

Cloud Adoption in Various Domains and Factors Influencing Its Adoption

Mahesh S. Kavre, Vaibhav S. Narwane and Rakesh D. Raut

Abstract - Day by day cloud computing is becoming popular for delivering and hosting services through internet. By considering need of computing in near future, companies like IBM, Microsoft and Google put huge efforts for development of cloud computing. Though cloud provides lot of opportunities for IT sector, this cloud technology is at early stage of development and still many issues are needed to be solved. Cloud computing makes use of technologies like virtualization, utility computing, grid computing, autonomic computing etc. Cloud technology gained popularity around the world due to its various advantages like utility based pricing, reduced up-front investment, shared pool of resource, lowering operating cost, scalability, etc. In our paper, on basis of literature we have presented how cloud is useful in various domains like education, government and manufacturing industry along with factors (i.e. drivers and barriers) responsible for cloud computing adoption.

Keywords - Cloud computing, E-governance, Cloud manufacturing, Drivers, Barriers.

I. INTRODUCTION

Nowadays cloud computing paradigm has started gaining popularity in distributed computing. After cluster computing and grid computing, vision of utility computing is now proposed by cloud computing [17]. The availability of virtually infinite processing as well as storage capabilities at lower cost, easy access to internet makes cloud computing ubiquitously available [14]. Related to cloud computing there are many perceptions. Instead of technology we can consider it as a operational model, which provides services as per user's requirement without bothering about how they are deliver and from where service are hosted. Thus to access services on demand and from anywhere in world, users and businesses make use of cloud technology [20]. This computing vision is transforming rapidly towards development of software for millions [21]. In order to ensure reliability in case of failure of sites and to provide redundancy in hosting cloud computing applications from anywhere, providers like Microsoft, Salesforce, Google, Amazon, Sun Microsystems and IBM had started developing new data centers around the world [17].

Purpose of this paper is to represent cloud's usefulness in various domains and factors influencing its adoption. For this we have arranged our paper as follows: section II represents services offered by cloud implementation. Section III explains about types of cloud. How cloud is useful in various domains is illustrated in section IV followed by factors influencing its adoption are explained in section V. Conclusion of our study and future directions are suggested in section VI.

II. CLOUD SERVICES

Cloud computing uses a service driven business strategy i.e. platform and hardware level resources are provided on demand as a service. Cloud service providers basically provides three types of cloud services i.e. Infrastructure as a service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) as shown in Fig 1 [14].

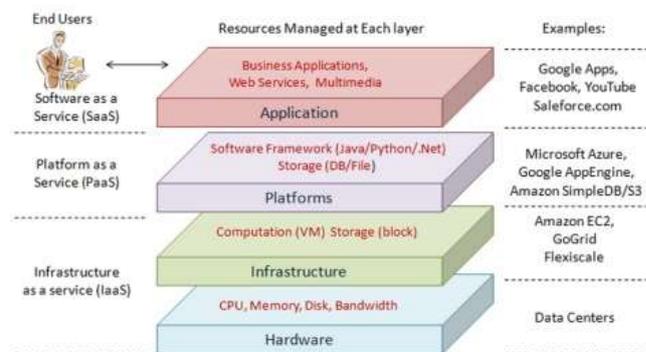


Fig. 1 Cloud services [14]

A. Infrastructure as a Service

In IaaS, providers provides infrastructure like hardware, server, storage, networks etc. as per user requirement. And user needs their own IT manpower in order to develop platform and applications [21].

B. Platform as a Service

In PaaS user gets platform like supporting environment, operating system (Windows, Linux) etc. as well as supporting infrastructure so as to develop required software [21]. Depending on applications, platform is provided. In this case user needs to develop their own software on platform provided by service provider [14].

C. Software as a Service

In SaaS user gets software or Application along with supporting infrastructure and platform. Non IT firms mostly prefer this service, since all the maintenance work is carried out by service providers and thus firm need not to have their own IT staff [21].

III. TYPES OF CLOUD

Generally cloud is classified as per the proprietorship of cloud. It may be available sometimes to all public or may be to particular group of people. It is classified basically into three categories i.e. Public cloud, Private cloud and Hybrid cloud as shown in Fig 2.

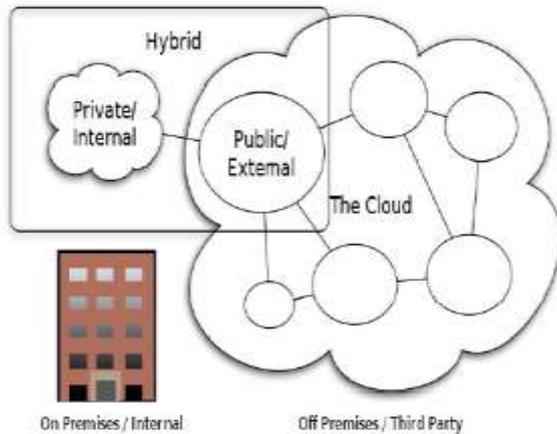


Fig.. 2 Types of cloud [21]

A. Public cloud

In this type of cloud, general public can get resources as a service from service provider. It gives advantage of low upfront investment. But in case of public cloud, there is lack of control over security and network settings as well as poor control over data [14].

B. Private cloud

It is also considered as internal cloud designed for absolute uses by particular organization. It can be managed and built by external service provider or organization themselves. It provides highest degree of security, reliability and control over performance. But it involves high upfront investment [21].

C. Hybrid cloud

A hybrid cloud is considered as an amalgam of private and public cloud. This cloud is designed to overcome limitations of both private and public cloud. It is more flexible than other type of clouds. Since, in this cloud, some part of service infrastructure run in public cloud, at the same time rest part of service infrastructure run in private cloud. As compare to public cloud, it provides better security and control over applications and data [14].

IV. CLOUD ADOPTION IN VARIOUS DOMAINS

Since cloud adoption results in multiple advantages like shared pool of resources, utility based pricing, flexibility, scalability etc. there is increasing demand for cloud from all the sectors of industry. Some important sectors in which cloud adoption take placed are as follows:

A. Education

It is need of 21st century to make use of technologies in educational institutes, since need of new generation students largely differs from their predecessors and to provide high quality education. Some cloud service providers such as *Google* and *Microsoft* provides free services like contact list, mail, storage and sharing of documents and ability to make website etc. to the staff and students of educational institutes [23]. Regardless of local computer's processing capability and location, cloud allow students to access and run their required software [24]. Through cloud computing initiative rural

students are the one who can have most to gain from it, since students from rural schools are mostly dispersed and they need to travel longer distances to get to the school [1]. Cloud computing plays a vital role in educational settings. While using cloud, since processing of computer is done outside, schools or colleges can use older computers for longer period. In addition, repairing errors or software installation can be carried out by IT staff centrally at server level, which saves cost as well as time [22]. In order to make students to use this tool, a positive in class instructor is needed, who can make them to aware about cloud benefits and its uses [11].

B. E-Governance

Especially e-governance in developing countries is considered as a way to change the idea of governance, which results in increasing transparency in public dealing with the government and citizen's empowerment [2]. Through e-governance, governments are trying to provide more attractive services to businesses and citizens which results into significant cost saving. Presently there are two main factors that pull e-governance adoption; first one is increase of user's knowledge and skills to operate computer and internet. And second one is availability of IT infrastructure at low cost [15].

Japan's national government had undertaken *Kasumigaseki Cloud* as a cloud computing initiative. Not only for getting operational advantages and reduction in cost but also for getting environment friendly green operations they transferred all of their governmental activities under cloud infrastructure [6].

In South-eastern China, the government with help of *IBM* had set-up a "Cloud services factory" to provide on demand computing resources to the start up firms within city, which are facing finance problems for having IT infrastructure to compete effectively [6].

C. Manufacturing industry

Cloud manufacturing is emerging era within manufacturing industry which proved to be more efficient than traditional manufacturing system [9]. Still most of automation systems and robots are operated using onboard programming, memory and computation. Advances in networking and cloud technology allow processing to be done remotely, also provides access to global dataset for its functioning [3]. Many of the firms in manufacturing industry are facing problems of co-ordination of the supply chain, lack of the capability of research and development and operation management. Most of the problems are now gradually uncovered due to gradual transformation of manufacturing industry from traditional product oriented type to new service oriented type. Aiming at this issue, paper [4] analyzed the deficiency of the current solutions and related new technologies, and proposed a SME oriented service platform for cloud-manufacturing. Paper [7] shows economic impact of cloud based design and manufacturing (CBDM) i.e. cost saving in CBDM over traditional manufacturing and design.

V. DRIVERS AND BARRIERS FOR CLOUD ADOPTION

Factors which facilitate adoption of technology are considered as drivers. Various drivers we identified from

literature are as shown in Table 1, which are explained as follows:

- *Reduce capital cost:* Since cloud allows pay as per our use, firms doesn't require high investment in infrastructure, they can simply take resources on rent. Since resource allocation and de-allocation is rapid, one can have huge saving during low demand. At the same time maintenance is carried out by service provider, thus maintenance cost is also getting reduced [19].
- *Scalability:* Shared pool of large number of resources and on demand provision of these resources allow user to get more resources during peak time [18].
- *Flexibility:* User can access, update and upload data through mobile, laptops or personal computers to cloud independent of location. Thus cloud adoption allow user to do work from workplace as well as from home [18].
- *Top management support:* This factor is considered as important link between organizational and individual technology adoption. It has been estimated that technology adoption is influence mainly by attitude towards change and support of top management [25].
- *Compatibility:* Compatibility is considered as degree to which new technology adoption remain consistent with existing past experiences and results [25].
- *Market scope:* It is considered as horizontal scope of operations of company. Especially SMEs can take advantage from cloud to work at national and international level independent of location [5].

TABLE I
 DRIVERS FOR CLOUD ADOPTION

| No. | Drivers | Reference |
|-----|------------------------|-----------------------|
| 1 | Reduce capital cost | [19], [8], [12], [18] |
| 2 | Scalability | [19], [8], [18] |
| 3 | Flexibility | [19], [18] |
| 4 | Top management support | [25], [13], [10] |
| 5 | Compatibility | [25], [16], [5], [10] |
| 6 | Market scope | [25], [5] |

Factors which inhibit the technology adoption are considered as barriers. Various barriers we identified from literature are shown in Table 2, which are explained as follows:

- *Security:* Security is considered as one of the major challenge of cloud computing. Since data centers are located at remote locations, for physical security of resources and data, user need to remain dependent on resource providers [19].
- *Complexity:* Complexity can be defined as degree to which a user found technology difficult for use and to understand. If technology is found difficult for use, most probably it is not get implemented by organizations [25].
- *Uncertainty:* Uncertainty may be considered as lack of knowledge about adopted technology, which leads to less predictable results [25].
- *Loss of control:* Organizations and IT departments are mostly worried about giving control of their resources and data to the outside providers. Results of ENISA survey shows 62 out of 29 SMEs responded loss of control as a barrier for cloud adoption [14].

- *Internet connectivity concern:* Since cloud services can be access through internet, speed of internet is one of the major considerable factor. Sometimes due to lowered internet connection one cannot access files from cloud, it may lead to huge loss in corporate world [8].
- *Vendor lock in:* Since there are no common standard for APIs (application programming interface) and for other processes, service providers provide services through their own interfaces thus portability of data becomes difficult [14].

TABLE II
 BARRIERS FOR CLOUD ADOPTION

| No. | Barriers | Reference |
|-----|-------------------------------|----------------------------|
| 1 | Security | [19], [8], [12], [18], [5] |
| 2 | Complexity | [25], [16], [10] |
| 3 | Uncertainty | [25] |
| 4 | Loss of control | [14], [18] |
| 5 | Internet connectivity concern | [14], [8] |
| 6 | Vendor lock-in | [8], [18] |

VI. CONCLUSION AND FUTURE WORK

Since various advantages are coming from cloud computing implementation, it becomes popular around all the sectors of industry and day by day its adoption rate is also increasing. Reduced capital cost and top management support are identified as major drivers for cloud adoption. On other side, security is identified as major barrier for cloud adoption. By conducting survey research one can represents more practical drivers and barriers for cloud adoption across educational institutes, government sector and/or manufacturing industries etc. Also by taking barriers under consideration, one can try to develop more robust cloud platform for its future use.

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Dr. Rakesh D. Raut, Assistant Professor, Dept. of Operations and Supply Chain Management, National Institute of Industrial Engineering (NITIE), Mumbai, India.
Email: rakeshraut09@gmail.com

AUTHORS

Mahesh Shivaji Kavre, M.Tech (CAD, CAM and Robotics), K. J. Somaiya college of Engineering, Vidyavihar, Mumbai, India.
E-mail: maheshkavre@gmail.com

Vaibhav S. Narwane, Associate Professor, Dept. of Mechanical Engineering, K. J. Somaiya college of Engineering, Vidyavihar, Mumbai, India.
E-mail: vsnarwane@somaiya.edu