

CLOUD COMPUTING AS A STRATEGY FOR BUSINESS SUSTAINABILITY

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ABSTRACT

Cloud computing is the practice of using a network of remote servers hosted on the internet to store, manage and process data rather than a local server or a personal computer. This, when used as a strategy, results in Business sustainability, a process through which businesses manage their financial, social and environmental risk, obligations and opportunities. Certainly Cloud computing has become one of the best practices of business across the globe. This is because of the multiple benefits offered by the technology of 'Cloud'. However the environmental considerations relevant to the use of this technology, like massive energy consumption, sourcing of energy required for cloud computing etc., are not being given the same weightage. This study aims at critically analyzing the impact of Cloud Computing as a strategy for business sustainability. Simultaneously focus will also be laid on whether the strategy of cloud computing is ecologically sustainable.

Keywords: Business sustainability, Carbon footprint, Cloud computing, Energy issue.

1. INTRODUCTION

1.1. THEORETICAL BACKGROUND

Cloud computing refers to storing of data and applications on remote servers and using the internet for accessing them, rather than saving or installing them on one's own computer. The term 'cloud' is used because all data and applications are stored on the 'cloud' or a set of web servers owned by a third party. The cloud can be accessed by using the cloud computing system interface software, which, is like using web based services like an email account that hosts all the necessary applications. Cloud computing is not only used for the purpose of storage but also as an inexpensive, flexible and efficient alternative to buying and maintaining computer equipment and software. At the same time it provides the benefit of access from anywhere at any time, the only requirement being a computer that is compatible for this function.

National Institute of Standards and technology (NIST) : NIST defines cloud computing as “A Model for enabling convenient, on- demand network access to a shared pool of configurable computing resources (e.g., network, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management efforts or service provider interactions. This Cloud model promotes availability and is composed of five essential characteristics, three service models and four deployment models

The choice of cloud computing is beneficial in many ways, mainly because its applications are limitless.

One, cloud computing allows the users to access data and applications from anywhere any time. Since access to data is through the internet, users’ files will not be confined to a single hardware or geographical location.

Two, with the information being moved to the cloud there is no need for individual users to purchase expensive high storage computers or other storage devices. It requires only a device with enough power to connect to the cloud system.

Three, in a Company setting with cloud computing, the employer need not buy software or its licenses for every employee in the organization. Instead, a certain amount of fees can be paid by the employer to the cloud service provider thereby allowing the employees to access a group of applications online.

Four, servers and storage maintained by individual companies take up physical space, which the company may have to rent. But with the cloud computing companies storing the user’s data on their hardware, no physical space for storage is needed for the users.

Five, stream lining the hardware and software reduces the IT problems and costs.

Finally, cloud computing systems back end is a network of computer. The clients therefore, may be able to take advantage of the networks combined processing power, in order to increase the speed of operations.

1.2. STATEMENT OF THE PROBLEM

In the course of literature review it was found that the existing researchers focused on a few aspects of cloud computing. There is no paper offering a holistic approach to cloud computing as a strategy for business sustainability. Most papers discuss in detail the reduction in costs and benefits of the same to businesses, while very few papers elucidate the impact of cloud computing on environment and energy efficiency.

This paper focuses not only on cloud computing as a concept and practice to enable organizations to cut costs and ensure better performance and profitability, but also on how it can be used as a strategy for business sustainability, and whether it is in fact environment friendly.

1.3. OBJECTIVES OF THE STUDY

2. To analyze the technology of Cloud Computing for business sustainability.
3. To review various services offered by Cloud Computing.
4. To understand the suitability of Cloud Computing to different sectors.
5. To evaluate the challenges of Cloud Computing.

2. REVIEW OF LITERATURE

This study has reviewed the existing literature through an organized approach. Each of the published literature has been searched for concepts such as cloud computing, business sustainability, environmental impact, carbon footprint and energy efficiency.

1. Maricela-Georgiana (2013), Avram Advantages and Challenges of Adopting Cloud Computing from an Enterprise Perspective
The study emphasizes many on the benefits and challenges of cloud computing to a business organization, benefits and barriers of cloud computing to a company's point of view.
2. Mohiuddin Ahmed, Abusina Md. Raju Chowdhury, Mustaq Ahmed, Md. Mahmudul Hasan Rafee (January 2012), An Advanced Survey on Cloud Computing and State-of-the-art Research Issues, International Journal of Computer Science Issue, *Vol.9, Issue 1, No.1*.
This paper renders a better understanding of cloud computing and recognizes some of the advance research issues therein. The focus lies on the key research issues in the developing area of computer science.
3. Ilango Sriram, Ali Khajeh-Hosseini, Research Agenda in Cloud Technologies.
This paper decides the technical aspects of the cloud and lessons from technologies related to the cloud, along with new use-cases arising through cloud computing.
4. Saurabh Kumar Garg, Rajkumar Buyya, Green Cloud Computing and Environmental Sustainability.
This paper discusses various elements of clouds which result in total energy consumption and the implication of these solutions for enabling green cloud computing.
5. Gerard Conway, Edward Curry , Brian Donnellan (2014), Cloud Computing Adoption: An SME Case study
This paper adopts the case study research on an SME which is in the process of developing the capability in the area of cloud computing. It discusses how a highly collaborative research project based on design science principles, involving a startup company and an innovative research organization proved to be successful.
6. Danping Wang (2013), Influences of Cloud Computing E-Commerce Business and industry, Journal of Software Engineering and Applications, 6,313-318.
This paper throws light on how the traditional E-Commerce business and industry were influenced by cloud computing. Also it analyses the driving forces that laid to the change of E-Commerce in the era of cloud computing.

7. Ratna Kumari Challa, Kanasu Srinivas Rao (February 2014), Services of Cloud Computing, International journal of Advance Research in Computer Science and Management Studies, *Vol. 2, Issue 2*.

This paper presents various services offered by Cloud Computing. Besides , certain other services of Cloud Computing are also studied.

8. Suruchee V.Nandgaokar, Prof A. B. Raut (April 2014), A Comprehensive Study on Cloud Computing, International Journal of Computer Science and Information Technology, *Vol. 3, Issue 4*, 733-738.

This paper explores certain benefits of Cloud Computing along with avoidance issues. It includes vertical scalability as a technical challenges in cloud computing.

3. METHODOLOGY

The current research paper aims to study cloud computing as an emerging phenomenon and answer the ‘how’ and ‘what’ questions. Hence a qualitative methodology of conceptual analysis has been adopted. An important reason for selecting this approach is that it studies a contemporary phenomenon within its practical context. Generally this method is used when the lines between the concept and context are unclear, and when multiple sources of data are available. Since cloud computing is an emerging trend a conceptual analysis renders the most comprehensive understanding of the same.

3.1 DISCUSSION

Business organizations are compelled to expand their IT infrastructure, in order to meet changing technological needs. This broadly includes Hardware, Software and Services. However, if this expansion must be on the premises then the process may slow down resulting in companies not being able to optimize the use of the IT infrastructure.

Cloud Computing is the technology that involves usage of network servers that are remotely located. The users can access these servers via the internet to manage, store and process the required data, instead of accessing the same on the personal computer of a local server. A number of businesses are therefore using cloud computing because of evident benefits like speed, reduced cost and ease of maintenance.

The discussion involves four sections:

- 3.1.1. Technology of Cloud Computing: Definition, Meaning and Constituents
- 3.1.2. Cloud Computing as a Strategy for Business Sustainability
- 3.1.3. Impact of Cloud Computing on different sectors of the economy
- 3.1.4. Challenges of Cloud Computing

3.1.1. Technology of cloud computing

The definition of cloud computing as given by NIST is one of the most comprehensive definitions and is often referenced in official documents. It describes cloud computing as being inclusive of five essential characteristics, three service models and four deployment models. This paper analyses each one of these components in detail.

1. Five Essential Characteristics

While the option of cloud computing is persuading a number of companies to reduce their IT costs, it is crucial to understand five essential characteristics of cloud computing.

- a. *On-demand self service*: Self service mode will help the customer to take full control of the allocated cloud infrastructure. The customer is free to add or reduce the resources based on the current requirement. Changes such as these can be done without any technical support.
- b. *Broad network access*: This means that the cloud computing services can be accessed with the use of any internet connected device. These services can be controlled from anywhere since it is available online at all times.
- c. *Resource Pooling*: The users of cloud computing share the resources with other users, which facilitates sharing of resources among users. These options may also be restricted if necessary. The allocation of resources is dynamic. It means, whenever user is in need of more resources, it will be dynamically allocated from the available pool of resources. It is important to note that this allocation may be done from any geographical location.
- d. *Rapid elasticity*: The cloud has the ability to allocate or de-allocate resources dynamically. The conditions for scaling up and down can be defined by the user. This dynamic allocation ensures both efficient performance of the application and optimum use of resources.
- e. *Measured service*: In cloud computing the cost to the customer is based on the usage of resources. It is calculated through a mechanism that automatically measures the extent of resources used. The user will be billed on the basis of pay-per-use.

2. Three Service Models

The three significant services offered by cloud computing, namely IaaS (Infrastructure as a Service), PaaS (Platform as a Service) and SaaS (Software as a Service) allow users to run applications and store data online. The extent of user flexibility and control offered by each of these services are different.

- a. *IaaS* allows the users to acquire computing resources such as processing power, memory and storage on a remote server, and use these resources to run their own applications. The pre configured storage and programming environment saves time for users since they need not build their system from the scratch. The existing applications of companies can be migrated from the data center to that of the IaaS provider which results in reduction of IT costs. This component of cloud computing

gives users more flexibility than PaaS because it allows the users to pile any software on top of the operating system.

- b. *PaaS* allows the user to create their own cloud applications using supplier-specific tools and languages. It acts as a platform for development and deployment of applications on cloud infrastructure. Google AppEngine and Microsoft Azure are the most well-known examples for this component of cloud computing. It is a method that facilitates a rapid development of applications at minimal cost. Therefore it is useful for both public and private deployment.
- c. *SaaS* allows the users to run existing online applications. It is a software delivery model which provides on-demand access to applications. The most well known services are CRM (Customer Relationship management) and ERP (Enterprise Resource Planning) applications, which are widely used in both Medium and Large scale businesses. It is the easiest way to cloud compute because it allows access to off-the-shelf applications over the internet. It is beneficial especially since it is accessible from any computer and facilitates collaborative working.

3. Four Deployment Models

Cloud computing services can be deployed by using any of the available models. There are different types of cloud depending on who owns and uses them. Implementing this is called as a cloud deployment model and the four common models are as follows:

- a. *Private Cloud*: A private cloud functions solely for one organization on a private network. It is highly secured since it is not shared with the other organization. The cloud may be operated either by the organization itself or a third party. These clouds are more expensive and more secure when compared to public clouds.
- b. *Public Cloud*: A public cloud is owned by the cloud service provider. The customer has no visibility and control over where the computing infrastructure is hosted. It offers the highest level of efficiency in shared resources. Public clouds need a significant amount of investment and therefore are generally owned by large corporations.
- c. *Community Cloud*: A community cloud involves sharing of computing infrastructure among organization of same community. It is usually set up for the community's specific requirements. For example all the government organizations with in the state of Karnataka may share the computing infrastructure on the cloud to manage the data related to citizens residing in Karnataka.
- d. *Hybrid Cloud*: A hybrid cloud is one that is set up using the mixture of public, private and community cloud models. In a hybrid cloud specific resources are used on a public cloud and others are run on a private cloud or on the premises. Generally businesses outsource non-critical information and processing to the public cloud, and keep critical services and data in their control.

3.1.2. Cloud Computing as a Strategy for Business Sustainability

The various ways in which the technology of cloud computing is beneficial to the economy, have been discussed above. This section looks into the ways in which it is beneficial to the ecology, when it is implemented as a strategy by businesses. The environmental friendliness of the technology can be analyzed by taking into consideration, its positive and negative impact, and the extent of such impact on energy and environment.

Positive Impact

- The report by Accenture states that four key factors have enabled cloud computing to reduce energy usage and carbon emissions from ICT. Reduction of over allocation of infrastructure (Dynamic provisioning), sharing of applications between multiple-organization (multi-tenancy), optimum server utilization and data center efficiency are the four important factors due to which business can lower the carbon emissions by at least 30%, when cloud computing is used.
- A research executed by Google infers that business can save up to 85% on the energy cost by switching to cloud facility. The ecological impact of such migration is incomparable. Cloud computing operates on an on-demand model and therefore eliminates the necessity to keep IT infrastructure running 24 hours a day. Naturally this reduces consumption of electricity and in turn results in rapid reductions in carbon dioxide emissions.
- Cloud computing with its features like versatility, dynamism and server efficiency, reduces 'idling' of servers. This helps a great deal in avoiding the eco nightmare resulting from owning extra server space.

Negative Impact

- According to the recent report by Greenpeace titled '*How dirty is your data? A look at the energy choices that power cloud computing*', the various studies on cloud computing overlook a major variable, namely the energy source. A number of companies that claim to have 'Green' data centers may not be considered sustainable without accounting for the full environment picture. The report says the savings of energy are superficial if the data centers are powered from a non-renewable source of energy. Greenpeace states that most of the energies consumed by the data centers (up to 80%) come from coal and nuclear energy sources (Non-renewable).
- The sustainability of business becomes a tough result if cloud computing studies miss the network contribution. If the size of the files being processed is large, then network becomes a significant contributor for the consumption of energy. Therefore it will be greener to run the applications on premises than in clouds. Further some business may concentrate only on a few aspects of cloud computing while neglecting the others. This may result in the lack of overall energy efficiency.
- Even though corporate organizations across the globe are working on making their servers energy efficient, they are still powered significantly by coal or nuclear power. Therefore the internet with cloud computing is on its way to become a huge contributor to carbon emissions because of dirty energy usage.
- What must also be considered is that it is not just the server that consumes needless energy to keep itself functioning round the clock, but also the existence of backup

systems most often powered by generators and lead-acid battery power which are mostly even less eco-friendly than servers, since they release diesel fumes which are hardly cooperative in having clean air in the locality.

Considering the fact that most of the companies have sufficient resources to relocate their operations on more sustainable grounds, it can be concluded that there is no necessity for them to give up cost effectiveness in order to relocate the energy sources.

3.1.3. Impact of Cloud computing different sectors

- *Education:* The educational sector has evolved in the areas of software and IT over the years. The expectations of students, faculty and staff in the recent period have also evolved. The IT services are expected to work not only on the computer system but also on a wide range of devices like phones, web browsers and tabs. To meet the increasing demand the IT departments supplementing their on-premises software with software delivered over the internet. In other words cloud computing has seen a tremendous rise in being used in the field of education. The most significant benefits of cloud computing are derived by the institutions that have implemented ICT enabled learning environment. This is because in an ICT enabled education, teaching and learning, whether individual or collaborative takes place innovatively, at the same time reducing the infrastructure and cost requirements of the institutions.
- *Healthcare:* A number of health agencies have identified the need to follow patients' information no matter where they go. The different stakeholders who need such access to information are doctors, nurses, clinics, insurers, pharmacists and most importantly, patients. Cloud computing enables patients become more engaged with their own healthcare at all levels. Patients are free to move or change doctors at any given time without much hassle, since they can access these portals, modify appointments, share information and interact with physicians and pharmacists, get historical health information and stay updated with relevant records. On the other hand, it is extremely beneficial for healthcare providers due to low cost maintenance, easy access to patient information, better connectivity among different stakeholders of the health sector.
- *Government:* Cloud computing in the government sector will bring about transparency which ensures better co-ordination between State and Central governments. The technology can be used to make the relationship between government sub-units better and measure the effectiveness of government schemes. Apart from these it not only helps in reducing communication divide but also assists improved connectivity with citizens residing in remote parts of the nation. Sharing of computing resources between Central and State governments results in cost reduction due to optimum utilization of existing infrastructure, thereby benefiting both the government as well as its stakeholders.
- *Media and Entertainment:* Broadcasters experience a number of disruptions like demand for more choice by consumers, time pressures, cost pressures, requirement for more computing power and resources than traditional broadcasting and so on, which drives them towards cloud computing because of the scale and flexibility involved. Cloud

computing brings with it a quick expansion in the choice of content, reduction of technology investments and offers flexible business models, which in turn helps the broadcasters to match their costs more closely with usage and revenues.

3.1.4. Challenges of Cloud Computing

The relocation of business enterprises to the 'Cloud' is said to be enormously beneficial to all the stake holders. A recent study by the Global E-Sustainability Initiative (GEI) has studied the impact of cloud computing on the environment. The study has found that if 80% of the world enterprise adopted cloud computing then approximately 4.5 mega ton of green house gas emissions would be reduced. This reduction in turn decreases the contribution of carbon foot print by global IT sector by 2% (This 2% equates to 1.7 million cars disappearing from the roads)

Studies such as these indicate that cloud computing is the future of business enterprises. But there is more debate. Since the users do not on the network, it is open to the world there by making the cloud more insecure than storing data on premises. A few challenges and barriers are discussed below:

- a. *A lack of comprehensive understanding the cloud:* In a business organization if the top level management is not fully educated on the usage and benefit of cloud computing, then a decision to migrate to the cloud may not be implemented. Unless an industry as a whole makes a deliberate attempts to accurately understand the offering of cloud computing, it may not see full fledge implementation.
- b. *Data security and loss of control:* There exists the tremendous amount of uncertainty about the security at all levels of cloud computing, making security the number one concern.
- c. *Connectivity:* High speed access of internet may not be possible at all times. This area requires more attention since the functioning of entire cloud computing system relies on the fact that the technology offers efficient, all time connectivity.
- d. *Hidden costs:* even though the technology of cloud computing is said to offer in comparable cost reductions, the organizations cannot be completely relaxed in this concern. There is a compelling need to identify and incur hidden costs like system support, disaster management, and recovery processes and data loss insurance, to achieve economies of scale.
- e. *Political issues:* since cloud computing is applicable globally, geographical boundaries have the potential to become barriers to seamless usage and utility. Given the variability of where the data is stored, where it is processed and where it is accessed from, the different privacy policies of different government may apply, resulting in legal complications.
- f. *Migration may be problematic:* Due to the simple reason that different cloud provides operate with different cloud designs, which are not only unlike each other but also vary greatly from enterprise resource designs, moving data from one's own business to that of cloud providers, or from one provider's to another, becomes challenging.

- g. *Downtime*: Where there is large scale implementation of cloud computing, the downtime of servers is a common problem. Such interruptions due to server downtime can be a costly affair for the business firms, since performance and profitability are measured and altered every minute. This is especially more significant in companies that deal directly with customer log-ins, because one such slow down can damage the image of the organization in the minds of the customer, for a long time.

4. FINDINGS AND SUGGESTIONS

4.1. FINDINGS

1. Cloud computing comes with the baggage of benefits including access to data and applications anywhere, anytime, reduced IT infrastructure and costs, and high speed of operations.
2. Cloud computing has the ability to revolutionize the fields of education, healthcare, media and entertainment.
3. The implementation of cloud computing in the government sector helps to bridging the gap between the government and its stake holders.
4. The challenges of cloud computing are primarily security and privacy issues.
5. A pressing issue in cloud computing is that the technology being sourced from non-renewable sources of energy could take a back seat in the light of all ecological and economical benefits derived from it.
6. Technology of cloud computing contributes positively towards energy efficiency there by reducing carbon emissions significantly.
7. The ecological impact of cloud computing can be considered as favorable in the long run only if it is sourced from renewable sources of energy.

4.2. SUGGESTIONS

1. Security and privacy issues can be dealt with by entering into contracts with cloud providers which will make them accountable for any breach of security.
2. Limitations like connectivity, understanding of technology and down time of servers can be overcome by businesses by deploying highly efficient servers.
3. Business organizations together can explore the idea of developing more efficient ways in which renewable sources of energy like wind and solar can be used to power cloud computing.
4. Large business organizations must consider encouraging policy makers to develop and implement renewable sources of energy on national and international scale.

5. CONCLUSION

Cloud computing is the best available solution for addressing constraints in costs infrastructure and resources, thereby becoming an effective strategy for business sustainability. The availability of different types of clouds removes various limitations since it facilitates customization according to organizational activities. The reduction in carbon footprints, energy consumption and other dangers to the ecological system gets minimized as more number of organizations adopts this technology. The impact of cloud computing, however, can be said to be truly environment friendly, only if it is sourced from sustainable or renewable sources of energy.

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