekaran&Bougie, 2010).

Secondary data is use of information already collected by someone else. Secondary data may either be published data or unpublished data. Usually published data are available in various publications of the organizations, governments, researchers, individuals, and others sources of published information. The sources of unpublished data are many; they may be found in diaries, letters, unpublished biographies and autobiographies and also may be available with scholars and research workers, trade associations, and other public/private individuals and organizations. The already available data should be used by the researcher only when the data are reliable, suitable and adequate (Kothari, 1990).

The decision of which information acquisition method to use depends on the research goals and the advantages and disadvantages of each method relative to those goals. Because it is worth remembering that one method of data collection is not inherently better than another method (Nyaora, 2012). This research has preferred to use primary data for different reasons. Firstly, primary data is up to date/fresh, and this is vital where the research is looking at issues in an environment with a rapidly changing landscape such as the cloud computing environment. This original data is important for identifying the real requirements of banks. Secondly, scarcity of finding secondary data that are suitable for this study; because cloud computing is an emerging technology in the developing country.

For the purpose of this study interviewing the best suitable respondents selected through purposive sampling are used as information acquisition method. Interview was selected as the information acquisition method because as Hirsjärvi et al. (2009) and Hirsjärvi and Hurme (2008) argue, it is good method when working with unknown or less explored topic and when predicting answers beforehand is difficult. They also argue that interview is good method because it makes possible to expand the information, clarify desired answers, and get illustrative examples. This method was used to develop the knowledge base to identify the requirements for cloud based service provisioning strategy and its elements for constructing cloud based service framework for EBIs.

Hirsjarvi and Hurme (2008) define interview by suggesting that interviewer's task is to mediate picture of respondent's thoughts, opinions, experiences, and feelings. Interviews are a systematic way of talking and listing to people (Nyaoro, 2012). The researcher often uses

open questions to obtain responses from the interviewee, who is the primary data for the study. There are many types of interviews, which include: structured interviews, semi-structured interviews and unstructured interviews (Sauders et al., 2009).

In structured interview the aim is for all interviewees to be given exactly the same context of questioning so that their replies can be aggregated. Questions tend to be closed ended, pre-coded, or of fixed choice. Structured interviews make probing a problem area difficult because they introduce some rigidity to the interview (Corbetta, 2003). Nevertheless, the common format utilized within this types of interview makes it easier to code, analyze and compare data (David & Sutton, 2004).

Semi-structured interviews, on the other hand, are non-standardized and are frequently used in qualitative analysis. The interviewer does not do the research to test a specific hypothesis. Instead he has a list of key themes, issues, and questions to be covered (David & Sutton, 2004). Semi-structured interviews give the researcher flexibility to establish own style of conversation depending on the direction of the interview (Corbetta, 2003). This flexibility enables probing, which is a way for the interview to explore new path which are not initially considered (Gray, 2004).

The unstructured interview or in-depth interview takes a further step towards a more open discussion where no predetermined question is needed. The interviewee is encouraged to speak freely about events, behavior, and beliefs, with reference to the subject. The problem with this is that the researcher may not know what to look for or what direction to take the interview especially if his interviewers are inexperienced. Respondents may talk about irrelevant and inconsequential issues and also it may be difficult to code and analyze the data. The unstructured interview would be highly disadvantageous for this research especially when one considers the limited research time and resource that study's offer.

After carefully understanding each types of interview method semi-structure interview method was selected for this study because it is most suitable considering the nature of the subject. Semi-structured interviews give the researcher flexibility to establish own style of conversation depending on the direction of the interview. This flexibility was important to

obtain rich information systematically from the interview about the subject. Interview questions were adopted from (Sewale, 2012).

Interviews were conducted between April 15 and April 25, 2014 and responses were obtained from all selected informants. The objectives and concepts of the study were briefly explained for interviewees. Each informant was interviewed individually by the researcher.

- **Analysis Technique**

After interviewing all selected informants, the collected data are analyzed and summarized for better understanding of the current ICT need, structure and usage. Interpretation, description, classification, and/or combining of the data are few standardized analysis techniques for qualitative data (Jaatmaa, 2010). The procedure followed in this study was: using the interview to collect data, describing the data, grouping the issues, and interpreting what is happening. In terms of analysis the research deploys the following approach: results and findings from the interview will be described and analyzed, findings from the interview would be compered and contrasted to relevant literature review findings.

The analysis made based on the finding of the literatures and the data collected from the interview for presenting the requirements to constructing the framework intended in this study. Analysis of business requirements through comparisons of information obtaining from primary data with relevant literature finding was necessary to fulfill the gap in current research. The survey of concerning literature happens to be the most simple and fruitful method of formulating precisely the research problem or developing framework (Kothari, 1990). According to Kothari (1990), researcher may review two types of literature: the conceptual literature concerning the concepts and theories, and the empirical literature consisting of studies made earlier which are similar to the one proposed. In this study literatures on concepts of cloud computing including similar studies were reviewed. Accordingly interview and review of relevant literature are employed for this study to develop the knowledge bases required for developing the proposed cloud computing framework.

3.4. Reliability and Validity

The concept of validation refers to the determination of the correctness of the system with respect to user needs and requirements. Validation criteria include comparisons with known

past cases, comparison against exert performance, comparison against theoretical possibilities.

The quality of a research refers to its reliability and validity. In qualitative research validity refers to the appropriateness of the choices in terms of research strategy and data collection and analysis techniques (Jaatmaa, 2010). Validity means consistency of description and its explanation and interpretation (Uusitalo, 1991).

The question templates used to conduct the semi-structured interview coupled with interview findings and discussion could be used by other researchers to validate the findings.Readily available literatureswere carefully selected from the authenticated sources. Consistent practices were applied to the interpretation and explanation of findings.

Reliability also refers to repeatability of a study, i.e., ability to deliver non-random results. This research is reliable because it used valid strategies and techniques appropriate to the research objectives (Nyaoro, 2012). It has a detailed record of research plan and its implementation. The purpose of the research and the use of the collected data were discussed to the interviewees to collect unbiased response.

Finally, the outcomes are measured by considering the objectives and feedbacks collected from users using qualitative measurement analysis techniques, which described how a proposed framework is expected to support solutions to problems not hitherto addressed.

Chapter Four

Findings and Discussion

This chapter presents the results of the interview described in chapter three. The data collection method utilized was the semi structured interview that provided both control and direction through a list of question under interview. Respondents were ICT managers` and senior staff who have an authority to decide which direction banks takes with regard to adopting new IT infrastructure or not. Interviewees were selected randomly from five different banks ICT department using purposive sampling. Ten interviewees from NBE, CBE, Dashen, Addis International and Enate bank were interviewed. Accordingly, results are discussed in this chapter by grouping the issues and comparing the interview findings from relevant literature findings.

4.1. Structure for Cloud Computing Development

There are many factors associated with cloud computing developments, which include benefits with the adoption of cloud computing, reasons which leads development of the system, and outcomes which affects the decisions for implementing the cloud system. In case of Ethiopian banking industries, many commercial0banks using the conventional IT systems based on the “hosted applications model” and don’t have access to take advantage from the new business and technological model i.e. cloud computing IT model. Both models have several features in common; fundamentally their difference is from the business model standpoint (ITU, 2012).

The difference between cloud computing and the existing computing models in EBIs can be better demonstrated by ways of using the service and deployment models and its key enabling technologies of virtualization. ITU, 2012 studies indicated that the major differences between the two modes lies in the fact that, in the case of cloud, responsibility for security is entirely a matter for the cloud computing provider, whereas in the “hosted applications” mode, that responsibility is shared between the owner of the application and the host.

On the other hand Nyaoro (2012) discussed that, under cloud computing IT model, organizations can access computing infrastructures from a cloud provider instead of the traditional purchase of physical servers and software needed to set up a datacenter. Also Armburst et.al. (2009) studies demonstrated that Cloud computing IT model allows the dynamic integration and extraction of computing resources based on the workload and target performance parameters needed by banks, while billing is based on resource consumptions such as CPU hours used, volume of data moved, or gig bytes of data used.

Additionally, Garg (2011)observed the following reasons which may be considered as an attractive option for a financial service institutions for the use of cloud computing.The factors that make cloud computing an attractive options for financial service institutions are perceived cost savings, ease of scaling-in and scaling-out, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move. These critical factors can drive EBIs to adopt and implement cloud computing. Moreover, the main components that can needed to be analyzed for the development of cloud computing framework for EBIs regarding with determinants, strategies and outcomes of cloud computing development were presented as follows.

4.1.1. Determinants of cloud computing

4.1.1.1. Benefits and Risks of Cloud computing

The issues raised in this study in relation with the potential benefits of cloud computing banks gained from adoption it and the potential risk which hinder banking industries from the adoption of new technological innovations.

In Ethiopia, banking services are provided on a group of networked banking channel services to the dedicated customers from a single bank infrastructure. In this context, for expanding the geographical coverage of these banking services, banks need to distribute the channels with the necessary resources (human, financial, computing and etc.). Distributing branch offices and installing ATMs to expand the market coverage of the banking services needed high investment costs to acquire hardware and software infrastructure to support it. This does not protect the investment costs of ICT or it does not the financial efficiency of banks.

When the market reaches at the peak time or computing needs changed, banks also need to procure and install the required IT infrastructures to support the banking operation. This does

not provide a flexibility to respond to fluctuations of market supply and demand, because resources are procured and installed in a fixed time interval.
Customers wants to access any banking services everywhere and anytime nearer to their places without access limitations from any banks available in Ethiopia. But in case of EBIs, the dedicated customers to the specifics banks access only from banks channel they are registered. So customers needed to search bank`s channels, this wastes customers time and money, while reduces their satisfaction. Employees also loaded by large routine transaction volumes, this leads high customer traffic to access the banking services from the branches and limiting the access. Improving operational, financial and CRM efficiency using ICT is the strategy of all banks in Ethiopia. However, because of the above factors banks do not address their strategic efficiency. The overarching and most disruptive impacts of cloud computing will be how redefines the relationship between consumers and their providers of banking products and services. Cloud computing will make these services more convenient, more accessible, easier to use, and more personalized to the individual needs and lifestyle (Sardat, 2012).
One of the basic barrier a firm faces, while adopting technological innovation is the perceived risks. The major reasons that continue to hinder the level of adoption of this new computing infrastructure acquisition paradigm are: performance bottlenecks due to use of HTTP protocols and bandwidth issues; increased threats of single point of failure; customer data lock-in; concerns over data privacy and security; lack of frequently used tools; and the switching costs of migrating from in-house IT infrastructure (Nyaoro, 2012).

Without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011). The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009). Garg (2011) suggest that data privacy, compliance, availability, lack of standards, etc. are the common challenges of implementing cloud computing in a more regulated and security-sensitive financial service institutions.

Moreover, all of the bank manager's participated in this study were asked whether security issue is raised with the use of technological facility in the banking industries, and all of them stated that security is the main concern that hinders our bank to use technological facilities.

The finding indicated that fear of security risks is main barriers if banks used external resources to adopt and implement cloud solutions to support electronic banking for EBIs. In the case of using mobile banking, ATM and POS, security risk affects banks' decision to use external public cloud service providers. Banks do not trust the technology provided by external cloud service providers.

The respondents asked whether banks will decided to use IT resource and support from external public cloud provider to support electronic banking services with greater cost saving and flexibility, and largest number of respondent were agreed on the issue, however fear of risk is one of the factor that hinder the use of external cloud vendor resources and support for EBIs. Similarly the result from the interview revealed that lack of confidence with the security issue is considered as barrier for using external cloud vendor resources and support. This result were consistent with the findings of Garg (2012) in which all indicted that, technological barriers, such as security risk as hindrance factor for the adoption of cloud computing.

Also the result indicated that lack of trust on the use of technological facility provided by external cloud service providers is another factor that can hinder adoption of technological innovation by Ethiopian banking industries. This result confirms the finding of Sarfraz and Brohi et al. (2011) which suggests; the greatest challenge among the banking sector is winning the trust of customers in the issue of security or perceived security risk as a key inhibitor in the adoption of cloud computing. Also Savola, Juhola, &Uusitalo (2010) indicated that there is the difficulty of winning consumer trust, and they suggested that the most important aspects that enforce trust in the cloud are good level of security and privacy.

4.1.1.2. Internal Capacity of Banks

One of the basic issue related with internal capacity assessment to develop cloud computing for EBIs is, the availability of financial as well skilled human resource to implement the system. In this study costs related with the use of E-banking instrument and technical or managerial skills required to implement E-banking system were considered as organizational factors.

Through the years, the value of ICT is increasing for general purpose computing and industry specific computing in banks. Many banks in Ethiopia have already using the digitized and

networked banking services at enterprise level IT infrastructure. Also they are investing millions of dollar for fulfilling the changing computing needs to deliver the banking services consistently in the market, mostly at enterprise level/individually.

Core Banking Systems are applied in many private and public banks of Ethiopia. The use of core banking solutions is expected to achieve a nationwide electronic payment system according to the central bank`s targets. CORE ("centralized online real-time environment".) banking is services provided by a group of networked bank such as: branches, ATMs, POS, phone &etc. This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw or transfer the deposited money from any of the bank's member branches throughout the country. User computing devices used as banking service channels are interconnected with the centralized server or datacenter of bank`s using virtual private network telecom infrastructure.

Moreover, the IT manager of CBE, indicated that: ‘Our bank were aggressively doing on the provision of high quality service to customers by employing different technological innovation, for example the bank purchase CORE banking system software, which offers service to customers more than the sophisticated ATM machine. It would enable banks to provide Internet banking to deliver product/service to customers. It helps customers to view their balances, transfer funds, and pay bills online. Banks could also offer mobile banking services through which customers can check their balance and transfer funds by short message service (SMS), as well as phone banking to check balances and make account inquires by phone.

Thus the cloud computing performance and features have an attractive option to allocate the required resources to implement cloud computing, because the existing core banking solution implemented in many banks in Ethiopia are suitable for integrating the data among them through cloud collaboration or hybrid cloud deployment model (Sardat, 2012).

Similarly the result shows that recently banks and their customers are familiar with the different IT based service provided through ATM, Internet banking, telephone and mobile phone, relatively technical and managerial skills on the use of technological innovation are available. And also this availability of skills and the suitability of the existing core banking solution are considered as favorable input to adopt and implement cloud computing solution for EBIs.

In general, supporting E-banking service such as internet banking, mobile banking and others using cloud computing model achieves greater total cost saving and simplifying the management of IT complexity when compared with the existing IT model to support banking system.

Limitations of ICT Investment and Usage

All Respondents agreed that high investment cost on IT infrastructures, inefficient use of IT resources, lack of collaboration among banks to share IT resources, internet bandwidth inconsistency, the changing computing needs which bear compatibility problems and other related factors were the key challenges in the current ICT usages of Ethiopian Banking Sectors. Lack of up-to-date plan for ICT service delivery strategy also considered as a limitation for banks` to fully harvest the opportunities presented by the latest technology.

The result shows that in regarding to the existing cost incurred on ICT infrastructure to support the non-core and core banking services (different E-banking system like internet/online banking and mobile banking) many respondents did not agreed about its efficiency. The suggestions from all respondents on cloud indicated that, 'compared with the existing IT system to support banking services, using cloud computing in banking industry is efficient to perform banking activities at lower costs. This finding is consistent with the studies of Aarti Singh et al. (2012) which suggested that cloud computing gives adopters two main advantages over: First, it frees them from spending high up-front costs on IT resources that may not be fully utilized in the future, Second, it allows them to face occasional spikes by flexibly adding more resources at whatever time needed.

Respondents agreed on the insufficiency of the current ICT infrastructure investment and usage suggested that banks needed to improve the banking services by employing the state of the art technology being used anywhere in the world. They also suggested that continual improvement and advancement of technology would assist banks` for harvesting the actual and expected benefits from ICT. However, some experts in the banking industry speculate that underdeveloped telecommunications infrastructure may hinder the visibility and practicality of the CORE banking system.

4.1.1.3. External Environment

In principle cloud service is provisioned over the internet to multiple users on as needed and pay as you go model in the world. When we evaluate the external public cloud providers that can provide resource and support to banks in Ethiopia the different prerequisites are under consideration in this study which included: their ability to provide cloud service(IaaS, PaaS and SaaS) required by banks, favorability of their pricing model, the ability to meet high security, trust and privacy measurement standards, the adequacy SLA commitment for banks, availability of alternative cloud providers, availability of data movement from one provider to another provider in terms of time and resource, latency issues, and switching cost.

On the other side the availability of legal frame works, the maturity of national ICT infrastructure, competitive pressure and government support which can affect the adoption of technological innovation in Ethiopian banking industry also analyzed in this study. The result obtained from interview and literatures regarding those issues were presented in the following sections.

i. Legal and Regulatory Framework

National Electronic payments systems, mobile and agent banking system currently covered in Ethiopian legal system, but it is not specifically covered how cloud computing model support E-banking systems. Such legal framework encourages and enhances the introduction of modern electronic payment instrument such as ATMs, credit and debit cards, mobile/telephone/internet banking.

All respondents were agreed that there is no specific legal frame works in Ethiopia to adopt and implement cloud computing. Likewise, respondents were agreed that the differences on banking regulation in different country will have impact on the adoption of new technological innovation such as cloud computing. Similarly, An interview conducted with one of the bank supervision manager at national bank of Ethiopia (NBE) also prove that, Ethiopia does not have special rule on the use of cloud computing or it is not yet included in the banking regulation.

The promotion of cloud computing is an important matter for policymakers and regulators worldwide, since the cloud computing holds out distinct benefits for governments, companies, service providers, industry and research. To enable full enjoyment of these benefits, a coherent regulatory framework guaranteeing transparency, data protection and

respect for data integrity has to be established (ITU, 2012). So the availability of an adequate legal structure and security framework on cloud computing implementation could also encourage the use of cloud computing to support banking services in Ethiopia.

However there is no specific legal framework for the adoption of cloud computing standardized with other countries regulation at central bank. Cross-country legal and regulatory differences will have impact on the adoption of cloud computing in the banking sector that support e-banking services like, ATM, internet banking, mobile banking and Point of sale terminals (POS). These may hinders the use of external cloud service provider for EBIs. Moreover, the result from the interview about legal framework on implementation of cloud computing revealed that lack of legal frame works that meets on cross country legal and regulatory difference is considered as barriers faced by banking industries for the adoption of cloud model to support E-banking system in Ethiopia.

ii. Regulation of Mobile and Agent Banking Services in Ethiopia

Recently the government (NBE) established a clear set of legal framework on the use of technology in banking industry. NBE encourages and enhances banks to focus on technological innovation competition rather than traditional bases of retail bank competition.
The National Bank of Ethiopia is responsible for ensuring that financial institutions are delivering mobile and agent banking services without compromising the safety and soundness of the financial system of the country. Based on this the researchers have been reviewed the Regulation of Mobile and Agent Banking Services (NBE, No. FIS /01/2012)**.**
The use of technology and innovative financial service delivery channels such as mobile devices and agents have significant contribution in deepening financial service accessibility to the wider section of the population at an affordable price. This regulation stated that the use of alternative and innovative financial services delivery channels are essential to encourage and enhance savings mobilization. The minimum standards set by NBE for risk management and customer protection on the delivery of mobile and agent banking services reviewed in this study are:

Modes of Business Conduct

Mobile and agent banking service shall be carried out only within the geographical boundary of Ethiopia and with only Ethiopian Birr within financial institutions that are licensed by the National Bank are allowed to engage in mobile banking services.

Any person who is engaged in valid and lawful business or commercial activity within Ethiopia can be an agent of a financial institution. However, i) a foreign person or entity that is fully or partially owned by foreign nationals ii) religious entity which is faith based and iii) not for profit such as non-government organizations whose applicable law prohibits from engaging in profit making business shall not be an agent of any financial institution.

System Technology

The technology used for delivery of mobile and agent banking services must be secure and should at least ensure the following, which shall be part of the technology risk management program of a financial institution:

User Risk: User awareness on their information security including how to secure Personal Identification Number (PIN) and other security features.

Infrastructure and Software Application Risk: Information security standard, PIN and user authentication, Financial and non-financial data storage, availability of services and backup, Confidentiality of user information, Data and transaction integrity, maintenance of audit trails,, and authorization controls.

Communication Media Risks: Communication protocol risks, Data storage risks, and Availability and quality of service

Agent and Third Party Service Provider Risks: Data Encryption and message integrity, Data storage and backup, Physical and logical access to system, and authenticity and non-reputability of communication

Business Continuity Plan: Availability of services, Disaster recovery site, Standardize way of the data center, Redundancy of network communication, and antivirus protection.

Interface Feature of the Application: The system should be open (need to have a feature of interoperability with other system in any file format.

iii. ICT Infrastructure

Despite the recent improvements made by Ethiopian government on the national infrastructure, the overall ICT infrastructure in Ethiopia created an opportunity for many banks to introduce and expand networked and digitized banking systems rapidly. Card-based payment systems in Ethiopia have been growing fast in recent years. Many banks in Ethiopia

have introduced wider use of debit or ATM cards. The studies of ITU (2012) stated that the level maturity in telecommunication infrastructure is one of the basic elements in the development of cloud computing.

The result shows that ICT infrastructure in Ethiopia for internet access is relatively favorable to use online banking service, which indicated that the current development and improvement strategy of the government for the available and new ICT infrastructure in the country considered as driver to use E-banking system through cloud computing model.

Similarly, an interview result from the CBE E-payment manager indicates that the occasional inconsistency of telecommunication network service is a major obstacle for all banks in Ethiopia to effectively deliver some services such as internet banking, mobile banking and others. However some respondents agreed that the current government effort on improvement of national infrastructure, it will encourage banks to adopt different technological innovation. Therefore, one of the major obstacle factor for adopting external cloud providers resources and support identified in this study is the current maturity level of ICT infrastructure which might create latency problems for transferring data to and from the cloud stakeholder.

iv. Competition

As it is stated in different cloud computing literature, competitive pressure is considered as driver for the adoption of cloud computing in developed country. Respondents from Addis and Enat bank ICT managers were agreed with the idea that the current competitive pressure among newer and old banks in Ethiopian banking sectors is considered as factors for the rapid growth of using innovative technologies. The finding consistent with the studies of Sardat (2012) indicated that cloud computing can help to increase the pace of innovation, specifically for emerging market banks by allocating them to deploy new products quickly and at low cost which allows them to compete more effectively with matured banks whose deployment process in enterprise datacenter can be significantly longer. Thus cloud enables those banks to provide new services and products or to speed the market easily which can be various electronic banking services.

On the other hand an interview conducted with IT managers and experts of NBE confirms that, the central bank enforces and encourages the banks to work collaboratively by integrating their services to improve the speed and efficiency of banking market in Ethiopia.

4.1.2. Strategies for Cloud Computing Development

This section aims to evaluate the essential strategies such as security, legal and architectural requirements for cloud computing deployment and delivery for EBIs. The study of Garg (2011) stated that without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems.

Cloud-based services can be provided by IT companies which have large datacenters and huge software infrastructures with skilled manpower who can run the datacenter. Such cloud service providers are Amazon, IBM, Google, Azure, and others, which provide various IT services such as IaaS, PaaS and SaaS to consumers (Armbrust, 2012). Virtually customers can deploy and run their data or applications on the providers IT infrastructures without the need to invest on IT infrastructures, pay for that infrastructure they are used. This might reduce infrastructure investment cost and its management complexities to enterprises. However, the result shows that banks would not be willing to put their data/application on the external public clouds because of fear of risks on customer data privacy, security and confidentiality issues that might be brought from using it.

Moreover, the regulations covered in the national payment system and mobile and agent banking services limits the third party IT service provider to those only working in Ethiopia. Since processing financial data abroad the country is a difficult issue because of these regulatory framework and various concerns of security risks brings from using external public cloud service providers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer.

On the other hand the existing maturity level of telecommunication infrastructure in Ethiopia would create latency problems for deploying and running the banking system on the public cloud. Transferring data to and from the cloud has high latency than when transferring data

to and from an in-house datacenter. Respondents agreed that high bandwidth internet is required as a basis for providing cloud computing services. These security, legal, and architectural requirements identified above indicated that developing cloud computing infrastructure with external cloud service providers in case of Ethiopia does not present the success we seek from cloud computing.

Additionally, the respondents were asked to suggest about cloud deployment and service delivery suitable for banks. The objectives of the study and the main concepts of cloud computing were briefly discussed with interviewees before conducting the interview. So many of them were recognized the concept of cloud computing such as its service and deployment and delivery model. Accordingly, respondents suggested that hybrid and private deployment models have better role in the banking markets and the availability of IaaS, PaaS and SaaS in the cloud system are essential to provide and meet any demand levels of IT services for banks. Also many respondents agreed that cloud computing have new technological alternatives to produce, develop and deliver IT services than the current ICT investment and usages in banks. They also saw cloud computing as an easier, faster, cheaper and more flexible way to sell and buy all stacks of IT services. Finally, respondents suggested that before goes to investing in the cloud computing references of banks that have successfully implemented cloud-based solutions and are still operating it could be considered.

Therefore, based on the discussions covered in this chapter about cloud benefits, internal capacity of banks for cloud computing development and external environment the researchers decided to select hybrid delivery model that can be formulated between banks and NBE for provisioning cloud based services.

4.1.3. Outcomes of Cloud Computing Adoption

The findings of the interview indicate that the existing ICT investment and usage in Ethiopia Banking Industries were insufficient. Very high IT investment cost, network and internet bandwidth problem and lack of collaboration between banks were the major challenges.

While improving QoS, facilitating collaboration among competing banks, efficiency of ICT usage, and reducing both capital and operating expenses on ICT investment were the main driving forces to adopt alternative IT solutions. And also the major factors that affect cloud computing adoption in Ethiopian Banking Industries identified in this study were: efficiency of ICT investment and usage, increased collaboration with partners for opening new channels and markets, and reduced organizational burden of installing and managing resources in infrastructure and platforms. While the security issues (such as data privacy, confidentiality and etc.), the evolving financial regulations, and poorly developed telecommunication infrastructure are the main barriers for cloud computing adoption. In the following sub section the finding are discussed in each category.

4.2. Requirements for Cloud Computing Framework

Legal and security frameworks are identified, the decisions of cloud computing deployment and delivery model completed and here the architectural requirements to develop cloud computing frameworks that can be independent from the specific cloud service model (SaaS, PaaS, IaaS) are identified below based on legal, security, and architectural consideration of cloud computing for Ethiopian banking industries. These cloud computing framework requirements can be used as evaluation criteria to the final output (Repschlaeger, Zarnekow, Stefan and Turowski, 2011).

i. Service and Cloud management

This includes aspects necessary for the Cloud management and the maintenance of the relationship between customer and provider. Provider management contains support and contact information of the provider. This criterion considers all facts regarding support and customer service, e.g. which support is offered and under which conditions. Service management includes all activities necessary to control and manage the obtained Cloud services which are subsumed in this criterion, e.g. monitoring of services and volume control via APIs.

ii. Costs

It is characterized through monetary aspects like small capital commitment or low acquisition costs and consists of three requirements: pricing model, payment and service charging. Payment and pricing models are shaped by monetary considerations regarding the decision of EBIs and NBE. The payment opportunities include the possible payment method (e.g. credit

card or bank transfer), the time of payment (pre-paid or post-paid) and which level of granularity is priced (e.g. 1 MB, 100 MB or 1 GB steps). Service charging defines how the service is charged (volume based, time based, account based) and the available booking concept, e.g. pay per use, subscription fee, market based prices (spot pricing).

iii. IT Security and Compliance

It summarizes everything related to protection and safety and is composed of the following requirements: datacenter protection, network protection, operations protection and IT compliance. IT compliance is separated into the proposed provider requirements for privacy (e.g. encryption of data) and compliance (e.g. location of data center). Communication security refers to the provided infrastructure and focuses on the communication protection via secure cryptographic protocols and dedicated firewall settings. Operations protection includes the access management and role concept related to the used services. Furthermore, it can provide a multi-tenancy and firewall protected infrastructure, including virus protection systems.

iv. Reliability and Trustworthiness

It describes how certain the bank can be that the service from the Cloud has the guaranteed availability. The proposed cloud framework includes the requirements: reliability, trustworthiness and service level agreements. Trustworthiness characterizes the proposed cloud provider infrastructure including performance and service transparency (e.g. reports, service description), market experience, the number of customers or the annual revenue. Availability and liability include the probability that service commitments and promises can be met by the provider, based on indicators like the service availability, accessibility to several internet service providers and the liability agreements including penalties if the guaranteed service level is not met.

v. Flexibility

It describes the ability to respond quickly to changing capacity requirements and competition pressure. It included the requirements: interoperability, portability, delivery model, and automatization degree. Provisioning and set-up time are subsumed under the associated flexibility advantage of Cloud Computing. Resources, for instance, can be allocated and de-allocated as required. The provisioning time is shorter compared to traditional outsourcing and the set-up time to get in contact with the provider (e.g. register or set up a new account) is shorter as well. Interoperability and scalability comprise all features regarding the maximal

number of available resources (e.g. user accounts, instances, functions, services) which can be used simultaneously. Additionally the interoperability describes the integration between services of banks and the provider. The browser compatibility is important especially on the SaaS level, whereas the development environment is of high relevance on the PaaS level. Contract flexibility and renewal of contract both represent the commitment between the bank and the provider and defined contract automatisms based on the directives of NBE.

vi. Scope and Performance

It covers the functionality and performance of the Cloud service and the requirements consists of service characteristics, service optimizing, hardware, and performance. Usability and customizability refer to the usability and adaptability of the surface of the web portal, the user interacts with. The Usability mainly represents the structure and the ease of use following the self-service concept. Regarding individual preferences predefined templates, editable user views and function settings can be configured by the user. Add-on services describe additionally bookable services like storage, database services, communication services (e.g. collaboration, messaging) or security services.

Chapter Five

Cloud- Based Service for EBIs

5.1. Backgrounds of the Framework

5.1.1. Identifying Cloud Services and Deployment Models

For identifying the required cloud computing solutions that can be provided to EBIs`, the researcher started by analyzing the requirements of bank by means of interview and looking at other financial institutions best cloud service experience and best practice. The analysis

process was based on interviewing Information System directors from selected banks, reviewing best cloud service experience and practices of business companies and financial institution around the world as described in chapter four. Following the results of the analysis the researcher identifies the potential cloud services such as IaaS, PaaS and SaaS, while hybrid cloud delivery/deployment model are proposed for EBIs. The proposed cloud types and deployment model that could best meets banks functional, service, security, and regulatory requirements are discussed in the next sub sections.

5.1.1.1. Hybrid Delivery Model for Ethiopian Banking Industries

Several cloud deployment models are now available to banks and other financial services firms, including (Ryan, 2012): Firstly, the public cloud infrastructure, which is made available to the general public or a large industry group and is owned by an organization providing cloud services.Secondly, the private cloud infrastructure, which is operated and managed solely for an organization or it may be managed by a third party and mayexist on premises or off premises. Thirdly, a hybrid cloud is a composition of two or more cloud environments, in which an organization provides and manages some resources in-house and has others provided externally through a public or community cloud.

By considering the knowledge derived from the literatures and the banks intention from the interview result the researcher decided to propose a hybrid cloud delivery model for EBIs. The researcher also decided to form Ethiopian-based cloud service provider to formulate a secured cloud environment for hybrid cloud model. The formulation of a hybrid model, then, is based on a range of variables, including security and data concerns; the evolving financial services regulatory environment; and a specific institution’s application and infrastructure requirements (Ryan, 2012).

The proposed hybrid cloud model will have a capabilities to combine cloud and non- cloud IT infrastructures such as private, shared, and traditional IT with in banks, in which banks provides and manages some resources in-house and has others provided externally through a local cloud service provider in security rich environments.

The proposed hybrid delivery approach allows banks to accelerate speed-to-market by better aligning IT and the business itself. This strategy instills greater agility, which enables banks to better respond to new opportunities and competitive challenges. By integrating traditional IT and private cloud-based services with the new local cloud service provider, this hybrid

approach protects current investments in EBIs. By leveraging flexible sourcing and usage-based pricing, it can help to reduce both capital and operating expenses of banks. This hybrid cloud formulation will fortify vital risk and security management that were considered as the major barrios on cloud computing adoption from using external public cloud service provider in EBIs. Thus, it will mitigate the major barriers raised on cloud computing adoption in Ethiopian Banking Industries.

5.1.1.2. Identifying the Type of Cloud-Based Services

The cloud-based services were selected and identified by considering the needs of their uses on the cloud environment for EBIs. The following sections discuss the three types of cloud services.

Software as a Service (SaaS)

SaaS is one of the service deployment mechanisms which enable user's access different software from the cloud wherever they are, and whenever they need without installing it on their machine (Sewale, 2012). In SaaS users can access different software from the cloudIn SaaS users can access different software from the cloud: CRM, Email, Virtual Desktop, Office applications, Simulation software, Enterprise Resource Planning and different Business Information system applications, like core banking systems, finance systems, HRM system.

Platform as a Service (PaaS)

Platform as a Service delivers a solution stack, which is an integrated set of software that provides everything a developer needs to build an application for both software development and runtime (Bhattachariee, 2009).. The proposed hybrid cloud will offer developer tools as a service to build services, or data access and database services, or billing services on the cloud. The developers who seek to develop and run a cloud application for a particular platform can access these services using the interface presented to them. The developer interacts only with the platform through the proposed hybrid cloud interface, and the platform does what is necessary to manage and scale it to provide a given level of service. Using the cloud, developers do not need to physically install any specific services, solution stacks or databases on their machine. According to Raoj& Reddy (2011) PaaS provides the images to users where they can simply select these images and use them on a machine provided in a

cloud. The hybrid cloud provides the following services for PaaS users: solution stacks (Java, PHP and .NET), and Storages (database and file storage).

Infrastructure as a Service (IaaS)

IaaS is another mechanism to deliver computer hardware such as servers, networks, datacenter space and others, which allows cloud users to host/run their data/applications on the provider computing infrastructure (Esteves, 2011).. The proposed hybrid cloud delivers these infrastructures using virtualization or multi-tenancy architecture at one place to all distributed banks. Under this cloud service model, the provider manages and maintains the hosting and the development environments. By consuming IaaS cloud banks canreduce infrastructure cost and complexity through its capabilities of rapid provisioning, ability to scale up/down and pay only for what you use. The hybrid cloud provides the following services for IaaS users: physical machine, Virtual machine, OS-level virtualization, storage, network and etc.

5.1.2. The Proposed EBIs Cloud Services Provider

Analyzing the potential benefits and risks on cloud computing adoption for EBIs was one of the objectives of this study. These could be considered as a significant starting point for cloud system development effort. Thus this study presents the potential benefits and risks that could be brought from cloud computing adoption. The major factors that affect cloud computing adoption in Ethiopian Banking Industries identified in this study were: efficiency of ICT investment and usage, increased collaboration with partners for opening new channels and markets, and reduced organizational burden of installing and managing resources in infrastructure and platforms. While the security issues (such as data privacy, confidentiality and etc.), the evolving financial regulations, and poorly developed telecommunication infrastructure are the main barriers for cloud computing adoption.

Regulatory risk or the need to secure and protect customer data is a primary concern when evaluating and choosing any cloud-based solution. Ryan (2012) suggested that to select the best cloud model, banks need to consider several issues such as: assess the critical need for security, privacy, and control in a cloud environment, and evaluate the potential cloud solutions based on value, competencies, and risks to decide on building in-house or consuming an external cloud service. This implies that the choose of an appropriate cloud-based solution depends on: security and data concerns; the evolving financial services regulatory environment; and a specific bank's application and infrastructure requirements.

The interview results indicate that Ethiopian banking industries are working in a very highly restricted regulatory policy. Processing financial data abroad the country is a difficult issue because of these regulatory risks and security concerns brings from using external public cloud service providers. Banks also would not be willing to locate their data on external public cloud. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer. Thus the need to find an alternative local cloud service provider that could provide cloud-based solutions for EBIs than external cloud service providers were mandatory.

Through taking in to account the above issues we are discussed the researcher decided to propose Ethiopian-based cloud service provider that can provide the identified cloud services by deploying hybrid cloud model for EBIs. The proposed local cloud service provider will be formed and equipped with essential cloud technology infrastructure that can be provisioned as a service to banks based on their specific application/infrastructure requirements using cloud computing business model. This cloud provider will provide scalable, elastic and reliable resources to the users.

The cloud-based services offered by the proposed cloud service providers could be: (1) IaaS which deliver infrastructure resources includes servers, storage, operating systems, and networking. (2) SaaS which deliver domain-specific applications or services over the Internet including collaboration and communication tools, CRM, Office applications, and different Business Information system applications (like core banking systems, finance systems, HRM system). (3) PaaS which offer developer tools as a service to build services, or data access and database services including: solution stacks (Java, PHP and .NET), and Storages (database and file storage).

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Therefore, the proposed hybrid cloud model allows users to run the different workloads on the local cloud service provider infrastructure or platform services. These potential workloads that could run on that infrastructure/platform services to extend the performance of internal infrastructure/platform services are: development and test, storage, collaboration, desktop,

Webmail, self-service application development environments, ERP and virtualization (Gulla, 2013). Additionally, users will consume the local provider platform services such as: database as a service, middleware as a service, software as a service and software lifecycle as a service.

5.2. Building the Framework

The existing Information communication technology investment and usages in Ethiopia Banking Industry were described as insufficient based on the interview results and the ICT usage practices of other banking industries in the developed world reviewed in this study. Bank is a financial institution and a financial intermediary that accepts deposits and channels those deposits into payment activities, either by loaning to others or withdrawing to depositors. Building an efficient ICT investment and usage strategy to support these activities by leveraging EBIs from recent technological model i.e. cloud computing IT model for ensuring QoS was the main intention of this study.Using this model all channels of EBIs are interconnected with each other virtually and customers can access various banking services from any channels available anywhere through cloud interface. These virtual banking Services helps to solve limitations of the current ICT usage in EBIs. The following figure shows a high level cloud-based service delivery architecture for the proposed Ethiopian Banking Industries Cloud system based on cloud computing model with cloud interface layer to facilitate the interactions among banks from the provider and the cloud service partners to all banks.

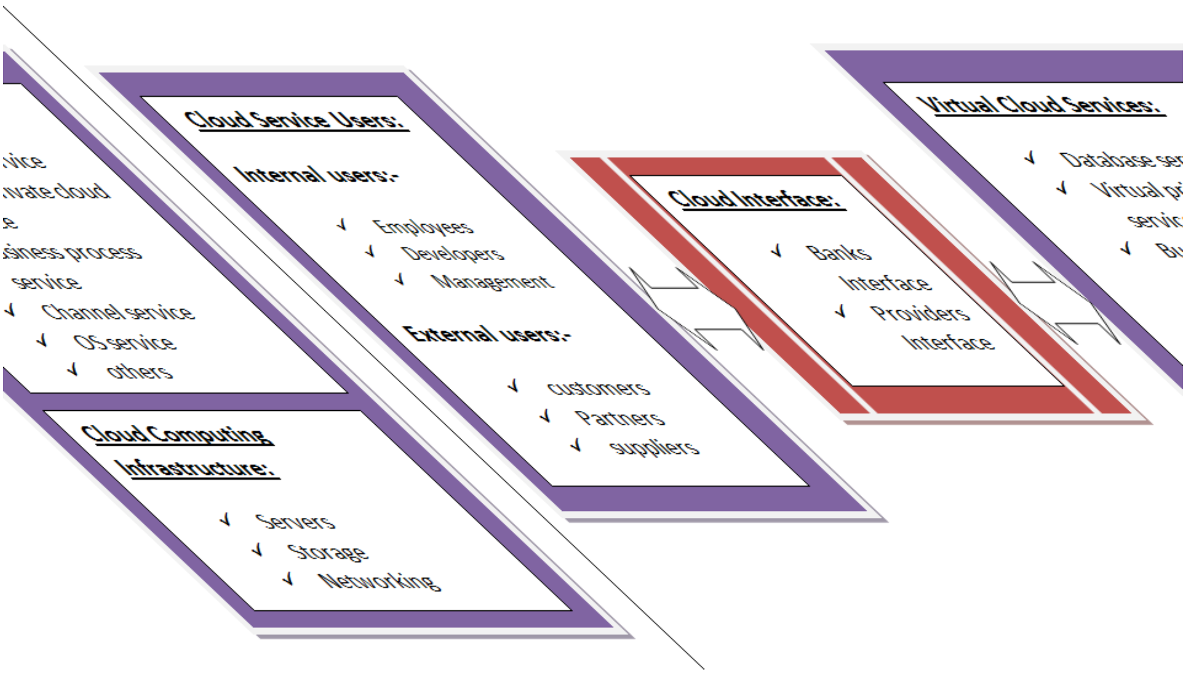

Figure 4.1: High level cloud based service delivery architecture

Virtually the cloud services can be deployed and run on the proposed service provider physical IT infrastructures. Users of cloud services are employees, customers, joint ventures/partners, and others users of the bank. EBIHC have an interface for both banks private cloud and the local service provider cloud. Users can store their data and access virtual machine instances (software containers) on cloud computing infrastructure easily. Users can create virtual machine image, launch the required services and terminate the virtual machines through cloud interface. In cloud, computing resources will not exit but functions by creating virtual version of an IT resource such as OS, a server, Storage Device and Network Resource on rent base when needed (Ryan, 2012)..

Based on the identified cloud services and the selected Cloud model discussed in the framework background, the researchers proposed a collaborative cloud computing architectural framework for EBIs. The following figure shows the proposed Ethiopian Banking Industry Cloud framework.

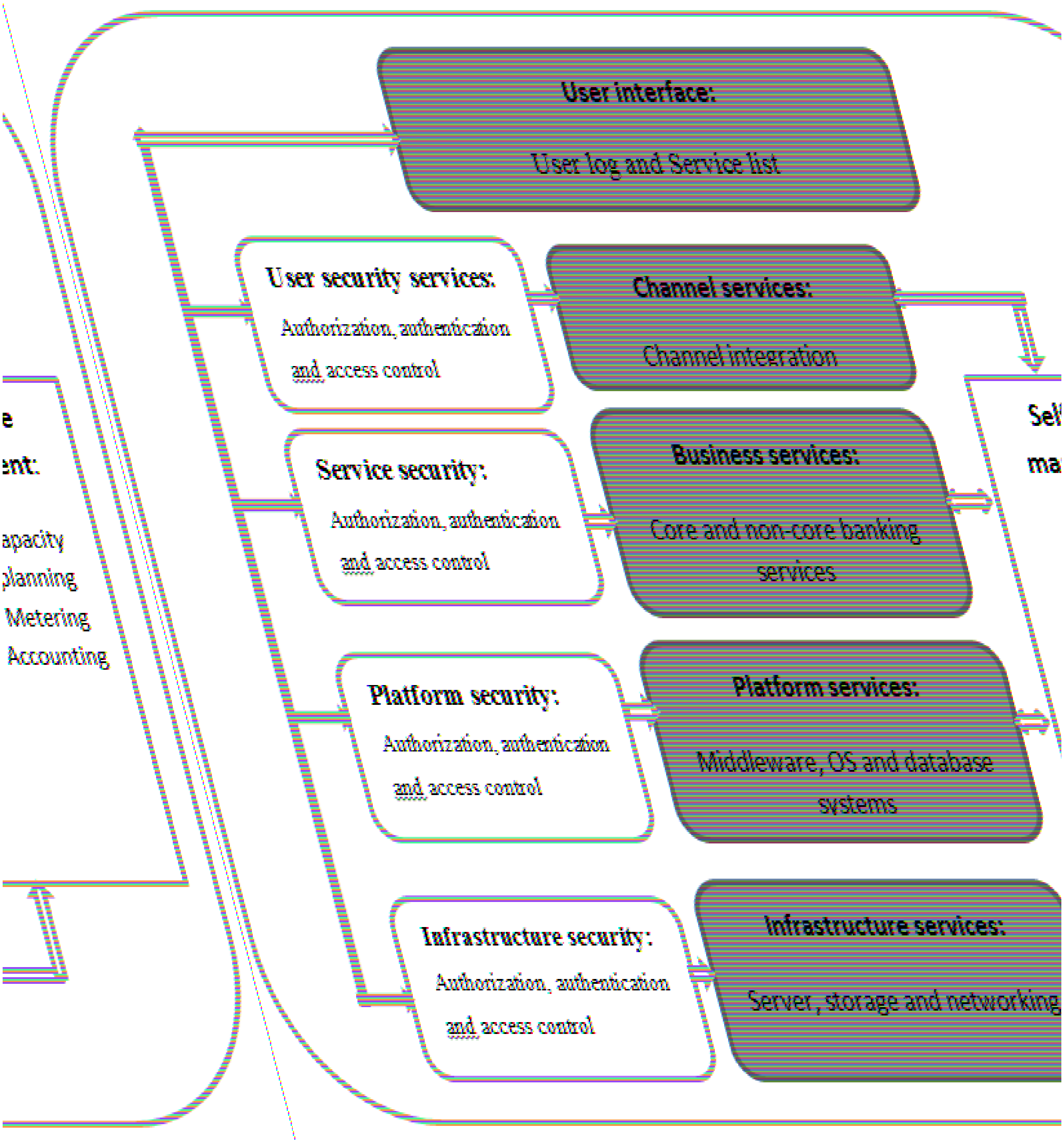
User interface:
User log and Service list
User security services:
Authorization, authentication and access control
Channel services:
Channel integration
Service security:
Authorization, authentication and access control
Business services:
Core and non-core banking services
Platform security:
Authorization, authentication and access control
Platform services:
Middleware, OS and database systems
Infrastructure security:
Authorization, authentication and access control
Infrastructure services:
Server, storage and networking
Metering
Accounting

Figure 4.2: A collaborative cloud computing architectural framework for EBI

The proposed framework illustrated in the above figure contains five cloud service layers (interface, channel service, Business service, platform service and Infrastructure service). The following sections discuss the five service layers of the proposed framework.

5.2.1. Interface layer

This layer acts as an interface between the user and the Cloud content. Access to each cloud services are protected by the proposed security framework. This allows users to access the cloud services in a security rich environment. The User Interface layer contains two important components. The first one is user log which provides an access path to specific cloud services, and the second is a service list which provides the list of the available services on the cloud environment.

5.2.2. Channel Services Layer

The services offered in this layer are channel integration toward a single architecture that supports all channels (ATM, branch, call center, mail, mobile, online, telephone, video, etc.), for delivering a consistent customer experience, common banking services, and information across all channels. The proposed framework provides a user security services to protect unauthorized access from unwanted users. Using this service EBIs can share their channels to provide common banking services collaboratively.

5.2.3. Business Services Layer

The business Services offered in this layer includes core bank services (corporate and retail banking, wealth management, treasury management, risk management and compliance, trading, etc.), as well as noncore services as a hosted application on the cloud environment. Banks may build, operate and manage their core banking services internally, while they can consume other business services offered by the proposed local service provider based on their needs.

5.2.4. Platforms Service Layer

This layer provides access to application hosting and development environments including middleware technology, operating systems, programing languages, database systems and other platform services on a security rich cloud environment. Users are able to build more sophisticated systems and distributed DBs using this application hosting and development environments.

5.3.5. Infrastructure Service Layer

This layer offers infrastructure services including servers, storage, and networking on the cloud environment. The users can consume the services virtually without buying managing it from the proposed EBIs infrastructure service providers. Customer can use these computing resources to run software (both operating systems and applications) and to store data. This layer is often called IaaS.

Additionally, the proposed framework includes security modules and self-service management module. The framework has the security services in each cloud services. First, user Security Services which is included in the framework to control unauthorized access from channels. Second, service security which allows to protects the business services or application from unwanted users. Third, Platform Security services which allows the hosted application/business process run on the platform securely. Fourth, the security module also includes the infrastructure securities that are the building blocks for delivering any cloud based services securely.

The real-time system performance information can be monitored on self-service management module. The local CSPs can measure performance and availability of the overall cloud system. The monitoring service can also be used by users to measure the performance of provisioned virtual machines, and to determine whether new virtual machines need to be started. In a cloud system, everything is metered and accounted. Metered usage information provides for flexible pricing and charging in cloud environment. Historic usage information together with monitoring information is critical to automate capacity planning and ensured agreed QoS.

□□□□□□

5.3. Implementation Plan for the Proposed Framework

The proposed framework`s i.e. EBIHC which are described in the previous sections are promising for efficient utilization of ICT investment and usage of EBIs. In such a situation, the framework needs an implementation plan to deploy cloud-based solution for EBIs. The hybrid Cloud model, which combines the internal IT infrastructure with the proposed local Cloud service provider, was proposed. The next figure shows the general layouts of the hybrid Cloud computing model proposed for Ethiopian Banking Industries.

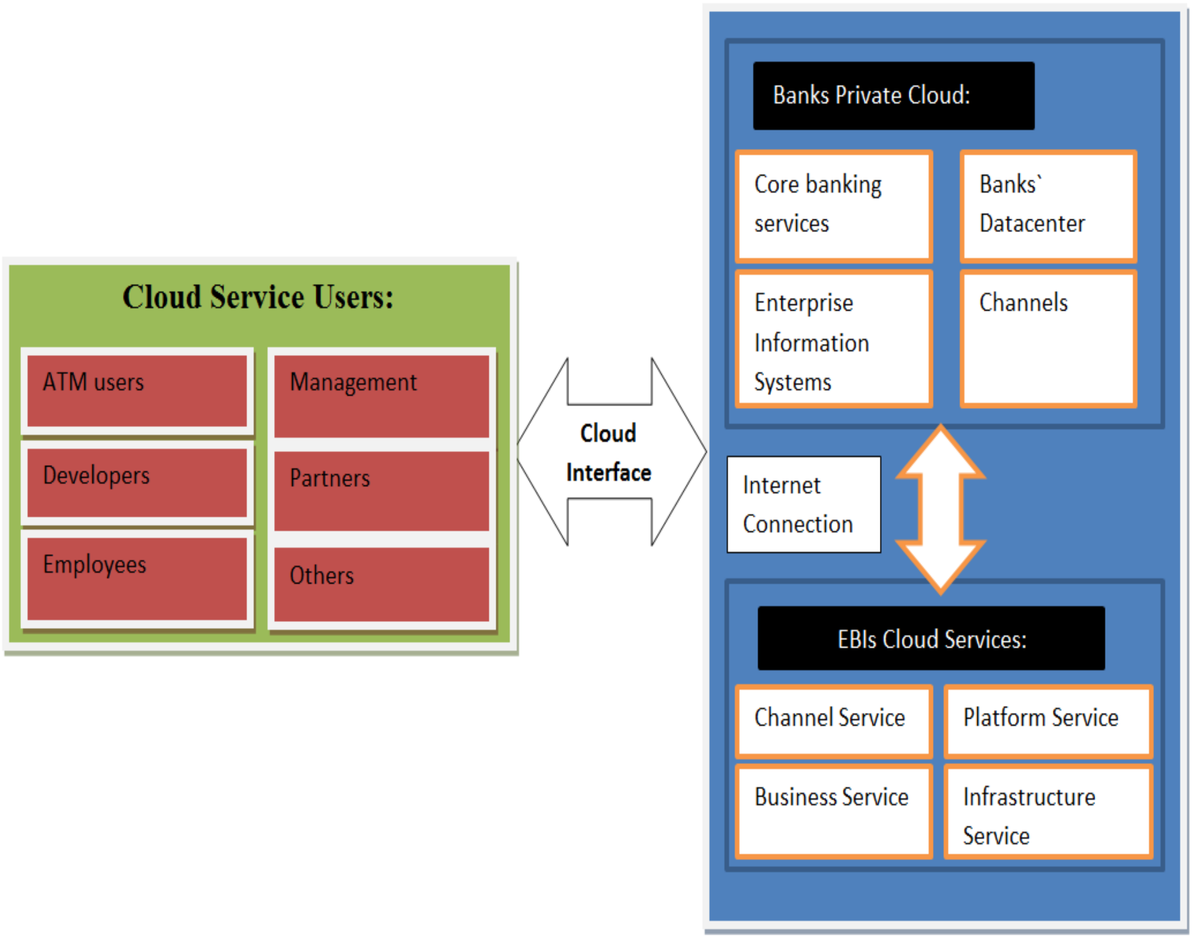

Figure 4.3: The general layouts of a hybrid Cloud for Ethiopian Banking Industries

The figure above shows the general layouts how the user can use computing resource using the central hybrid cloud from providers. The proposed hybrid cloud model could have an interface for both the private cloud and the EBIs cloud. Using this interface cloud users and provider could operate on the hybrid cloud environment. Banks private cloud and EBIs cloud would be combined using internet connection. The cloud service users might be banking service users or cloud administrators.

The following steps illustrate the mechanisms for operating in the cloud environment:

1. The user submits a service request using the EBIHC interface on their devices such as ATMs`, mobile, workstations and etc.
2. The user request would be checked to verify authorization of access to the requested services.
3. If the user is unauthorized to access the requested services, the system will reject the user's request or the request will be sent to the virtual infrastructure manager to redirect the request to the appropriate location.
4. If the user is authorized (users information is available in cloud datacenter) to access the requested service, the system will establish a connection between the requested service from the cloud (EBIs or private) and the user.
5. When the user accomplish their tasks/accessed the required service from the cloud they can terminate the application they was used. The system also terminate the application/services if the users don`t access the services on the time limited to access that service, and the user can submit the request again to the cloud.

To operate in the cloud efficiently each cloud services should be protected on the security framework. As we have seen in the above step accessing any cloud services on the virtual cloud environment is secured.

Developing hybrid cloud model needs to made changes on the existing IT infrastructure for efficient hybrid cloud delivery strategy. So Banks need to standardize their enterprise level IT infrastructures through the proposed EBIs cloud for easy integration of their IT infrastructure

to the cloud. Then they can extend the performance their enterprise level IT infrastructure using EBIs cloud computing environments when computing needs are increased and internal infrastructures are incapable to provide the computing requirements. These will utilize the current Ethiopian Banking Industries IT investment and usage. After a standardized private cloud is established using the proposed EBIs cloud, the cloud provided a manageable hybrid Cloud for the banks. Thus, banks will increase their IT infrastructure efficiency by extending their datacenter and computing power using provider infrastructure without buying additional computing resources when the changing storage and high performance computing power need increased. The proposed hybrid Cloud architecture formulates through combining the proposed EBIs and banks internal IT infrastructure/private cloud using internet connection. The several elements included to formulate a hybrid cloud for delivering the requested service are illustrated in the following figure. The following figure illustrates the proposed EBIHC hybrid Cloud implementation architecture:

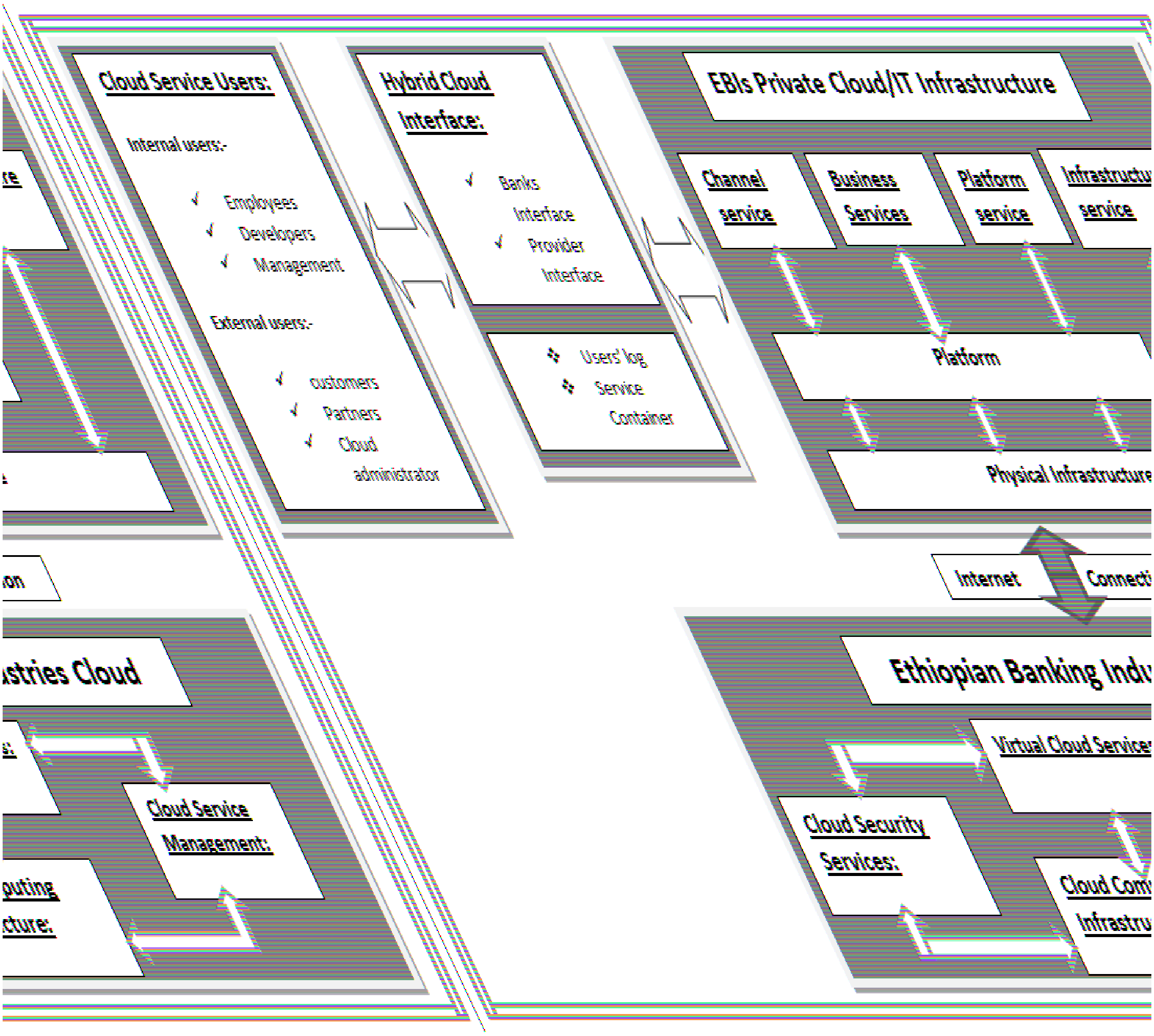

Figure 4.4: The proposed Hybrid Cloud Implementation Architecture for EBIs

There are four elements included in the hybrid cloud implementation architecture such as: cloud users, user interface, internal IT infrastructure/private cloud and the proposed EBIs cloud with their respected cloud services. First, the user interface element contains two services to manage the cloud user's access privileges control and business service delivery. Next, the internal IT infrastructure/private clouds of banks contain four services that can provide all IT services to deploy and use banking services. Finally, proposed EBIs cloud contains four services such as: virtual cloud services, infrastructure services, security services and self-service management that could offer as a service to banks on demand. The following list discusses the proposed hybrid cloud arrangements:

Cloud users: cloud users might be identified as business service users, channel services users, platform users or infrastructure users. Channel service users are customers, partners, employees and others, those who will access the hosted banking services through channels. The proposed hybrid delivery model supports all channels using a single architecture for integrating them. Then banks business services might be hosted on their internal datacenter or on the provider datacenter to be accessible for authorized users through integrated channels. Platform users are mainly developers who will develop applications using cloud development platform environments. Platform service provider offer different platforms to developers on demand. The physical infrastructures of the banks` will be virtualized using virtual private cloud services or internet connection by developers.

User interface: The users' access mode is identified in this element. The system administrator/cloud coordinator will create users type and access privileges. The created users might be customers, employees, administrators, managements and others and their access privileges are determined based on their priority to access the system. User logs are one of the security services included in the interface, which is important for controlling and checking the authorizations of users to access the services. This is mainly responsible for checking the track of the authorizations users and its access mode which is selected for them. Users' information such as access modes, user passbook account, card password, providers` account, user type, and so on are verified using the information stored about the user for access permission in the cloud datacenter. Additionally different business services are listed on the cloud container with specific details about business services to users on the interface. Such business services might be core banking services and other enterprise information

systems. So the authorized users who are verified by the cloud security services can access the services they required using these secure interface service.

The internal IT infrastructure/private clouds: contains four services that can provide all IT services to deploy and use banking services.Banks` private Cloud would be built on the available infrastructure and standardized by the proposed EBIs cloud facilities. Then the physical infrastructures of the banks` will be virtualized using internet connection. An infrastructure service provides IT resource from the Infrastructure resources to the infrastructure service users. The private cloud also contains the platform services which will work and manage the platforms to enable development and deployment of applications and programs with the abilities to access proposed cloud resources and platforms. The platform services provide platforms from the platform container to the platform service users. These infrastructure and platform resources would be offered from the private cloud or provider cloud.

Platforms would be connected to the service container to integrate the platform services with different business services. Then the business service provides access to platforms, so users can use one of the deployed/hosted applications on the platform through platform services. Additionally, Platforms would be connected to all channels to integrate the platform services with channel services. So channel users can access the hosted banking services on the platform.

The proposed EBIs cloud: To build the proposed EBIs cloud large datacenter, large scale software infrastructure and technical manpower to run these datacenter would be required. After having the required infrastructure EBIs cloud provides virtual cloud services on the top of its physical IT infrastructure for banks in Ethiopia. EBIs platform services would allow scalable deployment of applications by providing a web service through which a user can boot virtual machine image to create a virtual machine or an instance containing any cloud services desired. The virtual cloud services offered by EBIs cloud are database services, virtual private cloud services, business services, channel services, operating system services, compute and storage services, and others. The sample virtual cloud services offered by EBIs cloud were presented below.

Storage services: EBIs cloud provides online storage services using a web interface. Customers can access raw computing power from virtual servers or virtual machine instances. And also banks can store and access their data on EBIs cloud storage spaces on-demand. Various information or data would be deployed, stored and accessed by users.

Operating system services: The proposed EBIs cloud will offers a variety of operating systems in image form; the cloud users can operate and perform multiple tasks on the available operating system images. This will facilitate the users to operate their tasks in different operating systems according to their task requirements and compatibility.

Database services: Under cloud-based database service, users can run databases on a cloud computing platform independently, using a virtual machine image, or they can purchase access to a database service, maintained by a cloud database service provider i.e. EBIs cloud. In these cloud environment database developers can create relational databases; link different databases from diverse locations implement and maintain relational databases, and retrieve information using different database languages like, Oracle application or Structured Query Language (SQL) with PHP to connect the databases in the Internet.

Networking services: User can create and launch EBIs cloud resources using a virtual network. By using this virtual networking environment, customers will select their own IP address range, create subnets, configure route tables and network gateways.

Additionally, the proposed EBIs cloud also contains self-service interfaces for on-demand provisioning and management (i.e. start, stop, reboot, and destroy) of virtual services, and self-management interfaces for auto-scaling and other automatable management facilities.

5.4. Evaluation of the Framework

i. Data Privacy, Security and Regulations

Many respondents from the selected banks appreciate the relevance of the proposed cloud solutions. Data privacy and security regulations in many countries including Ethiopia prohibit the storage and processing of customer data outside national borders.Banks are also wary of the potentially disastrous impact of a serious breach of security or privacy, or of even a brief outage in areas such as ATM operations, fraud monitoring or credit card processing. To comply with the rules which prohibit customer data to be passed beyond national borders and the fear of risks banks wary, the options of local cloud service provider considered in this study have positive feedback from respondents.

Interoperability and scalability comprise all features regarding the maximal number of available resources which can be used simultaneously from the cloud system. This capability of the system allows easy data and service integration between banks and provider. In the proposed framework all banks IT infrastructures can be virtualized using internet connection, then using the platform data and applications integrated and made available to end users. In this situation,Platform and infrastructure security focuses on the communication protection via secure cryptographic protocols and dedicated firewall settings. While channel and business protection includes the access management and role concept related to the used services.

The proposed framework supports the data privacy requirements of the banks through the technics of data encryption and they know the physical location of the datacenter. The use of well-understood technologies such as data encryption, the network middle ware manager,which are included in the proposed framework, couldeasily make data in the cloud as secure as that banksdatacenter. This meets the concern of security raised by banks whether the cloud environment can be made as secure as that for most in-house IT environment.

The proposed cloud computing framework security posture is characterized by the effectiveness, and completeness of the risk-adjusted security controls implemented. These controls are adjusted in all layers of the proposed framework ranging from channel (channel security), to business (application security), platform (platform security), and infrastructure (infrastructure security). Additionally controls are adjusted at the people and process levels, such as separation of duties and change management, respectively. These characteristics of the framework facilitate secure cloud deployment and delivery systems for Ethiopian banking industries.

ii. Business Impacts

The cloud computing system being developed for all banks in this study were designed to support a secure electronic services sharing between customers, banks and cloud services providers, facilitating smooth collaboration and integration.

The use of cloud system minimizes the risks inherent in purchasing physical IT infrastructures. When pushing an application out to the cloud, scalability and the risks of purchasing too much or too little IT infrastructure becomes the cloud providers' issues. In a growing number of cases, the cloud provider has such a massive amount of infrastructures that it can be absorb the growth and workload spikes of banks, reducing the financial risks they face.

These capabilities of cloud computing helps banks to reduce the cost to enter new market, because infrastructure is rented, not purchased, the cost is controlled, and the capital investment can be zero. Also applications are developed more by assembly than programing. Moreover, cloud computing can help to increase the pace of innovation, specifically for emerging market banks by allocating them to deploy new products quickly and at low cost which allows them to compete more effectively with matured banks whose deployment process in enterprise datacenter can be significantly longer. Thus cloud enables those banks to provide new services and products or to speed the market easily which can be various electronic banking services.

Cloud computing improves easy collaboration between banks in which customers of the collaborated bank` can interact with the shared system in a more engaging way than before. Customers' ability to access the banking services are improved, they can access the banking services anywhere and anytime from any channels of banks in Ethiopia and with their available devices. Thus customers can easily access the banking services based on their experience, digitally or manually from the branch offices or automated devices, simultaneously banks will reduce duplicated investments and freeing them from routine transaction.

Example: if we consider the concepts ofsynergy to enable effective collaboration and speed to market, banks can improve the operational efficiency or greater total cost saving for production of banking services and speed to market or expanding the geographical coverage easily.

Providing electronic banking services within a single bank infrastructure is not more efficient than providing it within a total network of the whole bank infrastructures. Assume that the total network of digital banking channels (i.e. ATM, POS) for production of banking services within individual banks such as: CBE, Dashien Bank, Addis International Bank, Enat Bank,

70, 40, 15, and 10 respectively. Then providing the banking services using 135 total networks of ATMs and POS of the whole banks distributed in different geographical area are more efficient than using a total network of ATMs and POS within such individual bank infrastructure.

In summary, the above evaluations criteriadiscussed related to the performances of protection and safety of the proposed cloud computing framework which included: channel service protection, business service protection, platform protection and infrastructure protection, while the outcomes of cloud computing for business efficiency brought positive feedbacks from the respondents.

Chapter Six

Conclusion and Recommendation

6.1. Conclusion

The development of fundamental techniques that integrate Ethiopian Banking Industries existing IT infrastructure with the proposed EBIs clouds in a collaborative fashion would be critical to enable composition and deployment of elastic application services for banks. That was the main aim of this research work. For developing cloud-based services framework`s for Ethiopian Banking Industries the study started by understanding the banks requirements

through interview, cloud service models and cloud-based service delivery alternatives, and evolutionary options of today's maturing cloud solutions. And also the study discusses the potential benefits and limitations of cloud computing to banking sectors, and the cloud adoption strategy suitable to banks.

The study indicates that processing financial data abroad the country were theproblematic issue because of the evolving financial regulatory and security concerns brings from using external public cloud service providers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer. Due to this consideration researchers decided to proposed Ethiopian-based cloud service provider to formulate a secured cloud environment for banks.

The research shows that hybrid cloud computing modelwould be the main form of cloud adoption forEthiopian Banking Sectors. The proposed hybrid cloud provides a benefit for blending banks IT infrastructure with the proposed EBIs cloud depending on the sensitivity of banks data and applications in each process, and the degree of business criticality and differentiation.By integrating traditional IT and private cloud-based services with the new local cloud service provider, this hybrid approach protects current investments in EBIs.

The resulting framework facilitates collaboration between banks, quality of services and assist new comers in to the market. The different components of the proposed framework offer powerful capabilities to address both services and resources management. This will provide enhanced degrees of scalability, flexibility, and simplicity for management and delivery of services in the clouds. Thus the proposed framework in this study used as a blue print for implementing actual cloud-based services in EBI that can ensure secure services collaboration among banks and cloud service providers.

6.2. Recommendation

Although the results of this study are promising, further work needs to be done in order to realize the proposed framework to Ethiopian Banking Industries. The proposed framework should be implemented on the selected business process and tested with iterative feedback

reflection from the users so that the proposed framework will be modified based on the feedback before the framework`s full implementation in all banks business process.

Cloud computing literature is still in its infancy. The scope of current literature is fairly narrow and thereby future research should consider cloud computing from less charted and novel perspectives. As this study revealed, cloud computing paradigm has still many aspects that should be understood better before it can evolve to the mainstream of enterprise IT. Some suggestions and future research directions are presented next.

- ✓ Developing framework`s for banks on enhancing the security architecture of virtual data centers in Cloud Environment. Researchers might focus on providing security in cloud that protects the data in the Cloud Environment.
- ✓ Future studies can carry out on exploring business models of cloud computing services. Researchers will assess the different cloud business models and their differences according to business model ontology. In particular, it should be analyzed what different capabilities different business models require from the services provider.
- ✓ Exploring the changes in risk sharing model between services provider and banks`/other customer that cloud computing paradigm necessarily inflicts. The implications of changing customer on pricing should be carefully reviewed in order to ensure cloud computing's viability from services provider viewpoint.
- ✓ Exploring the critical issues in selecting cloud service providers, cloud-based service delivery model, and cloud computing deployment model (Private & hybrid). In particular, it should be analyzed by describing the strength and weakness from service provider to cloud-based service delivery and deployment model for financial institutions.

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Appendix

Interview Questions:

1) What are the ICT services and supports that are provided for internal and external users of the bank by your office?

A. For internal users, employees and management staff?

B. For external users, customers, partners and suppliers?

2) Do you think these services are enough to achieve your mission and vision, in improving quality service to customers, reducing cost and IT complexity, optimizing ICT usage efficiently, dynamic scalability of resources, increasing competitive advantage and modernizing your company?

3) What are the limitations in providing an efficient ICT services?

4) What are the feedbacks of the users about your ICT service? Positive and negative

5) What is the yearly budget for the ICT department of the bank?

6) Does your bank have an ICT policy based on country ICT policy and legal framework for new technology adoption? Do you know them?

6) What is your suggestion in formulating a new paradigm for providing ICT services and supports in the bank? And if possible suggest your own solution from the current technology trends?

7) As an ICT manager, what do you think is best strategy to provide ICT services for Banks to support with the current economic, business and legal context of Ethiopia?

8)If an integrated cloud computing infrastructure is to be built in EBI that could be used by all banks in Ethiopia to provide ICT services, what will be your reaction to this strategy, what kind of services do you think your bank will benefit from the cloud-based technology?

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June, 2014

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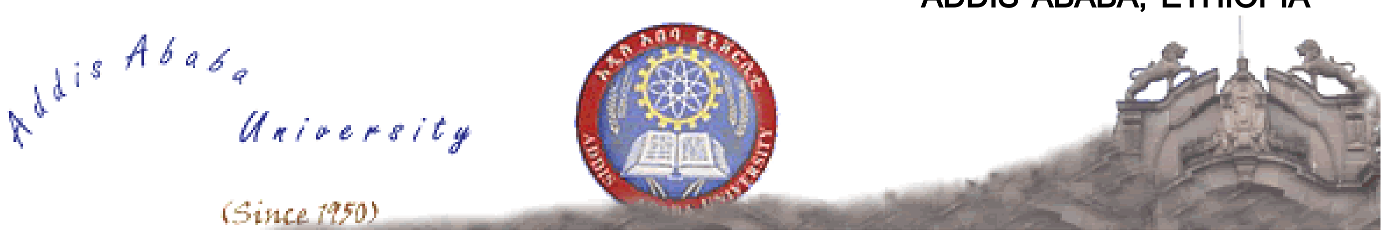
A CLOUD COMPUTING FRAMEWORK FOR ETHIOPIAN BANKING INDUSTRY

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Information Science

BY: ALEMAYEHU ABERE MULU

May, 2013
ADDIS ABABA, ETHIOPIA



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Name and signature of members of the examining board,

Name Title Signature Date

1. --------------------------- --------- (Advisor) -----------------------Date----------
2. -------------------------- --------- (Examiner) ----------------------Date-----------
3. -------------------------- --------- (Examiner) ----------------------Date-----------
4---------------------------- -------- (Chair Person) ----------------Date----------
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DEDICATION

This thesis is dedicated to my late mother MelkamaBekele.

Acknowledgement

First of all, I would like to forward my gratefully and deepest thanks to the almighty God for his guidance, help, support and who added days to my age, Glory to God. Next, my heartfelt thanks go to my research advisors Dr.DerejeTeferi for his invaluable advice, patience and constructive criticisms of this work. Thirdly, I would like to thanks all intervieweesfrom IT staffs of the banks` (NBE, CBE, United&Dashen) for their honesty, suggestion and cooperation by giving interview.

I am thankful to my friends SeleshTefera, FerawoKassay, TadleTefera, TimkiteabeYacobe, Osman Taha, TesfayaDessi and Bezunehu, for their kindness and assistance during my thesis writing.

My special thanks goes to my father, AbereMulu, my brother, Yalemezewod and Yohannes, my sister Almaz, for their encouragement and support. My heartfelt & deepest gratitude also goes to my lovely wife Tigist (TG) and son Ezana (Chuloya). I wouldn't have finished this thesis without their support and love.

Finally, I would like to thank everyone at the College of Natural Science, Department of Information Science, AAU, who has encouraged and assisted me throughout the completion of this thesis.

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List of Figures

List of Acronyms

AAU -------Addis Ababa University
API ------- Application Programming Interface
APIs -------Application Programming Interfaces
ATM-------Automated Teller Machine
AWS ------Amazon Web Service
AWS ------Amazon Web Service
CBE------..Commercial Bank of Ethiopia
CBS------ .Core Banking Solution
CPU -------Central Processing Unit
CRM ------Customer Relation Management
CSP -------Cloud Service Provider
DB ------- Database
DBs ------.Database Systems
EBI------ .Ethiopian Banking Industry
EBIHC ---Ethiopian Banking Industries Hybrid Cloud
EBIPC ---Ethiopian Banking Industries Private Cloud
EBIs------Ethiopian Banking Industries
EC2 ------Elastic Compute Cloud
ERP ------Enterprise Resource Planning
GUI ------Graphical User Interface
IaaS ------Infrastructure as a Service
IBM ------International Business Machine
ICT -------Information Communication Technology
ICTs -----Information Communication Technologies

IT ------- Information Technology
NBE----- National Bank of Ethiopia
OS -------Operating System
OSS -----Open Source Software
PaaS -----Platform as a Service
POS-------Point Of Sale
QoS ------Quality of Service
S3 ------- Simple Storage Service
SaaS -----Software as a Service
SLA ------Service Level Agreement
SOA ------Service Oriented Architecture
SQL ------Structured Query Language
UK ------- United Kingdom
US ------- United States
USD------.United States Dollar
VM -------Virtual Machine
VMs ------Virtual Machines
VPC ------Virtual Private Cloud
VPN ------Virtual Private Network
SLA ------Service Level Agreement

Abstract

Acquisition and use of information technology affect banks` on every front of their business processes. Substantial, banks spend highinvestment on IT to position themselves for mergers or acquisitions, to simply protect their competitive advantages, or to expand geographical coverage into the marketplace. In today's difficult business and economic climate challenged by complex and changing customer and line of business needs, banksare confront problems in providing necessary IT supports to deliver services to customers, partners, and employees anytime, on their preferred device, through the optimum channel.The objective of this research work is to find an alternative solution for acquisition and use of information technology to deliver efficient, flexible and scalable IT services for leveraging Ethiopian Banking Industries from innovative technologies.

Interview and a concise survey on cloud computing were used as the research methodology for this study. Interview was selected for information acquisition method from the selected IT managers of banks. On the other hand a concise survey of concerning literatures on the existing state-of-the-art in Cloud provisioning, management and securitywere conducted. The overall system architecture and its elements that form collaborative Cloud infrastructures in banking

sectors, and best practices on cloud-based service implementations from the early adopter banks in the world also explored in this study.

The advantages of cloud computing for banking sectors, the limitations of current ICT usages in EBI were briefly discussed in this research paper. Also, an alternative solution to the current ICT utilizationslimitations in EBI is given. The study proposed Hybrid Cloud Computing model. The result shows that the proposed cloud computing service framework can have a capabilities for reducing IT investment cost and management complexity, efficient IT utilization for delivering banking services andimprove collaboration among partners. When the proposed framework implemented it could have significant importance to EBI.

Keywords: Cloud Computing, Ethiopian Banking Industries

Chapter One

Introduction

1.1. Background

The growth of high speed networks and computing power is making possible to process different banking services or applications in microseconds undreamed of in the past. These rapid explosions of technology are changing the banking industries from paper and branch banks to digitized and networked banking services (Wakeham, 2010). Delivering banking services on this networked environment are more convenient and effective than ever before. Expanding the geographical coverage of digitized and networked banking services are the mainstreams for banks to deliver QoS to customers (NBE, 2012). In developing countries, the cost of expanding the geographical coverage of digitized and networked banking services to customers would be difficult for a single bank. In this environment, banks would start to collaborate to pool non-differentiated activities using private cloud computing within a closed group of banks in a similar way to telecommunication sharing network infrastructure (Sardet, 2012). These bundling could provide shared services that interact with customers in more engaging ways while simultaneously freeing banks from the burden of routine transactions. Thus, when the transaction volumes decline these collaboration could enables banks to stop duplicating investment, industrialize their security processes for economies of scale, gain new service options and have immediate access to the latest apps. These collaborative private clouds could even be hybrid cloud powered by a third-party, increasing the benefits of cost and flexibility (Sardet, 2012). .

Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (NIST, 2012). By deploying IT infrastructure and services over the network, an organization can purchase these resources on an as-needed basis and avoid the capital costs of software and hardware. With cloud computing, IT capacity can be adjusted quickly and easily to accommodate changes in demand. While remotely hosted,

managed services have long been a part of the IT landscape, a heightened interest in cloud computing is being fueled by ubiquitous networks, maturing standards, the rise of hardware and software virtualization, and the push to make IT costs variable and transparent (Sewale, 2012).Cloud computing delivers: Infrastructure as a Service (IaaS), platform as a Service (PaaS), and Software as Services (SaaS), which are made available as subscription-based services in a pay-as-you-go model and other essential features to customers (NIST, 2012).
Cloud computing uses the internet to deliver remotely hosted applications, data, and infrastructure services as a new business model for ICT services. The cost for services are typically billed on a recurring, pay-as-you-go basis, cloud solutions require no end-user infrastructure other than client devices equipped with a browser and reliable web access (Furht, 2010). And since most cloud solutions are hosted in service provider data centers/third-party servers (equipped with processors that deliver excellent performance, strong I/O characteristics, low energy consumption, and robust virtualization assistance), banks can scale them up on the fly, without having to invest time and money in procuring and provisioning new computing resources and maintenance costs (Armbrust et al., 2009).

The new business and technological model, such as cloud computing technology will enable banks to create new base of competition, new streamlined business process and improved customer service environments (Ryan, 2012). Cloud computing enables newer banks to have low cost startups by allowing them to rent resources offered by cloud providers/matured infrastructure legacy banks instead of having their own sets (Sardet, 2012). Thus banking industries in Ethiopia would take advantage of cloud computing as a tactical solution to face seasonal peaks without spending big sums to acquire resources that will be idle for most of the time. Operational expenses including salaries and energy costs are equally reduced. Cloud allows banks to share their infrastructure to provide integrated channel services to the whole customers. All these will reduce costs, setup time, installation/upgrade hassles and gives high scalability.
Therefore Cloud technology offers secure deployment options that could help banks develop new customer experiences, enable effective collaboration and improve speed to market, deploy new applications more quickly, trim development costs, and achieve greater agility. Thus, all while increasing IT efficiency through cloud-based services.

1.2. Statement of the Problem and its Justification

In any financial services institutions, IT infrastructure and support are constantly facing cost pressures, while computing needs and amount of data are ever increasing. These increasing IT usages enforce banks to invest million dollars for procuring computing resources and re-procuring when computing needs and business data are increased over time. Cloud computing has generated a tremendous amount of interest and excitement in recent years as it gives a new and useful way to address IT challenges across and beyond financial services (Ryan, 2012).Banks would needs to transform their current ICT service delivery systems and the manner in which their product offerings, channels and customer serviceto enable effective collaboration and improve speed to market with reduced ICT infrastructures investment costs. Banks also would starts to collaborate with partners or third party IT service provider to share IT resources for supporting and providing common banking services to their customers on a security rich environment(Sardet, 2012).

Cloud-based services could be provided by different IT companies which have large datacenters and huge software infrastructures with skilled manpower who can run the datacenter (Nayro, 2012). Amazon, IBM, Google, Azure, and many other IT organizations provide various IT services such as infrastructure as a service, platform as a service and software as a service to consumers. Virtually customers could deploy and run their data or applications on the providers IT infrastructures or public cloud without the need to procure that infrastructures, and pay for the infrastructure they are used (Raoj& Reddy, 2011). This might reduce infrastructure investment cost and its management complexities to banks. However, banks would not be willing to put their data/application on the external public clouds because of fear of risks on customer data privacy, security and confidentiality issues that might be brought from using it.

Banks in Ethiopia are working in a highly controlled and regulated environment, while their customer data are the main assets to run the business securely. Deploying and running the banking services on the public cloud infrastructure would bring unauthorized access from the banks private datacenter that could leads conflict from the financial policy of the country and customers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to

the affected customer. Additionally, the existing telecommunication infrastructure in Ethiopia would bring latency problems for deploying and running the banking system on the public cloud. Transferring data to and from the cloud would have high latency than when transferring data to and from an in-house datacenter.

Currently, many banks in Ethiopia are including self-service and mobile applications into their mix of offerings across staffed and automated channels.Banks in Ethiopia have already using the CORE banking solutions at their enterprise level IT infrastructure. These services provided by a group of networked channels such as: branches, ATMs, POS, phone &etc.This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw or transfer the deposited money from any of the bank's member channels throughout the country.Also the existing core banking solution used by banks are suitable for integrating the data between banks and cloud provider for cloud computing deployment model (Sardat, 2012).Since cloud computing can play a significant role in banks efforts to reinvent its business and operating models (Nikam et al., 2012).

IT capital expenses typically include enterprise software licenses, servers and networking equipment are more expensive and harder to forecast than routine IT operating expenses(Sardat, 2012). With cloud applications, there is no longer a need to build hardware, install software or pay dedicated software license fees. Adopting cloud services allows EBIs to shift costs from capital to operational or from fixed to variable. The bank pays for what it needs when it needs it. This pay-per-use model is more flexible and eliminates the need for significant capital expenditures. Cloud offers more than just IT scalability; it allows a bank to scale their business operations. By allowing for rapid provisioning of resources without scale limitations, using cloud technology enables a company to benefit from economies of scale without needing to add more servers(Nikam et al., 2012).

Moreover, the success of the cloud implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009).In developing cloud computing strategy and infrastructure, it is important to keep security in mind. It needs to understand which delivery models are appropriate based on security and trust requirements with connecting systems. Then assessing the security requirements for banking industries such as: governance,

architecture, applications and assurance to develop the cloud computing framework also an important consideration in this study.

Therefore, the cloud computing framework developed for all banks in this study were designed to support a secure and cost effective electronic services sharing between customers, banks and cloud services providers, facilitating smooth collaboration and integration. However, developing cloud-based applications requires new approaches. Because without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011).But, in the best of my knowledge there was no research conducted on a cloud computing framework to cloud-based application for banking industries in Ethiopia.

Hence, the aim of this study was to answer the following three research questions.

1. Is the current ICT usage strategy efficient in EBI?
2. Do we need to change the current ICT service delivery strategy deployed in EBI?
3. Could cloud computing model be an alternative solution for efficient ICT service provisioning strategy for EBI?

1.3. Objective of the Study

1.3.1. General objective

The general objective of this study was to examine existing ICT infrastructure and usage in Ethiopian banking industries and to develop an integrated cloud computing framework for Ethiopian banking industries.

1.3.2. Specific objective

The specific objective of the study is:

- ✓ To Review cloud computing related literatures to understand various cloud services, deployment models and framework development methods.

- ✓ To examine the current ICT infrastructure and usage strategy and efficiency in Ethiopian banking industries.
- ✓ To explore the potential benefits of Cloud Computing in banking sectors.
- ✓ To examine the necessity of Cloud Computing for Ethiopian banking industries.
- ✓ To compare the cost effectiveness of using cloud computing technology in Ethiopian banking industries.
- ✓ To develop an integrated cloud-based service architectural framework model that can be placed in a moderate place and can provide cloud service for different bank.
- ✓ To identify and recommend future research directions for further investigation on the benefits of Cloud Computing in bank industry.

1.4. Significance of the study

This research could allow the Ethiopian banking industries to consider alternative ways of deploying ICT infrastructures for an efficient and effective customer service delivery. The study would give new insights to the Ethiopian banking industries and other financial sectors on how to invest ICT budgets on their institution. The Proposed Hybrid cloud computing model and the presented implementation plan could be used as a baseline for the physical realization of the cloud. Additionally the study could be used as a baseline for further studies of this newly emerged ICT utilization strategy to be considers in different governmental and nongovernmental organizations of Ethiopia. The proposed Cloud Computing framework could also be used as a baseline for Ethiopian banking industries ICT managerial on how the cloud computing would be implemented and used in banking institutions.

1.5. Scope and limitation of the Study

The main intent of the study is to examine the current ICT service delivery strategies to support Ethiopian banking industries, to consider cloud computing in the field of banking

specifically in Ethiopian banking industries and propose a Cloud Computing framework that could be used as a baseline for implementation of Cloud Computing in Ethiopian banking industries. This study does not consider the development of cloud service implementation prototype. This work focus on examining and analyzing the current ICT usage in Ethiopian banking industries, exploring possible cloud service frameworks for banking sector and developing an integrated cloud-based service framework.

1.6. Organization of the Thesis

The rest of this study is organized as follows: Chapter two covered related literatures on the basic concept of cloud computing: service types, tools, deployment models, cloud computing adoption strategy, cloud challenges and benefits for banking industry; different publications about CBE existing ICT usages; and related works done on cloud based service frameworks locally and abroad in order to understand how it is implemented or used in banking sectors.Chapter three describes the research methodology and strategy that aims to identify the potential cloud solutions that could be provided to banking industries. It begins by describing exploratory research approaches. Primary data collection and analysis technique were described as information acquisition method. Validity and reliability requirements also identified. Chapter four presents the results of the interview described in chapter three. The data collection method utilized was the semi structured interview that provided both control and direction through a list of question under interview.In Chapter five, backgrounds of a framework for building the proposed Cloud Computing Framework for EBI, the detail elements of the proposed cloud computing framework, the architectural components of the proposal for implementing a framework are given. Additionally, technological requirement identification for EBI also presented. What design is better for EBI, why the specific design was selected for EBIs also discussed. Finally in chapter six conclusions about the research and suggestions for future research direction were presented.

Chapter Two

Literature Review

This chapter reviews the different literatures that are related to the objective of the study. Literatures covered in this section are the basic concept of cloud computing: service types, tools, deployment models, cloud computing adoption strategy, cloud challenges and benefits for banking industry; different publications about CBE existing ICT usages; and related works done on cloud based service frameworks locally and abroad in order to understand how it is implemented or used in banking sectors.

2.1. Cloud Computing

Over the last few years, many IT professionals, business managers, and researchers have started to talk about a new phenomenon called cloud computing. Each of these groups defined cloud computing

differently according to their under standing of its offerings. Although there was no agreement about what precisely constituted cloud computing, it still offered a promising paradigm that could enable businesses to face market volatility in an agile and cost-efficient manner (Qusay F. Hassan, 2011). Regarding its relations to other pre-existing computing models, cloud computing can be used in principle to deliver computing services, including grid computing services, high-performance computing services, etc. This does not imply that cloud computing is a replacement for grid computing, high-performance computing, or any other pre-existing computing model. Instead, cloud computing should be thought of as a new business model that aims at service delivery in a highly scalable and highly flexible manner. The difference between cloud computing and other pre-existing computing models can be better demonstrated by ways of using the service and deployment models and its key enabling technologies of virtualization.

Recently a group of domain-specific experts have proposed definitions that aim at abstracting common characteristics of the cloud and cloud computing. Here are four representative definitions quoted from Gartner, US National Institute of Standards and Technology(NIST), EU commission Expert Group, and Berkeley Institute (cited in TeciRes project research group: Xiaoyu Chen, Gary B. Wills, Lester Gilbert, David Bacigalupo, 2010)

"The term 'cloud computing' refers to any computing capability that is delivered as a service over the internet. While there is no authoritatively accredited definition of the concept, one of the most frequently used defamations is the one given by Gartner, who describe cloud computing as 'a style of computing where massively scalable IT-related capabilities are provided as a service' across the internet to multiple external customers"(Gartner). "A cloud is an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality of service" (EU commission Expert Group).

"Cloud computing refers to both the applications delivered as services over the internet and the hardware and systems software in the data center that provides those services. The services themselves have long been referred to as Software as a Service (SaaS), so we use that term. The data center hardware and software is what we will call a cloud" (Berkeley Institute).

"Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (US National Institute of Standards and

Technology, NIST). The following figure can better demonstrate the definitions of cloud computing.

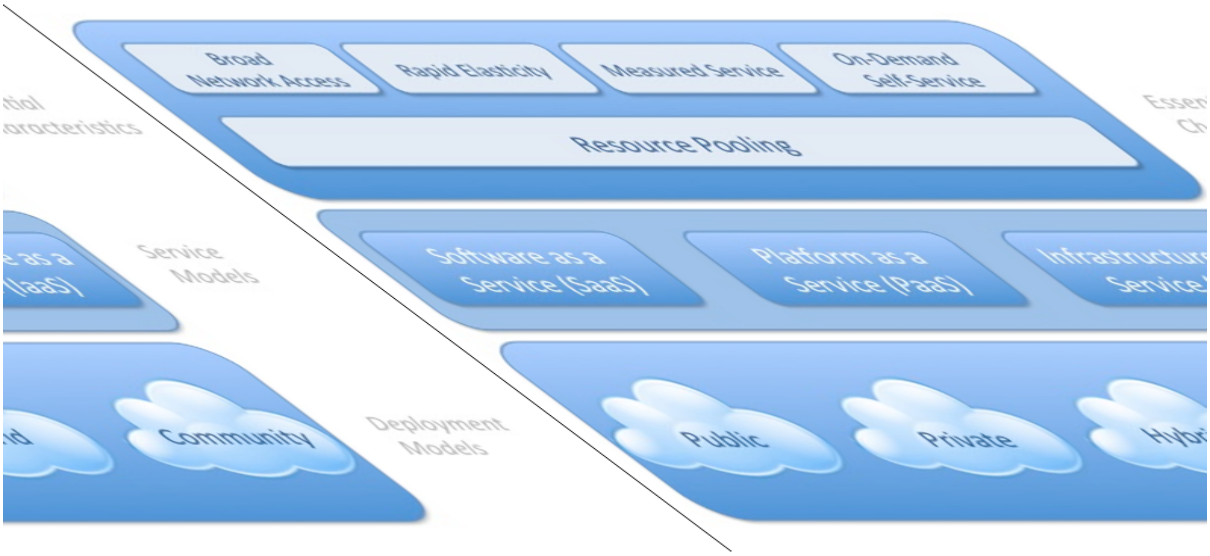


Figure.1. Visual model for cloud computing working definition (source NIST)

2.2. Characteristics of Cloud Computing

According to US National Institute of Standards and Technology (NIST) and Sun Microsystems, Inc (2009), cloud services exhibit the following essential characteristics that demonstrate their relation to, and differences from, traditional computing approaches:

On-demand

A consumer can unilaterally provision computing capabilities such as server time and network storage as needed automatically, without requiring human interaction with a service provider. Instead of requiring a long-term contract for services with an IT organization or a service provider, clouds work on needed model where an application may exist to run a job for a few minutes or hours, or it may exist to provide services to customers on a long-term basis.

Broad network access

Cloud capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs) as well as other traditional or cloud-based software services. Cloud computing extends the existing trend of making services available over the network. Virtually business organization can make available different applications to their internal and external customers using web based interfaces. While enterprises are well aware of the ability to secure communications using Secure Socket Layer (SSL) encryption along with strong authentication, bootstrapping trust in a cloud computing environment requires carefully considering the differences between enterprise computing and cloud computing. When properly architected, Internet service delivery can provide the flexibility and security required by enterprises of all sizes.

Resource Pooling

The provider's computing resources (such as: storage, processing, network bandwidth, and virtual machines) are pooled to serve multiple consumers using a multi-tenant model, thus, different physical and virtual resources dynamically assigned and reassigned according to consumer demand. Even private clouds tend to pool resources between different parts of the same organization.

Rapid Elasticity

Cloud allows the dynamic integration and extraction of computing resources. Cloud services are available for provisioning, often appear to be unlimited and can be purchased in any quantity at any time. Elasticity is an essential core feature of cloud systems and circumscribes the capability of the underlying infrastructure to adapt to changing. This cloud capability allows service users to create an elastic environment that can expand and contract based on the workload and target performance parameters. In general, it is assumed that changes in the resource infrastructure needs are announced first to the middleware manager and then that such changes can be maintained automatically.

Measured service

Cloud system automatically control and optimize resource usage by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, or active user accounts). Resource usage can be monitored, controlled, and reported to providing transparency for both the provider and consumer of the service. Based on this metering and accounting capability of cloud computing, users pay

only for service they are used. Thus, billing is based on resource consumptions such as CPU hours used, volume of data moved, or gig bytes of data used.

Virtualization

It is an essential technological characteristic of clouds which hides the technological complexity from the user and enables enhanced flexibility (through aggregation, routing and translation). More concretely, virtualization supports the following features:

- ✓ Ease of use: through hiding the complexity of the infrastructure (including management, configuration etc.) virtualization can make it easier for the user to develop new applications, as well as reduces the overhead for controlling the system.
- ✓ Infrastructure independency: in principle, virtualization allows for higher interoperability by making the code platform independent.
- ✓ Flexibility and Adaptability: by exposing a virtual execution environment, the underlying infrastructure can change more flexible according to different conditions and requirements (assigning more resources, etc.).
- ✓ Location independence: services can be accessed independent of the physical location of the user and the resource.

2.3. Cloud Computing Service Model

Cloud computing means using IT infrastructure as a service — and that service may be anything from renting raw hardware to using third-party APIs. Cloud service models offer financial institutions the option to move from a capital intensive approach to a more flexible business model that lowers operational costs. In practice, cloud service providers tend to offer services that can be grouped into three categories: SaaS, PaaS, and IaaS. These categories group together the various layers illustrated in Figure 2, with some overlap.

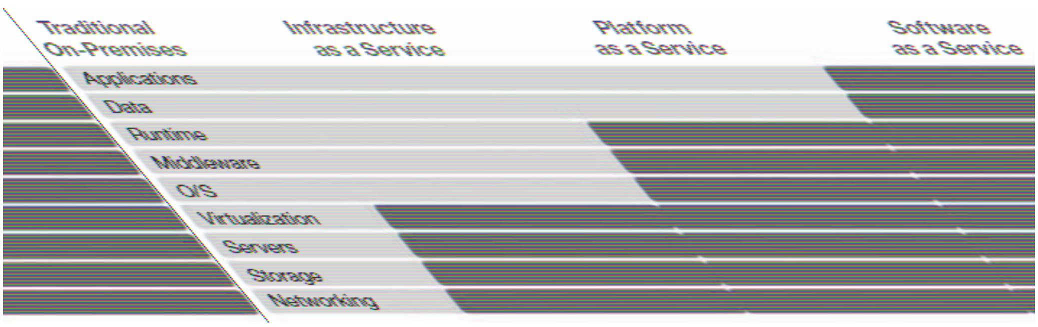


Figure.2. cloud based service layers

2.3.1. Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) refers to making available basic computing resources (storage, processing, and networking) as a service (RuiEsteves, 2011). Under this forms of delivery, organizations can access computing infrastructures from a cloud provider instead of the traditional purchase of physical servers and software needed to set up a datacenter (Maurice Nyaoro, 2012). Infrastructure as a Service (IaaS) allows the customer to run software (both systems and applications), to store data, and to transfer an existing workload to the cloud with limited control at lower total infrastructure cost.

For infrastructure as a Service, the provider maintains the storage, database, message queue or other middleware, or the hosting environment for virtual machines; while user can uses that service with the capabilities to control the operating system, storage, deployed applications and possibly networking components such as firewalls and load balancers, but not the cloud infrastructure beneath them (Raoj& Reddy, 2011).

According to Raoj& Reddy (2011) IaaS operates on a "Pay as you go" model ensuring that the users pay for only what they are using. To operate on this model, IaaS providers offer almost unlimited instances of servers to customers and make cost-effective use of the hosting hardware through virtualization. While the user can buy the infrastructure according to their requirements at any particular point of time instead of buying the infrastructure that might not be used for months and very costly if purchased completely. Thus dynamic scaling, usage based pricing, reduced costs and access to superior IT resources are some of the benefits of IaaS. Examples of IaaS provider: Mossol/Rackspace, AmazonS3, GoGrid&Fexiscode).

2.3.2. Software as a Service (SaaS)

Software as a service (SaaS) is a way of delivering applications over the internet as a service, where the web browser is often the interface for delivery (Bhattachariee, 2009). Instead of installing, maintaining and managing complex software and hardware task, SaaS allows to simply accessing application via the internet (Raoj& Reddy, 2011). The consumer uses an application without having hardware or software to buy, install, maintain, update, and manage the infrastructure on which the applications running. SaaS applications run on a SaaS provider's servers and the provider manages access to the application, including

security, availability, and performances using open standards apply at the application level (Raoj& Reddy, 2011).

According to Raoj& Reddy (2011) this types of cloud computing delivers a single application through the browser to thousands of customers using a multitenant architecture. Thus SaaS eliminates upfront investment in servers or software licensing for users and reduce the costs to manage access to the application compared to conventional hosting.

2.3.3. Platform as a Service (PaaS)

Platform as a Service (PaaS) provides an environment upon which the customer can use to build and deploy cloud applications. These applications may be for use by the customer or offered as a service to others. Building applications using PaaS means that they are inherently cloud-enabled and the PaaS provider also provides the service upon which these applications run (Bhattachariee, 2009).

In the traditional model of software development applications are written in one environment, tested in another environment and deployed elsewhere ((Maurice Nyaoro, 2012). PaaS is a combination of a development platform and a solution stack, delivered as a service on demand. It provides infrastructure on which software developers can build new applications or extend existing ones without the cost and complexity of buying and managing the underlying hardware and software and provisioning hosting capabilities (Raoj& Reddy, 2011).

Platform as a Service (PaaS) layer incorporates all the environments used for development or for run time support, not being directly accessible by the final user (RuiEsteves, 2011). The consumer uses a hosting environment for their applications and controls the applications that run in the environment (and possibly has some control over the hosting environment), but does not control the operating system, hardware or network infrastructure on which they are running.

2.4. Cloud Computing Deployment Model

Regardless of the service model utilized (SaaS, PaaS, or IaaS) there are four deployment models for cloud services, such as:

2.4.1. Public cloud services

Public cloud or external cloud describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet via web applications/web services, from an off-site third-party provider who shares resources and bills on a fine-grained utility computing basis (VenkateRao J. et.al. 2011). The

cloud services are available for anyone to subscribe and to use in a pay-as-you-go manner. A public cloud customer can access these services over the internet from a third-party provider who may share computing resources with many customers.

The public cloud model is widely accepted and adopted by many enterprises because the leading public cloud vendors as Amazon, Microsoft and Google, have equipped their infrastructure with a vast amount of data centers, enabling users to freely scale and shrink their rented resources with low cost and little management burden (B. Furht, 2010). Security and data governance are the main concern with this approach. Sharing applications and infrastructure with unknown co-tenants can lead to concerns over data security and data leakage. If a public cloud is implemented with performance, security, and data locality in mind, the existence of other applications running in the cloud should be transparent to both cloud architects and end users (Sewale, 2012).

2.4.2. Private cloud service

A Private Cloud, or internal cloud, is used when the cloud infrastructure, proprietary network or data center, is operated solely for company or government departments who prefer to keep their data in a more controlled and secure environment, and serves customers within the business fire-wall (B. Furht, 2010). The private cloud allows organizations to outsource the management of their IT infrastructure while retaining tighter control over the location and management of the resources. The price to pay for this is that the costs are likely to be higher because there is less potential for economy of scale, and resilience may be lower because of the limit on service resources available (Larry Ryan, 2012).

The difference between a private cloud and a public cloud is that in a private cloud-based service, data and processes are managed within the organization without the restrictions of network bandwidth, security exposures and legal requirements that using public cloud services might entail (VenkateRao J. et.al. 2011). Isolation is one of the key techniques for ensuring security and, while in the public cloud applications and data exist in a shared environment, the private cloud offers greater isolation by dedicating resources to a particular customer.

2.4.3. Community cloud service

The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, or compliance considerations) (CSA, 2009). In a community cloud, several enterprises with similar requirement can share their

infrastructures, thus increasing their scale while sharing the cost (Wikipedia – Cloud Computing, 2010). Another form of community cloud may be established by creating a virtual data center from virtual machines instances deployed on underutilized users machines (Briscoe &Marinos, 2009). A community cloud provides many of the benefits of scale of the public cloud, while retaining greater control over compliance and data privacy.

Community cloud services already exist, but under a different name – for example NHSmail, the national e-mail and directory service available to NHS staff in England and Scotland, is effectively software-as-a-service with a community deployment model. As regards security, NHSmail is accredited to government "restricted" status, and is the only NHS e-mail service that is secure enough for the transmission of confidential patient information.

2.4.4. Hybrid Cloud service

The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds) (CSA, 2009). Hybrid Cloud is a composition of the two types of cloud (private and public) where, a private cloud is able to maintain high services availability by scaling up their system with externally provisioned resources from a public cloud when there are rapid workload fluctuations or hardware failures (B. Furht, 2010).

In the Hybrid cloud, many enterprises would prefer to keep their critical data and applications within their own control to ensure security firewall, while hosting the less critical ones on a public cloud. Under this cloud deployment model users typically outsource non-business critical information and processing to the public cloud, while keeping business-critical services and data in their control (VenkateRao J. et.al. 2011). A hybrid cloud can be delivered by a federated cloud provider that combines its own resources with those of other providers. Thus hybrid cloud delivery model encompasses provisioning all components and services that are required to deploy services (e.g. Hardware, network services, operating systems, databases, middleware, applications, and third party service provisioning). The following figure summarizes the cloud computing deployment model with potential governance of the cloud.

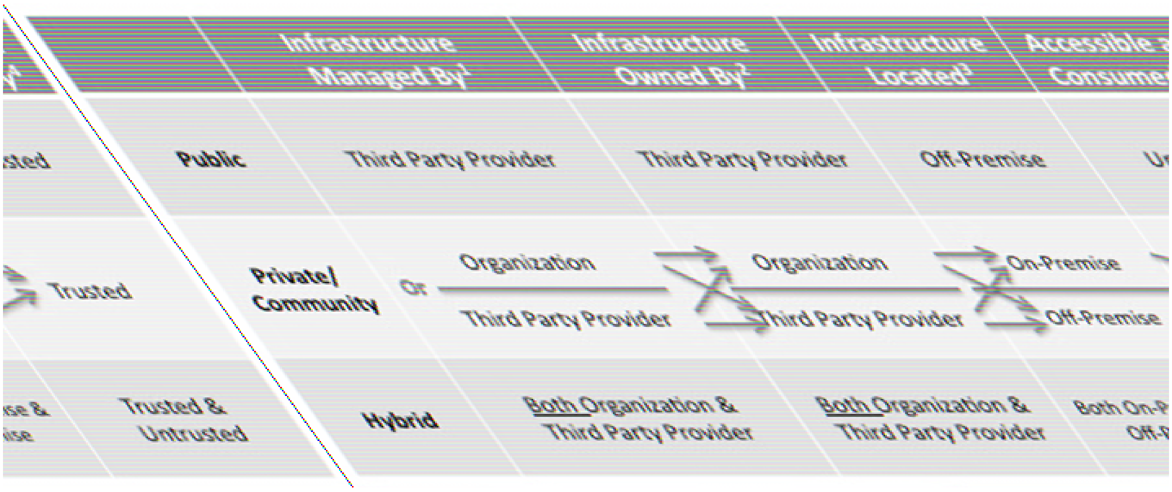


Figure.3. cloud computing deployment model

As a figure 3 shows computing infrastructure are managed and owned by third party providers, third party providers/organizations and both third party providers and organizations through different cloud service deployment models public, private and hybrid clod respectively. Infrastructures can be located as off-premise, off-premise/ on-premise and both off-premise and on-premise ways. Finally Infrastructures can be consumed by un-trusted (authorized to consume some/all services but are not logical extension of the organization), trusted (part of an organization legal policy umbrella including employees, contractors, and business partners) and both un-trusted and trusted consumers of the cloud services.

2.5. Cloud Computing Benefits for Banks

Cloud computing can help financial institutions to improve performance in a number of ways. Cloud based service have many benefits to the provider and to the consumer of cloud services. For the purpose of the study cloud benefits for banks will be discus under this topic.

Cloud computing can enable banks to turn a large up-front capital expenditure into a smaller, ongoing operational cost (including salaries and energy costs). Cloud allows banks to reduce the heavy investments in new hardware and software to expand internal IT infrastructures, while it allows customers to pick and choose the services required on a pay-as-you-go basis offered by cloud providers. This elasticity gives adopters two main advantages over on-

premises models. First, it frees organizations from spending high up-front costs on IT resources that may not be fully utilized in the future. Second, it allows them to face occasional spikes by flexibly adding more resources at whatever time needed (Aarti Singh et al., 2012).

Cloud computing enables emerging market banks to have low cost startups by allowing them to rent resources offered by cloud providers or by establishing collaboration with matured infrastructure legacy banks instead of having their own sets. While, large enterprises can take advantage of cloud computing as a tactical solution to face seasonal peaks without spending big sums to acquire resources that will be idle for most of the time (Qusay F. Hassan, 2011). With cloud computing, the provider is responsible for managing the technology. Cloud computing also provides a high level of redundancy and back-up at lower price than traditional managed solutions (B. Furht, 2010). Thus, financial firms can gain a higher level of data protection, fault tolerance, and disaster recovery

Cloud-based operating models enhance business agility and focus. Cloud is operating in a flexible way to develop new products within shorter development cycle and with less capital investment (Aarti Singh et al., 2012).With on-premises, organizations spend much time and effort to setup and run IT resources. Conversely, cloud computing put all these complexities on provider sides enabling clients to easily operate hardware and software appliances (Qusay F. Hassan, 2011). Cloud computing also allows businesses to move non-critical services to the cloud, including software patches, maintenance, and other computing issues (AbhinarGarg, 2011). As a result, firms can focus more on the business of financial services, not on IT. This also supports a faster and more efficient response to the needs of technological and business solutions.

Additional, cloud enables banks to contribute on green IT development. Financial service sectors can use cloud computing to transfer financial services on a virtual environment that will reduces the energy consumption and carbon footprint comes from setting up of a physical infrastructure

2.6. ICT and Banks Transformation

2.6.1. Role of ICT in the Banking Ecosystem

A bank is a financial institution and a financial intermediary that accepts deposits and channels those deposits into lending activities, either directly by loaning or indirectly through capital markets. A bank is the connection between customers that have capital deficits and customers with capital surpluses. Due to their influence within a financial system and the economy, banks are highly regulated in most countries. Most banks operate under a system known as fractional reserve banking where they hold only a small reserve of the funds deposited and lend out the rest for profit (Wikipedia – Bank, 2013).

The 21st century will bring about an all-embracing convergence of computing, communications, information and knowledge. The growth of high speed networks and computing power is making possible to process different applications in microseconds undreamed of in the past. The rapid explosion of technology is changing the banking industries from paper and branch banks to digitized and networked banking services. (Giacomo&Brunzel, 2010). This explosion of technology is changing the banking industry from paper and branch banks to' digitized and networked banking services (Ostergaard, 2010). It has already changed the internal accounting and management systems, and the service delivery systems of banks used to interact with their customers. Delivering banking products and services using this system can be more convenient and effective than ever before. All over the world, banks are still struggling to find a technological solution to meet the challenges of a rapidly-changing environment (Ryan, 2012). It is clear that this new technology is changing the banking industry forever. Banks with the ability to invest and integrate information technology dominates in the highly competitive global market.

Advances in technology are allowing for delivery of banking products and services more conveniently and effectively than ever before. Rapid access to critical information and the ability to act quickly and effectively will distinguish the successful banks of the future. The bank gains a vital competitive advantage by having a direct marketing and accountable customer service environment and new, streamlined business processes (Gardachew, 2010). Thus the advantages accruing from computerization are three-directional - to the customer, to the bank and to the employee.

2.6.2. Challenges in the Present Banking Ecosystem

There are different challenges available in the current banking ecosystem that demands continual technological change and high investment costs. According to MCsuresh (2010) and VMware (2011) some of the challenges that are directly related to ICT infrastructures needs are:

- ✓ Rapid geographical expansion of banking market has forced banks to replace their off-line systems by an on-line system linking the branches to the head office through the telecommunications network.

- ✓ The need for restructuring banks processes in order to reduce staff expenses which constitute a large part of the operating costs and a heavy burden on operating profitability.

- ✓ Incompatibility of the old systems with the strategic necessity of integrating new technologies like ATMs, telebanking, etc. in order to provide the high quality services to the customers and competing on an equal foot with the foreign banks.

- ✓ Competition through technology enforces banks to offer the entire range of services like telebanking, ATMs and others collaboratively. These require banks to respond very actively in the marketplace in introducing new products and services bundling.

- ✓ Banking services demanded a more dynamic banking web site with real-time transaction processing and rich functionality without limitations for service to be slow or unavailable.
- ✓ The rapidly changing computing needs such as comprehensive customer transaction history requires large and increasing transaction-data storages, and high-performance computing capacity needs for running complex algorithms and a high number of computations.

- ✓ Lack of proper planning for the development of any new applications. A computerization plan is the basis for implementing successful information technology solutions. To be relevant, these plans have to be linked closely to organizational strategies, objectives, priorities and processes.

This leads to very high investment cost for building and maintaining infrastructure to ensure high availability at any demand level (i.e. maintaining more dynamic banking web sites, large storage needs, high performance computing needs, and etc.). Providing innovative services, cost reduction through capital expenditure control, and improving the customer experience are challenging in these context.

More frequent need for risk analysis adds to the loads on in-house systems, forcing increased capacity and increased capital investment costs. A multi-sourced infrastructure allows faster resources provisioning than building in-house HPC infrastructure (VMware, 2011). Building in-house HPC infrastructure has the limitations to provide flexibility to schedule necessary simulations when business requires it, not just when internal resources are available. Additionally, there are lacks of mechanism for on-demand scaling solution that can enable superior customer experience and capacity. Therefor banks need to upgrade or change their internal datacenters during peak load times of the market. This leads very high investment to procure and provision the infrastructures.

Additionally, in developing countries telecommunications infrastructure is the greatest obstacle to real time electronic banking in the banking sector. Telecommunications in the banking sector is a major factor to the success or failure of any application or service. The result of such situation is a delay in implementing new services and products like remote banking, electronic funds transfer, and real time bank information systems (MCsuresh, 2010). This has also an effect on the reliability of the services already implemented like ATMs. In order to face this challenge, banks began studying the feasibility of installing a private telecommunications network. This network will also be used to connect the ATMs machines which will thus function on-line. However there are problems to obtaining a license from monopolized telecommunications market, high cost of equipment to installing and lack of coordination between banks.

2.6.3. Challenges for Adopting Cloud Computing

Banking industries operate within a highly competitive and finely regulated environment. Therefore all of the service aspects are influenced not only by business considerations but also by the compliance requirements. Innovations, so far, have been evaluated, customized, adopted, deployed and managed inside the enterprise – security, control, reliability & governance have always been managed internally. Since, Cloud based services attempt to

take the functional, technology and operational aspects of the business out of the enterprise, these considerations significantly influences the adoption (SarfrazBrohi et al. 2011). Thus, According to Staten et al. (2008) for cloud-based services to be ready for enterprise to consume, it must pass from the early-adopter phase to early majority. Early majority is depicted by a sufficient volume of customers using the services for business-critical purpose. The major reasons that continue to hinder the level of adoption of this new computing infrastructure acquisition paradigm are: performance bottlenecks due to use of HTTP protocols and bandwidth issues; increased threats of single point of failure; customer data lock-in; concerns over data privacy and security; lack of frequently used tools; and the switching costs of migrating from in-house IT infrastructure (Nyaoro, 2012). The following sections discus some of major challenges to adopt cloud computing by presenting possible ways to tackle them.

Performance bottlenecks

The latency encountered when transferring data to and from the cloud is higher than when transferring data to and from an in-house datacenter (Nyaoro, 2012). With applications continuing to become more data intensive latency becomes a big concern. Bhattacharjee (2009) states that one of the key causes of this latency problem is that the architecture being used for data interchange in the cloud relies on the traditional get/post mechanism of the HTTP protocol which was not designed for the dynamic user interfaces supported by the cloud. Nevertheless, Bhattacharjee (2009) suggest that a probable solution could be realized through use of multiple geographically dispersed datacenters. This should widen and shorten the channel between the user and cloud service provider.

Data confidentiality, privacy and trust

This is the commonly cited reasons for organizations apathy towards the cloud. For starters, the non-uniform structure of legislations across the world characterized largely by the United States` Patriot Act makes enterprises unwilling to move their data into the cloud. Cloud providers are trying to work around this by building data centers in more parts of the world but this only solve the aspects of legislation.

The second concern of security is whether the cloud environment can be made as secure as that for most in-house IT environment. Ambrust et al. (2009) downplays this by stating that use of well-understood technologies such as encryption, Virtual LAN and network middle boxes could easily make data in the cloud as secure as that an a local datacenter.

Thirdly, there is the difficulty of winning consumer trust. How can cloud adopters trust their cloud computing providers not to disclose their data to competitor or alter their data? The end user perspective of trust makes this a highly subjective property. According to (Savola, Juhola, &Uusitalo, 2010) the most important aspects that enforce trust in the cloud are good level of security and privacy. One of the best ways of achieving this is through cutting off the semantic link of the data to the owner while presenting the cloud provider with the capability to properly and reliably charge for the usage of its cloud resources (Jensen, Schage, &Schwenk, 2010). The provider can solve this through use of cryptographic solutions based on ring and group signature to create an accounting scheme that ensures a user`s anonymity and guarantees authenticity of service requests (Jensen et al., 2010).

Switching costs

Organizations that are contemplating moving to the cloud face a dilemma on whether to discard their IT investments-such as that used on setting up their local datacenter at a discount and opt for the cloud (Nyaoro, 2012). To migrate to the cloud organizations have to be prepared to incur not only the cost of migrating data and application but also the cost of restructuring their organizations to fit new computing paradigm (Bhattacharjee, 2009). To mitigate against this the large cloud providers could leverage their economies of scale to offer competitive prices that will entice organizations to encounter these switching costs.

2.7. Cloud System Controlling Wings

2.7.1. Security for Cloud Computing

Security controls in cloud computing are, for the most part, no different than security controls in any IT environment. However, because of the cloud service models employed, the operational models, and the technologies used to enable cloud services, cloud computing may present different risks to an organization than traditional IT solutions (CSA, 2009).

According to CSA (2009) study, an organization's security posture is characterized by the maturity, effectiveness, and completeness of the risk-adjusted security controls implemented. These controls are implemented in one or more layers ranging from the facilities (physical security), to the network infrastructure (network security), to the IT systems (system security), all the way to the information and applications (application security). Additionally controls are implemented at the people and process levels, such as separation of duties and change management, respectively.

The security responsibilities of both the provider and the consumer greatly differ between cloud service models. Amazon’s AWS EC2(one of the leading cloud service provider) infrastructure as a service offering, as an example, includes vendor responsibility for security up to the hypervisor, meaning they can only address security controls such as physical security, environmental security, and virtualization security. The consumer, in turn, is responsible for security controls that relate to the IT system (instance) including the operating system, applications, and data.

The inverse is true for Salesforce.com’s (the known cloud service vender on software service offering) customer resource management (CRM) SaaS offering. Because the entire ‘stack’ is provided by Salesforce.com, the provider is not only responsible for the physical and environmental security controls, but it must also address the security controls on the infrastructure, the applications, and the data. This alleviates much of the consumer’s direct operational responsibility.

The deployment and consumption modalities of cloud should be thought of not only within the context of ‘internal’ vs. ‘external’ as they relate to the physical location of assets, resources, and information; but also by whom they are being consumed by; and who is responsible for their governance, security, and compliance with policies and standards. Cloud Computing Security helps customers regain visibility and control through its end-to-end coverage for securing private, hybrid and public clouds.

IaaS is the foundation of all cloud services, with PaaS building upon IaaS, and SaaS in turn building upon PaaS. In SaaS environments the security controls and their scope are negotiated into the contracts for service; service levels, privacy, and compliance are all issues to be dealt with legally in contracts. In an IaaS offering, while the responsibility for securing the underlying infrastructure and abstraction layers belongs to the provider, the remainder of the stack is the consumer’s responsibility. PaaS offers a balance somewhere in between, where securing the platform itself falls onto the provider, but securing the applications developed against the platform and developing them securely, both belong to the consumer.

Understanding the relationships and dependencies between Cloud Computing models and how they are deployed is critical to managing Cloud Computing security risks posture of an organization.

2.7.2. Self-service management capabilities of cloud systems

The key feature of a self-managing cloud system is dynamic capacity planning, which is underpinned by monitoring and accounting services. Capacity planning hides complex infrastructural tasks from users by automatically scaling in and out virtualized resource instances in order to enforce established SLA commitments (TeciRes project research group: Xiaoyu Chen, Gary B. Wills, Lester Gilbert, David Bacigalupo, 2010).
Monitoring is an import technological aspect in cloud computing. Monitoring is a lower-level service that aims at providing real-time system performance information. With a monitoring service, CSPs can measure performance and availability of the overall cloud system. The monitoring service can also be used by users to measure the performance of provisioned virtual machines, and to determine whether new virtual machines need to be started. Monitoring processes can take place at the service level and provide information for SLA management.

In a cloud system, everything is metered and accounted. Metered usage information provides for flexible pricing and charging in a public cloud environment. Historic usage information together with monitoring information is critical to automate capacity planning and ensured agreed QoS.

Cloud users can use self-service API (allowing developers take care of scalability and autonomic capabilities themselves) for capacity planning, or self-management API (that allows developers to call auto-scaling and autonomic capabilities provided by CSPs) facilities for dynamic resource provisioning by specifying high-level policies, rules, or SLAs. In the latter case, the burden of capacity planning shifts to the Cloud providers' side. For CSPs, well-defined strategies of capacity planning are critical to successful business. Nevertheless, users may use utility functions to combine different QoS metrics and maximize their usage of paid Cloud services.

One of the key characteristics that distinguish cloud computing from standard enterprise computing is that the infrastructure itself is programmable. Instead of physically deploying

servers, storage, and network resources to support applications, developers specify how the same virtual components are configured and interconnected, including how virtual machine images and application data are stored and retrieved from a storage cloud. They specify how and when components are deployed through an API that is specified by the cloud provider.

An analogy is the way in which File Transfer Protocol (FTP) works: FTP servers maintain a control connection with the client that is kept open for the duration of the session. When files are to be transferred, the control connection is used to provide a source or destination file name to the server, and to negotiate a source and destination port for the file transfer itself. In a sense, a cloud computing API is like an FTP control channel: it is open for the duration of the cloud's use, and it controls how the cloud is harnessed to provide the end services envisioned by the developer. And unlike the FTP protocol, cloud APIs are not yet standardized, so each cloud provider has its own specific APIs for managing its services.

2.8. The Future of Cloud Computing in Banking

The rapidly changing customer relationship management task, the emerging generation of cloud based socially-driven money management tools, the emerging collaborative cloud based service sharing in to joint venture, scale of IT infrastructure, and competitors' pressure will influence cloud computing adoption for banking industries in the future (Emmanuel Sardet, 2012).

The relationship between consumers and their providers of banking services and products are rapidly changing from time to time. Consumers' migrations to digital, mobile and contactless payments will affect the buying habits, channels and customer services in all markets, and will impact all consumer-facing industries. Cloud computing will make these services more convenient, more accessible, easier to use, and more personalized to the individual's needs and lifestyle.

Currently many banks are focusing to advance the IT stacks at all level on IaaS and/or SaaS, having virtualized their infrastructure and started to use SaaS for undifferentiated activities. Additionally banks will continue to ramp up effort to win customers not just from banks, but from others to respond the competitor pressures in order to avoid disintermediation by investing in capabilities around social media, analytics, and targeted product and service bundling. Banks can take the same approach with their own systems and processes. Scale of IT infrastructure will also influence cloud computing adoption. Newer and smaller banks built on client/server architectures have less overlapping legacy systems and infrastructure,

and will therefore be quicker to adopt cloud technology higher up the stack. Underscoring the fact that cloud computing adoption is not an all-or-nothing choice for newer and matured market banks.

Emerging market banks that have less systems infrastructure legacy than their counter parts in the market are enforced to invest on the infrastructure to compete in the banking market ecosystem. For those emerging market banks too small to invest alone in a cloud-based core banking infrastructure, they may choose to form a consortium to leverage a shared cloud. Banks can compete either as ecosystem leader, if they are matured or as a participant in the ecosystem if they are an emerging market bank.

Collaboratively banks can pool non- differentiated activities in to joint venture using private clouds with in a closed group banks. These JVs could provide shared services that interact with customers in more engaging ways while simultaneously freeing banks from the burden of routine transactions. Collaborative JVs could also be suited to areas that are integral to core banking but not differentiators with customers, such as security. By turning security into a service that is shared with other banks and operated via a joint venture private cloud, banks could stop duplicating investment, industrialize their security processes for economies of scale, gain new service options and have immediate access to the latest applications. These collaborative private clouds could even be “hybrids” powered by a third-party, increasing the benefits of cost and flexibility.

According to Emmanuel Sardet (2012), in the foreseeable future, cloud computing will be omnipresent. No industry can afford to ignore it. But its impact will vary in every case. Competition, collaboration, and convergence will impact future banking products, services and technologies.

2.9. Ethiopian Banking Industries

2.9.1. Overview of Ethiopian Banking Industries

The history of the use of modern money in Ethiopia can be traced back more than 2000 years (Pankhrust 1968 cited in Gedey1990, and Simeneh 2012). Modern banking in Ethiopia was introduced in 1905. At the time, an agreement was reached between the Ethiopian Emperor Minelik II and a representative of the British owned National Bank of Egypt to open a bank

which led to Bank of Abyssinia inaugurated in Feb.16, 1906 by the Emperor himself. In the 30's the bank was bought by the Ethiopian government and the State Bank of Ethiopia and was established by a proclamation issued in august 1942. Twenty six year later, Bank of Abyssinia was legally replaced by Bank of Ethiopia shortly after Emperor Haile Selassie came to power. The new Bank, Bank of Ethiopia (http://www.nbe.gov.et/), was a purely Ethiopian institution and was the first indigenous bank in Africa. This bank was later disintegrated to two different banks forming the National Bank of Ethiopia and the Commercial Bank of Ethiopia. (Lulseged, 2005)
These days Ethiopian banking sector comprises a central bank (National Bank of Ethiopia), three public and over sixteen private owned banks. The common banking functions provided by public and private banks in Ethiopia are deposit mobilization, credit allocation, money transfer and safe custody.
The Ethiopian banking industry as a whole has a network of 1289 branches at the end of the fiscal period ended in June 2012, which is not enough compared to the size of the country (1.1milion square km) and number of population (above 80 million) and this shows that the number of population being served by a single branch stood at around 62,063.6 (NBE, 2012)..

With such scattered branch network and disintegrated working system it is hard to ensure efficient flow of financial resources, efficient usages of ICT infrastructure, customer satisfaction, and optimize the contributions of the entire financial system to the development processes. Money banks in Ethiopia are too late to move with technological advancement used in the rest of the world and they are not integrated with each other for rendering non differentiated banking services for all customers of the bank in Ethiopia.

The banking system has developed well over the years in terms of its geographical coverage, deposit mobilization and credit expansion. Commercial Bank of Ethiopia is the largest, controlling the majority assets of the industry followed by Construction & Business Bank, Dashen Bank, Awash International Bank and etc. Hence, the share of private banks branch network was 47.6 percent at the end of 2011/12.

2.9.2. Current ICT usage Practice in Ethiopian Banking Industries

Many banks in Ethiopia have already using the digitized and networked banking services at enterprise level IT infrastructure. Banks invest millions of dollar for fulfilling the changing

computing needs to deliver the banking services consistently in the market at enterprise level individually. These modern e-banking technologies used to provide banking services for customers are ATMs, Debit cards, Credit cards, Tele banking, Internet banking, Mobile banking and others technologies.

Recently, Core Banking Systems are applied in many private and public banks of Ethiopia. The use of core banking solutions is expected to achieve a nationwide electronic payment system according to the central bank`s targets (NBE, 2012). CORE ("centralized online real-time environment".) banking is services provided by a group of networked bank branches. Bank customers may access their funds and other simple transactions from any of the member branch/channel offices/computing devices by accessing the application from centralized data centers. This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw the deposited money from any of the bank's branches throughout the country. Thus, using core banking technology bank`s provide banking services (including cash withdrawals, bill payments, fund transfer, mobile top up, balance inquiry, and etc.) available across multiple inter-connected channels like ATMs, Internet banking, and branches. Example, customers` of Commercial Banks of Ethiopia can access various banking services from any channels of CBE located anywhere at any time.

Cooperation among banks is the best strategy to improve electronic card payment system in Ethiopia. Recently, three private commercial banks - Awash International Bank S.C., Nib International Bank S.C and United Bank S.C. – have deployed an ATM network called Fettan ATM network. Fettan ATM is installed in ATM machines and POSs across Ethiopia (Gardachew, 2010). The customers of the member banks can have an access from all service channels of the banks across the country. On the other side through collaboration between Zemen Bank and Dashen Bank under the “Q-Link” network the customers of Zemen and Dashen Banks are both able to benefit from a total network of more than 100 ATMs at locations throughout Addis Ababa and several regional cities. This collaboration marked as a significant cooperation between competing banks in Ethiopia, which others should be encouraged to follow (Zemen Bank, 2013). There is no single bank in Ethiopia that can afford the infrastructures to provide extensive geographical coverage and access. Additionally, the first ever electronic banking gateway was signed between Ethiopian Commodity Exchange (ECX) and Dashen Bank and CBE (Dashen, 2012). The electronic

banking system being developed with both banks is designed to give a secure electronic data sharing gateway between clients, banks and ECX, facilitating a smooth transaction.

However, low level of internet penetration and poorly developed telecommunication infrastructure, high cost of internet compered to developed countries, limitations of collaboration among banks to share resources, high rate of ICT illiteracy, security issues, lake of trained personnel, the changing computing needs and other related factors are the key challenges in the current ICT usages of Ethiopian Banking Sectors (Gardachew, 2010). Lack of up-to-date plan for ICT service delivery strategy can be considered as a limitation for banks` to fully harvest the opportunities presented by the latest technology.

Certainly the banking industry in Ethiopia is in a developing stage and therefore there is an all immediate need to embark on capacity building arrangements and modernize the banking system by employing the state of the art technology being used anywhere in the world. Continual improvement and advancement of technology would assist banks` for harvesting the actual and expected benefits of ICT. Developing a framework for adopting new technologies that are well applicable in the developed country banking market has been helpful in selecting the right tracks to profitable ICT adoption strategy.

2.10. Cloud Computing for Ethiopian Banking Sector

Literatures indicate that many financial institutions including banking sector are shifting their ICT paradigm from traditional data centers to centralize and distributed one for the improvement of services with lower costs and better efficiency. In Ethiopia, banking service development and rendering quality of service that can meet customer needs has suffered by high investment cost to ICT infrastructures and the rapidly changing computing needs. In Ethiopia, banking industries are being expanding in a very high speed across the country. Currently there are 19 private and public banks with their many branch offices/automated channels.

Without quality customer service distributing branches by itself cannot give the solution we seek for customer satisfaction, profitability, cost reduction, overall growth of the bank specifically, and economic development and poverty reduction of the country as a whole through banking service. Banking service should be supported through up-to-date technologies and new market models. Many Banking sectors in Ethiopian has been investing

millions of dollars every year to support their banking service by technology. However due to struggling economy and technological limitation it is not able to supply full ICT infrastructure requirements recently applicable in the civilized world. As it has been discussed in the previous sections this infrastructure requirements can be solved using cloud computing strategy .i.e. implementing a central Hybrid Cloud computing infrastructure that can be used by all banks.

The Proposed Ethiopian Banking Industries Hybrid Cloud (EBIHC) combines private and EBIs clouds. The private cloud is implemented and managed by each banks. Every computing resource (such as servers, connections, storage, and related tools necessary to build an application environment) that can be shared by multiple bank branches will be placed at EBIHC and then it will be available to all hosted bank service channels. This can be an attractive option for Ethiopian Banking Industries for cost savings, ease of scaling-in and scaling-out computing resources, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move. Therefore the proposed EBIHC cloud system will reduce duplicated cost by provisioning computing resources in a very affordable way that are necessary to build an application environment on-demand by renting base rather than procuring resources for extending the performance of internal infrastructure.

The proposed EBIHC can have an interface from each Ethiopian Banking Industries Private Cloud (EBIPC) to local Cloud Service Providers. The hybrid cloud interface creates a connection between private clouds and public clouds. By deploying Hybrid cloud computing model, the fear of privacy and other related security issues can be avoided, since critical and sensitive data could be owned by the bank responsible bodies.

The proposed EBIHC can improve collaborative work between banks through sharing infrastructures. This presents new streamlined business process and new bases of competition among matured banks and emerging market banks. Emerging market banks generally have less systems and infrastructure legacy than their counterparts in mature markets, making it easier for them to adopt cloud models by paying fewer service charges for the matured market banks. At the same time, banking innovation in emerging markets is being accelerated by faster economic growth and distinctive social needs. Therefor emerging market banks can use mature market ICT infrastructure and service channels without investing the

infrastructure from scratch with some level of service charge agreement; in other side mature market banks have an opportunity for expanding their business and earning revenue from the new service.

2.11. Cloud Computing Adoption Strategy for Banks

Cloud computing has caused more debate than many other recent technological advancements. Regardless, there has been a tremendous rise in its adoption by financial services firms over the last couple of years. Without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011). The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009). Also, in order to have success, the cloud strategy must be aligned with the banks strategy. The prominent cloud adoptions strategies that are agreed in many experts and organizations have included the following phases as illustrated in the figure below.

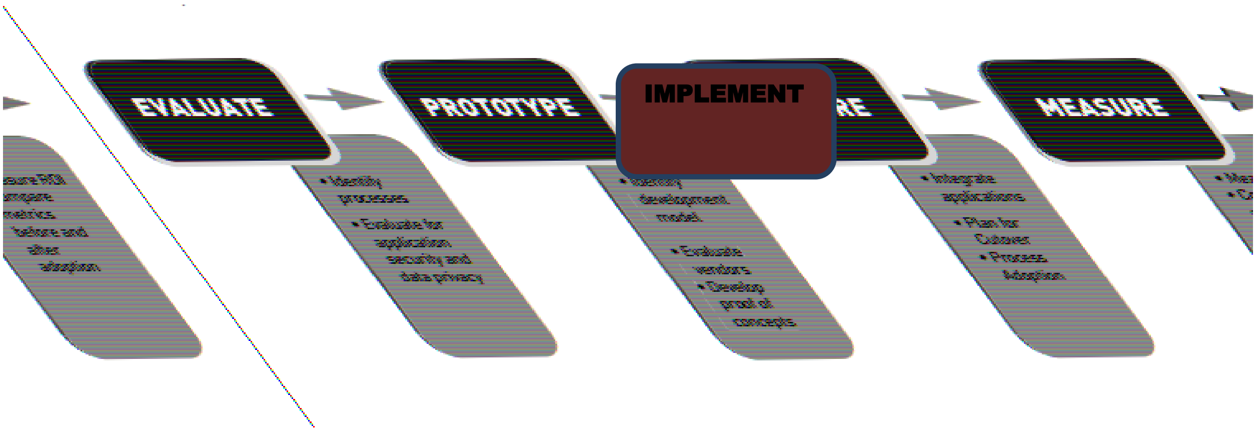


Figure.4. Cloud Adoption Strategy

Phase I: Evaluate

The development of a successful cloud strategy starts with thorough evaluation of current business processes and applications and identifying those that can be moved to a cloud. The phase consists in developing the knowledge base by participating at seminars, conferences,

discussions with the suppliers and consulting the most recent researches in the field. The success of the phase depends on the allocation of sufficient resources for research, for understanding how Cloud Computing functions in different banking industries in the world as a benchmark, the benefits and risks, policies and the best usage practices of Cloud Computing. The research is conducted by a team formed mainly of IT staff who permanently communicates with the users of the solution regarding the objectives, the progress, costs and benefits of the Cloud Computing solution.

The processes and applications should be evaluated from the banks point of view of the IT needs, structure and usage. The service oriented architecture represents the base for understanding the data, services, processes and applications that may be migrated or need to be maintained within the banks, so as to observe the security policy. With respect to the IT needs, their structure and usage, the analysis may start from the categories of users who interact with the present IT infrastructure and their necessities. Additionally, privacy requirements when the information is stored on a cloud, peak load hours, architecture constraints and such legal requirements as the physical location of hardware, which will decide applicable legal jurisdiction and laws of country, and other important points, should be identified in this phase.

Phase II: Prototype

In the Prototype phase, particular processes are selected and the type of deployment model, including public, private or a hybrid cloud, is decided. Plus, strategies for storing data with different security requirements and complexities are developed. Some of the key decisions focus on where the most sensitive data should be located and how less sensitive data will be processed. This phase also includes the evaluation of cloud vendors based on data and architectural parameters. Proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability are completed. Choosing the right vendor involves understanding what each one can offer and how their offerings align with the firm's requirements.

Phase III: Implement

Once the deployment model is decided and cloud vendors are chosen, the implementation phase begins. In this phase, applications are deployed on cloud. Several factors are kept in mind during this phase, including migration and cutover planning, as well as the adoption and operational management of the new process.

Phase IV: Measure

Finally, an organization should spend considerable time measuring the ROI achieved and fine-tuning the adoption process. In this phase, ROI is measured considering the objectives and feedback is collected from end users. The output of this phase is fed back into the evaluation process to fine-tune the next roll-out.

2.12. Related works

Cloud adoption frameworks are developed to predict what customers might do with cloud, based on the frameworks cloud based service implementations are developed and deployed to validate customer predictions from the cloud services. This section describes the available literatures on best practices of cloud-based service implementations and framework development works for cloud-based service adoption strategy in the banking sector.

BBVA, one of the largest financial institutions in the world, announces today that it is adopting Google's cloud-based collaboration and communication suite Google Apps for Business to increase productivity and drive innovation. Over 35,000 BBVA workers in Spain will initially use the productivity tools integrated in to the Google Apps suite including: Gmail with Google Chat, Google Calendar, Google Docs, Google Groups, Google Sites and Google Video. By the end of 2012 BBVA expects to migrate 110,000 employees in over 26 countries to Google Apps.

BBVA chose Google Apps to increase efficiency and to help its workers collaborate more easily, regardless of location. BBVA's new global intranet is the main technology project that will be transformed thanks to Google's collaboration tools such as Google Talk, Google Sites and Google Docs, changing it from a corporate communications and process management site to a place where all employees will be able to share, contribute and manage knowledge globally. Integrating the Google Apps for Business suite with our own tools will allow us to introduce a new way of working where employees have access to all the information they need with just one click, no matter where they are, and can reap the benefits of using advanced collaboration tools. In addition, BBVA will create a social network to improve communication and explore new ways of working. BBVA will now join the four million businesses worldwide which are using Google's enterprise solutions to embrace technological change, and open the door to constant innovation, collaboration and cost savings.

Accenture (2012) describes the Citigroup and Banks of America practices for using cloud services to communicate with customers using social media. Citigroup has implemented various social media strategies to communicate better with its customers, including a blog that actively seeks questions and comments from customers, a YouTube channel, and a service that will allow customers to talk to bank staff through Twitter or other social media. Bank of America uses Twitter as a customer service and advice tool, and reports that

customers find it a faster and more effective way of getting the help they need than traditional customer service channels.

IBM Academy of Technology (2010) conducted 110 case studies and examines those survey findings: where clients are with cloud computing, what challenges they face, how they are benefiting from their existing implementations and where they expect to be in the future. According to IBM Academy of Technology survey findings from the cases studied on financial institutions show that: Firstly, IT efficiencies, consumer interfaces featuring ease of use, and new charging models are the primary motivations for client cloud implementations.Secondly, conversely, security concerns, pricing strategies, system complexity, rapid technology advancements of cloud capabilities, gaps in standardization and a lack of clear value propositions are seen as the biggest inhibitors to cloud computing. Thirdly, integrated vendor offerings combined with ongoing support (applying best practices) are in high demand.

IBM sales and distribution also identifies the successful cloud implementation works (such as cloud desktop, cloud collaboration, cloud analytics, cloud storage, and etc.) in the banking and financial services industry across the world.

Some of the organizations are: (1), a global Japanese bank was concerned that it would suffer security and business continuity risks if the H1N1 virus were to spread to pandemic levels. The 34,000-employee bank is deploying an IBM private cloud to centralize management of desktops using an enterprise-class data center rather than at the user stations. This change gives the bank greater remote flexibility without sacrificing control. (2), a central European bank facilitated continuous, standardized operations and enabled employees across its distributed branches to quickly access trading and banking systems through a security-rich cloud infrastructure. (3), a subsidiary of a large European bank designed a new sales platform based on an application package, which enables tellers to enter data into the system only once, instead of entering it up to 20 times for different applications. The new platform also gives the bank a 360-degree view of customer data, which when combined with embedded artificial intelligence can help generate more sales. (4), a Chinese financial services organization reduced system management costs, speed up deployment for resource requests, standardized software configuration for each deployment request and improved the tracking of system resource usage by implementing a cloud computing solution to deliver powerful provisioning capabilities that simplify system management and maintenance.

AbhinavGarg (2011) conducted a study on how cloud computing is applicable to the financial services industry and provide an approach for adoption by a financial services firm. He was start the study by introducing cloud computing and its characteristics. Then he outline the common challenges that different financial services firms that are more in a regulated and

security-sensitive environment have faced while implementing cloud computing like data privacy, compliance, availability, lack of standards, etc.

The study discusses the factors that make cloud computing an attractive option for a financial services firm. This factors are perceived cost savings, ease of scaling-in and scaling-out, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move are all critical consideration factors that can drive financial services firms to adopt cloud computing.

Additionally, the study suggest a cloud computing readiness approach, which can be adopted by firms to make sound decisions around their approach to—and readiness for—cloud computing. These approaches are: first evaluating current business processes and applications and identifying those that can be moved to a cloud. Second prototype the particular processes that are selected and the type of deployment model, including public, private or a hybrid cloud is decided. Plus, strategies for storing data with different security requirements and complexities are developed. Third implement the application and deployed on the cloud. Fourth measure the ROI achieved and fine-tuning the adoption process.

Finally the study concludes that hybrid clouds with the appropriate allocation of data and applications are recommended where data secrecy is more important. Cloud Computing is a promising paradigm for delivering computing utilities as services. Just as personal computers and servers shook up the world of mainframes and minicomputers or as smart phones and tablets revolutionized the mobile commerce industry, cloud computing is bringing similar far-reaching changes to the licensing and provisioning of infrastructure and to methodologies for application development, deployment and delivery. Some firms have already realized the benefits of cloud computing, which include scalability, cost savings and time to market. Firms that are still looking to leverage the cloud should begin by moving nonrevenue generating and non-core systems to the cloud. And, they should consider developing a comprehensive cloud strategy to move core applications to the cloud.

Chapter Three

Research Methodology

The main aim of this chapter was to design the methodology to carry out the study, which included: determining design strategy for the study including a conceptual framework, defining the deliverables, and articulating the methodology. The requirements to this study were: developing the knowledge base about the state of the problem and the importance of its solution to define the problem; developing the knowledge base about the state of the problem and current solutions to identify the requirements; the knowledge of theory that brought to bear in a solution to design the proposed cloud computing framework; and developing evaluation tool to measure the performance of the resulting framework. Thus the instruments used to develop the knowledge base to the study requirements were data collection using interview and review of relevant literature including similar studies.

3.1. Research design

The research method used in this study is based on the design science paradigm in IS research (Nunamaker et al., 1990; Walls et al., 1992; Hevner et al., 2004). The design science research is a prescription-driven and problem-solving paradigm that seeks to create viable artifacts in the form of a construct, a model, a method, or an instantiation (design artifacts) which provide solutions for management problems (Hevner et al., 2004; Gregor and Jones, 2007; van Aken, 2004).The study focused to use a consensus building approach to produce the framework based on well-accepted elements of the DSRM process, which contains four phases discussed below (Peffers et al., 2007).

i. Problem identification and motivation

This phase includes defining the knowledge of the state of the problem and the importance of its solution. Researchers begun by defining the specific research problem and justify the value of a solution by conducting interview and rigorous analysis of literatures on cloud computing adoption in the banking sector. Since based on the problem definition the researchers atomize the problem conceptually to capture its complexity for developing the proposed cloud computing framework that can effectively provide a solution. The value of the solution also justified to motivate the researcher and the audience of the research to pursue the solution and to accept the results and to understand the reasoning associated with the researcher's understanding of the problem.

ii. Define the objectives for a solution

This phase aims at to identify or drive the requirements for developing the proposed cloud computing framework from knowledge of the state of problems and current solutions. The researchers infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible to align with the bank's requirements. The qualitative objectives are used, which described how a proposed framework is expected to support solutions to problems not hitherto addressed. The researcher used the conceptual framework to inferred objectives rationally from the problem specification. In order to develop the study conceptual framework, researchers started with the literature review to gather relevant requirements and aspects of existing Cloud frameworks.

iii. Design and development

Conceptually, a design research artifact can be any designed object (models, frameworks or instantiations) in which a research contribution is embedded in the design. This phase includes determining the artifact's desired functionality and its architecture and then creating the actual artifact. The knowledge of theory that can be brought to bear in a solution is required to move from objective of a solution to design and development of the proposed framework.

Based on the required knowledge of a solution identified in phase one and two with the literature review and expert interviews analysis to develop the proposed framework:

particular processes are selected; the type of deployment model is decided; strategies for storing data with different security requirements and complexities are developed; and proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability are completed. After determining the framework functionality and its architecture, the proposed collaborative cloud computing framework for EBIs with the implementation plan to deploy application on the cloud could be developed.

iv. Evaluation

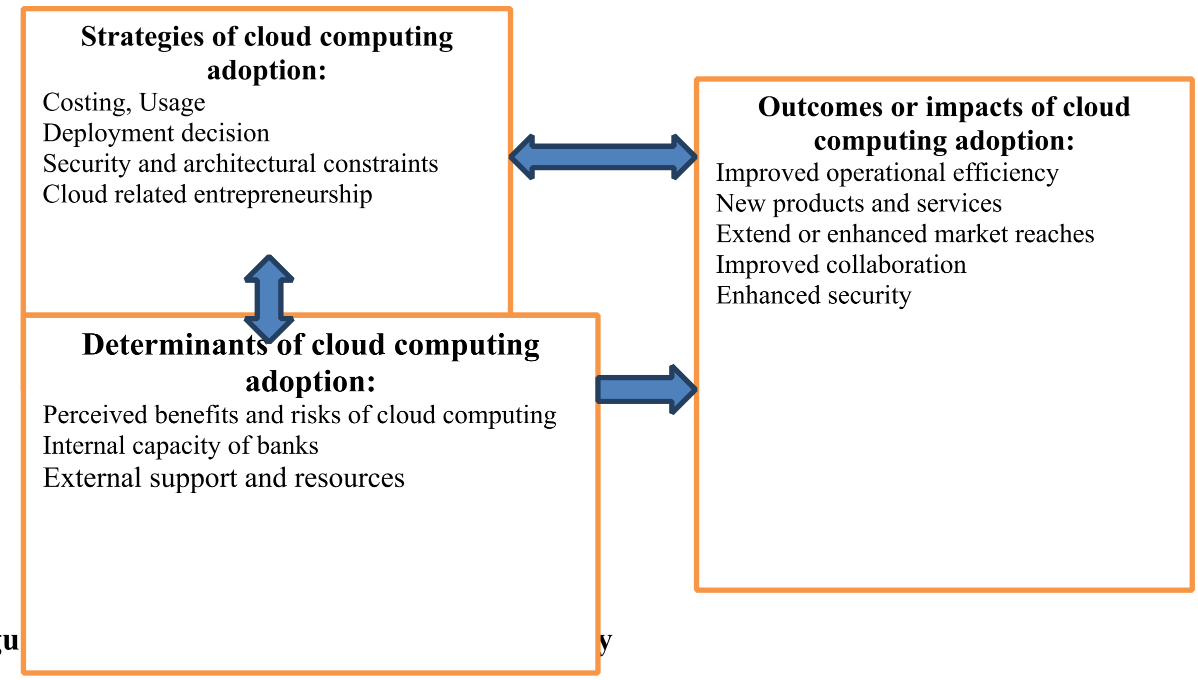
This phase aims to Observe and measure how well the framework supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the framework in the demonstration. It requires knowledge of relevant metrics and analysis techniques. Depending on the nature of the problem venue and the artifact, this study took the qualitative evaluation analysis techniques which include: a comparison of the proposed framework functionality with the solution objectives from activity two above, objective qualitative performance measures, such as business impacts, extents of actual use and user satisfaction. Conceptually, such evaluation could include any appropriate empirical evidence or logical proof. At the end of this activity the researchers can decide whether to iterate back to step three to try to improve the effectiveness of the artifact or to continue on to communication and leave further improvement to subsequent projects. The nature of the research venue may dictate whether such iteration is feasible or not.

3.2. Conceptual Framework for the study

A conceptual framework used in this study was to limit the scope of the relevant data required in the DSRM process phases discussed above by focusing on specific variables and defining the specific viewpoint (framework) that the researcher took in analyzing and interpreting the data to be gathered, understanding concepts and variables according to the given definitions, and building knowledge by validating or challenging theoretical assumptions (Herbert, Asher and William, 2006). Many researchers have been used different frameworks in the study of adopting new technological innovation. Among frameworks that have been developed based on the past studies that are well received framework in the context of innovation adoption by organizations and have been used in many studies are discussed below.

Tornatzky and Fleischer (1990) proposed the Technology-organization-Environment framework (TOE) for studying the likelihood of adoption success of technology innovations. According to Tornatzky and Fleischer (1990), technology adoption within an organization is influenced by factors pertaining to the technological context, the organizational context, and the external environment. While, Kshetri (2010) proposed a framework that explains contexts, mechanisms and processes associated with the development of the cloud industry in the developing world in terms of three inter-connected flows: determinants, cloud related performances and impacts of the cloud. Based on this, the researcher modified this framework and created a more relevant framework for this study by integrating ideas from the two frameworks.

Figure 3.1 shows the resulting conceptual framework that was used to carry out the baseline study on cloud computing for EBIs. The direction of arrows shows an element of causal effect which could either be one directional or bi-directional.



Figu y

As shown in in figure 3.1 the conceptual framework for this study consisted three elements including: determinants of cloud computing adoption which used to describe the key factors for cloud computing adoption, strategies of cloud computing which used to describe the deployment strategies for cloud computing adoption, and outcomes of cloud computing

adoption which used to describe the values created by cloud computing adoption. The elements of concepts in figure 3.1 are discussed below.

3.2.1. Determinants of cloud computing adoption

The aim of this element in the framework was to assess the key factors that affect cloud related performance and its outcomes or impacts from its adoption. It contained three components that could affect the adoption: Perceived benefits and risks of cloud computing that refers to adopter's perception of cloud computing attributes,internal capacity of banks that refers to the organization's characteristics that influence its ability to adopt and use of cloud computing, and External support and resources that refers to the external environment in which an organization operates and its condition for supporting the development of cloud computing. For each context, various factors have been identified from the literature but only those that are considered relevant for cloud computing adoption are included in the framework. Details of determinants considered in this element are discussed below.

a) Benefits of cloud computing

This aims to evaluating whether there are sufficient benefits to warrant on cloud computing adoption for banks. For successful cloud computing adoption, the study needed to go through evaluating: operational, financial, CRM and strategic efficiency of using cloud computing for supporting banking services by comparing with the existing IT services provisioning. The current banks preference or innovation culture needed to be analyzed to determine whether it is supportive towards the process of adopting cloud computing or not. These is vital for referring typical characteristics of cloud computing technology considered in technology adoption studies, which include relative advantages (perceived benefits), and relative disadvantages (perceived risks), based on the assumption of Roger's diffusion of innovation (Rogers 2003).

b) Internal capacity

It aims at determining whether the banks has within it sufficient internal resources and appropriate procedures necessary for the successful selection and implementation of cloud computing. Standard compliances such as development and structure of related industries with the considerations of e-government service availability and strong demand strengthen

forward linkages and bandwidth provision with horizontal linkage. For example, cloud computing is IT infrastructure provisioned over the internet, this means that for an organization to adopt this technology it would require good internet connection or bandwidth, where good determined by the bank's core activity and the services that it would acquire from the cloud.

Internal resources also look at: the technological capacity and financial constraints necessary to making the switch from traditional computing to cloud computing. There is also need to evaluate the organizations current policy on IT with the considerations of availability, flexibility, and effectiveness to meet the needs of this new paradigm. While the market situations need to be assessed with the considerations of availability, readiness and dominance of certain actors in the market.

The development of a successful cloud strategy starts with thorough evaluation of current business processes and applications and identifying those that can be moved to a cloud. The evaluation consists in developing the knowledge base by reviewing recent literature in the field and interviewing banks IT staffs who permanently communicates with the users of the solution regarding the objectives, the progress, costs and benefits of the Cloud Computing solution.

c) External environment

It aims to evaluate the external environment, support and resources, particularly if in-house resources and support are lacking. To assess the external environment, the researchers needed to acquire the knowledge about how Cloud Computing functions in different banking industries in the world through considering: benefits, risks, strategies, and the best usage practices of Cloud Computing. There is also needed to evaluate the technologies deployed by service provider with the considerations of reliability, investment cost, agility, usability, availability of the technology and sustainability that affect cloud related performance and its outcomes or impacts from its adoption. Here the researchers look at: data security, number of operating systems and application supported, training and back end support, provider reputation, SLAs guaranteed and so on. At the end of this stage the researchers typically able to have an answer to the question of which cloud provider it should subscribe to.

3.2.2. Strategies of cloud computing adoption

It aims to assess the strategies of cloud computing development for banks or various actors that are instrumental in delivering the outcomes or impacts of cloud computing adoption based on the evaluation on determinants of cloud computing adoption and its outcomes. Strategies look at: costing, usage, deployment decisions and cloud related security and architectural requirements.

The researchers needed to used the available service oriented architecture that represents the base for understanding the data, services, processes and applications that may be migrated or need to be maintained within the banks, so as to observe the security policy. With respect to the IT needs, structure and usage, the analysis started from the categories of users who interact with the present IT infrastructure and their necessities. Additionally, privacy requirements when the information is stored on a cloud, peak load hours, architecture constraints and such legal requirements as the physical location of hardware, which decide applicable legal jurisdiction and laws of country, and other important points, identified in this stage.

In this context, particular processes are selected and the type of deployment model is decided; strategies for storing data with different security requirements and complexities are developed; and proper assessment of cloud vendors with respect to their focus on security, data confidentiality and availability that can align with the bank's requirements completed. After the deployment model and cloud vendors option are decided, the proposed cloud computing framework for EBIs developed.

3.2.3. Outcomes or impacts of cloud computing adoption

This aims to evaluate the values created by the cloud or benefits, which are the ultimate objectives that decision makers want to accomplish. Outcomes or impacts of cloud computing adoption includes: improved operational efficiency, new products and services, extend or enhanced market reaches, improved collaboration, enhanced security and Job creation. Finally, the outcomes are measured by considering the objectives and feedbacks collected from end users using qualitative measurement analysis techniques.

3.3. Instrument design

In order to develop the knowledge base about the current state of IT need, structure and usage in Ethiopian Banking Industries the researchers used a qualitative research approach. This approach was selected because this study aims at to investigate existing IT infrastructure, understand what is happening, and find alternative solution from an operational point of view.The contribution of qualitative studies is normally based on its ability to present a new way to investigate existing phenomena, understand what is happening, and find new phenomena and perspectives from an operational point of view (Koskinen et al., 2005). Hirsjärvi et al. (2009) describe qualitative research with three key characteristics. First, qualitative methods such as interview are used. Second, inductive reasoning is employed, which means that diverse analysis of the data and revelation of unexpected things are essential for formulating a problem and developing the working framework from an operational point of view. Second, purposive sampling is used in data collection, which means that the best suitable respondents are chosen in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations.

3.3.1. Sampling method

Sample designs are basically of two types: non-probability sampling and probability sampling. Probability sampling is based on the concept of random selection, whereas non-probability sampling is 'non-random' sampling. Under probability sampling design, every item of the universe has an equal chance of inclusion in the sample. Under non-probability sampling each item in the population has of being included in the sample (Kothari, 1990).

Purposive sampling was used for data collection in this study, which means that the best suitable respondents were chosen from different banks in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations (Kothari, 1990). Under this sampling the organizers of the inquiry purposively choose the particular units of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be typical or representative of the whole. According to Kothari (1990), in purposive sampling, personal element has a great chance of entering into the selection of the sample. The investigator may select a sample which shall yield results favorable to his point of view. Accordingly different persons including IT experts and ICT managers from different banks were selected for interviews. The criteria for selecting

interviewees were their position of authority due to formal position or expertise and knowledge in some specific area to this study. Also the criteria to select the banks were their status of maturity in the market and infrastructure legacy with regulator of the market by categorizing them in to: matured infrastructure legacy banks, less infrastructure legacy banks and regulator bank. The following table shows the organization of the sample and population for the study.

Banks Status	**No. of Selected Banks**	**Name of Selected Banks**	**No. of respondents selected**
Matured infrastructure legacy banks	2	Commercial Bank of Ethiopia	2
		Dashen Bank	2
Less infrastructure legacy banks	2	Addis International Bank	2
		Enat Bank	2
Regulator bank	1	National Bank of Ethiopia	2
Total	5		10

3.3.2. Data Collection and Analysis Technique

- Data collection

Research differs in a number of aspects but they do have some commonalities. One of the common aspects is the need to collect data. Data collection can be derived from a number of methods, which include interviews, focus groups, surveys, telephone interviews, field notes, taped social interaction, questionnaires, and from various publications. Data collected to this study could be a base to understand and identify the banks IT needs, structure and usages.

Data collection consists of either primary or secondary data. Primary data is information that is collected a fresh by the researcher to answer his current research questions. There are several methods of collecting primary data; it can obtain either through observation or through direct communication with respondents in one form or another or through personal interviews (David & Sutton, 2004; Saunders et al., 2009; Sekaran&Bougie, 2010).

Secondary data is use of information already collected by someone else. Secondary data may either be published data or unpublished data. Usually published data are available in various publications of the organizations, governments, researchers, individuals, and others sources of published information. The sources of unpublished data are many; they may be found in diaries, letters, unpublished biographies and autobiographies and also may be available with scholars and research workers, trade associations, and other public/private individuals and organizations. The already available data should be used by the researcher only when the data are reliable, suitable and adequate (Kothari, 1990).

The decision of which information acquisition method to use depends on the research goals and the advantages and disadvantages of each method relative to those goals. Because it is worth remembering that one method of data collection is not inherently better than another method (Nyaora, 2012). This research has preferred to use primary data for different reasons. Firstly, primary data is up to date/fresh, and this is vital where the research is looking at issues in an environment with a rapidly changing landscape such as the cloud computing environment. This original data is important for identifying the real requirements of banks. Secondly, scarcity of finding secondary data that are suitable for this study; because cloud computing is an emerging technology in the developing country.

For the purpose of this study interviewing the best suitable respondents selected through purposive sampling are used as information acquisition method. Interview was selected as the information acquisition method because as Hirsjärvi et al. (2009) and Hirsjärvi and Hurme (2008) argue, it is good method when working with unknown or less explored topic and when predicting answers beforehand is difficult. They also argue that interview is good method because it makes possible to expand the information, clarify desired answers, and get illustrative examples. This method was used to develop the knowledge base to identify the requirements for cloud based service provisioning strategy and its elements for constructing cloud based service framework for EBIs.

Hirsjarvi and Hurme (2008) define interview by suggesting that interviewer's task is to mediate picture of respondent's thoughts, opinions, experiences, and feelings. Interviews are a systematic way of talking and listing to people (Nyaoro, 2012). The researcher often uses

open questions to obtain responses from the interviewee, who is the primary data for the study. There are many types of interviews, which include: structured interviews, semi-structured interviews and unstructured interviews (Sauders et al., 2009).

In structured interview the aim is for all interviewees to be given exactly the same context of questioning so that their replies can be aggregated. Questions tend to be closed ended, pre-coded, or of fixed choice. Structured interviews make probing a problem area difficult because they introduce some rigidity to the interview (Corbetta, 2003). Nevertheless, the common format utilized within this types of interview makes it easier to code, analyze and compare data (David & Sutton, 2004).

Semi-structured interviews, on the other hand, are non-standardized and are frequently used in qualitative analysis. The interviewer does not do the research to test a specific hypothesis. Instead he has a list of key themes, issues, and questions to be covered (David & Sutton, 2004). Semi-structured interviews give the researcher flexibility to establish own style of conversation depending on the direction of the interview (Corbetta, 2003). This flexibility enables probing, which is a way for the interview to explore new path which are not initially considered (Gray, 2004).

The unstructured interview or in-depth interview takes a further step towards a more open discussion where no predetermined question is needed. The interviewee is encouraged to speak freely about events, behavior, and beliefs, with reference to the subject. The problem with this is that the researcher may not know what to look for or what direction to take the interview especially if his interviewers are inexperienced. Respondents may talk about irrelevant and inconsequential issues and also it may be difficult to code and analyze the data. The unstructured interview would be highly disadvantageous for this research especially when one considers the limited research time and resource that study’s offer.

After carefully understanding each types of interview method semi-structure interview method was selected for this study because it is most suitable considering the nature of the subject. Semi-structured interviews give the researcher flexibility to establish own style of conversation depending on the direction of the interview. This flexibility was important to

obtain rich information systematically from the interview about the subject. Interview questions were adopted from (Sewale, 2012).

Interviews were conducted between April 15 and April 25, 2014 and responses were obtained from all selected informants. The objectives and concepts of the study were briefly explained for interviewees. Each informant was interviewed individually by the researcher.

- **Analysis Technique**

After interviewing all selected informants, the collected data are analyzed and summarized for better understanding of the current ICT need, structure and usage. Interpretation, description, classification, and/or combining of the data are few standardized analysis techniques for qualitative data (Jaatmaa, 2010). The procedure followed in this study was: using the interview to collect data, describing the data, grouping the issues, and interpreting what is happening. In terms of analysis the research deploys the following approach: results and findings from the interview will be described and analyzed, findings from the interview would be compered and contrasted to relevant literature review findings.

The analysis made based on the finding of the literatures and the data collected from the interview for presenting the requirements to constructing the framework intended in this study. Analysis of business requirements through comparisons of information obtaining from primary data with relevant literature finding was necessary to fulfill the gap in current research. The survey of concerning literature happens to be the most simple and fruitful method of formulating precisely the research problem or developing framework (Kothari, 1990). According to Kothari (1990), researcher may review two types of literature: the conceptual literature concerning the concepts and theories, and the empirical literature consisting of studies made earlier which are similar to the one proposed. In this study literatures on concepts of cloud computing including similar studies were reviewed. Accordingly interview and review of relevant literature are employed for this study to develop the knowledge bases required for developing the proposed cloud computing framework.

3.4. Reliability and Validity

The concept of validation refers to the determination of the correctness of the system with respect to user needs and requirements. Validation criteria include comparisons with known

past cases, comparison against exert performance, comparison against theoretical possibilities.

The quality of a research refers to its reliability and validity. In qualitative research validity refers to the appropriateness of the choices in terms of research strategy and data collection and analysis techniques (Jaatmaa, 2010). Validity means consistency of description and its explanation and interpretation (Uusitalo, 1991).

The question templates used to conduct the semi-structured interview coupled with interview findings and discussion could be used by other researchers to validate the findings.Readily available literatureswere carefully selected from the authenticated sources. Consistent practices were applied to the interpretation and explanation of findings.

Reliability also refers to repeatability of a study, i.e., ability to deliver non-random results. This research is reliable because it used valid strategies and techniques appropriate to the research objectives (Nyaoro, 2012). It has a detailed record of research plan and its implementation. The purpose of the research and the use of the collected data were discussed to the interviewees to collect unbiased response.

Finally, the outcomes are measured by considering the objectives and feedbacks collected from users using qualitative measurement analysis techniques, which described how a proposed framework is expected to support solutions to problems not hitherto addressed.

Chapter Four

Findings and Discussion

This chapter presents the results of the interview described in chapter three. The data collection method utilized was the semi structured interview that provided both control and direction through a list of question under interview. Respondents were ICT managers` and senior staff who have an authority to decide which direction banks takes with regard to adopting new IT infrastructure or not. Interviewees were selected randomly from five different banks ICT department using purposive sampling. Ten interviewees from NBE, CBE, Dashen, Addis International and Enate bank were interviewed. Accordingly, results are discussed in this chapter by grouping the issues and comparing the interview findings from relevant literature findings.

4.1. Structure for Cloud Computing Development

There are many factors associated with cloud computing developments, which include benefits with the adoption of cloud computing, reasons which leads development of the system, and outcomes which affects the decisions for implementing the cloud system. In case of Ethiopian banking industries, many commercial0banks using the conventional IT systems based on the “hosted applications model” and don’t have access to take advantage from the new business and technological model i.e. cloud computing IT model. Both models have several features in common; fundamentally their difference is from the business model standpoint (ITU, 2012).

The difference between cloud computing and the existing computing models in EBIs can be better demonstrated by ways of using the service and deployment models and its key enabling technologies of virtualization. ITU, 2012 studies indicated that the major differences between the two modes lies in the fact that, in the case of cloud, responsibility for security is entirely a matter for the cloud computing provider, whereas in the “hosted applications” mode, that responsibility is shared between the owner of the application and the host.

On the other hand Nyaoro (2012) discussed that, under cloud computing IT model, organizations can access computing infrastructures from a cloud provider instead of the traditional purchase of physical servers and software needed to set up a datacenter. Also Armburst et.al. (2009) studies demonstrated that Cloud computing IT model allows the dynamic integration and extraction of computing resources based on the workload and target performance parameters needed by banks, while billing is based on resource consumptions such as CPU hours used, volume of data moved, or gig bytes of data used.

Additionally, Garg (2011)observed the following reasons which may be considered as an attractive option for a financial service institutions for the use of cloud computing.The factors that make cloud computing an attractive options for financial service institutions are perceived cost savings, ease of scaling-in and scaling-out, faster time-to-market for deploying systems, virtualization of enterprise-wide data as a service, enterprise technology standardization, and the ability to access data and applications on the move. These critical factors can drive EBIs to adopt and implement cloud computing. Moreover, the main components that can needed to be analyzed for the development of cloud computing framework for EBIs regarding with determinants, strategies and outcomes of cloud computing development were presented as follows.

4.1.1. Determinants of cloud computing

4.1.1.1. Benefits and Risks of Cloud computing

The issues raised in this study in relation with the potential benefits of cloud computing banks gained from adoption it and the potential risk which hinder banking industries from the adoption of new technological innovations.

In Ethiopia, banking services are provided on a group of networked banking channel services to the dedicated customers from a single bank infrastructure. In this context, for expanding the geographical coverage of these banking services, banks need to distribute the channels with the necessary resources (human, financial, computing and etc.). Distributing branch offices and installing ATMs to expand the market coverage of the banking services needed high investment costs to acquire hardware and software infrastructure to support it. This does not protect the investment costs of ICT or it does not the financial efficiency of banks.

When the market reaches at the peak time or computing needs changed, banks also need to procure and install the required IT infrastructures to support the banking operation. This does

not provide a flexibility to respond to fluctuations of market supply and demand, because resources are procured and installed in a fixed time interval.
Customers wants to access any banking services everywhere and anytime nearer to their places without access limitations from any banks available in Ethiopia. But in case of EBIs, the dedicated customers to the specifics banks access only from banks channel they are registered. So customers needed to search bank`s channels, this wastes customers time and money, while reduces their satisfaction. Employees also loaded by large routine transaction volumes, this leads high customer traffic to access the banking services from the branches and limiting the access. Improving operational, financial and CRM efficiency using ICT is the strategy of all banks in Ethiopia. However, because of the above factors banks do not address their strategic efficiency. The overarching and most disruptive impacts of cloud computing will be how redefines the relationship between consumers and their providers of banking products and services. Cloud computing will make these services more convenient, more accessible, easier to use, and more personalized to the individual needs and lifestyle (Sardat, 2012).
One of the basic barrier a firm faces, while adopting technological innovation is the perceived risks. The major reasons that continue to hinder the level of adoption of this new computing infrastructure acquisition paradigm are: performance bottlenecks due to use of HTTP protocols and bandwidth issues; increased threats of single point of failure; customer data lock-in; concerns over data privacy and security; lack of frequently used tools; and the switching costs of migrating from in-house IT infrastructure (Nyaoro, 2012).

Without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems (Garg, 2011). The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation (Gartner, 2009). Garg (2011) suggest that data privacy, compliance, availability, lack of standards, etc. are the common challenges of implementing cloud computing in a more regulated and security-sensitive financial service institutions.

Moreover, all of the bank manager's participated in this study were asked whether security issue is raised with the use of technological facility in the banking industries, and all of them stated that security is the main concern that hinders our bank to use technological facilities.

The finding indicated that fear of security risks is main barriers if banks used external resources to adopt and implement cloud solutions to support electronic banking for EBIs. In the case of using mobile banking, ATM and POS, security risk affects banks' decision to use external public cloud service providers. Banks do not trust the technology provided by external cloud service providers.

The respondents asked whether banks will decided to use IT resource and support from external public cloud provider to support electronic banking services with greater cost saving and flexibility, and largest number of respondent were agreed on the issue, however fear of risk is one of the factor that hinder the use of external cloud vendor resources and support for EBIs. Similarly the result from the interview revealed that lack of confidence with the security issue is considered as barrier for using external cloud vendor resources and support. This result were consistent with the findings of Garg (2012) in which all indicted that, technological barriers, such as security risk as hindrance factor for the adoption of cloud computing.

Also the result indicated that lack of trust on the use of technological facility provided by external cloud service providers is another factor that can hinder adoption of technological innovation by Ethiopian banking industries. This result confirms the finding of Sarfraz and Brohi et al. (2011) which suggests; the greatest challenge among the banking sector is winning the trust of customers in the issue of security or perceived security risk as a key inhibitor in the adoption of cloud computing. Also Savola, Juhola, &Uusitalo (2010) indicated that there is the difficulty of winning consumer trust, and they suggested that the most important aspects that enforce trust in the cloud are good level of security and privacy.

4.1.1.2. Internal Capacity of Banks

One of the basic issue related with internal capacity assessment to develop cloud computing for EBIs is, the availability of financial as well skilled human resource to implement the system. In this study costs related with the use of E-banking instrument and technical or managerial skills required to implement E-banking system were considered as organizational factors.

Through the years, the value of ICT is increasing for general purpose computing and industry specific computing in banks. Many banks in Ethiopia have already using the digitized and

networked banking services at enterprise level IT infrastructure. Also they are investing millions of dollar for fulfilling the changing computing needs to deliver the banking services consistently in the market, mostly at enterprise level/individually.

Core Banking Systems are applied in many private and public banks of Ethiopia. The use of core banking solutions is expected to achieve a nationwide electronic payment system according to the central bank`s targets. CORE ("centralized online real-time environment".) banking is services provided by a group of networked bank such as: branches, ATMs, POS, phone &etc. This means that the deposits made are reflected immediately on the bank's servers and the customer can withdraw or transfer the deposited money from any of the bank's member branches throughout the country. User computing devices used as banking service channels are interconnected with the centralized server or datacenter of bank`s using virtual private network telecom infrastructure.

Moreover, the IT manager of CBE, indicated that: ‘Our bank were aggressively doing on the provision of high quality service to customers by employing different technological innovation, for example the bank purchase CORE banking system software, which offers service to customers more than the sophisticated ATM machine. It would enable banks to provide Internet banking to deliver product/service to customers. It helps customers to view their balances, transfer funds, and pay bills online. Banks could also offer mobile banking services through which customers can check their balance and transfer funds by short message service (SMS), as well as phone banking to check balances and make account inquires by phone.

Thus the cloud computing performance and features have an attractive option to allocate the required resources to implement cloud computing, because the existing core banking solution implemented in many banks in Ethiopia are suitable for integrating the data among them through cloud collaboration or hybrid cloud deployment model (Sardat, 2012).

Similarly the result shows that recently banks and their customers are familiar with the different IT based service provided through ATM, Internet banking, telephone and mobile phone, relatively technical and managerial skills on the use of technological innovation are available. And also this availability of skills and the suitability of the existing core banking solution are considered as favorable input to adopt and implement cloud computing solution for EBIs.

In general, supporting E-banking service such as internet banking, mobile banking and others using cloud computing model achieves greater total cost saving and simplifying the management of IT complexity when compared with the existing IT model to support banking system.

Limitations of ICT Investment and Usage

All Respondents agreed that high investment cost on IT infrastructures, inefficient use of IT resources, lack of collaboration among banks to share IT resources, internet bandwidth inconsistency, the changing computing needs which bear compatibility problems and other related factors were the key challenges in the current ICT usages of Ethiopian Banking Sectors. Lack of up-to-date plan for ICT service delivery strategy also considered as a limitation for banks` to fully harvest the opportunities presented by the latest technology.

The result shows that in regarding to the existing cost incurred on ICT infrastructure to support the non-core and core banking services (different E-banking system like internet/online banking and mobile banking) many respondents did not agreed about its efficiency. The suggestions from all respondents on cloud indicated that, 'compared with the existing IT system to support banking services, using cloud computing in banking industry is efficient to perform banking activities at lower costs. This finding is consistent with the studies of Aarti Singh et al. (2012) which suggested that cloud computing gives adopters two main advantages over: First, it frees them from spending high up-front costs on IT resources that may not be fully utilized in the future, Second, it allows them to face occasional spikes by flexibly adding more resources at whatever time needed.

Respondents agreed on the insufficiency of the current ICT infrastructure investment and usage suggested that banks needed to improve the banking services by employing the state of the art technology being used anywhere in the world. They also suggested that continual improvement and advancement of technology would assist banks` for harvesting the actual and expected benefits from ICT. However, some experts in the banking industry speculate that underdeveloped telecommunications infrastructure may hinder the visibility and practicality of the CORE banking system.

4.1.1.3. External Environment

In principle cloud service is provisioned over the internet to multiple users on as needed and pay as you go model in the world. When we evaluate the external public cloud providers that can provide resource and support to banks in Ethiopia the different prerequisites are under consideration in this study which included: their ability to provide cloud service(IaaS, PaaS and SaaS) required by banks, favorability of their pricing model, the ability to meet high security, trust and privacy measurement standards, the adequacy SLA commitment for banks, availability of alternative cloud providers, availability of data movement from one provider to another provider in terms of time and resource, latency issues, and switching cost.

On the other side the availability of legal frame works, the maturity of national ICT infrastructure, competitive pressure and government support which can affect the adoption of technological innovation in Ethiopian banking industry also analyzed in this study. The result obtained from interview and literatures regarding those issues were presented in the following sections.

i. Legal and Regulatory Framework

National Electronic payments systems, mobile and agent banking system currently covered in Ethiopian legal system, but it is not specifically covered how cloud computing model support E-banking systems. Such legal framework encourages and enhances the introduction of modern electronic payment instrument such as ATMs, credit and debit cards, mobile/telephone/internet banking.

All respondents were agreed that there is no specific legal frame works in Ethiopia to adopt and implement cloud computing. Likewise, respondents were agreed that the differences on banking regulation in different country will have impact on the adoption of new technological innovation such as cloud computing. Similarly, An interview conducted with one of the bank supervision manager at national bank of Ethiopia (NBE) also prove that, Ethiopia does not have special rule on the use of cloud computing or it is not yet included in the banking regulation.

The promotion of cloud computing is an important matter for policymakers and regulators worldwide, since the cloud computing holds out distinct benefits for governments, companies, service providers, industry and research. To enable full enjoyment of these benefits, a coherent regulatory framework guaranteeing transparency, data protection and

respect for data integrity has to be established (ITU, 2012). So the availability of an adequate legal structure and security framework on cloud computing implementation could also encourage the use of cloud computing to support banking services in Ethiopia.

However there is no specific legal framework for the adoption of cloud computing standardized with other countries regulation at central bank. Cross-country legal and regulatory differences will have impact on the adoption of cloud computing in the banking sector that support e-banking services like, ATM, internet banking, mobile banking and Point of sale terminals (POS). These may hinders the use of external cloud service provider for EBIs. Moreover, the result from the interview about legal framework on implementation of cloud computing revealed that lack of legal frame works that meets on cross country legal and regulatory difference is considered as barriers faced by banking industries for the adoption of cloud model to support E-banking system in Ethiopia.

ii. Regulation of Mobile and Agent Banking Services in Ethiopia

Recently the government (NBE) established a clear set of legal framework on the use of technology in banking industry. NBE encourages and enhances banks to focus on technological innovation competition rather than traditional bases of retail bank competition.
The National Bank of Ethiopia is responsible for ensuring that financial institutions are delivering mobile and agent banking services without compromising the safety and soundness of the financial system of the country. Based on this the researchers have been reviewed the Regulation of Mobile and Agent Banking Services (NBE, No. FIS /01/2012)**.**
The use of technology and innovative financial service delivery channels such as mobile devices and agents have significant contribution in deepening financial service accessibility to the wider section of the population at an affordable price. This regulation stated that the use of alternative and innovative financial services delivery channels are essential to encourage and enhance savings mobilization. The minimum standards set by NBE for risk management and customer protection on the delivery of mobile and agent banking services reviewed in this study are:

Modes of Business Conduct

Mobile and agent banking service shall be carried out only within the geographical boundary of Ethiopia and with only Ethiopian Birr within financial institutions that are licensed by the National Bank are allowed to engage in mobile banking services.

Any person who is engaged in valid and lawful business or commercial activity within Ethiopia can be an agent of a financial institution. However, i) a foreign person or entity that is fully or partially owned by foreign nationals ii) religious entity which is faith based and iii) not for profit such as non-government organizations whose applicable law prohibits from engaging in profit making business shall not be an agent of any financial institution.

System Technology

The technology used for delivery of mobile and agent banking services must be secure and should at least ensure the following, which shall be part of the technology risk management program of a financial institution:

User Risk: User awareness on their information security including how to secure Personal Identification Number (PIN) and other security features.

Infrastructure and Software Application Risk: Information security standard, PIN and user authentication, Financial and non-financial data storage, availability of services and backup, Confidentiality of user information, Data and transaction integrity, maintenance of audit trails,, and authorization controls.

Communication Media Risks: Communication protocol risks, Data storage risks, and Availability and quality of service

Agent and Third Party Service Provider Risks: Data Encryption and message integrity, Data storage and backup, Physical and logical access to system, and authenticity and non-reputability of communication

Business Continuity Plan: Availability of services, Disaster recovery site, Standardize way of the data center, Redundancy of network communication, and antivirus protection.

Interface Feature of the Application: The system should be open (need to have a feature of interoperability with other system in any file format.

iii. ICT Infrastructure

Despite the recent improvements made by Ethiopian government on the national infrastructure, the overall ICT infrastructure in Ethiopia created an opportunity for many banks to introduce and expand networked and digitized banking systems rapidly. Card-based payment systems in Ethiopia have been growing fast in recent years. Many banks in Ethiopia

have introduced wider use of debit or ATM cards. The studies of ITU (2012) stated that the level maturity in telecommunication infrastructure is one of the basic elements in the development of cloud computing.

The result shows that ICT infrastructure in Ethiopia for internet access is relatively favorable to use online banking service, which indicated that the current development and improvement strategy of the government for the available and new ICT infrastructure in the country considered as driver to use E-banking system through cloud computing model.

Similarly, an interview result from the CBE E-payment manager indicates that the occasional inconsistency of telecommunication network service is a major obstacle for all banks in Ethiopia to effectively deliver some services such as internet banking, mobile banking and others. However some respondents agreed that the current government effort on improvement of national infrastructure, it will encourage banks to adopt different technological innovation. Therefore, one of the major obstacle factor for adopting external cloud providers resources and support identified in this study is the current maturity level of ICT infrastructure which might create latency problems for transferring data to and from the cloud stakeholder.

iv. Competition

As it is stated in different cloud computing literature, competitive pressure is considered as driver for the adoption of cloud computing in developed country. Respondents from Addis and Enat bank ICT managers were agreed with the idea that the current competitive pressure among newer and old banks in Ethiopian banking sectors is considered as factors for the rapid growth of using innovative technologies. The finding consistent with the studies of Sardat (2012) indicated that cloud computing can help to increase the pace of innovation, specifically for emerging market banks by allocating them to deploy new products quickly and at low cost which allows them to compete more effectively with matured banks whose deployment process in enterprise datacenter can be significantly longer. Thus cloud enables those banks to provide new services and products or to speed the market easily which can be various electronic banking services.

On the other hand an interview conducted with IT managers and experts of NBE confirms that, the central bank enforces and encourages the banks to work collaboratively by integrating their services to improve the speed and efficiency of banking market in Ethiopia.

4.1.2. Strategies for Cloud Computing Development

This section aims to evaluate the essential strategies such as security, legal and architectural requirements for cloud computing deployment and delivery for EBIs. The study of Garg (2011) stated that without a well-defined strategy that supports Cloud Computing capabilities, migrating towards cloud has no sense from the financial point of view because it leads to high costs with reengineering of existent systems.

Cloud-based services can be provided by IT companies which have large datacenters and huge software infrastructures with skilled manpower who can run the datacenter. Such cloud service providers are Amazon, IBM, Google, Azure, and others, which provide various IT services such as IaaS, PaaS and SaaS to consumers (Armbrust, 2012). Virtually customers can deploy and run their data or applications on the providers IT infrastructures without the need to invest on IT infrastructures, pay for that infrastructure they are used. This might reduce infrastructure investment cost and its management complexities to enterprises. However, the result shows that banks would not be willing to put their data/application on the external public clouds because of fear of risks on customer data privacy, security and confidentiality issues that might be brought from using it.

Moreover, the regulations covered in the national payment system and mobile and agent banking services limits the third party IT service provider to those only working in Ethiopia. Since processing financial data abroad the country is a difficult issue because of these regulatory framework and various concerns of security risks brings from using external public cloud service providers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer.

On the other hand the existing maturity level of telecommunication infrastructure in Ethiopia would create latency problems for deploying and running the banking system on the public cloud. Transferring data to and from the cloud has high latency than when transferring data

to and from an in-house datacenter. Respondents agreed that high bandwidth internet is required as a basis for providing cloud computing services. These security, legal, and architectural requirements identified above indicated that developing cloud computing infrastructure with external cloud service providers in case of Ethiopia does not present the success we seek from cloud computing.

Additionally, the respondents were asked to suggest about cloud deployment and service delivery suitable for banks. The objectives of the study and the main concepts of cloud computing were briefly discussed with interviewees before conducting the interview. So many of them were recognized the concept of cloud computing such as its service and deployment and delivery model. Accordingly, respondents suggested that hybrid and private deployment models have better role in the banking markets and the availability of IaaS, PaaS and SaaS in the cloud system are essential to provide and meet any demand levels of IT services for banks. Also many respondents agreed that cloud computing have new technological alternatives to produce, develop and deliver IT services than the current ICT investment and usages in banks. They also saw cloud computing as an easier, faster, cheaper and more flexible way to sell and buy all stacks of IT services. Finally, respondents suggested that before goes to investing in the cloud computing references of banks that have successfully implemented cloud-based solutions and are still operating it could be considered.

Therefore, based on the discussions covered in this chapter about cloud benefits, internal capacity of banks for cloud computing development and external environment the researchers decided to select hybrid delivery model that can be formulated between banks and NBE for provisioning cloud based services.

4.1.3. Outcomes of Cloud Computing Adoption

The findings of the interview indicate that the existing ICT investment and usage in Ethiopia Banking Industries were insufficient. Very high IT investment cost, network and internet bandwidth problem and lack of collaboration between banks were the major challenges.

While improving QoS, facilitating collaboration among competing banks, efficiency of ICT usage, and reducing both capital and operating expenses on ICT investment were the main driving forces to adopt alternative IT solutions. And also the major factors that affect cloud computing adoption in Ethiopian Banking Industries identified in this study were: efficiency of ICT investment and usage, increased collaboration with partners for opening new channels and markets, and reduced organizational burden of installing and managing resources in infrastructure and platforms. While the security issues (such as data privacy, confidentiality and etc.), the evolving financial regulations, and poorly developed telecommunication infrastructure are the main barriers for cloud computing adoption. In the following sub section the finding are discussed in each category.

4.2. Requirements for Cloud Computing Framework

Legal and security frameworks are identified, the decisions of cloud computing deployment and delivery model completed and here the architectural requirements to develop cloud computing frameworks that can be independent from the specific cloud service model (SaaS, PaaS, IaaS) are identified below based on legal, security, and architectural consideration of cloud computing for Ethiopian banking industries. These cloud computing framework requirements can be used as evaluation criteria to the final output (Repschlaeger, Zarnekow, Stefan and Turowski, 2011).

i. Service and Cloud management

This includes aspects necessary for the Cloud management and the maintenance of the relationship between customer and provider. Provider management contains support and contact information of the provider. This criterion considers all facts regarding support and customer service, e.g. which support is offered and under which conditions. Service management includes all activities necessary to control and manage the obtained Cloud services which are subsumed in this criterion, e.g. monitoring of services and volume control via APIs.

ii. Costs

It is characterized through monetary aspects like small capital commitment or low acquisition costs and consists of three requirements: pricing model, payment and service charging. Payment and pricing models are shaped by monetary considerations regarding the decision of EBIs and NBE. The payment opportunities include the possible payment method (e.g. credit

card or bank transfer), the time of payment (pre-paid or post-paid) and which level of granularity is priced (e.g. 1 MB, 100 MB or 1 GB steps). Service charging defines how the service is charged (volume based, time based, account based) and the available booking concept, e.g. pay per use, subscription fee, market based prices (spot pricing).

iii. IT Security and Compliance

It summarizes everything related to protection and safety and is composed of the following requirements: datacenter protection, network protection, operations protection and IT compliance. IT compliance is separated into the proposed provider requirements for privacy (e.g. encryption of data) and compliance (e.g. location of data center). Communication security refers to the provided infrastructure and focuses on the communication protection via secure cryptographic protocols and dedicated firewall settings. Operations protection includes the access management and role concept related to the used services. Furthermore, it can provide a multi-tenancy and firewall protected infrastructure, including virus protection systems.

iv. Reliability and Trustworthiness

It describes how certain the bank can be that the service from the Cloud has the guaranteed availability. The proposed cloud framework includes the requirements: reliability, trustworthiness and service level agreements. Trustworthiness characterizes the proposed cloud provider infrastructure including performance and service transparency (e.g. reports, service description), market experience, the number of customers or the annual revenue. Availability and liability include the probability that service commitments and promises can be met by the provider, based on indicators like the service availability, accessibility to several internet service providers and the liability agreements including penalties if the guaranteed service level is not met.

v. Flexibility

It describes the ability to respond quickly to changing capacity requirements and competition pressure. It included the requirements: interoperability, portability, delivery model, and automatization degree. Provisioning and set-up time are subsumed under the associated flexibility advantage of Cloud Computing. Resources, for instance, can be allocated and de-allocated as required. The provisioning time is shorter compared to traditional outsourcing and the set-up time to get in contact with the provider (e.g. register or set up a new account) is shorter as well. Interoperability and scalability comprise all features regarding the maximal

number of available resources (e.g. user accounts, instances, functions, services) which can be used simultaneously. Additionally the interoperability describes the integration between services of banks and the provider. The browser compatibility is important especially on the SaaS level, whereas the development environment is of high relevance on the PaaS level. Contract flexibility and renewal of contract both represent the commitment between the bank and the provider and defined contract automatisms based on the directives of NBE.

vi. Scope and Performance

It covers the functionality and performance of the Cloud service and the requirements consists of service characteristics, service optimizing, hardware, and performance. Usability and customizability refer to the usability and adaptability of the surface of the web portal, the user interacts with. The Usability mainly represents the structure and the ease of use following the self-service concept. Regarding individual preferences predefined templates, editable user views and function settings can be configured by the user. Add-on services describe additionally bookable services like storage, database services, communication services (e.g. collaboration, messaging) or security services.

Chapter Five

Cloud- Based Service for EBIs

5.1. Backgrounds of the Framework

5.1.1. Identifying Cloud Services and Deployment Models

For identifying the required cloud computing solutions that can be provided to EBIs`, the researcher started by analyzing the requirements of bank by means of interview and looking at other financial institutions best cloud service experience and best practice. The analysis

process was based on interviewing Information System directors from selected banks, reviewing best cloud service experience and practices of business companies and financial institution around the world as described in chapter four. Following the results of the analysis the researcher identifies the potential cloud services such as IaaS, PaaS and SaaS, while hybrid cloud delivery/deployment model are proposed for EBIs. The proposed cloud types and deployment model that could best meets banks functional, service, security, and regulatory requirements are discussed in the next sub sections.

5.1.1.1. Hybrid Delivery Model for Ethiopian Banking Industries

Several cloud deployment models are now available to banks and other financial services firms, including (Ryan, 2012): Firstly, the public cloud infrastructure, which is made available to the general public or a large industry group and is owned by an organization providing cloud services.Secondly, the private cloud infrastructure, which is operated and managed solely for an organization or it may be managed by a third party and mayexist on premises or off premises. Thirdly, a hybrid cloud is a composition of two or more cloud environments, in which an organization provides and manages some resources in-house and has others provided externally through a public or community cloud.

By considering the knowledge derived from the literatures and the banks intention from the interview result the researcher decided to propose a hybrid cloud delivery model for EBIs. The researcher also decided to form Ethiopian-based cloud service provider to formulate a secured cloud environment for hybrid cloud model. The formulation of a hybrid model, then, is based on a range of variables, including security and data concerns; the evolving financial services regulatory environment; and a specific institution’s application and infrastructure requirements (Ryan, 2012).

The proposed hybrid cloud model will have a capabilities to combine cloud and non- cloud IT infrastructures such as private, shared, and traditional IT with in banks, in which banks provides and manages some resources in-house and has others provided externally through a local cloud service provider in security rich environments.

The proposed hybrid delivery approach allows banks to accelerate speed-to-market by better aligning IT and the business itself. This strategy instills greater agility, which enables banks to better respond to new opportunities and competitive challenges. By integrating traditional IT and private cloud-based services with the new local cloud service provider, this hybrid

approach protects current investments in EBIs. By leveraging flexible sourcing and usage-based pricing, it can help to reduce both capital and operating expenses of banks. This hybrid cloud formulation will fortify vital risk and security management that were considered as the major barrios on cloud computing adoption from using external public cloud service provider in EBIs. Thus, it will mitigate the major barriers raised on cloud computing adoption in Ethiopian Banking Industries.

5.1.1.2. Identifying the Type of Cloud-Based Services

The cloud-based services were selected and identified by considering the needs of their uses on the cloud environment for EBIs. The following sections discuss the three types of cloud services.

Software as a Service (SaaS)

SaaS is one of the service deployment mechanisms which enable user's access different software from the cloud wherever they are, and whenever they need without installing it on their machine (Sewale, 2012). In SaaS users can access different software from the cloudIn SaaS users can access different software from the cloud: CRM, Email, Virtual Desktop, Office applications, Simulation software, Enterprise Resource Planning and different Business Information system applications, like core banking systems, finance systems, HRM system.

Platform as a Service (PaaS)

Platform as a Service delivers a solution stack, which is an integrated set of software that provides everything a developer needs to build an application for both software development and runtime (Bhattachariee, 2009).. The proposed hybrid cloud will offer developer tools as a service to build services, or data access and database services, or billing services on the cloud. The developers who seek to develop and run a cloud application for a particular platform can access these services using the interface presented to them. The developer interacts only with the platform through the proposed hybrid cloud interface, and the platform does what is necessary to manage and scale it to provide a given level of service. Using the cloud, developers do not need to physically install any specific services, solution stacks or databases on their machine. According to Raoj& Reddy (2011) PaaS provides the images to users where they can simply select these images and use them on a machine provided in a

cloud. The hybrid cloud provides the following services for PaaS users: solution stacks (Java, PHP and .NET), and Storages (database and file storage).

Infrastructure as a Service (IaaS)

IaaS is another mechanism to deliver computer hardware such as servers, networks, datacenter space and others, which allows cloud users to host/run their data/applications on the provider computing infrastructure (Esteves, 2011).. The proposed hybrid cloud delivers these infrastructures using virtualization or multi-tenancy architecture at one place to all distributed banks. Under this cloud service model, the provider manages and maintains the hosting and the development environments. By consuming IaaS cloud banks canreduce infrastructure cost and complexity through its capabilities of rapid provisioning, ability to scale up/down and pay only for what you use. The hybrid cloud provides the following services for IaaS users: physical machine, Virtual machine, OS-level virtualization, storage, network and etc.

5.1.2. The Proposed EBIs Cloud Services Provider

Analyzing the potential benefits and risks on cloud computing adoption for EBIs was one of the objectives of this study. These could be considered as a significant starting point for cloud system development effort. Thus this study presents the potential benefits and risks that could be brought from cloud computing adoption. The major factors that affect cloud computing adoption in Ethiopian Banking Industries identified in this study were: efficiency of ICT investment and usage, increased collaboration with partners for opening new channels and markets, and reduced organizational burden of installing and managing resources in infrastructure and platforms. While the security issues (such as data privacy, confidentiality and etc.), the evolving financial regulations, and poorly developed telecommunication infrastructure are the main barriers for cloud computing adoption.

Regulatory risk or the need to secure and protect customer data is a primary concern when evaluating and choosing any cloud-based solution. Ryan (2012) suggested that to select the best cloud model, banks need to consider several issues such as: assess the critical need for security, privacy, and control in a cloud environment, and evaluate the potential cloud solutions based on value, competencies, and risks to decide on building in-house or consuming an external cloud service. This implies that the choose of an appropriate cloud-based solution depends on: security and data concerns; the evolving financial services regulatory environment; and a specific bank's application and infrastructure requirements.

The interview results indicate that Ethiopian banking industries are working in a very highly restricted regulatory policy. Processing financial data abroad the country is a difficult issue because of these regulatory risks and security concerns brings from using external public cloud service providers. Banks also would not be willing to locate their data on external public cloud. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer. Thus the need to find an alternative local cloud service provider that could provide cloud-based solutions for EBIs than external cloud service providers were mandatory.

Through taking in to account the above issues we are discussed the researcher decided to propose Ethiopian-based cloud service provider that can provide the identified cloud services by deploying hybrid cloud model for EBIs. The proposed local cloud service provider will be formed and equipped with essential cloud technology infrastructure that can be provisioned as a service to banks based on their specific application/infrastructure requirements using cloud computing business model. This cloud provider will provide scalable, elastic and reliable resources to the users.

The cloud-based services offered by the proposed cloud service providers could be: (1) IaaS which deliver infrastructure resources includes servers, storage, operating systems, and networking. (2) SaaS which deliver domain-specific applications or services over the Internet including collaboration and communication tools, CRM, Office applications, and different Business Information system applications (like core banking systems, finance systems, HRM system). (3) PaaS which offer developer tools as a service to build services, or data access and database services including: solution stacks (Java, PHP and .NET), and Storages (database and file storage).

□□□□□□□□□

Therefore, the proposed hybrid cloud model allows users to run the different workloads on the local cloud service provider infrastructure or platform services. These potential workloads that could run on that infrastructure/platform services to extend the performance of internal infrastructure/platform services are: development and test, storage, collaboration, desktop,

Webmail, self-service application development environments, ERP and virtualization (Gulla, 2013). Additionally, users will consume the local provider platform services such as: database as a service, middleware as a service, software as a service and software lifecycle as a service.

5.2. Building the Framework

The existing Information communication technology investment and usages in Ethiopia Banking Industry were described as insufficient based on the interview results and the ICT usage practices of other banking industries in the developed world reviewed in this study. Bank is a financial institution and a financial intermediary that accepts deposits and channels those deposits into payment activities, either by loaning to others or withdrawing to depositors. Building an efficient ICT investment and usage strategy to support these activities by leveraging EBIs from recent technological model i.e. cloud computing IT model for ensuring QoS was the main intention of this study.Using this model all channels of EBIs are interconnected with each other virtually and customers can access various banking services from any channels available anywhere through cloud interface. These virtual banking Services helps to solve limitations of the current ICT usage in EBIs. The following figure shows a high level cloud-based service delivery architecture for the proposed Ethiopian Banking Industries Cloud system based on cloud computing model with cloud interface layer to facilitate the interactions among banks from the provider and the cloud service partners to all banks.

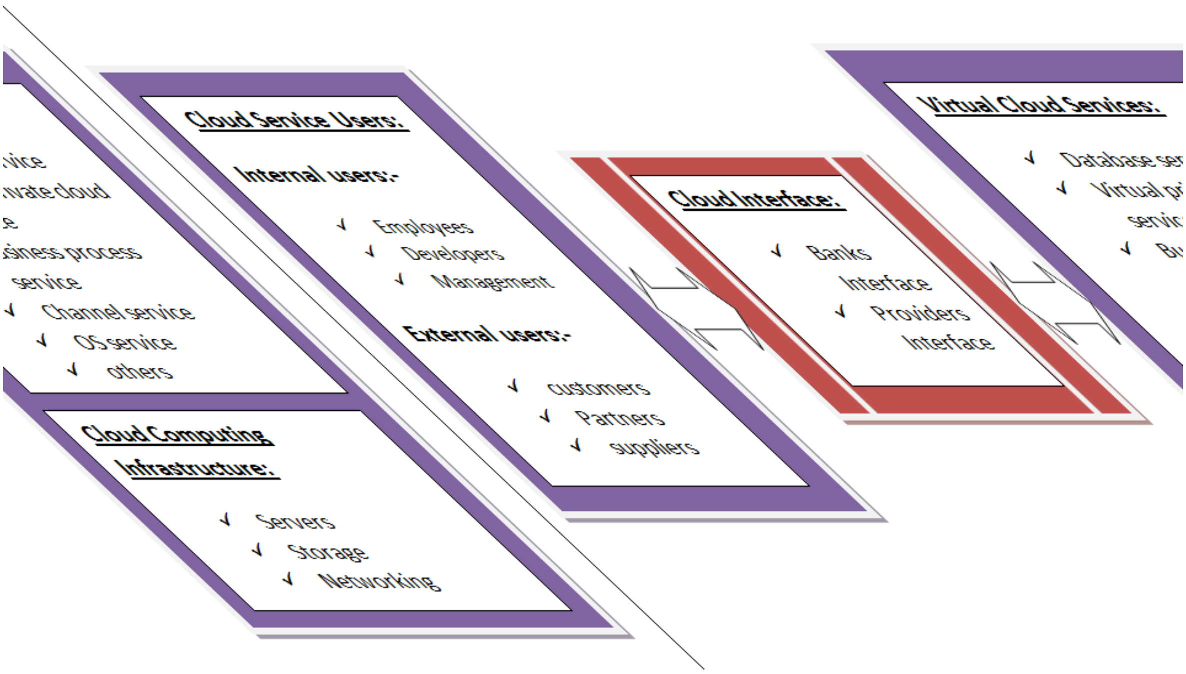
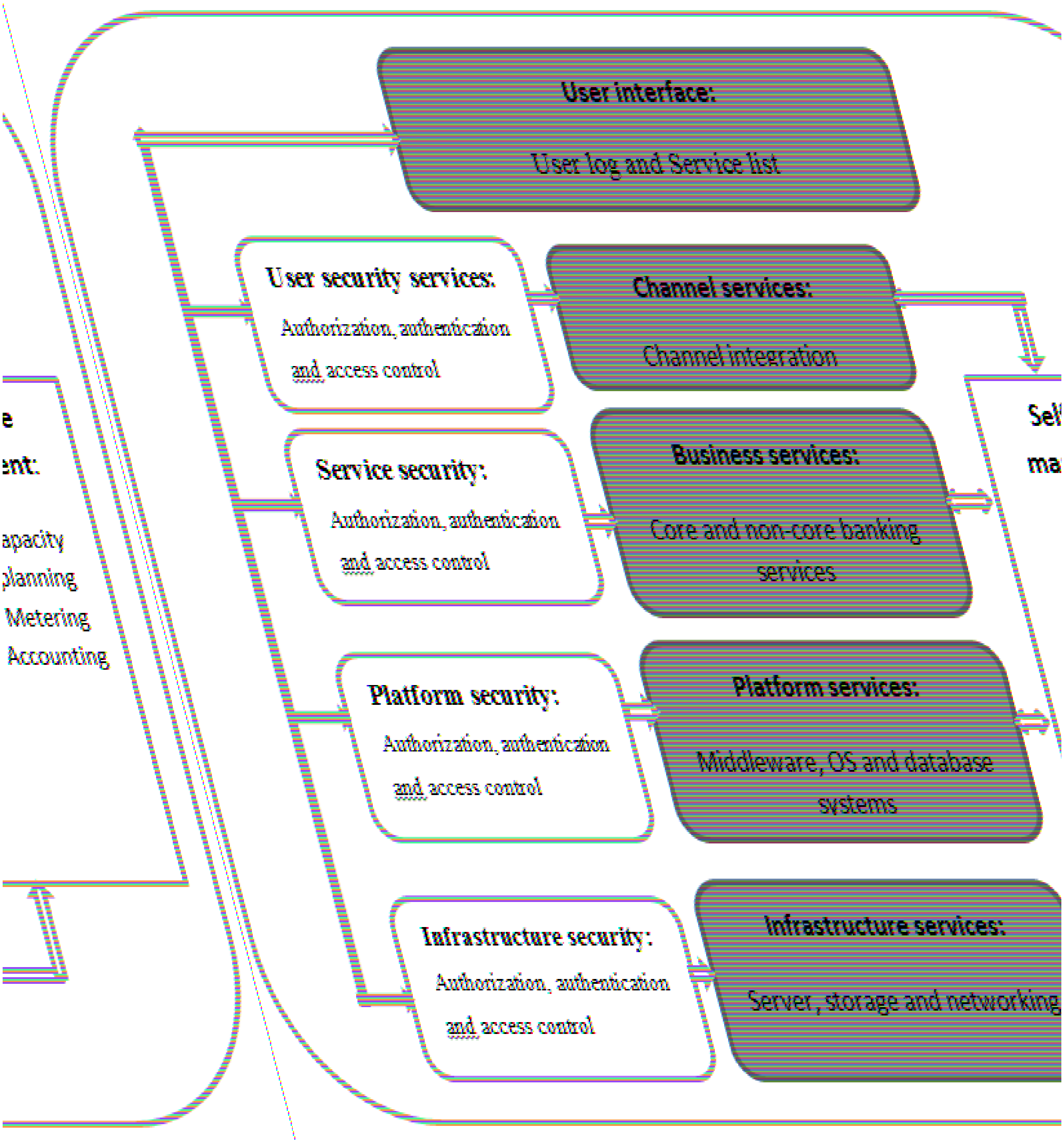


Figure 4.1: High level cloud based service delivery architecture

Virtually the cloud services can be deployed and run on the proposed service provider physical IT infrastructures. Users of cloud services are employees, customers, joint ventures/partners, and others users of the bank. EBIHC have an interface for both banks private cloud and the local service provider cloud. Users can store their data and access virtual machine instances (software containers) on cloud computing infrastructure easily. Users can create virtual machine image, launch the required services and terminate the virtual machines through cloud interface. In cloud, computing resources will not exit but functions by creating virtual version of an IT resource such as OS, a server, Storage Device and Network Resource on rent base when needed (Ryan, 2012)..

Based on the identified cloud services and the selected Cloud model discussed in the framework background, the researchers proposed a collaborative cloud computing architectural framework for EBIs. The following figure shows the proposed Ethiopian Banking Industry Cloud framework.



User interface:
User log and Service list
User security services:
Authorization, authentication and access control
Channel services:
Channel integration
Service security:
Authorization, authentication and access control
Business services:
Core and non-core banking services
Platform security:
Authorization, authentication and access control
Platform services:
Middleware, OS and database systems
Infrastructure security:
Authorization, authentication and access control
Infrastructure services:
Server, storage and networking
apacity
planning
Metering
Accounting

Figure 4.2: A collaborative cloud computing architectural framework for EBI

The proposed framework illustrated in the above figure contains five cloud service layers (interface, channel service, Business service, platform service and Infrastructure service). The following sections discuss the five service layers of the proposed framework.

5.2.1. Interface layer

This layer acts as an interface between the user and the Cloud content. Access to each cloud services are protected by the proposed security framework. This allows users to access the cloud services in a security rich environment. The User Interface layer contains two important components. The first one is user log which provides an access path to specific cloud services, and the second is a service list which provides the list of the available services on the cloud environment.

5.2.2. Channel Services Layer

The services offered in this layer are channel integration toward a single architecture that supports all channels (ATM, branch, call center, mail, mobile, online, telephone, video, etc.), for delivering a consistent customer experience, common banking services, and information across all channels. The proposed framework provides a user security services to protect unauthorized access from unwanted users. Using this service EBIs can share their channels to provide common banking services collaboratively.

5.2.3. Business Services Layer

The business Services offered in this layer includes core bank services (corporate and retail banking, wealth management, treasury management, risk management and compliance, trading, etc.), as well as noncore services as a hosted application on the cloud environment. Banks may build, operate and manage their core banking services internally, while they can consume other business services offered by the proposed local service provider based on their needs.

5.2.4. Platforms Service Layer

This layer provides access to application hosting and development environments including middleware technology, operating systems, programing languages, database systems and other platform services on a security rich cloud environment. Users are able to build more sophisticated systems and distributed DBs using this application hosting and development environments.

5.3.5. Infrastructure Service Layer

This layer offers infrastructure services including servers, storage, and networking on the cloud environment. The users can consume the services virtually without buying managing it from the proposed EBIs infrastructure service providers. Customer can use these computing resources to run software (both operating systems and applications) and to store data. This layer is often called IaaS.

Additionally, the proposed framework includes security modules and self-service management module. The framework has the security services in each cloud services. First, user Security Services which is included in the framework to control unauthorized access from channels. Second, service security which allows to protects the business services or application from unwanted users. Third, Platform Security services which allows the hosted application/business process run on the platform securely. Fourth, the security module also includes the infrastructure securities that are the building blocks for delivering any cloud based services securely.

The real-time system performance information can be monitored on self-service management module. The local CSPs can measure performance and availability of the overall cloud system. The monitoring service can also be used by users to measure the performance of provisioned virtual machines, and to determine whether new virtual machines need to be started. In a cloud system, everything is metered and accounted. Metered usage information provides for flexible pricing and charging in cloud environment. Historic usage information together with monitoring information is critical to automate capacity planning and ensured agreed QoS.

□□□□□□

5.3. Implementation Plan for the Proposed Framework

The proposed framework`s i.e. EBIHC which are described in the previous sections are promising for efficient utilization of ICT investment and usage of EBIs. In such a situation, the framework needs an implementation plan to deploy cloud-based solution for EBIs. The hybrid Cloud model, which combines the internal IT infrastructure with the proposed local Cloud service provider, was proposed. The next figure shows the general layouts of the hybrid Cloud computing model proposed for Ethiopian Banking Industries.

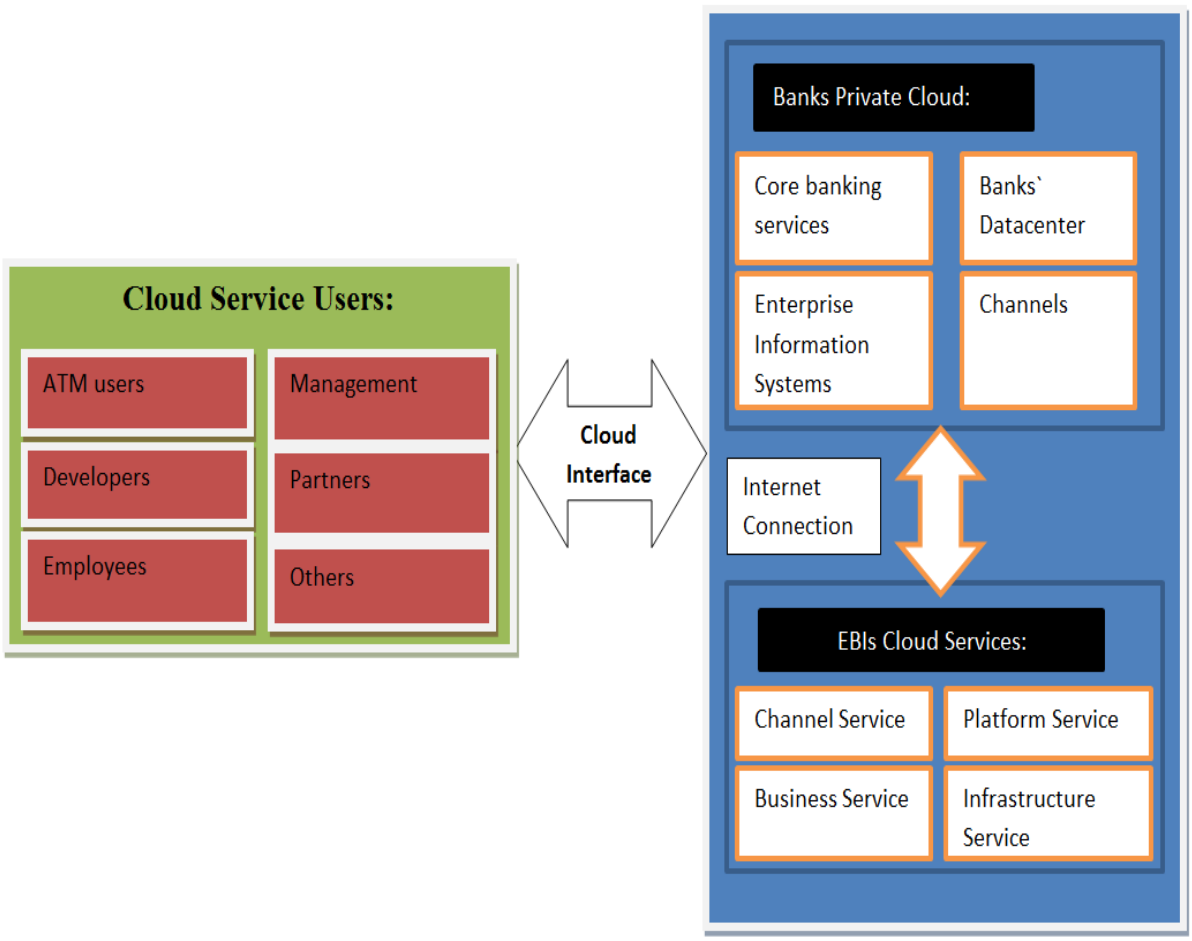


Figure 4.3: The general layouts of a hybrid Cloud for Ethiopian Banking Industries

The figure above shows the general layouts how the user can use computing resource using the central hybrid cloud from providers. The proposed hybrid cloud model could have an interface for both the private cloud and the EBIs cloud. Using this interface cloud users and provider could operate on the hybrid cloud environment. Banks private cloud and EBIs cloud would be combined using internet connection. The cloud service users might be banking service users or cloud administrators.

The following steps illustrate the mechanisms for operating in the cloud environment:

1. The user submits a service request using the EBIHC interface on their devices such as ATMs`, mobile, workstations and etc.
2. The user request would be checked to verify authorization of access to the requested services.
3. If the user is unauthorized to access the requested services, the system will reject the user's request or the request will be sent to the virtual infrastructure manager to redirect the request to the appropriate location.
4. If the user is authorized (users information is available in cloud datacenter) to access the requested service, the system will establish a connection between the requested service from the cloud (EBIs or private) and the user.
5. When the user accomplish their tasks/accessed the required service from the cloud they can terminate the application they was used. The system also terminate the application/services if the users don`t access the services on the time limited to access that service, and the user can submit the request again to the cloud.

To operate in the cloud efficiently each cloud services should be protected on the security framework. As we have seen in the above step accessing any cloud services on the virtual cloud environment is secured.

Developing hybrid cloud model needs to made changes on the existing IT infrastructure for efficient hybrid cloud delivery strategy. So Banks need to standardize their enterprise level IT infrastructures through the proposed EBIs cloud for easy integration of their IT infrastructure

to the cloud. Then they can extend the performance their enterprise level IT infrastructure using EBIs cloud computing environments when computing needs are increased and internal infrastructures are incapable to provide the computing requirements. These will utilize the current Ethiopian Banking Industries IT investment and usage. After a standardized private cloud is established using the proposed EBIs cloud, the cloud provided a manageable hybrid Cloud for the banks. Thus, banks will increase their IT infrastructure efficiency by extending their datacenter and computing power using provider infrastructure without buying additional computing resources when the changing storage and high performance computing power need increased. The proposed hybrid Cloud architecture formulates through combining the proposed EBIs and banks internal IT infrastructure/private cloud using internet connection. The several elements included to formulate a hybrid cloud for delivering the requested service are illustrated in the following figure. The following figure illustrates the proposed EBIHC hybrid Cloud implementation architecture:

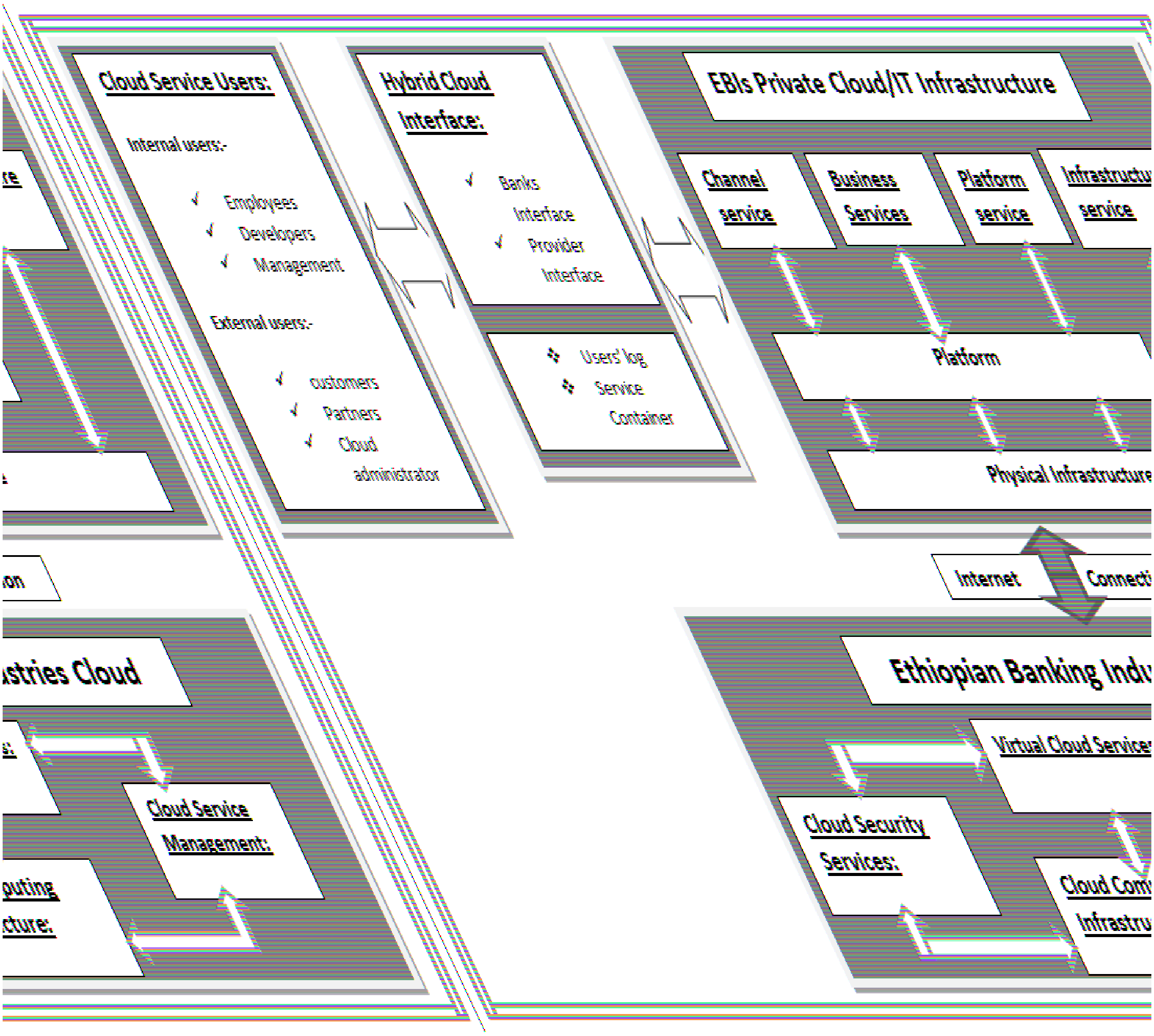


Figure 4.4: The proposed Hybrid Cloud Implementation Architecture for EBIs

There are four elements included in the hybrid cloud implementation architecture such as: cloud users, user interface, internal IT infrastructure/private cloud and the proposed EBIs cloud with their respected cloud services. First, the user interface element contains two services to manage the cloud user's access privileges control and business service delivery. Next, the internal IT infrastructure/private clouds of banks contain four services that can provide all IT services to deploy and use banking services. Finally, proposed EBIs cloud contains four services such as: virtual cloud services, infrastructure services, security services and self-service management that could offer as a service to banks on demand. The following list discusses the proposed hybrid cloud arrangements:

Cloud users: cloud users might be identified as business service users, channel services users, platform users or infrastructure users. Channel service users are customers, partners, employees and others, those who will access the hosted banking services through channels. The proposed hybrid delivery model supports all channels using a single architecture for integrating them. Then banks business services might be hosted on their internal datacenter or on the provider datacenter to be accessible for authorized users through integrated channels. Platform users are mainly developers who will develop applications using cloud development platform environments. Platform service provider offer different platforms to developers on demand. The physical infrastructures of the banks` will be virtualized using virtual private cloud services or internet connection by developers.

User interface: The users' access mode is identified in this element. The system administrator/cloud coordinator will create users type and access privileges. The created users might be customers, employees, administrators, managements and others and their access privileges are determined based on their priority to access the system. User logs are one of the security services included in the interface, which is important for controlling and checking the authorizations of users to access the services. This is mainly responsible for checking the track of the authorizations users and its access mode which is selected for them. Users' information such as access modes, user passbook account, card password, providers` account, user type, and so on are verified using the information stored about the user for access permission in the cloud datacenter. Additionally different business services are listed on the cloud container with specific details about business services to users on the interface. Such business services might be core banking services and other enterprise information

systems. So the authorized users who are verified by the cloud security services can access the services they required using these secure interface service.

The internal IT infrastructure/private clouds: contains four services that can provide all IT services to deploy and use banking services.Banks` private Cloud would be built on the available infrastructure and standardized by the proposed EBIs cloud facilities. Then the physical infrastructures of the banks` will be virtualized using internet connection. An infrastructure service provides IT resource from the Infrastructure resources to the infrastructure service users. The private cloud also contains the platform services which will work and manage the platforms to enable development and deployment of applications and programs with the abilities to access proposed cloud resources and platforms. The platform services provide platforms from the platform container to the platform service users. These infrastructure and platform resources would be offered from the private cloud or provider cloud.

Platforms would be connected to the service container to integrate the platform services with different business services. Then the business service provides access to platforms, so users can use one of the deployed/hosted applications on the platform through platform services. Additionally, Platforms would be connected to all channels to integrate the platform services with channel services. So channel users can access the hosted banking services on the platform.

The proposed EBIs cloud: To build the proposed EBIs cloud large datacenter, large scale software infrastructure and technical manpower to run these datacenter would be required. After having the required infrastructure EBIs cloud provides virtual cloud services on the top of its physical IT infrastructure for banks in Ethiopia. EBIs platform services would allow scalable deployment of applications by providing a web service through which a user can boot virtual machine image to create a virtual machine or an instance containing any cloud services desired. The virtual cloud services offered by EBIs cloud are database services, virtual private cloud services, business services, channel services, operating system services, compute and storage services, and others. The sample virtual cloud services offered by EBIs cloud were presented below.

Storage services: EBIs cloud provides online storage services using a web interface. Customers can access raw computing power from virtual servers or virtual machine instances. And also banks can store and access their data on EBIs cloud storage spaces on-demand. Various information or data would be deployed, stored and accessed by users.

Operating system services: The proposed EBIs cloud will offers a variety of operating systems in image form; the cloud users can operate and perform multiple tasks on the available operating system images. This will facilitate the users to operate their tasks in different operating systems according to their task requirements and compatibility.

Database services: Under cloud-based database service, users can run databases on a cloud computing platform independently, using a virtual machine image, or they can purchase access to a database service, maintained by a cloud database service provider i.e. EBIs cloud. In these cloud environment database developers can create relational databases; link different databases from diverse locations implement and maintain relational databases, and retrieve information using different database languages like, Oracle application or Structured Query Language (SQL) with PHP to connect the databases in the Internet.

Networking services: User can create and launch EBIs cloud resources using a virtual network. By using this virtual networking environment, customers will select their own IP address range, create subnets, configure route tables and network gateways.

Additionally, the proposed EBIs cloud also contains self-service interfaces for on-demand provisioning and management (i.e. start, stop, reboot, and destroy) of virtual services, and self-management interfaces for auto-scaling and other automatable management facilities.

5.4. Evaluation of the Framework

i. Data Privacy, Security and Regulations

Many respondents from the selected banks appreciate the relevance of the proposed cloud solutions. Data privacy and security regulations in many countries including Ethiopia prohibit the storage and processing of customer data outside national borders.Banks are also wary of the potentially disastrous impact of a serious breach of security or privacy, or of even a brief outage in areas such as ATM operations, fraud monitoring or credit card processing. To comply with the rules which prohibit customer data to be passed beyond national borders and the fear of risks banks wary, the options of local cloud service provider considered in this study have positive feedback from respondents.

Interoperability and scalability comprise all features regarding the maximal number of available resources which can be used simultaneously from the cloud system. This capability of the system allows easy data and service integration between banks and provider. In the proposed framework all banks IT infrastructures can be virtualized using internet connection, then using the platform data and applications integrated and made available to end users. In this situation,Platform and infrastructure security focuses on the communication protection via secure cryptographic protocols and dedicated firewall settings. While channel and business protection includes the access management and role concept related to the used services.

The proposed framework supports the data privacy requirements of the banks through the technics of data encryption and they know the physical location of the datacenter. The use of well-understood technologies such as data encryption, the network middle ware manager,which are included in the proposed framework, couldeasily make data in the cloud as secure as that banksdatacenter. This meets the concern of security raised by banks whether the cloud environment can be made as secure as that for most in-house IT environment.

The proposed cloud computing framework security posture is characterized by the effectiveness, and completeness of the risk-adjusted security controls implemented. These controls are adjusted in all layers of the proposed framework ranging from channel (channel security), to business (application security), platform (platform security), and infrastructure (infrastructure security). Additionally controls are adjusted at the people and process levels, such as separation of duties and change management, respectively. These characteristics of the framework facilitate secure cloud deployment and delivery systems for Ethiopian banking industries.

ii. Business Impacts

The cloud computing system being developed for all banks in this study were designed to support a secure electronic services sharing between customers, banks and cloud services providers, facilitating smooth collaboration and integration.

The use of cloud system minimizes the risks inherent in purchasing physical IT infrastructures. When pushing an application out to the cloud, scalability and the risks of purchasing too much or too little IT infrastructure becomes the cloud providers' issues. In a growing number of cases, the cloud provider has such a massive amount of infrastructures that it can be absorb the growth and workload spikes of banks, reducing the financial risks they face.

These capabilities of cloud computing helps banks to reduce the cost to enter new market, because infrastructure is rented, not purchased, the cost is controlled, and the capital investment can be zero. Also applications are developed more by assembly than programing. Moreover, cloud computing can help to increase the pace of innovation, specifically for emerging market banks by allocating them to deploy new products quickly and at low cost which allows them to compete more effectively with matured banks whose deployment process in enterprise datacenter can be significantly longer. Thus cloud enables those banks to provide new services and products or to speed the market easily which can be various electronic banking services.

Cloud computing improves easy collaboration between banks in which customers of the collaborated bank` can interact with the shared system in a more engaging way than before. Customers' ability to access the banking services are improved, they can access the banking services anywhere and anytime from any channels of banks in Ethiopia and with their available devices. Thus customers can easily access the banking services based on their experience, digitally or manually from the branch offices or automated devices, simultaneously banks will reduce duplicated investments and freeing them from routine transaction.

Example: if we consider the concepts ofsynergy to enable effective collaboration and speed to market, banks can improve the operational efficiency or greater total cost saving for production of banking services and speed to market or expanding the geographical coverage easily.

Providing electronic banking services within a single bank infrastructure is not more efficient than providing it within a total network of the whole bank infrastructures. Assume that the total network of digital banking channels (i.e. ATM, POS) for production of banking services within individual banks such as: CBE, Dashien Bank, Addis International Bank, Enat Bank,

70, 40, 15, and 10 respectively. Then providing the banking services using 135 total networks of ATMs and POS of the whole banks distributed in different geographical area are more efficient than using a total network of ATMs and POS within such individual bank infrastructure.

In summary, the above evaluations criteriadiscussed related to the performances of protection and safety of the proposed cloud computing framework which included: channel service protection, business service protection, platform protection and infrastructure protection, while the outcomes of cloud computing for business efficiency brought positive feedbacks from the respondents.

Chapter Six

Conclusion and Recommendation

6.1. Conclusion

The development of fundamental techniques that integrate Ethiopian Banking Industries existing IT infrastructure with the proposed EBIs clouds in a collaborative fashion would be critical to enable composition and deployment of elastic application services for banks. That was the main aim of this research work. For developing cloud-based services framework`s for Ethiopian Banking Industries the study started by understanding the banks requirements

through interview, cloud service models and cloud-based service delivery alternatives, and evolutionary options of today's maturing cloud solutions. And also the study discusses the potential benefits and limitations of cloud computing to banking sectors, and the cloud adoption strategy suitable to banks.

The study indicates that processing financial data abroad the country were theproblematic issue because of the evolving financial regulatory and security concerns brings from using external public cloud service providers. The fact that customer records and information must be secure and confidential, therefore, banks need to protect their customers' records against any anticipated threats or hazards as well as unauthorized access that could cause substantial harm or inconvenience to the affected customer. Due to this consideration researchers decided to proposed Ethiopian-based cloud service provider to formulate a secured cloud environment for banks.

The research shows that hybrid cloud computing modelwould be the main form of cloud adoption forEthiopian Banking Sectors. The proposed hybrid cloud provides a benefit for blending banks IT infrastructure with the proposed EBIs cloud depending on the sensitivity of banks data and applications in each process, and the degree of business criticality and differentiation.By integrating traditional IT and private cloud-based services with the new local cloud service provider, this hybrid approach protects current investments in EBIs.

The resulting framework facilitates collaboration between banks, quality of services and assist new comers in to the market. The different components of the proposed framework offer powerful capabilities to address both services and resources management. This will provide enhanced degrees of scalability, flexibility, and simplicity for management and delivery of services in the clouds. Thus the proposed framework in this study used as a blue print for implementing actual cloud-based services in EBI that can ensure secure services collaboration among banks and cloud service providers.

6.2. Recommendation

Although the results of this study are promising, further work needs to be done in order to realize the proposed framework to Ethiopian Banking Industries. The proposed framework should be implemented on the selected business process and tested with iterative feedback

reflection from the users so that the proposed framework will be modified based on the feedback before the framework`s full implementation in all banks business process.

Cloud computing literature is still in its infancy. The scope of current literature is fairly narrow and thereby future research should consider cloud computing from less charted and novel perspectives. As this study revealed, cloud computing paradigm has still many aspects that should be understood better before it can evolve to the mainstream of enterprise IT. Some suggestions and future research directions are presented next.

- ✓ Developing framework`s for banks on enhancing the security architecture of virtual data centers in Cloud Environment. Researchers might focus on providing security in cloud that protects the data in the Cloud Environment.
- ✓ Future studies can carry out on exploring business models of cloud computing services. Researchers will assess the different cloud business models and their differences according to business model ontology. In particular, it should be analyzed what different capabilities different business models require from the services provider.
- ✓ Exploring the changes in risk sharing model between services provider and banks`/other customer that cloud computing paradigm necessarily inflicts. The implications of changing customer on pricing should be carefully reviewed in order to ensure cloud computing's viability from services provider viewpoint.
- ✓ Exploring the critical issues in selecting cloud service providers, cloud-based service delivery model, and cloud computing deployment model (Private & hybrid). In particular, it should be analyzed by describing the strength and weakness from service provider to cloud-based service delivery and deployment model for financial institutions.

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Appendix

Interview Questions:

1) What are the ICT services and supports that are provided for internal and external users of the bank by your office?

A. For internal users, employees and management staff?

B. For external users, customers, partners and suppliers?

2) Do you think these services are enough to achieve your mission and vision, in improving quality service to customers, reducing cost and IT complexity, optimizing ICT usage efficiently, dynamic scalability of resources, increasing competitive advantage and modernizing your company?

3) What are the limitations in providing an efficient ICT services?

4) What are the feedbacks of the users about your ICT service? Positive and negative

5) What is the yearly budget for the ICT department of the bank?

6) Does your bank have an ICT policy based on country ICT policy and legal framework for new technology adoption? Do you know them?

6) What is your suggestion in formulating a new paradigm for providing ICT services and supports in the bank? And if possible suggest your own solution from the current technology trends?

7) As an ICT manager, what do you think is best strategy to provide ICT services for Banks to support with the current economic, business and legal context of Ethiopia?

8)If an integrated cloud computing infrastructure is to be built in EBI that could be used by all banks in Ethiopia to provide ICT services, what will be your reaction to this strategy, what kind of services do you think your bank will benefit from the cloud-based technology?

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