Utilizing Cloud Computing for Modernizing Universities IT

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ABSTRACT
Cloud in cloud computing refers to the combination of resources such as applications, networking, database, OS and infrastructure at one place and which will be provided by using Internet Media and Data Storage on a third party Server. Universities play an important role in development process of Nation. The research carried out in the Universities can be aligned with the needs of the region that will improve the local economy. Universities in India are dominant adopter of IT services. Most of the Indian Universities have adopted the traditional usage of IT resources and have incurred a heavy cost while implementing it. The paper presents the cost savings and reduction in the level of difficulty in adopting a cloud computing Service (CCS). In the cloud computing environment the Universities will not have to own the infrastructure so they can abstain from any capital expenditure and instead they can utilize the resources as a service and pay as per their usage. The paper also proposes Education ID (EID) for every Indian Citizens, which in turn can be linked to UID.

Keywords
Cloud Computing, Traditional Computing, Virtualization, University Cloud, IT, UID, EID, SMBs, Cloud Computing Market, Factor Rating Method

1. INTRODUCTION
Innovation in IT industry has always been faster compared to other industries. It has resulted in the industry witnessing a series of transformations over the last 50 years. Technology transformations started with mainframe computers than moved on to minicomputers, PCs and the web. The next wave of transformation in IT industry is cloud computing. We have already seen the success of cloud computing in the consumer world. Companies such as Facebook have grown over the last 5 years to reach over 400 million active users. The company is today valued at more than USD 15 billion dollars. The growth, revenue and the market valuation was only possible by using all three corner stone's of cloud computing i.e., *Technology Innovation*, *Delivery Model Innovation* and *Business Model Innovation*.

India's 73% of population lives in the rural areas and villages. This rural segment, commonly referred to as the 'bottom of the pyramid' showing a huge opportunity for companies. Even for the people, who can afford a computer become a headache to maintain, upgrade and buy licenses for the software on regular basis. Also, they need to carry their computer everywhere they go. If a "personal computer" can be made available on cloud, accessible from anywhere, that too free or minimal charges (pay-as-you-use) rural people can afford and grow their personnel life. The Cloud Computing can help the rural population in overcoming the huge costs incurred on infrastructure, software etc., hurdles and it can lead to rural area development and an overall economic progress of the nation. Using cloud computing to reduce price will create a world without poverty.

Over the past few years, the concept of cloud computing and virtualization has gained much momentum and has become a more popular phrase in information technology. Many organizations have started implementing these new technologies to further reduce costs through improved machine utilization, reduced administration time and infrastructure costs. Cloud computing is the environment that enables users to use applications on the Internet such as storing and protecting data while providing a service.

Cloud computing has been universally recognized as a critical component in the field of education. This is more so in the higher education sector where more advanced tools are necessary for data sharing, teaching, and protection, as well as for advanced instruction.

Generally, most countries in the world experience a decline in higher education budgets. In fact the universities need to be able to continue to offer quality services in spite of the limited budget. The role of IT has thus tremendously arisen to a whole new level. Of course, IT is a complicated technology to operate and maintain by itself. With cloud computing, however, things become more easily manageable and affordable.

The aim of the paper is to analyze possibilities of the cloud computing technology that help educational institutions or Universities to support a process of Teaching and Learning. To achieve this aim, the research tasks involved are as follows-

1. To study of Computing Paradigms, Concept of Virtualization, Variants of Cloud, Types of Cloud etc.
2. To analysis of Growth of Cloud Computing Market
3. To explore the Cloud possibilities for the educational organizations or Universities.
4. To predict the economics of Cloud Computing

Factor Rating Method was used to verify that cloud computing services are more adaptable than traditional computing services.

2. CLOUD COMPUTING

Definitions of cloud is defined by many expert, but the National Institute of Standards and Technology (NIST) definition is a generally accepted standard: "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (such as networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [1]. More simply, a cloud can be considered to be a collection of hardware, software and other resources that can be accessed over the Internet, and used to assemble a solution on demand (that is, at the time of the request) to provide a set of services back to the requester.

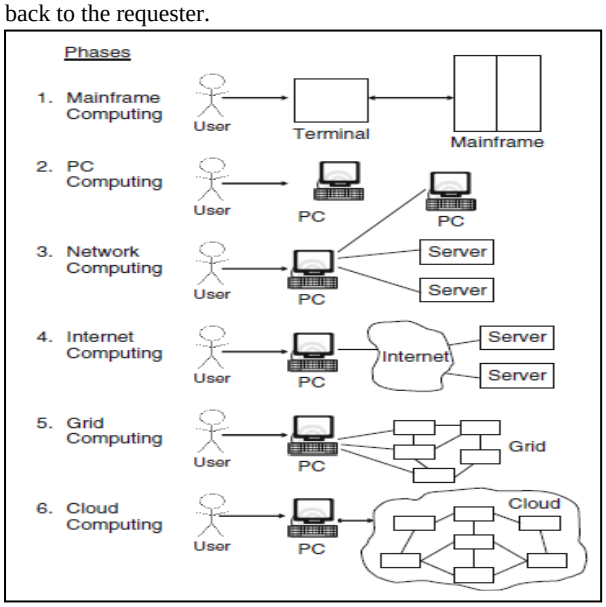


Fig 1: Six Computing Paradigms

Fig. 1[2] shows six phases of computing paradigms, from dummy terminals/mainframes, to PCs, networking computing, to grid and cloud computing. In phase 1, many users shared powerful mainframes using dummy terminals. In phase 2, stand-alone PCs became powerful enough to meet the majority of users' needs. In phase 3, PCs, laptops, and servers were connected together through local networks to share resources and increase performance. In phase 4, local networks were connected to other local networks forming a global network such as the Internet to utilize remote applications and resources. In phase 5, grid computing provided shared computing power and storage through a distributed computing.

"Cloud Computing" is a broad but fledgling area spurred by several important technological trends. The most important trends underlying all cloud offerings are 1) ubiquitous network connectivity and 2) virtualization. Connectivity is critical for the viability of the cloud model because services are delivered and accessed over the Internet. Virtualization is technique of abstraction applied at different layers of the computing hardware or software stack, decoupling resources' interfaces from underlying low-level details. Applied properly, it can allow seamless scaling of resources with changes in demand. It also enables more efficient sharing of surplus capacity that might otherwise be underutilized. Virtual Machine technology allows multiple virtual machines to run on a single physical Machine [3].

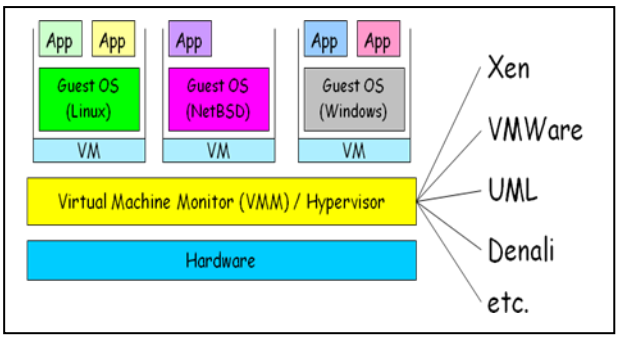


Fig 2: Virtualized Stack

The variants of cloud computing are shown in Table I [4] and the types of cloud computing are show in Table II [5].

Table 1. Variants of Cloud Computing

Level	Label	Description
User Level	SaaS "Software as a Service"	Companies host applications in the cloud that many users access through Internet connections. The service being sold or offered is a complete end-user application.
Developer Level	PaaS "Platform as a Service"	Very well Developers can design, build and test applications that run on the cloud provider's infrastructure and then deliver those applications to end-users from provider's servers.
IT Level	IaaS "Infrastructure as a Service"	System administrators obtain general processing, storage, database management and other resources and applications through the network and pay only for gets used.

Table 2. Types of Cloud

Category	Description
Private Cloud	The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.
Community Cloud	The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.
Public Cloud	The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
Hybrid Cloud	The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

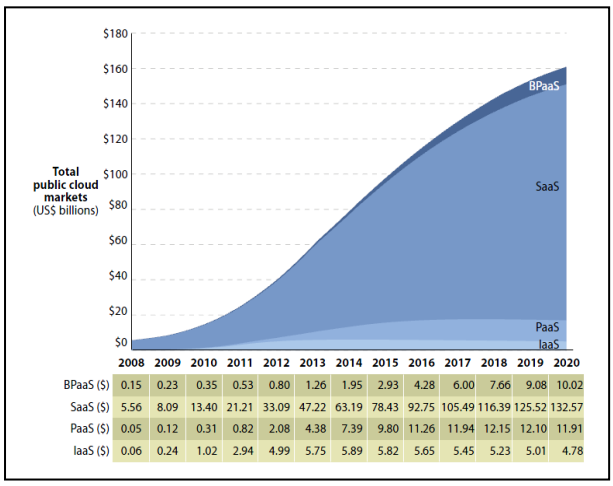
3. CLOUD COMPUTING MARKET ANALYSIS

The global cloud computing market will grow from a $40.7 billion in 2011 to $241 billion in 2020, according to Forrester Research, Inc [6].

Few remarkable nuggets from the report are follows-

1. For starters, the infrastructure as a service market will peak at $5.9 billion in global revenue in 2014 and then commoditization, price pressure and falling margins kick in. In other words, early wins by Amazon Web Services and Rackspace won't add up in the long run.
2. Software as a service will be adopted by companies of all sizes. In 2011, SaaS will be a $21.2 billion market and grow to $92.8 billion in 2016. AT that point SaaS came closer to saturation.
3. Business Process as a service will be notable, but face modest revenue.
4. Virtualization will recede to the background as new technologies take over.

Here's a look at the big cloud picture through 2020 as in Fig. 3



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BPaaS ($)	0.15	0.23	0.35	0.53	0.80	1.26	1.95	2.93	4.28	6.00	7.66	9.08	10.02
SaaS ($)	5.56	8.09	13.40	21.21	33.09	47.22	63.19	78.43	92.75	105.49	116.39	125.52	132.57
PaaS ($)	0.05	0.12	0.31	0.82	2.08	4.38	7.39	9.80	11.26	11.94	12.15	12.10	11.91
IaaS ($)	0.06	0.24	1.02	2.94	4.99	5.75	5.89	5.82	5.65	5.45	5.23	5.01	4.78

Fig 3: Forecast: Global Public Cloud Market Size, 2011 To 2020

Current IT architecture has led organizations world-wide to allocate nearly 70% of their IT budgets to keep existing applications running, leaving scope for only 30% to create new value. With increased business complexity and declining profit margins, companies are now looking at cloud computing as new IT business model to create more value, achieve cost benefits and business agility. Cloud computing is witnessing robust adoption across the world, especially amongst developing markets such as APAC and Latin America with countries from APAC such as India, China, Australia and Singapore leading the way [7].

TechNavio's analysts forecast the Cloud Computing market in India to grow at a CAGR of 54.5 percent over the period 2011-2015. Also, Enterprise cloud penetration will surge to 46% in 2016 which is 4% in 2011 [8]. One of the key factors contributing to this market growth is the growing need to reduce capital and operational expenditure. The Cloud Computing market in India has also been witnessing growing adoption of handheld devices. However, lack of data security and privacy could pose a challenge to the growth of this market [9].

Key vendors dominating this market space include Amazon.com Inc., Citrix Systems Inc., Google Inc., Hewlett-Packard Co., IBM Corp., Microsoft Corp., Salesforce.com Inc., and VMware Inc. The other vendors included in the report are AT&T Inc., Dell Inc., Cisco Systems Inc., Huawei Technologies Co. Ltd., Avaya Inc., EMC Corp., RedHat Inc., HCL Infosystems Ltd., and Tata Consultancy Services Ltd. [7].

Students' learning is no longer confined within the classroom in the era of e-learning. The environment of IT education could be improved to let student access learning resources anywhere. IGNOU (Indira Gandhi national Open University) is the good example of e-learning. The free software can be adopted for constructing the cloud computing service for the environment of IT like OpenOffice.org such as word processing, spreadsheets, and presentations. Only a browser is needed for students to connect to the cloud computing service for learning.

The adoption of cloud computing in India will be driven, in different ways, by three major groups [10],

1. The Indian Government with its renewed focus on e-governance projects. An example is the **Unique ID Authority of India's UID project**, which aims to provide a biometric validated identity to every citizen of this country. The UID system will maintain upward of 1.2 billion biometric records and process each query in less than two seconds (as proposed). Once implemented this will be the largest cloud-based service in the world, and provide "Identity as a Service."
2. The Indian **SMB** market. SMBs do not need private clouds or even Infrastructure as a Service, but can reduce costs and manage growth better with the use of public clouds. So the focus for this group will be on Software as a Service (SaaS) offerings.
3. **Large Enterprises**, especially the telecom and manufacturing sectors are setting up private clouds but are also relying on public clouds for scaling and supporting their distributed operations.

Cloud computing technology in India will dramatically change the way we compute. Some of the obvious segments that can directly reap the benefits are listed below:

1. Schools, Colleges & Universities - Embrace R&D and provide access to the latest technologies at an affordable price.
2. New Innovative Business Firms - Start-ups need not invest for their IT infrastructure cost and consume as their business grows. In fact, you can run your business on the Cloud J with an office at home.
3. Long Tail Business Units - A small petty shop can use a CRM available on the Cloud to send SMS greetings to their customers.
4. Multimedia Content Providers - Multimedia digital content can be distributed to various consumers for a lower price.
5. Telco (Network Operators) - Becomes the Cloud Computing technology provider, we have already seen TATA Communications is investing heavily on IaaS business [11].

4. UID IMPLEMENTATION USING CLOUD

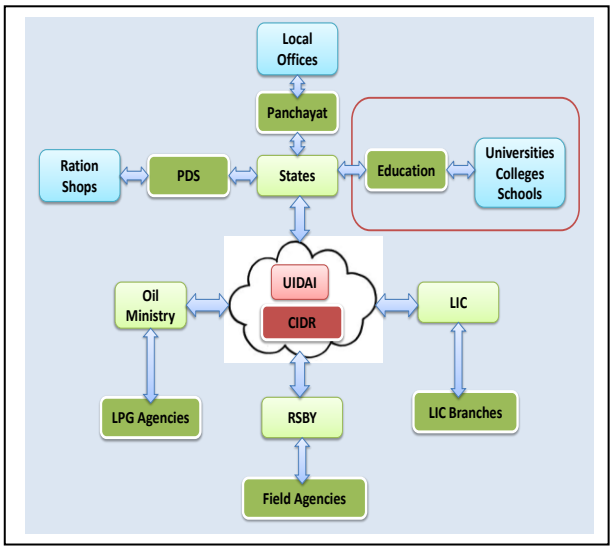


Fig 4: UID Implementation Using Cloud

UID implementation will give identity to every citizen of India. If Central Identities Data Repository (CIDR) which is linked to Oil Ministry, RSBY, LIC, States etc.(as in Fig. 4) is in the Cloud then it will be very easy in getting required details of an individual. UID implementation project is ideal candidate for cloud because in this identity needs to be authenticated as a Service.

EID (Education ID) should be generated in the childhood age itself, which will keep track of every citizen's educational details throughout their lifetime. This will be helpful in monitoring of dropouts, especially in the elementary education stage. EID can later on be linked to the UID.

5. CLOUD COMPUTING FOR INDIAN UNIVERSITIES

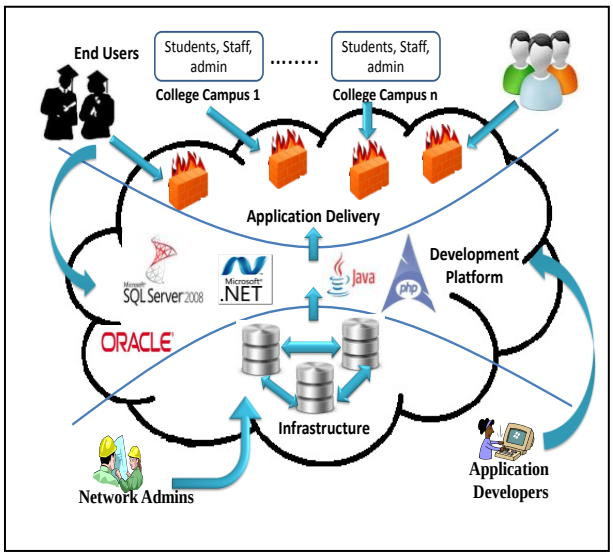


Fig 5: University Cloud

In traditional computing, we install software programs on system (computer) update the hardware as per our requirements. Documents we create or save are stored in our computer. Documents are accessible on our own network, but they can't be accessed by computers outside the network. Using of cloud computing, the software programs aren't run from one's personal computer, but are rather stored on servers accessed via the Internet.

Fig. 5 represents the proposed cloud computing for University. Students will have access to all software anytime, anywhere and any technological devices connected through internet by suggested cloud structure. Also, students will have access to development platform, and develop their applications, and stored on university infrastructure. In this way, lecturers will focus their basic tasks and not lose their workforce. With suggested cloud structure, universities can open their technology infrastructures to businesses and industries for research advancements and develop university-industry collaboration. Student can work from their lab as well from home. Where there data and application will be available always.

University has various departments and many semesters where lots of students need to access the computing so, it is a need of an hour that highly available up-to-date software and hardware is required. Which can be fulfilled by this structure? Cloud computing has the capacity of scaling and elasticity which is perfect for such an environment.

Cloud computing is a new business model wrapped around new technologies like virtualization, SaaS and broadband internet. But the average internet connection speed in India was 1Mbps in the Jan-March quarter, a growth of 16% quarter-over-quarter. Though the country has registered an increase in average speed, it still ranks 112th globally [12].

India's year-over-year growth in average internet speed grew more than 20%, but lagged far behind other Asia Pacific countries like South Korea (15.7Mbps) and Japan (10.9). The peak internet speed in the country stood at 6.9Mbps, far behind global leader Hong Kong's 49.3Mbps. Only 1.2% of connections in India have a speed of over 4Mbps, the new standard for broadband. This, however, represents an 85% increase in adoption rate in broadband speed [12].

There are many benefits of cloud computing for Universities and below are listed a few of them;

1. With cloud computing, universities can open their technology infrastructures to businesses and industries for research advancements.
2. The efficiencies of cloud computing can help universities keep pace with ever-growing resource requirements and energy costs.
3. The extended reach of cloud computing enables institutions to teach students in new, different ways and help them manage projects and massive workloads.
4. When students enter the global workforce they will better understand the value of new technologies.
5. Cloud computing allows students and teachers to use applications without installing them on their computers and also allows access to saved files from any computer with an Internet connection.

6. ECONOMICS OF CLOUD COMPUTING

The economic appeal of Cloud Computing is often described as "converting capital expenses to operating expenses" (CapEx to OpEx), we believe the phrase "pay as you go" more directly captures the economic benefit to the buyer [13]. It's better to pay by use rather than provisioning for peak as in Fig. 6 & Fig. 7.

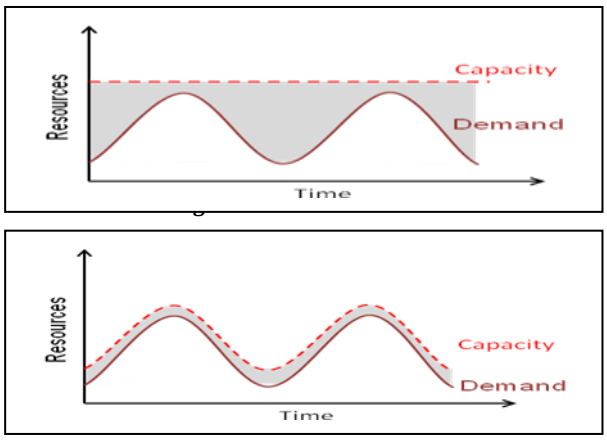


Fig 7: Cloud Data Centers

Assume our service has a predictable daily demand where the peak requires 500 servers at noon but the trough requires only 100 servers at midnight, as shown in Fig. 8. As long as the average utilization over a whole day is 300 servers, the actual utilization over the whole day (shaded area under the curve) is 300 * 24 = 7200 server-hours; but since we must provision to the peak of 500 servers, we pay for 500 * 24 = 12000 server-hours, a factor of 1.7 more than what is needed. Therefore, as long as the pay-as-you-go cost per server-hour over 3 years4 is less than 1.7 times the cost of buying the server, we can save money using utility computing.

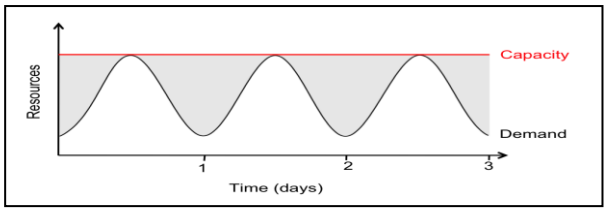


Fig 8: Provisioning for Peak Load

In one case of Underprovisioning we lose the revenue as in Fig. 9 and in another case some users desert the site permanently after experiencing poor service i.e. user is lost as in Fig 10.

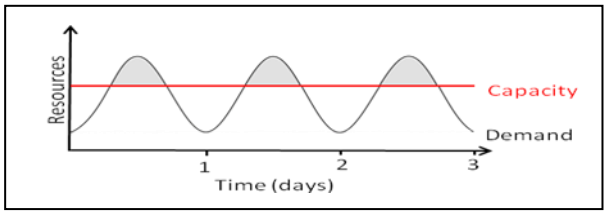


Fig 9: Lost Revenue

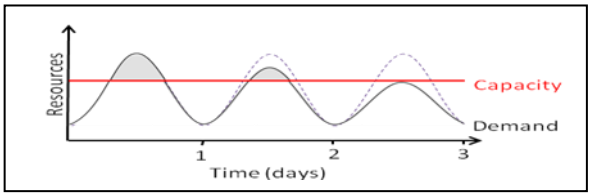


Fig 10: Lost Users

7. HYPOTHESIS DEVELOPMENT

Cloud Computing Model provides IT based services and capabilities online with data shared on a third party server. As the users are paying on hourly basis and in some cases on monthly basis, cloud computing will result in a substantial cost saving. Hence we hypothesize:-

H1: Cloud Computing Services are more adaptable than Traditional Computing Services.

H2: Cloud Computing Services are less adaptable than Traditional Computing Services.

8. RESEARCH DEVELOPMENT

The Main purpose of this paper is to examine and analyze the Scope of cloud computing for the Universities in India. So, this research paper aims to develop a research model which would justify this papers affinity towards the use of cloud computing for Indian Universities.

Parameter and Weights in Table III are selected after taking into consideration of Experts Opinion and deep study of Cloud Computing. The data in Table III is collected using E-mail based questionnaires from general users and developer who are working in IT Industries.

Table 3. Analysis of Factors of Adoption

Parameter	Trad. Comp. Score	Cloud Comp. Score	Wei-ghts	Trad. Comp. Weigh-ted Score	Cloud Comp. Weigh-ted Score
Scalability	3	1	7.5	22.5	7.5
Availability	2	1	8.5	17	8.5
Maintainability	3	1	7	21	7
Accessibility	2	1	6.5	13	6.5
Mobility	3	1	7.5	22.5	7.5
Performance	2	1	7.5	15	7.5
Implementation	3	1	7.5	22.5	7.5
Security	1	3	8.5	8.5	25.5
Integration	1	3	8	8	24
Deployment	3	1	5	15	5
Flexibility	3	1	5.5	16.5	5.5
Transparency	2	2	6	12	12
Installation	3	1	7.5	22.5	7.5
Up gradation	3	1	7.5	22.5	7.5
Sum			100	238.5	139

This research paper adopts a "DESCRIPTIVE TYPE" of research. The research methodology used for the paper was

kept very simple. Factor rating method was used to test the other hypothesis that traditional usage of Educational Software involves higher level of difficulty in terms of adaptability than the Cloud computing services.

8.1 Analysis using Factor Rating Method

In addition to the cost there are certain more factors based on which decision has to be made while implementing the cloud computing services for Universities. In view of this hypothesis H1 and H2 are analyzed:

To test this hypothesis factor rating method was used and the factors were analyzed on a scale of 3 in terms of difficulties faced by Traditional Computing and cloud computing users.

1 = Low difficulty
2 = Moderate difficulty
3 = High difficulty

Table III presents the different factors of adoption with their score and weighted score. It shows that Traditional computing has high weighted score in terms of every factor cited in table III except for security and integration.

The value of Cloud Computing Weighted Score comes out to be 139 which is less as compared to traditional Computing weighted score as shown below in Fig. 11. Table III clearly indicates that cloud computing has more factors that are less difficult for adaptation than traditional Computing and hence hypothesis 1 is accepted whereas hypothesis 2 is rejected.

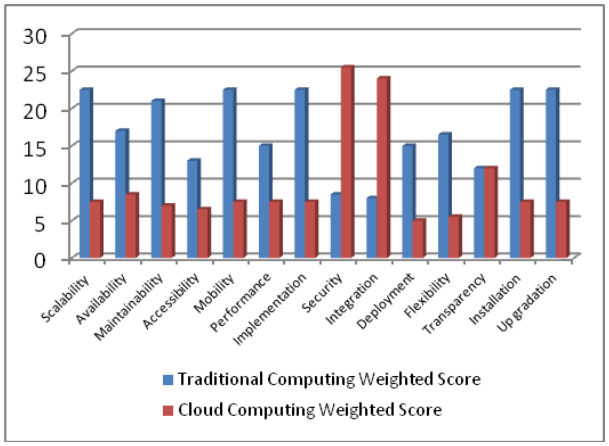


Fig 11: Graphical Analysis of Factors of Adoption

9. CONCLUSION

The objective of this research paper was to utilize cloud computing techniques for modernizing Universities IT in India. For this purpose the paper analyzes growing market of cloud computing especially in India. The global cloud computing market will grow from a $40.7 billion in 2011 to $241 billion in 2020, according to Forrester Research. In India Enterprise cloud penetration will surge to 46% in 2016 which is 4% in 2011. The paper suggests the structure of cloud computing services in modernizing the Universities IT infrastructure.

The paper also compares the difficulty level for adaptability of the traditional computing Services and Cloud computing Services. After the analysis following conclusions are drawn: Traditional Computing Services involve higher level of difficulty in terms of adaptability than the Cloud computing services. So our hypothesis (H1) that Cloud Computing services are more adaptable than traditional Computing Services naturally seems to be a good choice.

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