# Cloud Computing Services and Applications to Improve Productivity of University Researchers

Alkhansa A. Shakeabubakor, Elankovan Sundararajan, and Abdul Razak Hamdan

***Abstract*—One of the fundamental issues facing research universities is to raise productivity of their research community. A thorough study of the literature reveals that there are many articles on productivity, however, there are only a small number of them are relate to productivity issues affecting researchers in universities. In our work, we aim to use cloud computing services as a tool to help improve productivity of research activities. This is accomplished by identifying and addressing the main factors that influence improvement in productivity and identified researchers' needs from cloud computing services and applications. To obtain the needs and the factors affecting the productivity of university researchers, we conducted interviews with postgraduate students to determine them. In this paper, we report our findings on the important needs of researchers from cloud services for productivity improvement and the factors that have a negative influence on productivity in addition to suggestion resolving study problem.**

***Index Terms*—Cloud computing services, researchers, improve productivity.**

## I. Introduction

There is a lot of research already done to improve productivity. However, universities are all the time facing new challenges to meet their goals and opportunities because of the dynamic environment and constant change [1]. Effective applications and services which support productivity improvement play an important role in achieving university goals and boost researchers' performance by ensuring they are satisfied with their work and research activities [2]. Therefore, improving productivity, particularly for researcher community and scientific research are two components that are regarded as a basis for the success of a university. Productivity improvement is one the most studied topics the world [3]. Productivity can be described as the relationship between inputs "measured in terms of financial value or time" and outcomes and outputs "including both quantitative measures and measures of outcome quality, or services produced" [4], [5]. In other words, productivity refers to the amount of work that is accomplished in a unit of time using the factors of production environment, human resources, capital, technology and entrepreneurship [6]. This is due to its effects on increasing productivity [7], enhancing cognitive domain, and encouraging better performance and efficiency.

Although several studies have been conducted on the relationship between levels of researcher's productivity and factors affecting productivity [8]. In addition, identification of the needs of researcher and best services and applications as a key factor to improve researchers' productivity have been largely ignored, there are studies that focused on the researcher productivity, but on one side of researcher's activity such as publishing, researcher's role, and the relationship between researcher and supervisor. Consequently, there is still a lack of a study identifying the significant needs of university researchers and determine the services and applications which meet those needs in addition to improve productivity of university researchers.

To address this gap, this study aims to improve productivity of university researchers through the use of cloud computing services as a tool by identifying their needs from cloud technology and identifying the main factors that influence the productivity improvement.

## II. Literature Review

### A. Productivity Factors

Productivity is one of the most researched topic, and possibly the most complex topic in organizational process [9], [10]. Usually the researchers define productivity as a ratio between output, e.g. the quantity of products or services produced) and input (e.g. the time needed for production) – is a fundamental concept considering this efficient and effective use of resources. At the national economic level productivity improvement is seen at the base of economic growth, national competitiveness and increase in the standard of living. Equally at the organizational level productivity improvement is seen as a critical success factor and the foundation of profitability [11], [12].

On the other hand, academic productivity is defined as a combination of results that are generated by scientific performance, a product or a service (patent), and teaching and how much individuals and society are getting from the education sector, given the resources they put in. In other words, productivity refers to the amount of work that is accomplished in a unit of time using the factors of production "environment, human resources, capital, technology and entrepreneurship".

The rapid advancement in technology and increased awareness among people has made educational organizations and universities across the world to be productive, competitive and sensitive to changes in the learning methods and research environment. There are many factors that affect the effectiveness and productivity of their activities, among these factors are Technological Factors, Human Factors,

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Government factor, Managerial factors, Natural Factors, Sociological Factors, Political Factors and Economic Factor [13]. In addition, there are many other factors addressed in previous literature. Where these classifications are not considered standard classifications, but are classified as far as its impact on improving or lower the productivity process.

This study focuses on two most important factors affecting on the increase or decrease of productivity: **Human Factors**: Human nature and human behavior are the most significant determinants of productivity, which include their ability as well as their willingness and the ability to work. The productivity of an organization depends upon the competence and the caliber of its people-both workers and manager's ability to work is governed by education, training, experience, attitude, etc. of the employees. Motivation and morale of people are very important factors that determine productivity. **Technological Factors**: Technology is a general description of the way resources are combined in the production process, which improving through the commitment to R&D, quality management and a strong pursuit for innovation. It is found that cloud computing services improved any organizational productivity [14] and; this has influenced the rate of cloud computing adoption in organizations thus to the increase in their productivity. Although the importance of identification of technology needs as a key factor that affects on improves productivity, there is still lack of study in identifying the significant needs of university researchers related to the technological aspect.

### B. Cloud Computing

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [15] ,[16]. In an organization, effective cloud computing technology can create high-quality and more efficient applications and service as well as higher levels of satisfaction among end-users [17], [18].

### C. Cloud Computing Services, Deployment Models, and Characteristics

Cloud computing broken down into a few different categories based on the type of service provided: Applications (SaaS), Platforms (PaaS), and Infrastructure (IaaS). Each segment serves a different purpose and offers different products for businesses and individuals around the world. The four deployment models are public, private, community, and hybrid. Public cloud is available in pay-as-you-go manner to the general public. A private cloud is a data center used exclusively by one organization. Community cloud is shared between several organizations for specific requirements. On the other hands, a hybrid cloud is set up using a mixture of the above three deployment models of cloud computing. Each cloud in a hybrid cloud could be independently managed than others, but applications and data would be allowed to move across the hybrid cloud. Hybrid cloud allows cloud bursting to take place, where a private cloud can burst-out to a public cloud when it requires more resources, as shown in Fig. 1. Fig. 1 shows the NIST defines service models as a level of abstraction [19], [20] which includes:

1) *Software as a Service (SaaS):* Users use the web-browser to access to the software application, Google Docs is one popular example that is serviced in cloud computing.
2) *Platform as a Service (PaaS):* PaaS may include facilities such as application design, development, testing, deployment and hosting. Google App Engine and Microsoft Azure are popular PaaS examples.
3) *Infrastructure as a Service (IaaS):* Users can access the underlying infrastructure through virtual machines. Using virtual machines IaaS characterized more flexibility than PaaS as it allows the user to deploy any software stack on top of the operating system. As an example, Amazon Web Services'EC2 and S3 are examples of IaaS.

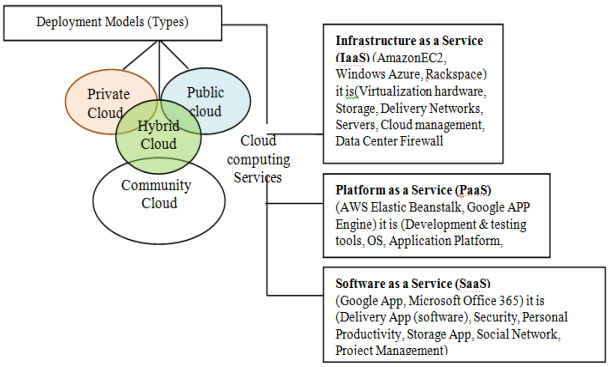


Fig. 1. Common deployment and service models in cloud computing.

Table I summarizes the essential characteristics of cloud computing service as defined by NIST [21] as follows:

TABLE I: CLOUD COMPUTING CHARACTERISTICS

| Characteristics | Specifications |
|---|---|
| On-demand self-service | A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider |
| A broad network access | Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or think client platforms (e.g., mobile phone, tablets, laptops, and workstations). |
| Resource pooling | The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. |
| Rapid elasticity | Capabilities can be elastically provisioned and released. In some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time. |
| Measured service | The cloud system automatically controls and optimizes resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service. |

Moreover, there are certain studies suggested another of the characteristics is also important which we cannot ignore as feature of cloud computing, these include quality of

Service (QoS), User-Centric Interface [22], virtualization, highly treatable, and versatility. Cloud services are not limited to, certain applications. It can serve several sectors in different disciplines which exist in the same cloud environment [23] all of these will help researchers to improve their research and their life.

In addition, effective services of cloud computing-based application plays a vital role in the growth and productivity of organizations, companies and universities environment, such as (accesses to open sources, E-mail services, productivity Apps, and social communication Apps, Storage services, and more). Therefore, it can be said that the future success of a university depends on the effective use of cloud environment.

### *D. Cloud Computing as Tool to Improve University Researcher's productivity*

There are many studies that have addressed the researcher as a key factor to raise the productivity of knowledge and exploration [24]. And there are relationships between the academic development for researcher and social evolution. The researchers need many tools, applications, and services in order to achieve their tasks efficiently, for example, tools for writing documents, for analyses and collecting data , for managing and organizing references, for communication with peers and experts, for databases, for storing data, other supporting software, and require a network connection, all these tools can be available in a cloud environment.

With cloud computing, researchers will not be constrained and confused by physical resources anymore [25]. On the contrary the resources on cloud can be accessed from anywhere any time that has an active Internet connection .The researcher can get many kinds of resources as services such as, office Applications (Google Doc "office" suite such as, word processing, spreadsheet and a presentation editor [26], and Adobe Reader) .In addition, users have the ability to create new documents, upload and store them securely online that does not need to be installed on a physical device for example, (Google Drive, Drop Box, OneDrive, Box Amazon Cloud Drive, and SkyDrive). Thus, this makes it possible to share files around the globe and can modify documents in real time, which makes these services highly desirable when uses occurs on the Internet. As well as, social communication tools such as, (Facebook, WhatsAapp, telegram, Skype, and Google+) those makes this a powerful online collaboration tool [27].

## III. The Current Status Usage of Cloud Computing Services and University Researchers

Based on the analysis done on literatures, it is clear that cloud computing it still not fully adopted in academic institutions. Only 4% academic institutions use cloud computing in education and the other 96% are related to industrial sectors and services that means the educational cloud computing industry is still at its infancy [28]. This study is focused on university researchers and determines the factors influencing on use cloud services and how they apply these services in their search performance and thus reflected on the level of their productivity. On the other hand, disclosure of researchers' needs from this technology. Nevertheless is still lack of research studies were found that explored needs of university researchers from cloud computing services and the role of this technology to improve their productivity in a university development environment.

## IV. The Theoretical Framework of the Impact of Using Cloud Computing Services on Improving University Researchers' Productivity

Fig. 2 shows the theoretical framework of study. The study believes that when the service and applications that support university researchers provided by the cloud computing more clearly and understanding, that will have a positive and significant effect on the use of cloud computing and increase their research performances is a Dependent Variable (Outcome) "That factor which is observed and measured to determine the effect of the independent variable [29]. In other word, the service and applications of cloud computing provide an indirect influence to improve university researchers' productivity through their use of this technology. In this case, researchers use cloud computing as a Mediating Variable in the study "one that explains the relationship between the two other variables" [30]. At the same time, the study assumes the service and applications that support researchers of a cloud computing would have a relationship between uses of cloud computing with researchers and improve their productivity in this case, the cloud computing service and applications is an Independent Variable "The factor that is measured, manipulated, or selected by the experimenter to determine its relationship to an observed phenomenon", is moderated by certain Moderating Variables "variable is one that influences the strength of a relationship between two other variables" namely researchers' knowledge and understanding for cloud computing services, their trust, and needs that influence into researchers productivity.

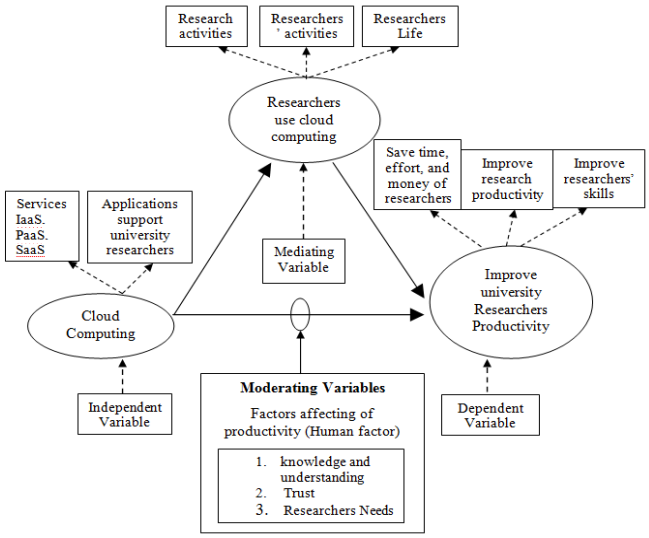


Fig. 2. the theoretical framework of the impact of using cloud computing services on improving university researchers' productivity.

## V. Methodology

In the beginning this study involves exploratory research

using qualitative methodology. Using a qualitative approach, the researcher is able to acquire detailed understanding of the factors influencing on use cloud computing services and applications and the level of they apply these services in their research performance. As will as, to determined researchers' needs of this technology in Malaysia. An open-ended question was asked. The selected respondents from Malaysia were asked whether they use cloud computing services and they were required to give reason(s) for their answers, As well as identifying their needs from this technology to support their research performance.

Interviews were conducted with 30 respondents who are different genera in Malaysia, Some from Malaysian origins and others from different races, such as (Arabic, Sudanese, and Iran). They were focused on postgraduate students (Master and Ph.D) in Malaysian Universities, which were UKM, UTM, UM, and UNITEN in specifying field of computer science and technology study in 2013. All interviews were conducted distantly by several methods face to face, phone call, and social media network (Skype call, Viper call, and Tango call). Interview questions were in English and Arabic, while answers and discussions were all translated to English by the researcher.

## VI. Data Analysis

Based on the Table II below:

TABLE II: Results of University Researchers' Interviews in 2013

| Issues | Number of Percent |
|---|---|
| Have used cloud apps and knew about it. | 18.5% |
| Never used cloud apps, but they have E-mails and other accounts. | 33.3% |
| Limited use of cloud apps in their research. | 48.1% |
| Lack of Knowledge about cloud services & apps | 88.9% |
| No Trust with cloud apps. | 70.7% |
| Never synchronize their research work on cloud | 81.5% |
| Synchronize their research work on cloud. | 18.5% |

It indicates that a respondent might give more than one answer as this was based on their opinions, experiences, and preferences. Every percentage was constituted from the total of 30 respondents.

The two highest responses given by respondents were based on lack of knowledge and distrust issues of cloud computing services and applications which were 88.9% and 70.7%. This led to high rates of limited use of this technology in their research performance, 48.1%, and 81.5% not synchronizing their research work with cloud computing services. On the other hand, some of them don't use cloud applications, but they have accounts such as (E-mail, WhatsAap, and DropBox) 33.3% due distrust with this technology. Thus, impact on the level of use of this technology, and led to reduction of benefit from cloud computing services and applications in their research activities that reflected on the growth of productivity.

The interviews revealed the important needs of researchers from this technology shown in Table III. Perceived for the higher percentages for publishing issue 90%. Where they need application on cloud to gather all tools that are related to the process of publishing such as, writing, editing tools (proofreading), international journal's list and the related templates of them, and alert the latest news of conferences. And 54.8% of desire for presence an application to collected the best tools of survey and data analysis on cloud. From these proportions, the researcher could describe that majority respondents are moving toward to tasks that need more procedure, publishing issue and survey and data analyses, due it is a important task for rises of research productivity in particular and in general. Cloud could possibly save a lot of researcher's time and effort. Following that was the 22.7% respondents who perceived the need for drawing diagrams, charts and structures of design on a cloud, without the need to install software on their own device. The smallest fraction response related to scientific search engines which was 18.7% responded shown in Table III. There were other needs, but are already available on the cloud applications for example, group of experts who have experiences in research field to obtain counseling for any problem related to research. This can be achieved through social network services, and storage issue is also available on cloud services.

TABLE III: Interviews Results of Researchers Need from Cloud Computing Services in 2013

| Researchers Needs | Number of Percent |
|---|---|
| Need application on cloud to gather everything related to the process of publishing. | 90% |
| Need application on cloud to gather the best tools and services that support survey and data analysis. | 54.8% |
| Need application on cloud to gather the most important scientific search engines to support literature searching. | 18.7% |
| Need enable to display any diagram, charts and structures of design on a cloud, without the need to install the software on its own device. | 22.7% |

## VII. Conclusion

We conclude, from the finding through interviews, that perceived lack of knowledge had substantial effect on the attitude towards trust and the usage of cloud services. Consequently, it impacts on the ability to raise productivity through the ability to access their work from anywhere and anytime. Furthermore, reduces cost where cloud applications are mostly free at the moment. Therefore, research institutions and research universities should play an important role to raise the level of knowledge and understanding of their community by holding roadshow or other awareness programmes. Researchers need to improve their knowledge in this technology at the beginning of their research as it provides important tools in particular for research community. Hence, improved productivity and development. The study is a step towards identifying the important needs and wants among university researchers from cloud. The findings have led us to propose a new model of application on cloud to support the publishing issues and to identify and develop tools that are related to the important needs of researchers.

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