

A Major Project Report
on
**Analysis of Cloud Computing Implementation Issues and
Benefits in Banking & Financial Services Sector**

Submitted for the Award of the Degree
of
Master of Business Administration (Executive)

by
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Semester - IV
2K13 / MBA / 509

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Certificate

This is to certify that **Lalit Taneja** (Roll No.: **2K13 / MBA / 509**) completed this project titled “**Analysis of Cloud Computing Implementation Issues and Benefits in Banking & Financial Services Sector**”, as part of his Master of Business Administration (Executive) Programme, under my supervision.

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Declaration

I, **Lalit Taneja** (Roll No.: **2K13 / MBA / 509**), student of Delhi School of Management, hereby declare that I have pursued the project titled “**Analysis of Cloud Computing Implementation Issues and Benefits in Banking & Financial Services Sector**” under the supervision of **Prof. P. K. Suri, Head of Department, Delhi School of Management**. I also declare that this work has not been submitted to this or any other organization / institute as part of any project work to the best of my knowledge.

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Executive Summary

Technology is always considered to be a disruptive force behind the discontinuities and the changing business models and ecosystems across industries. Ironically, it has sometimes taken unwarranted advantages for some enterprises which is evident all throughout history from the stone era, to the industrial revolution, to the silicon era, to the internet / dot com era and to the current mobile cum digital era. Technology has transformed the entire world into a virtual space, enabling incessant cycle of innovation.

Cloud computing happened to be a fastest emerging technology, which is a combination of technologies and is driven by the needs of the enterprises to deal with change in their markets and their financial circumstances. It is a “pay-per-use” or “pay-as-you-go” model that enables an effortless and demand based access to a common pool of computing resources viz. network, bandwidth, servers, storage, applications etc. This also helps the organizations in avoiding the large investments up-front and then hoping the investment pays off with the passage of time, which is quite uncertain. The resources on cloud could be swiftly provisioned and released back with least effort from management and minimal interaction with cloud infrastructure provider. The cloud computing services are delivered from a remote location through a network, usually the Internet.

Cloud computing today encompasses every vertical in the market across sectors. Organizations are adopting innovative cloud apps to support their day-to-day business operations. To impel growth and innovation in the banking industry, it has become increasingly essential for the banking organizations to radically compete using IT and transform their existing model of business. The radical changes that are taking place in the banking industry are enforcing the organizations to find new and innovative ideas for maximizing profitability and returns.

In a fast growing and changing global marketplace today, being swift in this digital world is an integral element for any organization to stay aggressive and competitive in its market niche. Providing service to the digital world requires scalable system access at all times. Banking organizations are spending majority of their IT budget on maintaining their legacy systems that have been developed and used since many decades, thus transformation to a digital venture appearing as an intimidating mission.

Cloud computing has evolved over many years resulting in reduction of implementation costs and improvement in agility for the businesses. The technologies are now prepared to empower the enterprise digital transformation that powered the consumer digital transformation earlier.

Banks are stepping in the cloud computing domain very vigilantly, there being no solitary delivery model of cloud services considered as the best in addressing their demanding and growing business needs. Cloud computing tenders number of advantages to the financial institutions, which include but are not limited to:

- Reduced Costs
- Billing based on usage
- Business agility
- Business continuity
- Enhanced offerings
- Quick response
- Customer satisfaction

Banks that are adopting the path of cloud computing are supposed to be positioned well in responding to economic uncertainties and ever demanding customer needs. Though cloud computing is bringing lots of opportunities for the banking organizations, there still have certain issues that should be addressed before migrating to cloud. Banks must have to identify the issues that could be regarding the efforts required in migration, data privacy and security, following regulatory compliance and standards, and the quality of services offered.

This project will analyze the implementation issues and benefits of migration to cloud in the banking and financial services sector, with specific reference to Oriental Bank of Commerce, and will reach the conclusion by evaluating the organization's migration strategy, and suggesting recommendations on significant aspects that required to be improved.

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1. INTRODUCTION

The banking and financial services industry is currently facing exceptional changes. Customers have taken the control and driving the new business models, rather than the bank. The emergence of new technologies and its use by customers is primarily driving the business transformation in the banking industry. Banks are forced to respond to this environment controlled by the customer with innovative business models, functions and information technology.

Banks might be having diverse motives for migrating to cloud, but the main motive is its Information Technology infrastructure setup and its maintenance cost. A pivotal hesitation as well as challenge for huge investments in emerging technologies is always considered to be the capital expenditure required in setting up advanced infrastructure. By way of migration to cloud, the banking organizations have to only focus on the budget required for their functional expenses and cost of the services supposed to be utilized. It would help the banks to become effortless and more cost effective to host and run their applications on cloud as compared to the prevailing traditional infrastructure setup and maintenance.

Computing has evolved from Mainframes to Cloud Computing as follows:

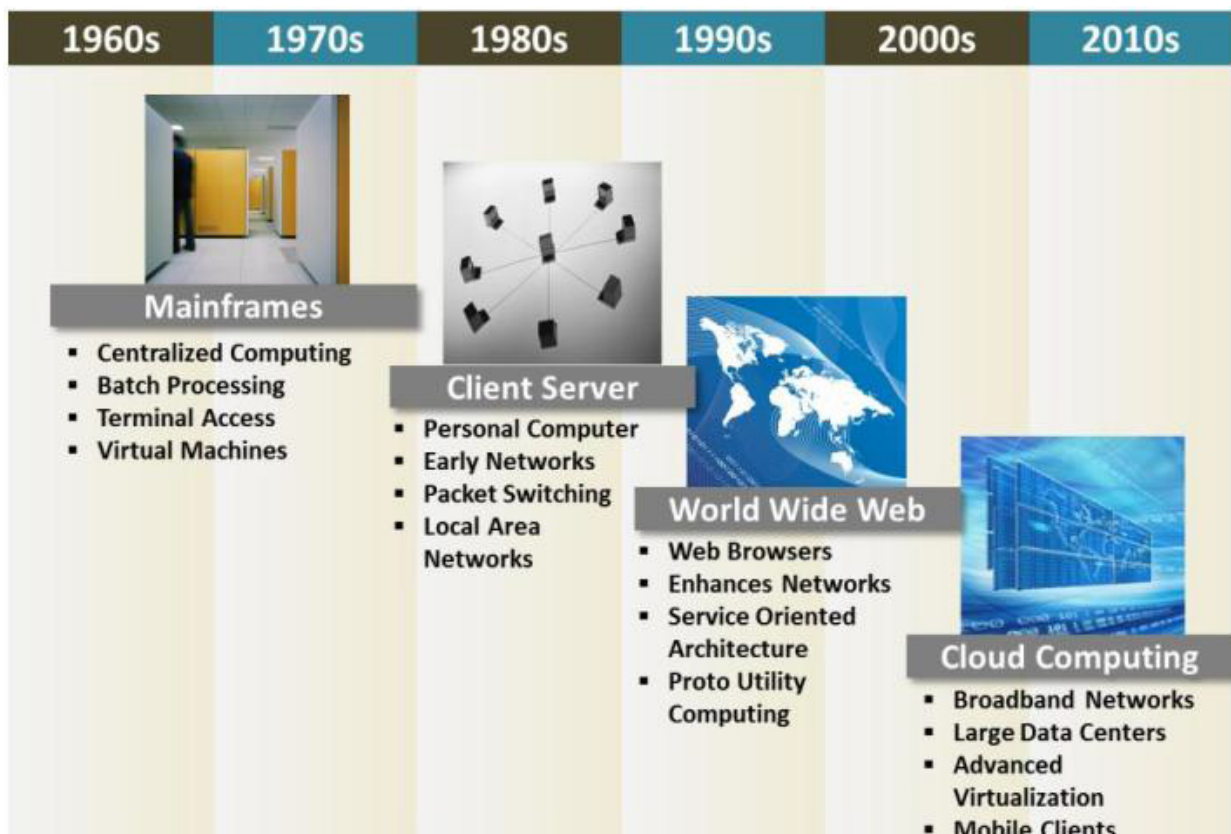


Figure 1.1: Computing Evolution

Source: IBM Sales and Distribution Thought leadership white paper

Cloud computing is continuously transforming the technology ecosystems across industries, with banking not being any exception. Cloud technology tenders an innovative model for delivering rich user experience, effective alliance, reduced time to market and augmented efficiency of IT in the organizations. Today, cloud technology is not only being utilized in technology infrastructure, but it is an exemplar move to a completely new model of carrying out business. Cloud computing assures the organizations and their IT departments to be more agile, responsive, efficient, focused along with the ability to cost-effectively offer novel products and services, thus enabling their business missions to succeed.

1.1 Industry Profile

The **Banking and Financial Service (BNFS) sector** in India is resonant, sufficiently capitalized and well-controlled. Currently, the Indian economic and financial environment is much superior to a lot of other countries. Researches on credit and liquidity risk markets have shown that Indian banks are usually flexible, and have effectively survived from the recession that occurred globally. Through a way optimism moving stealthily in the Indian economy, the banking industry is anticipating better prospects of growth. This optimism is due to factors stemming from recent Government policies to revive industrial growth in India. RBI is commencing quite many measures that are supposed to help the banks to restructure in the long run. The recent declarations and steps taken by RBI are an apparent indicator to the better future of the reorganized banking industry in India.

With the development in technology, the internet and mobile banking facilities have progressed and now moved to the forefront. Banks in India are now concentrating more on providing highest quality services to their customers and in this regard have also initiated to upgrade their technology infrastructure. This would definitely assist in improving user experiences and also offer a competitive advantage to the banks.

Both public sector banks like SBI, OBC, UBI etc. and private sector banks like ICICI, HDFC and AXIS etc. are exploring the opportunity to bring the contact-less debit and credit cards in this highly competitive market. Such cards will allow the users to perform the transaction without swiping or inserting the card. Such customer-friendly initiatives would also prompt huge investments in technology

infrastructure that banks need to consider while implementing such initiatives. The banks often outsource their technology infrastructure maintenance that allows them to focus on their core business activities.

1.2 Organization Profile

Oriental Bank of Commerce (OBC) is a prominent Public Sector bank in India that was incorporated in 1943. Initially its business activities included financial service offerings to commercial banks, saving banks and financial institutions trading in the securities market. OBC is now involved in following businesses:

- Personal Banking - OBC offers extensive range of financial products and services including but not limited to savings account, fixed and cumulative deposits, loans, mutual funds, internet banking, debit and credit cards, insurance, etc.
- Corporate Banking - OBC also offers various services to its corporate clients such as cash management services, loans, financing working capital, etc.
- NRI Banking - Besides various personal banking offerings, OBC also provides remittance (funds transfer) services, financial consultancy services to its NRI customers.

The total delivery channels of the bank as on December 31st, 2014 were 4661 (2200 Branches and 2461 ATMs). The customer base of the bank stood 24.78 million on the same date. With the passage of time, the bank has established its Information Technology Infrastructure with 100 per cent achievement on Core Banking Solution by networking all its branches and enabling the customers to access their bank account to carry out basic transactions at any of the branch, irrespective of the customers' home branch. The bank offers an assortment of IT products and services through its various branches, network of ATMs, net-banking and mobile banking delivery channels. To build-up the bank's obligation to provide constant service to its customers without any interruption, OBC has developed a vigorous corporate network through leased lines and VSATs with adequate redundancy, for achieving highest level of reliability. Moreover, OBC has also effectively implemented the biometric authentication where the user is authenticated by the system through his/her finger prints, in addition to user id and password, thus enhancing the access level security for its users in the CBS network. To comply with the RBI guidelines on accounts classification as per its

Income Recognition and Accounts Classification norms, the bank has been using system driven classification of accounts. The MIS software used in the bank has been modified to generate huge number of Statutory and Statistical Returns, in this manner ensuring information is being generated correctly and accurately.

OBC has taken proactive initiatives on the training of its employees to get them familiar with diverse aspects of banking, which include training on the latest IT products and services being provisioned by the bank or plan to procure in future. Regular training programs are being conducted at bank's training institutes and at other partner institutes of repute to train the employees on varied aspects of banking. Bank has also commenced following steps for bringing awareness among its employees in various domains:

- Information Security Awareness Campaign: Bank arranges Information Security campaigns at the branches at regular intervals where the employees are made aware or trained on various aspects of Information Security policies of the bank, which is now considered one of the most important aspects in any organization due to emerging security threats and concerns.
- Provision E-Learning portal on Internet: E-Learning tool is provisioned for online learning of employees at their own convenience through Bank's web portal which has also been extended through the bank's corporate website so that same can be utilized by the employees from Internet anytime and anywhere.
- Display of notifications on IT Products and Services on bank's corporate website: Bank displays the necessary information on the usage of various IT products and services along with notifications on the bank's corporate website for creating awareness among employees and customers, on the availability and usage of its delivery channels.
- IT Handbook: Bank has prepared an IT handbook which has been shared with all the EDP Officers for creating awareness regarding various IT products offerings and enabling them to guide the branches whenever required.

Technology is always the focus area in which OBC has invested and continues to invest, for providing highest quality customer service:

- The bank has established a cutting edge IT Infrastructure and hence able to provide an assortment of IT products and services through all its delivery channels.

- The bank has also launched chip-based Debit Card which is considered to be more secured than swipe cards.
- The bank's Internet Banking facility has been further improved and made safer by implementing quick and hassle free One Time Password (OTP) generation along with provisioning additional features.
- The bank has improved the online features on its corporate website by adding services like customer grievance redressal system, savings bank account opening and extending the link of e-learning portal on bank's corporate website for the employees.
- The bank has also established its mobile banking platform through which customers avail services such as retrieval of account balance information, viewing recent transactions, transfer funds through NEFT and RTGS, viewing mini statement etc.

1.3 Objectives of the Study

The objectives of analyzing the migration of technology infrastructure to Cloud are:

- a. To understand the cloud computing benefits expectations.
- b. To recognize the implementation issues while migrating to Cloud.
- c. Recommend the strategy to overcome the recognized Cloud migration issues.

2. LITERATURE REVIEW

2.1 What is Cloud computing?

Cloud computing is an innovative means of computing which provides scalable and virtualized computing resources as a “pay-per-use” service through the Internet. It is a “pay-as-you-go” model that offers on-demand access to a common pool of computing resources viz. network, bandwidth, servers, storage, applications etc.

Players involved in cloud computing implementation could be classified as follows:

- Cloud Provider: This player is an integrator of the systems who assimilates the offerings from numerous hardware and software vendors to deliver a solution and is a point of contact with the cloud consumers. These vendors could be providers of:
 - a) Infrastructure (hardware and software)
 - b) Data center
 - c) Application
 - d) Network
- Cloud Consumer: This player is a customer (like e-commerce, bank etc.) that avails the services on the cloud.
- Cloud Auditor: This player is an audit firm of repute who conducts an independent security, data confidentiality and performance audit of the processes followed during operations and deploying infrastructure. The scope of audit includes the aspects of banking based on the specified contract.
- Cloud Broker: These players are intermediaries who provide non-core services using negotiation over the services provided by cloud providers. These are in an evolving phase.
- Cloud Carrier: This player provides network infrastructure ensuring appropriate bandwidth for connectivity to organization’s subsidiaries with the data center.

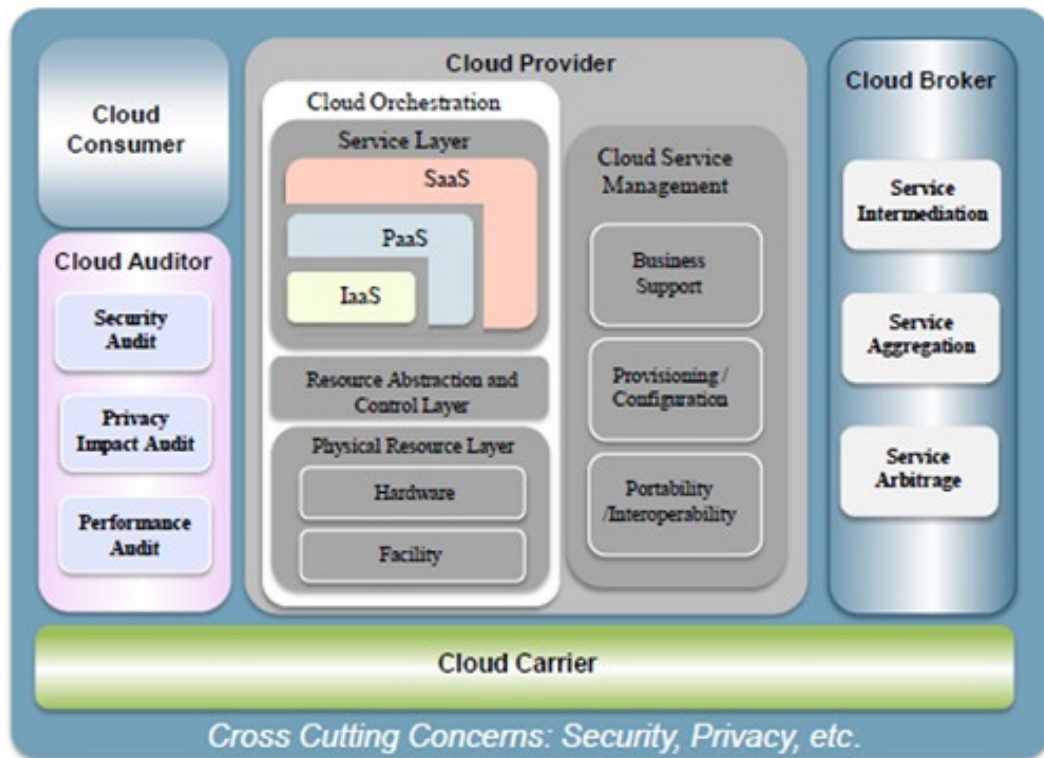


Figure 2.1: Players Involved in Cloud Computing
 Source: International Institute of Business Analysis

2.2 Characteristics of Cloud Computing

The crucial characteristics of cloud computing could be:

- i. On-demand self-service: Customers could be provisioned the cloud computing resources without requiring any human intervention, which is typically done through a web-based self-service portal, sometimes called as a Management Console.
- ii. Wide Network Access: Cloud computing resources are available through the internet, thus supporting varied client platforms such as mobile devices and workstations.
- iii. Resource pooling: Cloud providers service numerous customers from the same physical resources, by logically separating these resources in a secured manner. The computing resources are pooled and served to multiple customers using multiple-tenant model, with the physical resources being dynamically allocated and reallocated based on customer demand. These resources could be virtual machines, storage, processor, memory (RAM), network bandwidth, email services etc. This pooling of the resources leads to economies of scale at the service providers' end.
- iv. Rapid Elasticity: Resources are provisioned and released based on the demand

and / or automated based on set parameters. This ensures that the applications will have exactly the capacity it requires at any given point of time.

- v. Measured Service: The usage of resources are continuously monitored, measured, reported and billed transparently based on the utilization i.e. pay-per-use model.
- vi. High Scalability: Cloud environments are highly scalable to service business requirements for high capacity users.
- vii. Pay-per-use mode: Consumers are charged for the services availed only for the duration and when they use them, either for a short duration such as CPU time or for a longer term such as storage services.
- viii. Resiliency: The cloud service resiliency completely segregates the server and storage resources failure from the cloud users through disaster recovery mechanisms. The service requests are automatically routed to another physical resource in the cloud, with or without the user awareness or involvement.

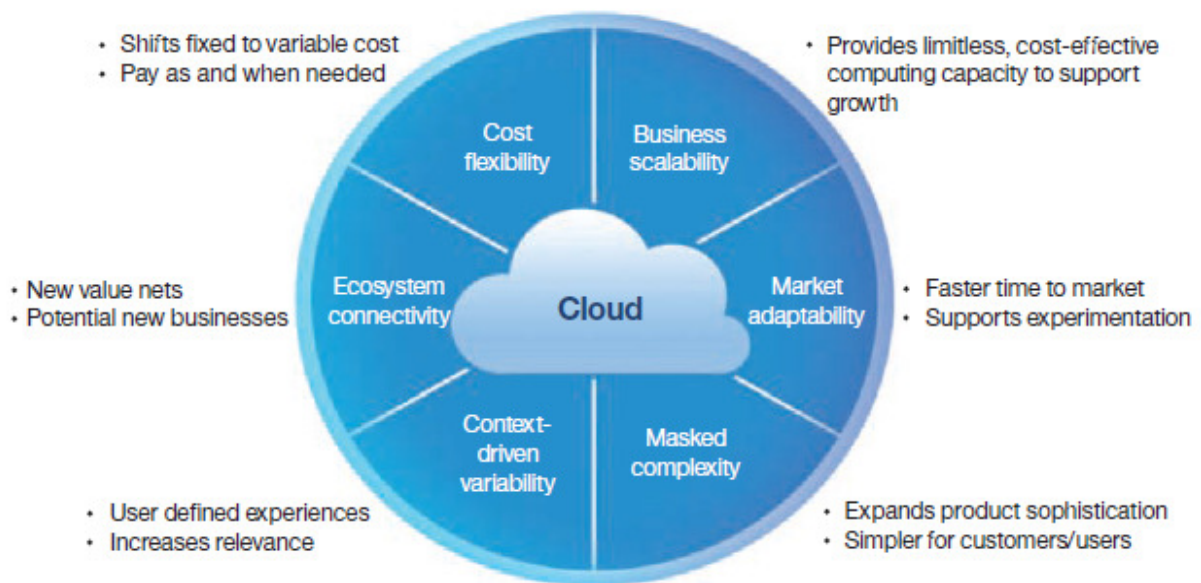


Figure 2.2: Cloud Computing Features

Source: IBM Sales and Distribution Thought leadership white paper

2.3 Cloud Computing Models

2.3.1 Service Models

As per *National Institute of Standards and Technology Information Technology* (NIST), following three service models are available in cloud computing services:

1. Infrastructure as a Service (IaaS)

IaaS refers to the cloud based infrastructure resources rendered as a service such as machines, network, storage etc. These resources are made available as virtual computers with definite processing speed and at specific bandwidth for storage and internet access. Some providers also provide additional assurance like physical hosts shared being not shared with any other user or direct accessibility of a physical host within a pool of hosts.

2. Platform as a Service (PaaS)

PaaS is considered to be similar to IaaS with a custom software pool for a given application. It differs from IaaS in a way that PaaS also comprises of operating systems and services required for a specific application. The infrastructure on the cloud in PaaS is used by the application development teams to build applications. The cloud consumer is not able to see or access the provisioned hardware and network directly, but can determine the configuration of application and hosting environment.

3. Software as a Service (SaaS)

SaaS provisions the licensed software and applications supplied by the service provider in the cloud infrastructure. The applications could be accessed from the supporting client devices through an interface like a web browser. It reduces the customer's physical equipment installation and related management cost. Moreover, SaaS allows application teams to develop their customized services as per their requirements as well.

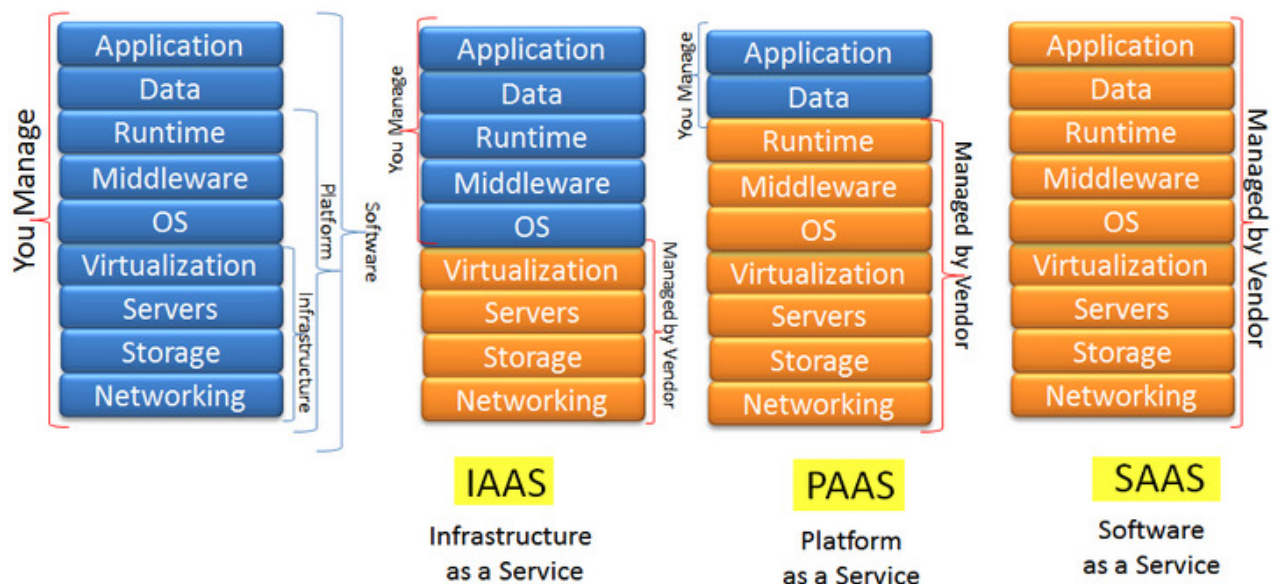


Figure 2.3: Cloud Computing Service Models

Source: TechGYD – Technology Blog

2.3.2 Deployment Models

The service providers usually deploy clouds through following deployment models:

1. Private Clouds

The entire computing infrastructure is dedicated to the customer and is available only for the organization, without any sharing with other customers / organizations. It offers cloud service to the organization's users within the corporate network. It is fairly secure as compared to public cloud. The primary concern is the capital required to build private cloud. Private clouds are usually developed within the organization's own premises / data centers. Since private clouds are not available to external users, due to which these are considered as the most secure environment for customer data, which is a prime concern for any organization. Private clouds may also be externally hosted on vendor's premises and such private clouds are not considered to be less secured as compared to on-premise hosted clouds. Examples of private cloud are VMWare vCloud and Citrix Virtual Desktop Infrastructure.

2. Public Clouds

The cloud vendor's premises hosts the entire computing infrastructure. The infrastructure is available to the customers through the internet. It is usually dependent on a usage-based model. It extends the capabilities of the data center by the provisioning of IT services from third-party providers through a network. The

data may be stored and processed at any location in the world on the infrastructure that is pooled and shared with other customers of the cloud service provider. There is no visibility to the customer regarding the location of hosting infrastructure, reason being the services being offered from the virtual space. Cloud customers also don't have any option to provide opinion in the selection of the physical host where their virtual machines shall be placed. Amazon EC2, Google App Engine and Salesforce.com are examples of public cloud service providers.

3. Hybrid Clouds

The organization could leverage the infrastructure service on more than one delivery models among private and public clouds. Organizations provide and manage some resources on-premises and also have others provisioned from cloud provider's external hosting environment. Hybrid clouds combine the public cloud and private cloud service offerings based on the data and applications criticality in each process, along with the degree of business sensitivity and segregation. Most banking organizations are usually following a strategy of utilizing hybrid cloud services. It can also be a cloud owned by and located within the organization premises, but operations outsourced to a vendor or technology partner.

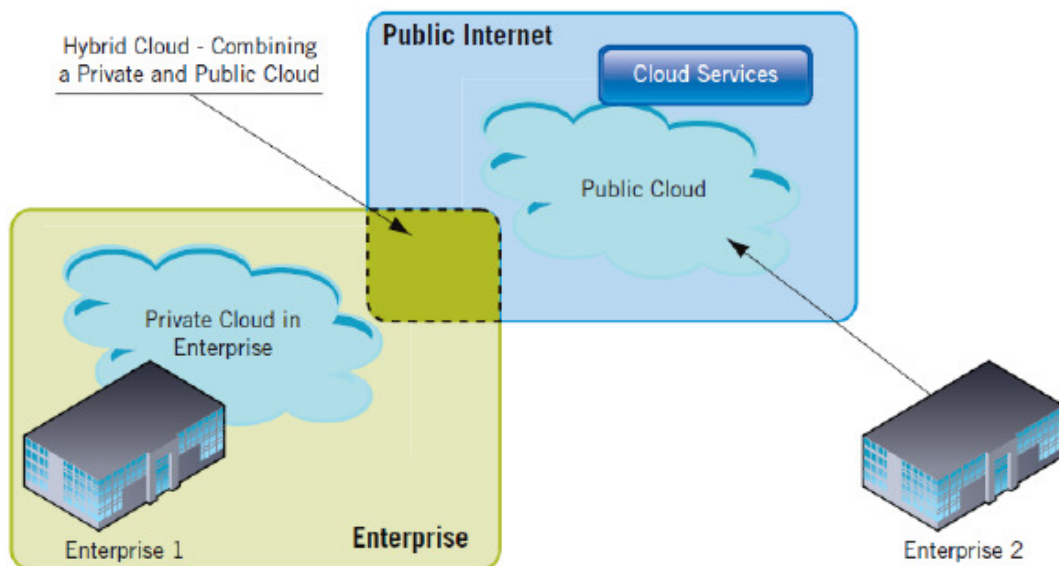


Figure 2.4: Cloud Computing Deployment Models

Source: Journal of Emerging Trends in Computing and Information Sciences

2.3.3 Operating Models

There is a need to determine the suitable operating model based on the assorted need of computing resources for the cloud computing implementation.

1. Staff Expansion

Banking organizations can achieve cloud expertise by employing personnel with the appropriate kind of skill sets from vendors of the cloud service. The supplementary human resources can be deployed at the organization's existing hosting and data center. This operating model permits flexibility and let the organizations select the finest resource for every specific requirement of cloud migration.

2. Virtual Centers

Virtual centers consist of a committed pool of resources to assist in operations pertaining to cloud migration and responding based on the demand. This operating model is comparatively a better alternative against the complete subcontracting approach.

3. Subcontracting Vendors

This approach utilizes facilities and human resources from the vendor to take care of the cloud operations. This model unites the investments and resources, thus enabling the vendors to offer cloud based services for multiple banking organizations.

2.4 **Why Cloud Computing for Banking Industry?**

The banking industry is currently undergoing the process of enormous changes and reforms, facing new compliances and regulations that require increased reporting and auditable processes, in addition to growing need of cost reduction from business operations. For achieving and sustaining top performance in the future, the banks would be required to adopt two fundamental changes:

1. The transformation in offerings of its product and services, distribution mediums and consumer services to reflect the expectations of the fluctuating consumer perception.
2. Focus on redesigning and reinventing its core business operations that would enable its business model to become more competitive, efficient, consumer centric and sustainable.

Cloud computing could play a crucial role in a bank's initiatives and efforts to radically change its business and operating models. In business terms, the cloud computing environment eradicates the constraints around physical presence of IT resources along with specific technologies required to be engaged, which enables it to rapidly deploy the business services and that too at a lower cost. In technical terms, the virtualized technology resources are automatically assembled, connected and configured to address the business objectives.

Clouds can help in cutting energy costs through reduced power consumption, lowering technology infrastructure expenses in terms of the capital investment in the infrastructure and the human resources required to manage the same. By deploying portions of their infrastructure to the cloud, banks could attain more agility in adopting new technologies and effectively plan for capacity management, with the ability to increase and decrease infrastructure and resources as circumstances demand, which is considered to be an option of high value during these times of high market volatility and cutting edge competition. Moreover, the cloud migration can help in improving information management, with centralized data storage centers resulting in enhanced productivity, data sharing and collaboration.

Cloud computing could enable the banking organizations in improving their performance through various ways:

1. Cost savings and usage based charging: With adoption to cloud computing, the banking organizations can convert a large capital expenditure on technology infrastructure setup into a smaller, continuing operational cost. The heavy investment on new hardware and software is not required. Additionally, the distinctive feature of cloud computing enables the banking organizations to select the required services on a "pay-as-you-go" basis.
2. Business Continuity: Through cloud computing, the accountability for managing the technology infrastructure lies with the cloud service provider. Banking organizations can certainly expect a higher standard of data security protection, error tolerance, and disaster recovery in case of failure. Cloud computing also provides a high standard of redundancy along with back-up at a comparatively low cost than other traditionally managed data solutions.
3. Business Focus and Agility: Cloud computing allows banks to focus on new

product development and provide various new product and service offerings in quite less time to their customers, without capital investment on technology infrastructure. Cloud computing also provides additional service to the banks to migrate their non-core and non-critical business services to the cloud, comprising software patches, maintenance etc. This would enable the banks to focus primarily on their core business activities, instead of IT.

The elasticity of cloud operating models allows the banking organizations to experience shorter development cycles for their products resulting in quick and efficient response to the changing needs of their customers. Since the availability of cloud being on-demand, less investments on infrastructure would be required, thus reducing initial deployment cost and time.

2.5 Benefits of Moving to Cloud

Cloud computing brings benefits for both consumers and cloud service providers. Consumers can attain reduction on IT infrastructure cost by choosing to procure cheaper services from external providers as opposed to heavy investments on IT infrastructure and hiring personnel for its maintenance. Cloud service providers achieve better operational costs; hardware and software infrastructures being developed to provide multiple solutions to various users, thus increasing efficiency and hence leading to faster ROI and lower TCO. Following are considered to be the benefits of moving the computing infrastructure to cloud:

1. Reduced Cost: Cloud technology cost is paid in incremental manner as and when service is received, thus saving organizations' cost.
2. Increased Storage: Organizations can provision more storage virtually on need basis and could then store more data than on personal computer systems.
3. Flexibility: Cloud computing offers much more flexibility in operations than legacy computing approaches.
4. More Mobility: Information is accessible to Employees from any location, instead of remaining at their desks.

2.6 Issues in Moving to Cloud

Following are the issues that are required to be addressed while planning for cloud migration and after moving computing infrastructure to cloud:

1. Security & Privacy: The major apprehensions about cloud computing are the security and privacy of organizations data hosted on virtual space. Customers may not be comfortable and have inhibitions in handing over their private data to external entities. This is an even larger concern for the organizations when they have to move / store their utmost sensitive and restricted information on the cloud servers.
2. Dependency (loss of control): The users do not have any control on the location and storage of their data on a cloud and have to be completely dependent on the cloud service provider.
3. Cost: While for a long run, hosting technology infrastructure on the cloud is much cheaper than traditional computing methods, the fact that it is currently evolving and requires more research and improvement might actually turn it to be quite more expensive. Cloud Service providers have to buy or develop the software that'll run the cloud, network the machines and resolve unanticipated problems (which always exist even after risk mitigation). This makes the initial cloud setup for the customer to be more expensive.

Security seems to be an authentic concern even though it is claimed that cloud computing is just as safe as traditional systems with respect to apparent security loopholes and vulnerabilities. This is due to the obvious nature of the cloud computing, specifically the public cloud, where there are other customers with proximity access to the data.

2.7 Roadmap for moving to Cloud

The following roadmap to cloud migration is supposed to help the organizations in successfully migrating to Cloud:

- Building the business case: The organization shall link the cloud migration initiative with the overall drivers or objectives of the business. The support from senior leadership and stakeholders shall be secured. There is a need to establish a baseline to assess the impact of the exploration. The costs and resource requirements shall be estimated.

- Developing the strategy: The exploration shall be aligned with the business strategy of the organization, and it shall demonstrate how business value can be delivered. The strategy shall demonstrate how the exploration might lead to the changes that will impact the organization's business environment. It is required to liaise with the key stakeholders for identifying business needs.
- Assessing readiness: Analysis and identification of the budget, human resource, timelines, technology details and other requirements necessary to prepare the business for the investigation needs to be carried out. A TCO analysis framework shall be developed. The established policies for assessing risk and managing governance shall be reviewed.
- Prototyping: A group shall be formed to develop a prototype for the investigation and / or create a Proof of Concept to ensure the model followed could be implemented. The detailed requirements need to be developed and communicated to the senior stakeholders. The pilot / prototype shall be managed for any changes, and demonstrated to the senior stakeholders.
- Gaining approval: The findings of the pilot readiness assessment and prototype efforts shall be analyzed, and the business case and strategy could be revised accordingly. The findings of the exploration shall be presented to the senior leaders and stakeholders to gain appropriate approvals.

2.8 Major Security concerns with Cloud Computing

Based on the findings by the research conducted by Intel IT Center in May 2012, following are the utmost security concerns:

2.8.1 Private Cloud Computing

1. Access Controls
2. No visibility into abstracted resources
3. Adequate firewalling
4. Traffic analysis (Virtual Machines disrupting other VMs)
5. Multitenant potential mixing of VMs
6. Different trust levels of VMs

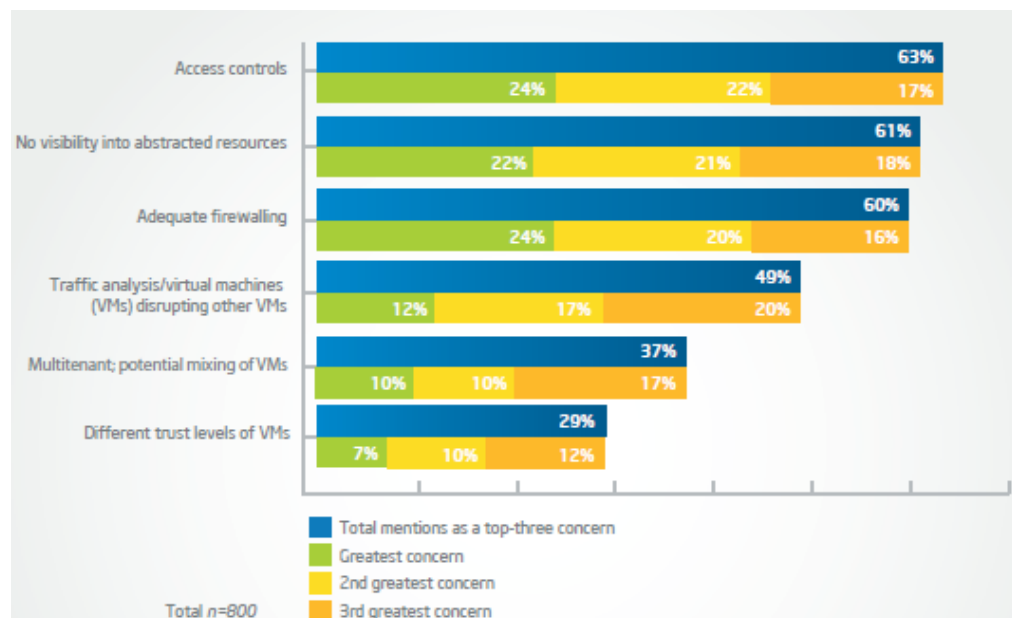


Figure 2.5: Major Security Concerns in Private Cloud

Source: Intel IT Center Research

2.8.2 Public Cloud Computing

1. Inability to measure security services
2. Lack of control over data
3. Confidence in providers security capabilities
4. Attesting to the integrity of hosting platforms
5. Lack of transparency / ability to perform audits
6. Physical / geographical boundary controls

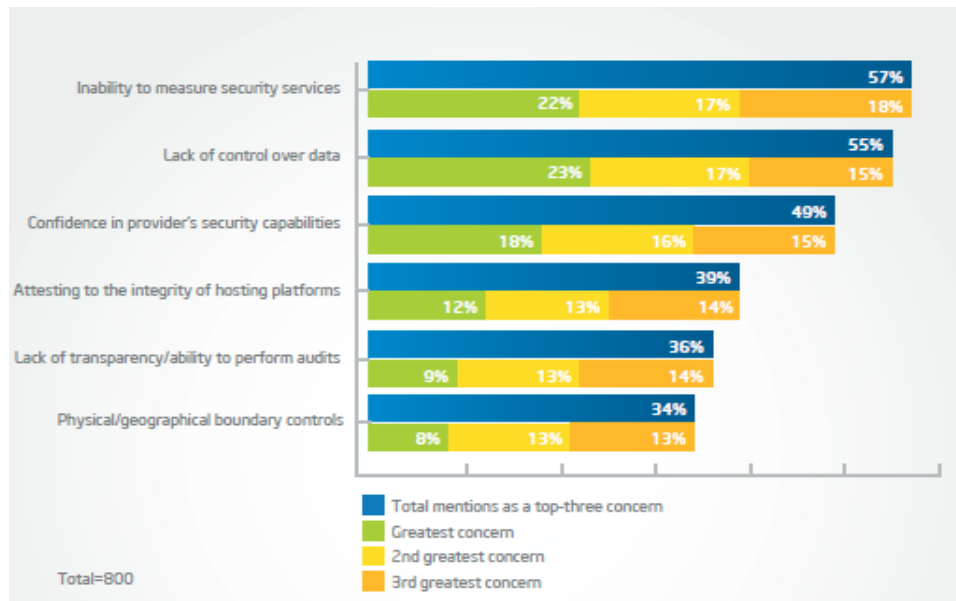


Figure 2.6: Major Security Concerns in Public Cloud

Source: Intel IT Center Research

2.9 Confidence Builders to address concerns with Cloud Computing

Based on the findings by the research* conducted by Intel IT Center in May 2012, following are the confidence builders to address concerns with Cloud Computing:

2.9.1 Private Cloud Computing

1. Ability to create data boundaries
2. Attesting to the integrity of the infrastructure
3. Ensuring network packets have not been compromised
4. Isolation / protection of VMs
5. A way to measure trust levels of VMs
6. Ensuring hypervisors have not been corrupted

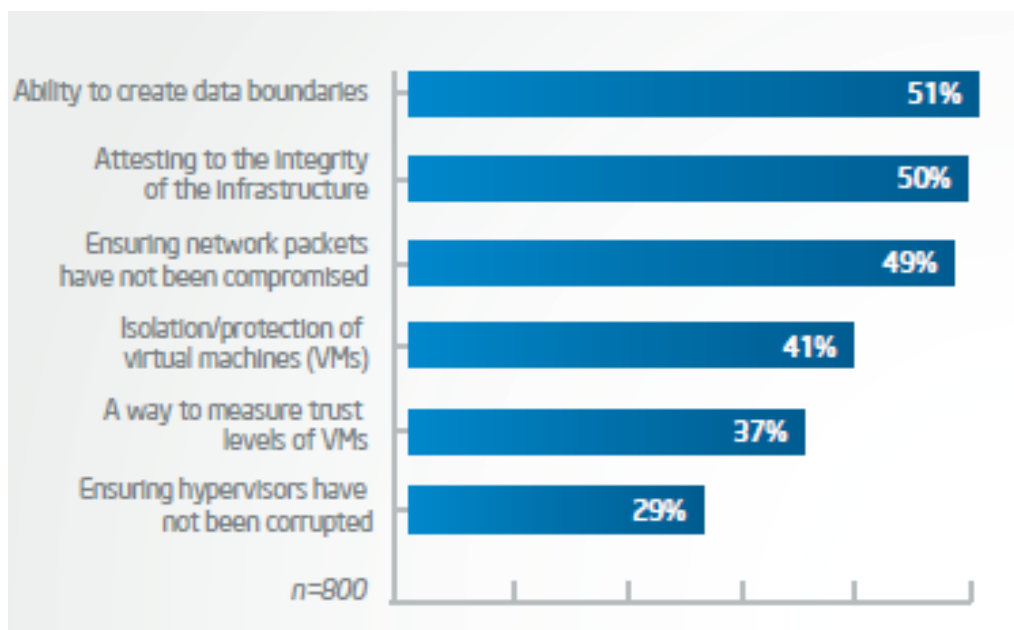


Figure 2.7: Private Cloud Confidence Builders

Source: Intel IT Center Research

2.9.2 Public Cloud Computing

1. Setting and enforcing security policies across clouds
2. Ability to create data boundaries
3. High-integrity infrastructure free of malware
4. Way to compare security levels across cloud service providers
7. Isolation / protection of VMs
5. APIs for reporting , auditing and providing alerts on security events
6. Clarity on providers' SLAs

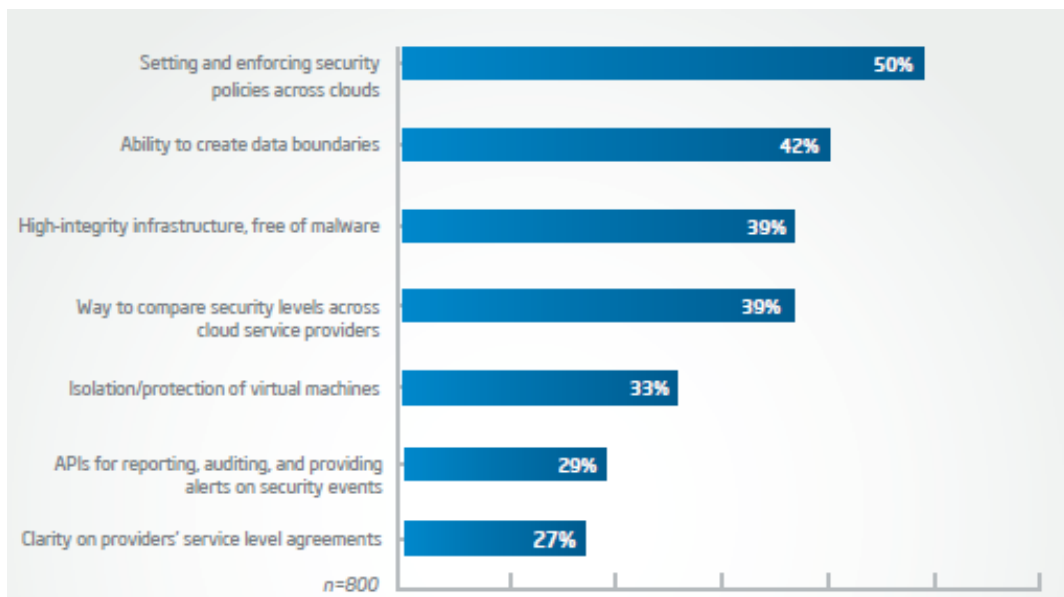


Figure 2.8: Public Cloud Confidence Builders

Source: Intel IT Center Research

2.10 Learning from Literature Review

Organizations can leverage cloud computing to improve the development and effective delivery of their products and services by migrating to cloud and consuming cloud services in a cost-effective and flexible way. In public cloud computing delivery model, a cloud provider offers and delivers the services as shared pool of computing resources. In private cloud computing delivery model, cloud environment is setup on-premises and delivers services to internal customers only. Organizations that utilize public cloud services can possibly save cost by leveraging the cloud provider's scalable and variably priced environment based on pay-per-use basis. However, public cloud computing services are exposed to concerns regarding security, data privacy, trust, control and performance. Most banking organizations would prefer to move toward with either private cloud computing models or hybrid cloud computing models based on the level of security and privacy expectations. Intense hype is surrounding cloud computing, making it hard to appreciate the available vendor options and roadmaps to be followed for successfully migrating technology infrastructure to cloud.

3. RESEARCH METHODOLOGY

3.1 Problem Description

Oriental Bank of Commerce is constantly working on the new initiatives in its IT offerings, with the primary focus on customer service and offering new delivery channels. The Bank has computerized all its branches, along with the extension counters, on the Core Banking Solution (CBS) platform and with this the complete business of the Bank is channeled through CBS. The Bank has deployed numerous electronic delivery channels like ATMs, Net Banking including utility payments, Mobile banking etc. which is enabled and supported by its robust IT infrastructure. The bank also has number of product offerings which are offered online viz. E-Taxes, E-Shoppe, Education Loan, Housing Loan, Vehicle Loan, Tax Accounting System etc. The bank has to focus on its technology infrastructure cost for supporting these delivery channels along with adequate security controls, which is a major part of its capital budget. The research would try to address the following questions:

1. How should cloud be understood in OBC banking environment?
2. What are the benefits of migration to cloud in OBC?
3. What are the implementation issues of cloud computing at OBC, considering the current technology infrastructure?
4. Do the benefits outweigh the issues for cloud migration in OBC?

3.2 Research Design

The approach to the research was exploratory in nature and based on both primary and secondary research. The primary research was done by conducting a survey at Oriental bank of Commerce, which is one of the largest Public Sector Bank in India, through some of its Information Technology department employees. The secondary research was done through literature review on Cloud Computing. The research was carried out to develop the understanding of cloud evolution in the banking sector. The study concludes by summarizing the key observations from the survey result, its qualitative analysis and recommending the approach that can be followed for Cloud migration.

3.3 Scope of Study

The scope of study was limited to assess the current technology environment of few applications for which response was collected from couple of OBC employees associated with its Data Centre and who can provide information about specific applications that support the bank's core business activities and are candidate for migration to Cloud environment. The applications' whose current technology environment is Microsoft and could be migrated to Microsoft Windows Azure cloud environment, were selected for analysis and recommendations were made for these applications.

3.4 Sampling Method

The sample i.e. a sub-group of the whole population, was couple of OBC employees associated with its Data Centre and the applications that support the bank's core business activities. These were selected as per the researcher's judgment based on certain limitations to approach the bank employees and retrieve the applications' information which is highly confidential for any organization.

4. DATA ANALYSIS

4.1 Data Collection sources/technique

Data Collection was carried out through a structured questionnaire that was floated to the Information Technology department employees of Oriental Bank of Commerce who are associated with the Data Centre and could provide their inputs on the Cloud migration and could also provide information regarding the technology infrastructure details of the applications that support the core business of the bank. The focus of the questionnaire was to gather potential issues and infrastructure data that could help in identifying the primary benefits being expected out of cloud migration and also able to justify the cost benefits to the bank in technology infrastructure setup and maintenance.

4.2 Descriptive Statistics

The response and data collected through the survey was analyzed qualitatively and quantitatively. The qualitative data was used to identify the major issues in cloud migration and the quantitative data was used to compare the technology infrastructure cost. The data was also considered in recommending the strategy for migration to cloud at OBC.

4.3 Findings and Recommendations

4.3.1 Findings from Survey

4.3.1.1 Response Analysis

Based on the 5 responses received from the Information Technology department employees of OBC, following are the observations:

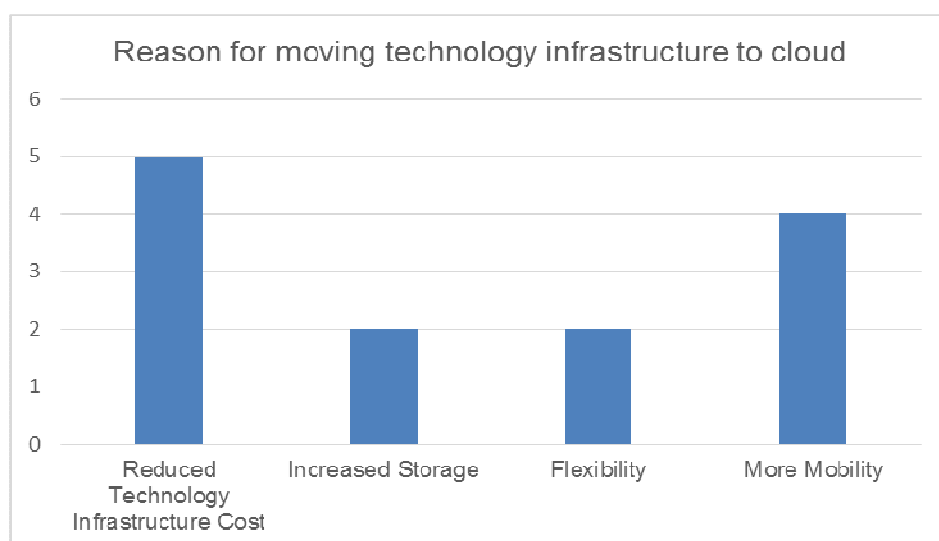


Figure 4.1: Reason for moving technology infrastructure to Cloud

Source: Analysis of survey data

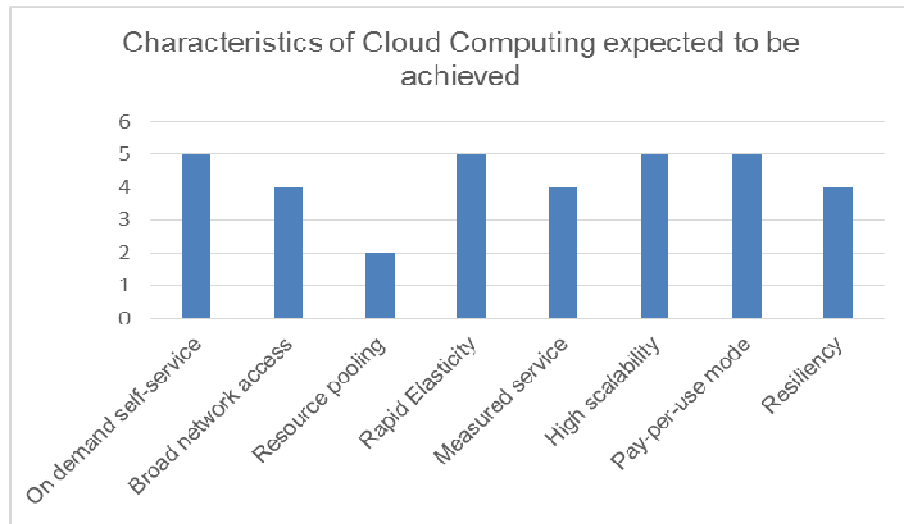


Figure 4.2: Characteristics of Cloud Computing expected to be achieved

Source: Analysis of survey data

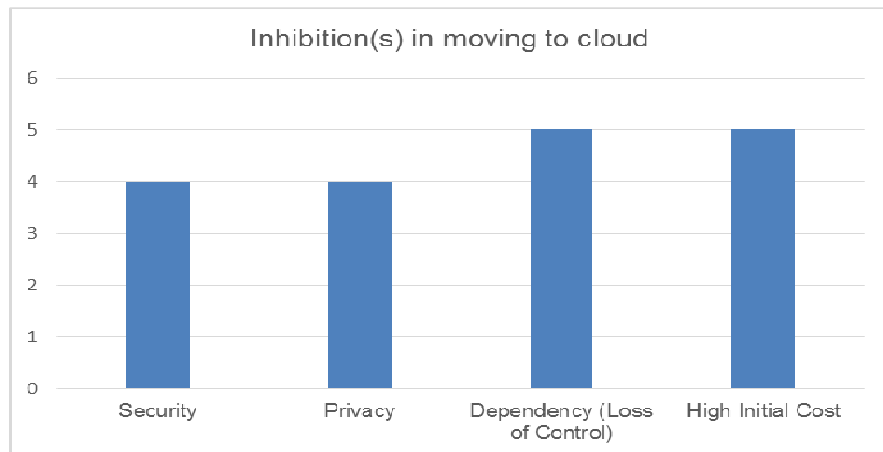


Figure 4.3: Inhibition(s) in moving to Cloud

Source: Analysis of survey data

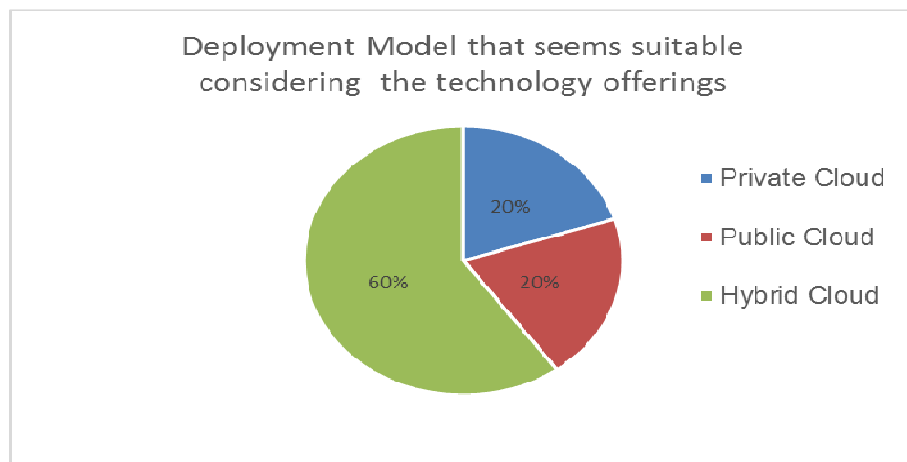


Figure 4.4: Deployment Model as found Suitable

Source: Analysis of survey data

4.3.1.2 Cost Analysis

The cost of the Cloud infrastructure using Windows Azure was found out by providing the captured server details and comparing the same with the existing technology infrastructure cost. The potential Cloud infrastructure cost was identified by accessing the following link provided by Microsoft Corporation:

<http://azure.microsoft.com/en-us/pricing/calculator/?scenario=virtual-machines>

Here is the comparison of the current and Cloud infrastructure (Public):

Current Windows Server Cost				
Env		Cost per App/1 Month	Cost for 5 Apps/1 month	Cost for 5 Apps/12 months
DEV			₹ 30,724.80	₹ 3,68,697.60
TEST			₹ 72,660.00	₹ 8,71,920.00
PROD			₹ 102,480.00	₹ 12,29,760.00
				₹ 24,70,377.60

Microsoft Azure Cost				
Env	Configuration	Cost per App/1 Month	Cost for 5 Apps/1 month	Cost for 5 Apps/12 months
DEV	768 MB RAM	₹ 1,785.60	₹ 8,928.00	₹ 1,07,136.00
TEST	1.75GB RAM	₹ 7,142.40	₹ 35,712.00	₹ 4,28,544.00
PROD	1.75GB RAM	₹ 7,142.40	₹ 35,712.00	₹ 4,28,544.00
				₹ 9,64,224.00
			Expected Savings	₹ 15,06,153.60
			Savings in % for 1 Year	61%

Current SQL Server Cost				
Env		Cost per App/1 Month	Cost for 5 Apps/1 month	Cost for 5 Apps/12 months
DEV			₹ 28,560.00	₹ 3,42,720.00
TEST			₹ 43,140.00	₹ 5,17,680.00
PROD			₹ 73,440.00	₹ 8,81,280.00
				₹ 17,41,680.00

Microsoft Azure Cost				
Env	Configuration	Cost per App/1 Month	Cost for 5 Apps/1 month	Cost for 5 Apps/12 months
DEV	38 GB	₹ 1,510.56	₹ 7,552.80	₹ 90,633.60
TEST	120 GB	₹ 2,493.60	₹ 12,468.00	₹ 1,49,616.00
PROD	150 GB	₹ 2,709.36	₹ 13,546.80	₹ 1,62,561.60
				₹ 4,02,811.20
			Expected Savings	₹ 13,38,868.80
			Savings in % for 1 Year	77%

4.3.2 Recommendations for Cloud Migration Strategy

Based on the response received from the survey, following would be the recommendations for the bank for migrating the technology infrastructure to cloud:

4.3.2.1 Form a technology team

A technology team shall be formed that would analyze the applications and check the suitability of the application for migration to cloud. The technology team shall consist of experts from the technologies used for cloud migration who could guide and support the application developments teams whenever required.

4.3.2.2 Questionnaire for application assessment

A standard questionnaire shall be devised to gather the existing technology details of the application to be migrated to Cloud, and the expected benefits for moving to cloud that would help the technology team to frame an appropriate strategy and assist in meeting the given timelines to complete cloud migration. The questions might include but are not limited to the following:

1. Are there any payment processing functions performed in the system?
2. What technology will be used for developing this application?
3. Will the application require any 3rd party installation/support?
4. Is there any PII data stored or transmitted in the application?
5. Current technology infrastructure setup details like servers, networks etc.

4.3.2.3 Selecting the right services and model

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. The key to success lies in selecting the right cloud services model to match business needs. Based on the response by the application teams, technology team could advise on appropriate services and models that needs to be procured. Based on the responses, it could be observed that hybrid cloud model is preferred. The bank can also partner with Microsoft which provides discount to its partners who are planning to move their technology infrastructure to Windows Azure.

4.3.2.4 Selecting the right pattern for cloud adoption

Patterns shall comprise of mandatory and best practices for complex tasks refined from repeated client and partner engagements. Patterns assist to define solutions in a clear format that addresses the reoccurring problems; which can then be applied in concrete use cases regardless of used technologies, including software, middleware, or programming languages. As more and more solutions are deployed to the cloud and as cloud computing becomes an emerging development field, new products and technologies would be made available to OBC and its customers; understanding cloud patterns, especially an adoption pattern, and reconciling the most appropriate pattern with its business's implementation scenario, motivation, and mitigation, can help OBC build a sound cloud solution.

The goal of this selection process is to help the technology team to select a suitable cloud adoption pattern that helps extend business capability and integrate existing on-premise systems with new services provided by cloud providers. The focus is mainly on the integration aspect that uses adoption patterns to support both cloud service models (IaaS, PaaS and SaaS) and cloud types (public, private or hybrid) in an abstract form to categorize the cloud solution offerings. These abstracts should help OBC to select a proper adoption model based on its own business model, desired cloud maturity level, and technology choices (such as software, platform, and tools) but the main goal remains to provide OBC with one of the first critical steps to a path towards cloud implementation.

4.3.2.5 On-boarding application to Cloud

After the review of questionnaire response, selecting the right model and adoption pattern, and completing the required approvals, technology team can initiate the on-boarding process of cloud migration of the selected application and provide support throughout the life-cycle of the cloud migration project as and when desired by application teams. The application teams can follow the guidelines created by technology team to implement the required changes.

4.3.2.6 Potential Implementation Issues to be addressed

Few of the major implementation issues that could arise and needs to be addressed could be as follows:

1. Connectivity with DB2 database which is not migrated to cloud and still resides on-premises of the organization.
2. Connectivity to other servers that are outside the cloud.
3. In case of PII (Personally Identifiable Information) data being stored in the SQL Server hosted in Cloud, such data needs to be encrypted to ensure that data security and privacy is maintained during storage and transmission.
4. In case of existing applications developed in .NET and using 'Session' state management technique, this technique needs to be changed by using 'Cache' since Session is not supported in Windows Azure.
5. Organization might have to spend on Proof of Concept to be developed for changes where there are not guidelines available to be followed
6. Lack of expertise in the organization due to which dependency on technology vendors would increase.

4.4 **Limitations of the study**

The study has following limitations:

1. The sample was limited to one bank and more specific to few employees in the Information Technology department.
2. It was difficult to get accurate application and technology infrastructure data due to these being highly secured.
3. The cost benefit analysis could be carried out of the applications that are supposed to be migrated to Microsoft's cloud service Windows Azure.

4.5 **Summary of Data Analysis**

Migrating to cloud environment would help OBC to:

- Subcontract the maintenance activities of its servers and the applications
- Be able to scale the systems availability up or down based on demand
- Get its data accessible from anywhere with an internet connection
- Replace its capital spending on technology infrastructure with a predictable operational expenditure
- Focus on its core business activities
- Offer new and varied products and services to its customers

- Partner with technology service providers to ensure success in product offerings through use of technology

Based on the analysis of implementation issues identified and cost incurred, it is observed that the benefits of migrating to cloud environment at OBC definitely outweighs the issues which could be evaluated and addressed. Cloud computing is an evolving technology and will definitely be a challenge during implementation since it would initially contain imperfections, might experience failures and invest heavily to identify and resolve the security loopholes. There are challenges in adopting cloud computing that definitely needs to be evaluated and then address certain open issues like computing performance, cloud reliability, regulatory compliances, and information security.

5. REFERENCES

1. Jennings, Roger. (2009). *Cloud Computing with the Windows Azure Platform*. Wiley Publishing, Inc.
2. Sarna, David E. Y. (2011). *Implementing and Developing Cloud Computing Applications*. CRC Press.
3. Angadi, Abhinay B., Angadi, Akshata B, and Gull, Karuna C. (2013). *Security Issues with Possible Solutions in Cloud Computing*. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 2, Issue 2, pp.7-9, February 2013. Retrieved from <http://ijarcet.org/wp-content/uploads/IJARCET-VOL-2-ISSUE-2-652-661.pdf>
4. Hashizume, Keiko, Rosado, David G. Fernandez -Medina, Eduardo, and Fernandez, Eduardo B. (2013). *An analysis of security issues for cloud computing*. Journal of Internet Services and Applications, Volume 2, Issue 5, pp.3-5, 2013. Retrieved from <http://www.jisajournal.com/content/pdf/1869-0238-4-5.pdf>
5. Peer Research. (May 2012). *What's Holding Back the Cloud? Intel Survey on Increasing IT Professionals' Confidence in Cloud Security*. Intel IT Center. Retrieved from <http://www.intel.com/content/dam/www/public/us/en/documents/reports/whats-holding-back-the-cloud-peer-research-report2.pdf>
6. IBM. (2013). *Cloud computing for Banking*. IBM Sales and Distribution Thought Leadership White Paper. Retrieved from <http://www-935.ibm.com/services/multimedia/Cloud Computing for Banking Janvier 2013.pdf>
7. Reserve Bank of India. *Working Group Report on Cloud Computing Option for Small Size Urban Cooperative Banks*. Retrieved from <http://rbidocs.rbi.org.in/rdocs/PublicationReport/Pdfs/RWGFUF031012.pdf>
8. KPMG. (2011). *The Cloud Changing the Business Ecosystem*. Retrieved from https://www.kpmg.com/IN/en/IssuesAndInsights/ThoughtLeadership/The_Cloud_Changing_the_Business_Ecosystem.pdf
9. Sriram, Sudhir. (2011). *Cloud Computing in Banking*. Retrieved from <https://www.capgemini.com/resource-file-access/resource/pdf/Cloud Computing in Banking.pdf>
10. Mell, Peter and Grance, Timothy. (September 2011). *The NIST Definition of Cloud Computing*. Retrieved from <http://csrc.nist.gov/publications/nistpubs/800->

[145/SP800-145.pdf](#)

11. India Brand Equity Foundation. (April 2015). *Banking Sector in India*. Retrieved from [http://www.ibef.org/industry/banking-india.aspx`](http://www.ibef.org/industry/banking-india.aspx)
12. Woodward, Steven. (January 2014). *Cloud Concepts and the Impact on Business Analysts*. Retrieved from <http://www.iiba.org/ba-connect/2014/january/cloud-concepts-and-impact-on-business-analysts.aspx>
13. Robert, Andy. (March 2013). *Significant Changes Required in the Cloud Network for Boosting Business Growth*. Retrieved from <http://www.techgyd.com/significant-changes-required-in-the-cloud-network-for-boosting-business-growth/2083/>
14. Syntel Inc. Retrieved from <http://www.syntelinc.com/technology-services/cloud>
15. Oriental Bank of Commerce. Retrieved from https://www.obcindia.co.in/obcnew/site/technology_des.aspx?menu_id=1
16. Microsoft Corporation. Retrieved from <http://azure.microsoft.com/en-us/pricing/calculator/?scenario=virtual-machines>

6. ANNEXURE

6.1 Survey Questionnaire

Following questions were presented in the survey* to retrieve the information for analyzing the benefits and issues of cloud computing at OBC:

1. Reason for moving technology infrastructure to cloud (can select multiple):

- Reduced Technology Infrastructure Cost
- Increased Storage
- Flexibility
- More Mobility

2. Characteristics of Cloud Computing expected to be achieved (can select multiple)

- On-demand self service
- Broad network access
- Resource pooling
- Rapid Elasticity
- Measured service
- High scalability
- Pay-per-use mode
- Resiliency

3. Inhibition(s) in moving to cloud (can select multiple):

- Security
- Privacy
- Dependency (loss of control)
- High Initial Cost

4. Deployment Model that seems suitable considering the technology offerings (select any one)

- Private Cloud
- Public Cloud
- Hybrid Cloud

5. Application Name: _____

6. Is application critical to core business?

- Yes
- No

7. Application Type (select any one)

- Internet
- Intranet

8. What technology is utilized for developing this application? (select any one)

- .NET
- JAVA
- Other

9. Which database, if any, your application connects to? (select any one)

1. DB2
2. SQL Server
3. Oracle
4. Other

10. Will the application require any SQL Server Integration Services (SSIS) support?

- Yes
- No

11. Will the application require greater than 99.95 % availability?

- Yes
- No

12. Application has transactions with PII (Personally identifiable Information) Data?

- Yes
- No

13. Number of Servers [Total of Development, Test and Production]: _____

14. Number of CPUs [Total of Development, Test and Production]: _____

15. Memory (RAM in GB) [Total of Development, Test and Production]: _____

16. Storage (Disk size in GB) [Total of Development, Test and Production]: _____

17. Infrastructure Procurement and Maintenance Cost (approx. in Rs.) (select any one):

- 1 to 50,000
- 50,001 to 1,00,000
- 1,00,001 to 10,00,000
- More than 10,00,000

18. Do you require to connect to a server outside Cloud (like Mail Server, Active Directory Server etc.)? If yes, please specify.

- Yes: _____
- No

19. Will the Database server be also migrated to Cloud environment?

- Yes
- No

20. Is it required to encrypt the data in Cloud environment?

- Yes
- No

21. Do you need Secured Socket Layer (SSL) certificates for web or app servers in Cloud environment?

- Yes
- No

22. Is Single Sign On (SSO) required for the application in Cloud environment?

- Yes
- No

23. Number of Servers required in Cloud environment [Total of Development, Test and Production]: _____

24. Number of CPUs required in Cloud environment [Total of Development, Test and Production]: _____

25. Memory (RAM in GB) required in Cloud environment [Total of Development, Test and Production]: _____

26. Storage (Disk size in GB) required in Cloud environment [Total of Development, Test and Production]: _____

* Survey Link:

https://az1.qualtrics.com/SE/?SID=SV_83cEibn4OkcaTJz&Preview=Survey&BrandID=qtrial2014

6.2 Abbreviations

RBI	Reserve Bank of India
BNFS	Banking and Financial Service
NFC	Near Field Communication
OBC	Oriental Bank of Commerce
ATM	Automated Teller Machine
NRI	Non Resident Indian
IT	Information Technology
VSAT	Very Small Aperture Terminal
CBS	Core Banking Solution
CISO	Chief Information Security Officer
EDP	Electronic Data Processing
OTP	One Time Password
NEFT	National Electronic Funds Transfer
CPU	Central Processing Unit
NIST	National Institute of Standards and Technology
IaaS	Infrastructure as a Service
PaaS	Platform as a Service
SaaS	Software as a Service
Amazon EC2	Amazon Elastic Compute Cloud
SLA	Service Level Agreement
VM	Virtual Machine
PMI	Project Management Institute
ROI	Return on Investment
TCO	Total Cost of Ownership