

‘Cloud Computing’ a Winning Differentiator for Enterprises! Part I: Findings and Implications from Longitudinal Analysis and Systematic Review

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Abstract — Cloud computing has been one of the highest growth technology segments over the last few years, and organizations of all sizes are showing a keen interest in investing in various forms of cloud computing solutions. Driven by various advantages, such as the reduction of capital and operational expenditure, higher scalability and productivity, and ease of management, the cloud computing market is poised to witness significant growth in the coming years.

Currently, the public cloud deployment model is more popular among enterprises, as it is considered to be the most cost effective cloud computing segment; however, the security concerns relating to this deployment model have created some doubts in the minds of those enterprises that are new to these services. This has led to the adoption of private cloud solutions among enterprises, especially in the healthcare and financial services sectors, wherein the data and applications are stored within the customer’s firewall, thereby reducing the probability of data misuse and other security threats. However, the cost of deploying a private cloud solution is considerably higher, which restricts its pervasive adoption, since cost reduction and scalability are generally the prime reasons for enterprises choosing to deploy cloud computing services. Meanwhile, with developments in the area of hybrid cloud, which enables users to deploy a combination of public and private cloud, the issues relating to security and compliance are relatively mitigated, and organizations are also able to achieve a high value to cost ratio.

Keywords — Frankenclouds, IaaS, Managed Services Providers (MSPs), OpenStack, PaaS, Returns on Investment (ROIs), SaaS, Total Cost of Ownership (TCO).

I. INTRODUCTION

Globally diminishing economic conditions have created the need for more sophisticated, low cost solutions for enterprises, through which they can derive high productivity and profitability. Consequently, cloud computing has been at the top of CIOs’ agendas over the last few years, primarily driven by its advantages relating to a lower total cost of ownership (TCO), higher flexibility, and improved disaster recovery.

Moreover, the availability of high-speed bandwidth and multi-tenant architectures has further boosted the wide scale adoption of cloud computing [1].

The below mentioned Fig (1) shows the overall ICT budget change pattern (flat, growth or shrink) from FY 2013-14 to FY 2014-15.

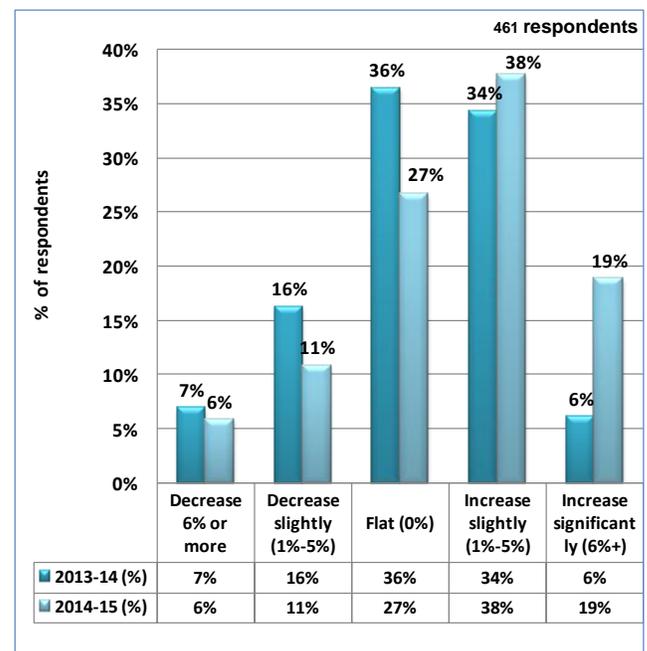


Fig.1. ICT budget change (growth or shrink) from 2013-14 to 2014-15

During the early phases of adoption, investment in cloud computing was considered more of an IT-driven decision, but over the years, spending on this area has increasingly been gaining strategic importance, with CXOs playing a key role in making decisions relating to the adoption of cloud computing services.

While the public cloud model is the simplest form of cloud computing deployment, where the data and applications are stored in third-party data centres shared by various users, the evolution of the private cloud and hybrid cloud has provided a new dimension to the way cloud computing services can be provisioned in a more secure environment. As the competition in the public cloud market is intensifying, vendors are looking to develop vertical specific cloud solutions, as they help in adhering to various vertical-specific compliance and regulations, in addition to enabling cloud vendors to achieve differentiation, by providing customized packages targeting the unique needs of customers in specific sectors [2].

Meanwhile, SaaS is the oldest and most mature cloud solution; over the last few years, SaaS based solutions have become an alternative to on-premise solutions, and are expected to overtake the on-premise market in the coming years. Moreover, with established software vendors and niche IT providers having ventured into the SaaS market, competition in this domain has intensified; as a result, vendors have now started to focus on providing more value-added offerings, rather than emphasizing the low-cost advantages [3]. The below mentioned Table (1) and Fig (2) illustrates the number of large enterprises responded for ICT survey.

Table 1:
Large enterprises ICT survey data geographic breakdown

Countries	Count
India	42
Spain	38
France	38
UK	36
US	34
Italy	28
Germany	25
Brazil	25
Russia	24
Japan	18
Canada	17
China	16
Others	120

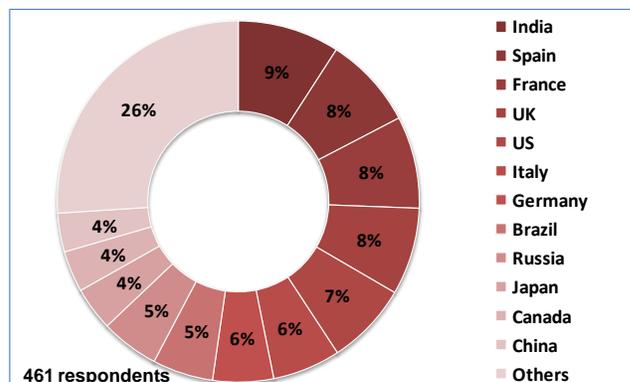


Fig.2. Large enterprises' ICT survey data geographic breakdown

II. EMPIRICAL EVIDENCES AND SUPPORTING ARGUMENTS

1. The emergence of managed cloud services

Enterprises globally, have been embracing all forms of cloud computing, as it appears to be a cost-effective option, which has resulted in the commoditization of cloud services. While some enterprises have been able to generate significant cost savings and achieve scalability, agility, and improvements to their operations, there have also been enterprises that were quick to jump on the cloud computing bandwagon, who are now finding it tough to deploy and manage their cloud projects. This situation has resulted in the development of a new set of services i.e. managed cloud services or managed cloud hosting services, which typically involves handing over the management or hosting of the private or hybrid cloud environment to one or more third parties, thereby freeing an organization's IT department from its monotonous operational responsibilities [4].

Whilst from a demand perspective this looks to be a win-win prospect, suppliers are also keen to latch on this opportunity, with vendors adding managed services to their existing cloud propositions. This will improve their relationship with clients, and provide them with an opportunity to up-sell and cross-sell their other services. For example, in order to achieve differentiation in the already competitive cloud market, Rackspace has relaunched its public cloud services as managed cloud offerings, under which the company will provide managed infrastructure services and managed operational services. According to survey results, cloud vendors supporting the OpenStack cloud standards will benefit from the emergence of the managed cloud services trend in the coming years.

The below mentioned graph reveals the proportion of overall ICT budget change from FY 2013-14 to FY 2014-15. The given figure shows that large enterprises allocated 24% and 30% of their overall ICT budget to cloud services in FY 2014 and FY 2015 respectively.

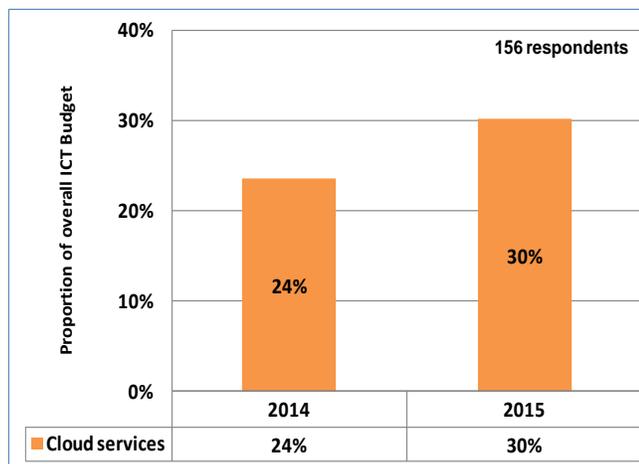


Fig.3. Proportion of overall ICT budget change (growth or shrink) from FY 2014 and FY 2015.

Moreover, the managed cloud services trend will also help those managed services providers (MSPs) who are looking to enter this burgeoning cloud computing market, primarily through the support of “white label” cloud providers, who provide wholesale cloud services. By bundling customized professional and support services with their usual cloud services offerings, MSPs can create differentiation compared to other established cloud computing vendors such as AWS and Google, who are more focused on providing core cloud offerings, rather than managed services [5].

2. Specialized clouds such as community clouds are evolving

The adoption of cloud computing is experiencing a second wave - from being considered as a mere cost cutting tool to assuming a stronger role, that brings in strategic and business transformation. In the current scenario, the decision to adopt cloud computing is not only being taken in accordance with IT executives, but also with non-IT executives, as investment in the cloud is now considered as more of a strategic decision than a tactical one. While there has been a noticeable shift in the way investment decisions relating to cloud computing are considered, vendors are also striving hard to differentiate their offerings, in order to gain competitive advantages and prevent the commoditization of their cloud computing solutions.

During the initial phase of cloud computing adoption [6], most IT or non-IT vendors were more focused on providing services primarily based on the public or private cloud model; however, in the last few years, vendors have been collaborating with each other to develop a range of innovative cloud computing solutions based on open source projects, and are also adopting various delivery models to improve their adoption rate.

The below mentioned Fig (4) illustrates the allocation of cloud computing budget to solution areas (PaaS, SaaS, and IaaS) among large enterprises in FY 2014 and FY 2015.

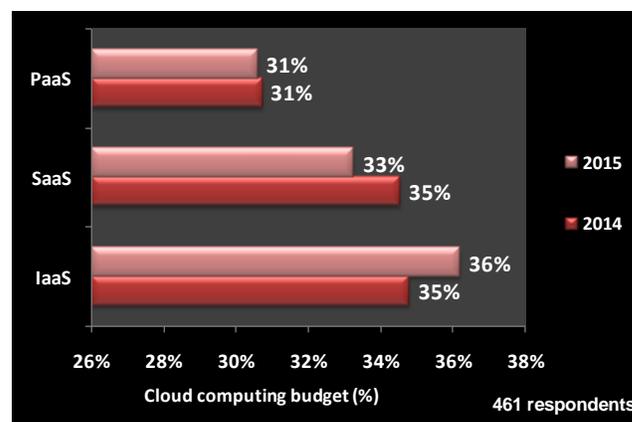


Fig.4. Cloud computing technologies adoption trends among large enterprises in FY 2014 and FY 2015.

Furthermore, over the years, it has been realised that the ‘one size fits all’ model for cloud adoption is not applicable to all industries, as different sectors have varied compliance, security, and operational requirements. This has resulted in the development of specialized cloud models such as community clouds, which are built and operated to fulfil the requirements of a particular group. The community cloud model is developed around normal cloud solutions such as SaaS and IaaS, but with a basic difference in the type of applications and functionalities it supports, which are in turn based on the specific industry requirements of the client. For example, as financial services, healthcare, and government institutions have stringent security, governance, and regulatory compliance requirements, organizations in these sectors are opting for the community cloud model, in order to gain access to a wide array of applications, reduce total cost of ownership, and implement new services faster [7]. Similarly, various enterprise applications and analytics tools from multiple vendors can be integrated and provisioned as community cloud offerings, helping enterprises across sectors with similar requirements, to gain access to these applications.

Vendors are also keen to adapt to the community cloud trend, as it enables them to provide more value added cloud computing offerings, rather than relying primarily on the low cost features of cloud computing, thereby creating differentiation in the otherwise highly competitive segment. The financial and government sectors are at the forefront of adopting the community cloud model, and it is expected that the adoption of this model to witness an upward momentum from the financial services sector [8].

3. Industry consolidation, competition, and the cloud first approach shaping the vendor landscape

The cloud computing market is primarily dominated by established IT vendors such as IBM, Salesforce.com, Microsoft, Fujitsu, and Oracle, with the exception of AWS, a non-IT player, which has been witnessing robust growth over the last few years, primarily driven by its IaaS offerings. Google is another vendor that has been witnessing tremendous growth in the last two years, backed by its IaaS and PaaS offerings. However, a variety of cloud based start-ups are also entering the market, aggressively looking to make their presence felt in this growing cloud computing segment [9]. As competition is extremely fierce among the top cloud vendors, they are continuously looking for any inorganic growth opportunities, to enhance their product portfolios and increase their market share.

The below mentioned Fig (5) illustrates the allocation of cloud computing budget to private cloud, public cloud and hybrid cloud among large enterprises in FY 2014 and FY 2015.

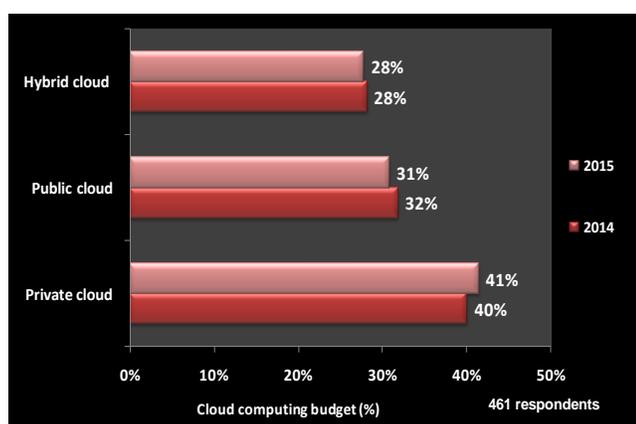


Fig.5. Cloud computing adoption trends among large enterprises in FY 2014 and FY 2015.

Although the last year has witnessed a range of acquisitions by established cloud vendors such as Concur Technologies by SAP, Metacloud by Cisco, Cloudscaling, Maginatics and Spanning by EMC, and Lighthouse Security Group, LLC, and SoftLayer by IBM, the cloud vendor landscape is still quite fragmented and complex. In addition, in order to focus on their core strengths, offload their non-core offerings, and improve margins, vendors are also looking to enter into strategic partnerships with other IT vendors. Moreover, the evolution of a new wave of cloud service providers, such as cloud managed service providers, cloud brokers, wholesale cloud providers, and other value added resellers, is further complicating the cloud vendor landscape and putting more pressure on established and niche cloud providers. According to survey results, consolidation in the cloud computing vendor landscape will be an ongoing trend over the next few years, with an increasing number of niche and small cloud vendors coming up with innovative cloud offerings, further intensifying the competition in an already fragmented market [10].

Over the last year, in order to curb competition, major cloud based vendors, primarily in the IaaS segment, have reduced their prices to achieve a competitive advantage and improve the attractiveness of their offerings. However, it is expected that this approach will not last long, as the revamping of a pricing strategy will ultimately impact the profit margins of vendors, rather than providing vendors with a sustainable growth model. For example, the recent launch of Haven OnDemand by HP is the company's effort to provide a big data analytics solution on its Helion cloud platform. Furthermore, to attract the greater share of this growing cloud computing market, ICT vendors have put the cloud as a central theme, adopting cloud first strategies (for example Microsoft's Mobile First, Cloud First Strategy), where they look to provide any new solution or update over the cloud platform prior to the release of the on-premise version.

It is expected that once the other big cloud computing vendors begin to focus on developing such solutions, the competition in the market will increase, and customers will have access to more innovative and cost-effective collaborative cloud computing solutions. The below mentioned Table (2) and Fig (6) illustrates the number of large enterprises responded for ICT survey across the industry verticals. The respondent size for retail banking counts for 56, similarly respondent size for healthcare counts for 43.

Table 2:
Large enterprises' ICT survey data industry breakdown

Industry	Count
Retail banking	56
Telco/service provider	49
Government	47
Healthcare	43
Energy	42
Financial markets	40
Retail	33
Education	33
Manufacturing	29
Insurance	29
Utilities	28
Pharmaceuticals	15
Media	15

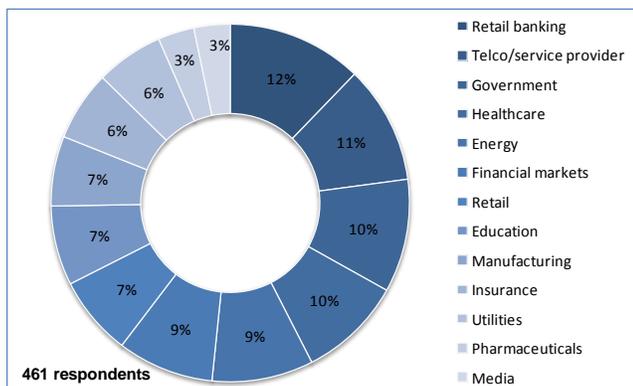


Fig.6. Large enterprises' ICT survey data industry breakdown

III. KEY INHIBITORS AND ISSUES

1. Data security, compliance, and legal challenges

While cloud computing brings various benefits to the table, such as scalability, ease of management, and cost reductions, the issues relating to data security and compliance are still hindering the fully fledged growth of this segment globally. The intensity of this challenge increases when an organization opts for a public cloud, where the data is hosted in a shared data centre anywhere in a global location. Although the data is encrypted, the cloud service provider has the encryption key, through which it can misuse the stored information for its own vested interest [12]. Moreover, there is also the possibility of the encryption key being accidentally damaged, in turn corrupting the data and making it unusable.

The varying regulatory and compliance requirements of clients are also hindering the growth of cloud computing solutions, such as the privacy laws in the European region and Japan, which demand that private data, including emails, be stored in data centres located within their region. Moreover, some regulations, which require the privacy of data in a particular geography, are often contradictory to regulations in another country, where the disclosure of private data to government organizations is mandatory. For example, the Federal Rules of Civil Procedure in the US allows the discovery of data, while it is a breach of code of conduct under Canadian and EU law. Apart from this geographic disparity, industry level regulations, especially in the healthcare and financial services sectors, are also giving headaches to cloud computing service providers catering to such verticals. Moreover, failure to protect the confidential employee and business data can have serious repercussions for cloud computing providers, ranging from huge fines to damaging their brand image. While, with the deployment of private and hybrid cloud services, issues concerning security and privacy should be resolved, the compliance challenges relating to the use of data nevertheless continue to create some doubts in the minds of organizations [13].

In addition to the security and regulatory issues, legal and intellectual property (IP) challenges are also negatively affecting cloud computing adoption. In certain scenarios, there is a clear cut demarcation line and the IP issues are taken care of diligently; for example, a cloud computing provider has the ownership of applications and infrastructure, while the client owns the data and results.

However, in some cases, the cloud provider, in the course of managing and uploading a customer's data, can create new IP (such as relating to service improvements or bug fixes), and as this IP is created from the client's data, it would be difficult to identify who owns this IP, thereby creating a conflict between the customer and the cloud provider [14].

The below mentioned Table (3) and Fig (7) illustrates various factors influencing large enterprises' decision to choose an IT provider in FY 2014. Various factors such as geographical reach, contract flexibility, financing options payment terms, expertise in industry and many others have been rated by respondents on a scale of one to four and shown below.

Table 3:
Factors influencing large enterprises' decision to choose an IT provider

Factors	Average rating (On a scale of one to four)
Financing options/payment terms	2.7
Geographical reach	2.7
Contract flexibility	2.8
Breadth of solution offerings	2.9
Financial stability	3.0
Specific functionality expertise/depth	3.0
Expertise in your industry	3.0
Price	3.1
Leading-edge technology	3.1

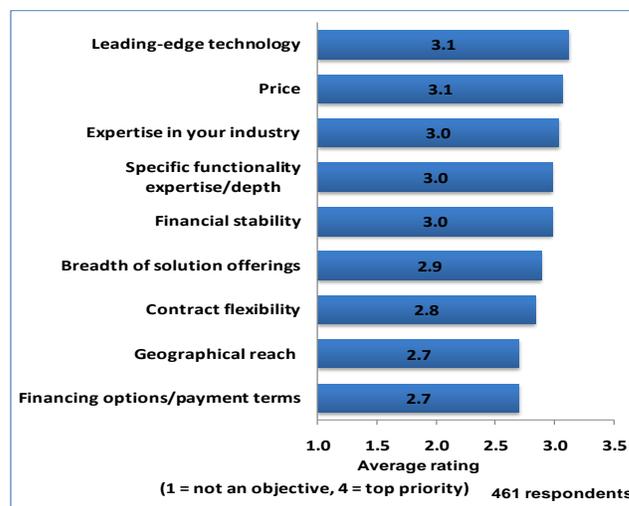


Fig.7. Factors influencing large enterprises' decision to choose an IT provider

2. Issues relating to interoperability and the rise of Frankenclouds

With enterprises opting for various forms of cloud adoption in terms of technology and deployment models, the need for interoperability and standardization is gaining consideration. As each cloud vendor has its own set of standards, the migration of applications or data from one cloud model to another is becoming a tedious task for enterprises that have deployed different cloud solutions from multiple vendor. Although this lack of standardization and interoperability is not stopping enterprises from investing in cloud solutions, it is expected to reduce the pace of investment in this domain [15].

The major problem lies in the fact that the cloud model is based on virtualization, and that each cloud platform deploys different hypervisor and virtual machine (VM) technologies, which are not interoperable. For example, Microsoft has Hyper-V, Citrix uses XenServer, and AWS uses Amazon Elastic Compute Cloud, which all deploy distinct VM versions and have different management and security standards that are not natively interoperable.

Moreover, to address this lack of standardization, some cloud computing vendors have come up with their own application programming interfaces (APIs) such as vCloudAPI by VMware and Deltacloud platform by Red Hat; however, as this will result in vendor lock-in, the pervasive adoption of such open standards has still not gathered momentum. To date, the closest standard for cloud computing is OVF (Open Virtualization Format), but that also deals with the infrastructure level or virtual machines.

Meanwhile, as enterprises are deploying multiple cloud solutions from different vendors, they are facing problems relating to integrating these solutions due to a lack of standardization and migration models [16]. This has led to the emergence of a new concept, known as “Frankenclouds”, which can sometimes be confused with the hybrid cloud model with composite multiple public and private cloud, but which is not as productive as the hybrid cloud model. While the hybrid cloud model supports features such as single sign-on (SSO) and seamless migration, the Frankencloud model reduces efficiency and increases the overhead cost of management.

With the need for the migration of the cloud solution from one platform to another expected to gain momentum in the coming years, enterprises have to work out some strategy to counter the effect of Frankenclouds and standardize their cloud portfolio.

3. Drawbacks relating to bandwidth and latency

As cloud services are provisioned through the internet, the bandwidths of enterprise networks become an important factor for efficiently accessing cloud based solutions. Any network downtime will restrict user access to cloud applications, whereas bandwidth shortage will result in the slow loading of any web based applications, thereby increasing latency and reducing operational efficiency and productivity. Moreover, with enterprises increasingly migrating to the cloud and deploying a range of applications on the cloud, problems relating to latency are becoming more complex. One way to tackle the growing demand for bandwidth and reduce latency is by upgrading the WAN link; however, this will result in an added cost, in turn diminishing the advantage of cloud solutions. Consequently, IT departments in enterprises are looking to deploy various WAN Acceleration tools to enhance productivity, by optimizing the network and application protocol, and improving the network dependent application performance [17].

Moreover, cloud computing vendors are also striving hard to overcome the latency barrier by optimizing network bandwidth, through limiting the amount of data that flows through the channel. Vendors are using technologies such as link load balancing and binary patching to restrict the complete transfer of data, by transmitting only the part that has witnessed some change or alteration. In addition, various de-duplication and compression techniques have also been deployed by vendors to reduce the file size being transferred through the network.

Meanwhile, organizations are selecting various co-location providers to take care of latency related problems, as most co-location vendors offer cloud hubs that provide seamless connectivity and interconnection with all partners such as cloud providers, exchange, and network providers, thus improving overall performance.

IV. DISCUSSIONS AND IMPLICATIONS FOR ENTERPRISES TO HARNESS CLOUD COMPUTING

1. Lower TCO, higher scalability, and the elimination of CAPEX

The major and ubiquitous factor in the growing proliferation of cloud computing services is its ability to free customers from investing in any infrastructure, software licenses, and platforms. As the cloud computing vendor takes full responsibility for major capital expenditure, such as all infrastructure requirements, to run the servers, storage, operating systems, cooling equipment, and back-ups, the total cost of ownership and CAPEX from the client perspective is significantly reduced. Vendors, on the other hand, take advantage of these economies of scale by creating a shared infrastructure and solution to various clients with similar requirements [18].

Moreover, as the prices of cloud services are primarily on a pay-per-use basis, the customer has to pay only according to their usage and requirement for the cloud resources. Consequently, by going for the cloud computing solution, organizations can scale-up or scale-down their use of various infrastructure and application resources, based on current requirements. For example, during the festive season, an e-commerce retailer can easily increase its server utilization to support the traffic spikes on its website, while it can reduce utilization during the down periods, which would otherwise have not been possible without installing a new server.

Therefore factors such as scalability and flexibility are set to drive the market for cloud computing in the coming years, as they enable enterprises to expand their operations without really investing significantly in IT infrastructure and software licenses.

Moreover, while public cloud solutions enable enterprises to do away with the capital and management cost of infrastructure and applications, private and hybrid clouds still require organizations to manage their cloud projects. However, with the emergence of various managed cloud service providers, this routine work of managing different cloud based solutions will be taken care of by such providers, thus reducing the time and effort on the part of the customer [19].

The below mentioned Table (4) and Fig (8) reveals large enterprises' overall ICT budget allocation in the FY 2014 and FY 2015 (how did large enterprises spend their overall ICT budget in FY 2014? How will this change in 2015?). The survey result shows that large enterprises allocated 26% and 22% of their overall ICT budget to hardware and software respectively in FY 2014, whereas large enterprises allocated 23% of their overall ICT budget to software segment in FY 2015, while the allocation for hardware segment remains the same in FY 2015.

Table 4:

Large enterprises' (external) ICT budget allocation, 2014 and 2015

Category	2014	2015
Hardware	26%	26%
Software	22%	23%
Services	16%	16%
Communications	15%	15%
Consulting	13%	12%
Other	8%	8%

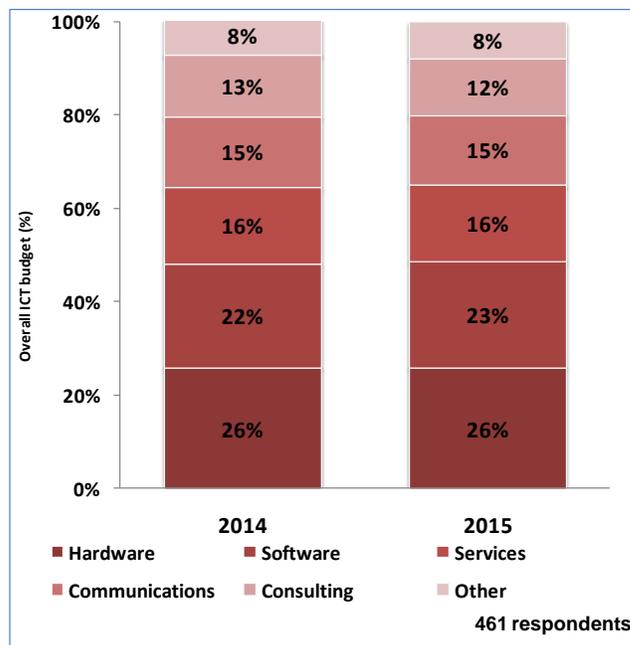


Fig.8. Large enterprises' ICT budget change from 2014 to 2015

2. Growing volumes of data and the emergence of big data

According to research reviews, one of the biggest challenges that enterprises are currently facing is the storage and management of rising volumes of enterprise and customer related data. Moreover, deploying, managing, and maintaining storage infrastructure to store this burgeoning amount of data is beginning to haunt CIOs, as it requires a huge capital expenditure from enterprises. In addition, purchasing more storage area networks (SAN) arrays will not be a profitable and practical option for enterprises, as it is not possible to predict the capacity that would be enough to support this growing data balloon. This precarious situation has created a huge market for cloud storage vendors, particularly private and hybrid cloud storage providers, as the scalable storage capabilities of the vendors provide the much needed option for enterprises to store their less frequently accessed data within third-party data centres, in an optimum secure environment.

In addition, while providing scalable resources and reducing capital expenditure, HCS maintains the on-premise processing speed to deal with the latency factor. Many cloud storage vendors are making large efforts to come up with HCS solutions, such as Nirvanix's launch of its hybrid cloud storage service, hNode storage, in order to cater to the growing demand for such solutions. Other major cloud storage providers, including the likes of AWS, Google, IBM, and Rackspace, are also working in this domain but without any major success. Therefore, it is expected that in the coming years, a major effort on the part of cloud storage vendors will be devoted towards developing a hybrid cloud storage solution.

Meanwhile, the growing volumes of structured and unstructured data available from various social networking sites, blogs, and other digital media, has created the need for various big data and analytics solutions in order to manage and analyze this data, to extract useful insights for business growth. However, the high costs of such business intelligence tools have somewhat restricted the pervasive adoption of these applications amongst enterprises. Moreover, deploying an on-premise RDBMS (relational database management system) often faces a processing dead-lock when a huge quantity of data is pushed in and queries start to impact the RAM and processor. To overcome these issues, vendors are coming up with cloud-based DBMS solutions such as the on-demand NoSQL solution, which not only helps in managing and analysing structured data, but also enables enterprises to manage unstructured data with scalable computing resources, at a lower cost.

3. Improved business continuity and disaster recovery

With the rising dependence on technology, organizations are always looking to keep their ICT systems up and running in order to continue their normal business operations and secure their critical business information. However, various natural catastrophes and terrorist attacks have been continuously testing the reliability of the disaster recovery and business continuity models currently in place. Although enterprises have become more open to investing and devising a comprehensive business continuity plan, the costs involved in putting the backup systems and infrastructure in place have somewhat restricted organizations from investing in this domain.

However, with developments in the space of cloud computing, the major hindrances for devising a disaster recovery plan, i.e. cost and space, have been resolved, as organizations can now reduce their power usage and processing requirements by adopting a shared environment.

As the data and applications are stored in a third-party data centre and server location, this facilitates enterprises to resume their operations quickly, in spite of the failure of their on-premise systems and applications.

Earlier, in order to ensure uninterrupted business operations, enterprises had to create duplicate backup systems, which were proving to be cost, time, and space consuming. Furthermore, the availability of disaster recovery in a cloud environment comes as a real confidence booster for SMEs, as they can now move their operations to a cloud platform and develop a comprehensive disaster recovery strategy for their entire ICT infrastructure [20].

V. CONCLUSIONS AND FUTURE RESEARCH

"The evolution of new cloud delivery models and developments in the Internet of Things, big data, and mobility are powering the demand for cloud computing services."

The need for organizations to improve their operational efficiency and profitability whilst reducing costs, has generated demand for various disruptive solutions, of which cloud computing solutions are gaining significant attention. In addition to the obvious advantages relating to improved cost structure and enhanced scalability, cloud solutions also enable enterprises to adopt advanced solutions such as business intelligence, mobility, and M2M applications, as well as facilitating the adoption of a comprehensive business continuity strategy among organizations.

Cloud deployment models such as public and private cloud are already popular amongst enterprises, with those organizations focusing on cost savings and scalability opting for the public cloud model, while those with high security and compliance requirements choosing the private cloud model. However, over the years, enterprises have been in a dilemma with respect to the choice of public or private cloud, and which applications or data should be deployed in the public cloud and vice-versa. Nevertheless, with developments in the space of hybrid cloud, this concern is somewhat resolved, and organizations can deploy a combination of multiple public and private clouds.

In addition to these deployment models, cloud vendors are also coming up with innovative delivery models, such as the community cloud and managed cloud services, to increase the penetration of their solutions. In order to mitigate the risks associated with specific industry compliance, vendors have come up with a community cloud model, which provides shared cloud services for specific industry players with similar requirements.

Meanwhile, managed cloud services involves handing over the management or hosting of private or hybrid cloud environments to other third-party providers, thereby freeing the organization from performing monotonous operational tasks. Some other important trends in the cloud computing market are the emergence of the fog computing concept, and the consolidation of the cloud computing vendor landscape.

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