

Economic challenges of cloud computing in Iraqi educational institutions using exploratory analysis

Farah Hussein Mohammed Jawad¹, Huda Husein M Jawad²

¹Department of Electrical and Computer Engineering, Faculty of Administration and Economics, University of Babylon, Hillah, Iraq

²Department of Computer Engineering Techniques, Al Mustaqbal University College, Hillah, Iraq

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ABSTRACT

Cloud computing (CC) implementation for educational services is confronting several challenges. Prior research focused on the technological related challenges while few examine the economic challenges. The purpose of this study is to examine the economic challenges for using CC in educational institutions in Iraq. Articles pertaining to the topics were extracted from main databases. Based on the review, the critical challenges were identified. To confirm their relatedness to Iraqi context, a questionnaire related to the challenges was developed. A total of 204 respondents working as IT professional has participated in this study. The findings showed that the challenges mainly related to the infrastructure readiness, internet connection, cost of establishing and managing the CC. The challenges were divided into three phases. The pre-implementation phase includes the challenges of selecting service provider and deployment as well as the readiness of stakeholders, training, and infrastructure readiness. The implementation phase includes the challenges of maintaining the bandwidth, compatibility, legacy system, internet connection, reliability, availability, connectivity, and management. The post-implementation phase includes the challenges of security, privacy, quality of education, switching cost, and lock-in. The most critical challenges in all phases are related to infrastructure readiness, internet connection, switching cost and management of CC. The findings were discussed and limitations of the study as well as the direction for future works were given.

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Corresponding Author:

Farah Hussein Mohammed Jawad
Department of Electrical and Computer Engineering
University of Babylon
Hillah, Iraq
Email: bus.farah.hus@uobabylon.edu.iq

1. INTRODUCTION

Cloud computing (CC) is a new technology that have transformed the way of doing business and delivering services. The cloud provides users and organizations with the access to material from anywhere at any time and reduce the operational cost of organizations [1]. CC is defined as the “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction” [2]. There are three main layers in CC that include the Software as a service (SaaS), Platform as a service (PaaS), and Infrastructure as a service (IaaS). In addition, the cloud can be divided into four deployments that include the public, private, hybrid, and community cloud deployment [3-6].

Cloud has provided several advantages for organizations. For this reason, it is obvious that most of previous studies view the CC as a source of competitive advantage and cost reduction [7-9]. Accordingly, prior research on CC underinvestigated the educational institution [10, 11]. In educational services, few studies looked into the challenges and benefits that these academic institutions might deal with when deploying the CC technology [12, 13]. While there are many challenges related to security, privacy, technology adoption, as well as infrastructure, this study focuses on the economic challenges that are related to the educational services. This is because the economic challenges has received less attention [14]. The economic challenge nowadays could be one of the most important challenges for university due to the fact that most of countries tightened the budget of higher education and encouraged universities to be self-funded [15, 16].

For this reason, this study reviews the existing literature related to economic challenges and test empirically the challenges using the inputs of IT professional in Iraq. Most of previous studies tackled the issue of CC in developed countries while the challenges and the criteria differ greatly in less developed countries such as Iraq, few studies looked into these issue among developing countries [17]. For this reason, this study investigates the challenges in Iraq higher educational institutions. This paper consists of six section. It starts by introducing the topic followed by literature review, methodology, findings, discussion, and conclusion.

2. LITERATURE REVIEW

This section discusses the cloud CC as well as the layers and deployment. In addition, the section discusses the CC in educational institutions and the economic challenges of CC for educational institutions. The section focuses in particular on the issue related to developing countries such as Iraq.

2.1. Cloud computing

CC is the result of the innovation in internet and technology applications. It enables convenient, on demand access to software, server, networks, services, and applications that can be reached from anywhere at any time [2]. It has three layers that includes SaaS, PaaS and IaaS [3-6]. There are also four deployments. The choice among deployments is one of the challenges of using CC [18, 19]. Deployments includes, public, private, hybrid, and community. The public is cost effective but less secure compared with the private, which is costly and requires huge investment. The hybrid is a combination between private and public where some services are offered using the public cloud while other services are provided via the private cloud. Lastly, the community cloud, which is a cloud sharing between organizations [18-21]. Choosing among these deployment is widely dependent on the need of the organizations. The choice of private cloud is costly from economic perspective while the public is less costly but require investment in security and privacy.

2.2. Cloud computing economic challenge for educational service

After the economic crisis in 2009, organizations including universities have become more cost focused to survive and thrive [7]. Governments have reduced the budget for education, which enforced universities to adapt to the new environment by adopting self-funding approach [22, 23]. The inclusion of technology is one of the main factors to reduce the operational cost and increase the organizational performance of organizations. However, keeping and maintaining this technology will increase the cost and might lead to negative financial performance [24]. Thus, cloud has come to rescue educational institutions and reduce the cost of upgrading, maintaining and increase the service offering of universities [25]. The need for technologies such as CC currently are more sever because of the increasing cost of operating the university and the need to provide additional fund to support and maintain the technological infrastructure in university such as the need for updated software and hardware [26].

To understand the challenges that faces educational institutions when using the CC, the literature was reviewed and article selection was conducted. Articles from reliable database were review. Based on the review of existing studies, Figure 1 summarizes the economic challenges of cloud computing for educational services. Educational institution that intended to offer CC services have to consider several decisions that result in various challenges. The first decision is related to the selection of service providers [27]. There are several service providers and each one has advantages and disadvantages. The choice among these service providers can be a cost analysis decision based on the benefits that can be gained and the cost of the services. Second most important challenge is to select the suitable deployment of CC [28].

Each of the four deployments (private, public, hybrid, and community) has its advantages and disadvantages. A cost analysis can be conducted to identify the most suitable deployment in light of the need of the university. Basic cloud services might require only public cloud. However, integrated cloud services require highly secured cloud. The cost is important factor in determining which deployment the university should choose [29, 30]. University also should conduct a feasibility study before implementing the cloud

computing. Cloud can reduce the operational cost of university but it might need between eight to ten years to pay off the cost. Thus, bearing in mind this fact, could prepare universities for the upcoming cost and making the necessary requirement to keep the cloud running [14, 31].

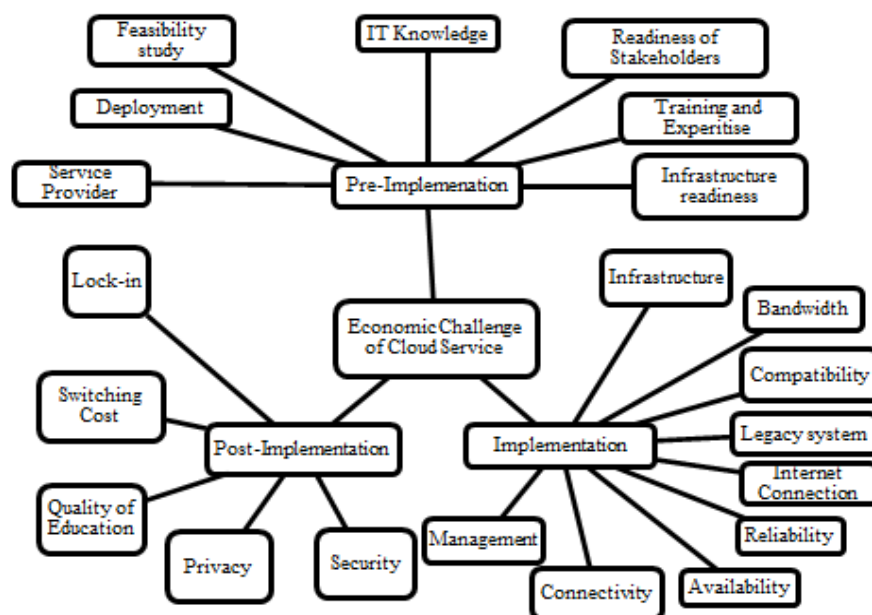


Figure 1. Three phases of economic challenges of CC

In the pre-implementation phase, the university must also consider the IT knowledge of the stakeholders [32, 33]. This includes the students, academic staff, non-academic staff, and technicians that are in charge of running the cloud. In addition, the management is an important challenge as new cloud system requires new management that understand the implications and applications of cloud. Important challenge is the acceptance of user for the cloud technology. Previous studies showed that 20% of students are utilizing the technology [34, 35]. Thus, universities have to prepare the students and enhance their knowledge regarding the technology before moving to cloud environment.

Training of staff academic and non-academic as well as having the require CC expertise is a challenge from technical and economic points views. The technical part is related to having staff capable of running the cloud. The economic one is related to the training requirement and the need to utilize external expertise which might add to the cost of cloud [36, 37]. The last challenge in the pre-implementation phase is the readiness of the infrastructure. This includes the hardware and the network as well as establishing speed internet connection that cover all the campus. Investing in this infrastructure might be costly for universities and will be challenging to run and maintain the network [16, 38, 39].

In the implementation phase, there are several challenges that face the educational services. Among these challenges that have economic impact is the infrastructure, bandwidth, compatibility with legacy system, internet connection, reliability, availability, and connectivity. Establishing and maintaining the infrastructure is a continuous effort and this requires the university to spend on the cost of upgrading and maintaining the infrastructure [40-42]. In addition, the legacy system that the university cannot abandon need to be compatible with the new cloud system. The internet connection also must be established and maintained in high speed that encourage users to deploy the cloud. The reliability of the service is an issue that face the cloud as the system might go down depending on the service provider. This raise the issue of the availability of the cloud at anytime from anywhere. However, the anywhere part requires establishing internet connection not only in the campus but outside the campus.

In this phase also the IT knowledge of the users will be examined and additional cost might be required for training of staff and other users to deploy the cloud. Important challenge also is the migration to cloud and the steps require to make this migration a success. The usage of hybrid migration (step by step or unit after unit) will requires double management, where a traditional management and cloud based management are required. However, a forklift migration strategy requires a one move from traditional to cloud.

After implementing the cloud and using it, the main challenges are related to the investment in the security and privacy of the users as well as the data and information stored on the system. One important challenge is the quality of education when cloud is used for e-learning or distance learning. Students might not adopt the cloud and prefer the traditional method. In addition, lecturers cannot assess the students perfectly due to the lack of interaction. This might affect the number of enrolled students and reduce the revenues of the university [43].

The challenges also include the switching cost. It is difficult to switch from one service providers to another after implementing the cloud. This is because of the difference in the system as well as the services that are provided by each service provider. The switching cost results in the lock-in. Even though the university might not be satisfied with the service provider, they have to stay and keep connected with the same service provider due to the high cost of switching to another provider [42, 44].

3. METHODOLOGY

The literature was reviewed to find articles that investigate the cloud computing economics' challenges. Based on the findings of the literature, three phases were identified to affect the implementation of CC in higher educational institutions. However, to investigate the accuracy of these phases in the context of higher educational institution in Iraq, there is a need to evaluate these criteria. Accordingly, it is necessary to identify the population and the sample of this study. The population of this study is the IT professional working in private and public organizations in Iraq. The sample was used based on convenience basis. Those IT professional who are holder of master or PhD degree, accessible, and willing to participate in this study were selected. The data was collected using a questionnaire. The questionnaire included the indicators of each phase and a ten Likert scale was used to identify the relatedness of the components. The ten scale ranged from extremely not important (1) to extremely important (10).

A total of 204 responses were collected. The responses were checked for missing values. Findings indicate that all the responses are complete. This could be due to the fact that all the questions were marked as required. The data was analyzed using the descriptive analysis. The analysis also included the mean score and the combined mean score to identify the most important phase and components.

4. FINDINGS AND DISCUSSION

This section presents the findings of this study. The section provides the background of the respondents as well as the exploratory factor analysis and the mean score of the variables.

4.1. Profile of respondents

This section provides a descriptive information of the respondents. The age, gender, education, and experience are included. The respondents are males (65%) and the age of the majority of 97.1% is less than 50 years. A total of 80.8% of the respondents are holders of master degree in IT and 66.7% have experience of more than 10 years.

4.2. Exploratory factor analysis

Exploratory factor analysis is important to identify the relatedness of the component to their phase and to indicate the weight of each components. Table 1 shows the results of EFA. The KMO was greater than 0.60 indicating that the sample is sufficient for the study.

The table shows that the components of the three phases are accurate as proposed. However, one of the components in implementation phase was removed due to the fact that it is correlated with infrastructure readiness. Under pre-implementation challenges, the most important is the deployment, feasibility study, choosing service provider, readiness of stakeholders, training and experience, and IT knowledge. For the second phase, the implementation, the most critical element is the management of CC, availability of the CC, connectivity, reliability, compatibility with existing system, legacy system, and bandwidth. In the phase of post-implementation, the lock in, switching cost, quality of education, privacy, and security are the most critical economic challenges.

To identify the most critical components and the weight of each components, Table 2 shows the weight of each component as well as the phase. To better understand the findings Table 2 presents a descriptive analysis of the challenges. The economic challenges can be divided into three main phases. 1) Challenges related to pre-implementation of CC, 2) challenges related to the implementation phase of CC, 3) challenges related to post implementation of CC. However, the findings in Table 2 shows the most important challenges. Infrastructure readiness is very critical to establish and use CC.

Table 1. EFA of the phases

| | Rotated Component Matrix | | |
|---------------------------|--------------------------|--------------------------|---------------------|
| | Pre-implementation | Component Implementation | Post-implementation |
| Deployment | .833 | | |
| Infrastructure Readiness | .815 | | |
| Feasibility Study | .800 | | |
| Service Provider | .773 | | |
| Readiness of Stakeholders | .767 | | |
| Training and Experience | .629 | | |
| IT Knowledge | .602 | | |
| Management | | .816 | |
| Availability | | .799 | |
| Connectivity | | .786 | |
| Reliability | | .721 | |
| Compatibility | | .713 | |
| Legacy system | | .696 | |
| Internet Connection | | .644 | |
| Bandwidth | | .619 | |
| Lock in | | | .850 |
| Switching Cost | | | .759 |
| Quality of education | | | .757 |
| Privacy | | | .742 |
| Security | | | .695 |

Table 2. Challenges of CC implementation

| Variable | N | Weigh | Rank |
|---------------------------|-----|-------|------|
| Infrastructure readiness | 204 | 8.68 | 1 |
| Internet connection | 204 | 8.64 | 2 |
| Switching Cost | 204 | 8.60 | 3 |
| Management | 204 | 8.53 | 4 |
| Deployment | 204 | 8.51 | 5 |
| Compatibility | 204 | 8.50 | 6 |
| Lock in | 204 | 8.35 | 7 |
| Availability | 204 | 8.34 | 8 |
| Security | 204 | 8.27 | 9 |
| Feasibility Study | 204 | 8.24 | 10 |
| Legacy system | 204 | 8.20 | 11 |
| Connectivity | 204 | 8.16 | 12 |
| Bandwidth | 204 | 8.14 | 13 |
| Readiness of Stakeholders | 204 | 8.14 | 14 |
| Training and Experience | 204 | 8.11 | 15 |
| IT Knowledge | 204 | 7.95 | 16 |
| Service Provider | 204 | 7.80 | 17 |
| Quality of education | 204 | 7.77 | 18 |
| Privacy | 204 | 7.71 | 19 |
| Reliability | 204 | 7.37 | 20 |

5. DISCUSSION

In Iraq, the war has caused major damage to the infrastructure of the country and building the infrastructure such as intranet, extranet, and internet is essential for the deployment of CC. Accordingly, internet connection was placed in second most important criteria. It can be seen that the challenges are also related to the cost of establishing the CC. This cost has several sub such as the cost of installment, cost of maintaining the CC, cost of training the staff and students as well as non-academic staff, cost of establishing the required infrastructure, and cost of paying the subscription to the service providers. This is followed by the challenge related to the management. The establishment of CC requires new management that can handle the CC. Third challenge is related to the quality of education when distance learning is used instead of traditional learning. Fourth economic challenge is related to the bandwidth and the reliability of the cloud as well as availability. Last challenge is the dependency on service provider.

Several stakeholders involved in the decision to use CC in the university. These includes those such as the students, lecturers, researchers, university system, administrators, non-academic staff, and IT professional [13]. However, one of the indirect economic challenge is the cost of adoption. Universities invest in the CC but the adoption rate among students and lecturers is limited to 20% [45, 46]. Thus, this makes the feasibility of the CC is low and the intended benefits hard to gain. Other involved party from outside the university include the service providers, software and hardware providers, the regulation of local

and federal government and agencies [47, 48]. This hesitation of higher learning institution could be due to factors such as the cost, reliability, availability as well as the selection criteria of CC applications, which include the criticality of the mission of university and the sensitivity of the activities that are being conduct in these universities [49]. In addition, the availability of large number of CC services has made it difficult for users to find and use suitable services after considered several factors such as scalability, licensing, curriculum, costing, and security [18]. The challenges that faces the educational institutions from economic perspective could be categorized into three groups. Challenges before installing the CC, challenges while using the CC, and challenges after using the CC. More details will be discussed in the findings of this study.

This study found that there are several challenges and they can be divided into three categories of CC for educational services. Pre-implementation phase included the challenges of selecting service providers, deployment, feasibility study, IT knowledge, readiness of stakeholders, training and expertise, and infrastructure readiness. Several research emphasized on the cost associated with selecting the service provider and the deployment of CC [14, 27, 41]. In addition, researchers highlighted the importance of conducting a feasibility study of the cloud services. This is because a cloud might take from eight to ten years to pay off the cost of establishment [31]. Researchers also referred to the challenge and the associated cost with training the staff, students, management, and preparing CC expertise to manage the cloud [29]. Increasing the IT knowledge of the stakeholders such as the students, staff, and technician will increase the cost of establishing the cloud. More importantly, is the readiness of the infrastructure. Cloud is a technology that requires high speed internet for downloading, uploading, and video streaming. The infrastructure might be the biggest economic challenge for a university to use CC services [38, 44].

In the second phase of the challenges of CC services is also the infrastructure, bandwidth, computability, legacy system, internet connection, reliability, availability, connectivity, and management. Research found that the infrastructure upgrading and maintenance need continuous improvement and choosing to have a private cloud deployment or hybrid will need the university to keep an eye on the infrastructure. The bandwidth also is important challenge because establishing a good CC requires good bandwidth. Compatibility of the existing system with the cloud should be addressed and additional cost could be encounter to adjust the existing system to be compatible with CC [29, 41]. Speed of the internet connection and establish high quality connection is one of the challenge during the implementation phase [14, 35]. Among the challenges also is the reliability of the service providers and the need to have new management that are capable of managing the CC [16, 30, 39, 40].

The post-implementation phase have critical challenges that are related to the security, privacy, quality of education, switching cost, and lock-in. Even though security and privacy are technical issue but they have indirect economic impact on educational institution. Preparing, establishing, and maintaining a secure cloud requires additional investment by the universities [16]. The usage of CC for educational services especially in e-learning and distance learning might reduce the quality of education and number of students might drop resulting in reduction of the revenue of the universities [34]. Another challenges in the post implementation phase is the switching cost. Once the service provider have been chosen, it is difficult for a university to move to another service provider due to the high cost involved in switching [39] and universities will experience the lock-in with the service providers [41]

6. CONCLUSION, LIMITATION AND DIRECTION FOR FUTURE WORK

This study was conducted to examine the economic challenges of using CC for educational services in Iraq. The findings indicated that the challenges can be divided into three phases. The pre-implementation phase, implementation, and the post-implementation phase. In all the three phases cost of establishing and managing the CC is the main challenge. The findings were based on input from 204 IT professional working in Iraq. Thus, future research can expand the sample to include more stakeholders such as the academic and non-academic staff and students so that the result can be more generalizable. The finding also were related to the economic challenges only. Future studies can adjust the inclusion criteria to examine the internal and external challenges as well as the technological and environmental challenges for education institutions. This study focused on the educational services, future studies are recommended to examine the challenges in other sectors such as the challenges for Small and Medium Enterprise (SMEs) and banking industry.

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