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Adoption of cloud computing in the information communication and technology industry in Ghana

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Abstract
The Ghanaian Information Technology (IT) sector is young but has potential for growth with the right tools and platforms incorporated. Cloud computing plays a major role in the drive for IT integration. Several adoption factors and challenges that influence the adoption of cloud computing will be elaborated on in this literature discussion. However, little work has been done to analyze the factors and challenges of cloud computing adoption within Ghanaian software development companies. This paper presents an analysis that evaluates the state of cloud computing within the Ghanaian software companies, determine the factors that affect the software companies' intention to adopt cloud computing, and outline the challenges of adopting cloud computing in the IT sector. The research was a quantitative study of developers from 8 Ghanaian software firms who were subjected to interviews, followed by a questionnaire-based survey with 24 respondents from the IT sector. The results show that cloud computing is widely adopted within Ghanaian IT corporations. It additionally indicates that the most motivations and cloud adoption factors within the Ghanaian development firms are: hardware and software value savings, less time, less effort and management, availability, greater scalability, and flexibility. Moreover, the study points out that security problems, privacy, and lack of cloud specialists are the principal obstacles the Ghanaian software development firms face.

Keywords
Cloud computing; Software; Ghana; Information Technology; Accessibility

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1. Introduction

Cloud computing has seen a transient rise in its adoption in recent years as it provides the technological avenue where institutions and organizations migrate from the use of locally installed storage systems to store and retrieve data to the use of internet-based services in a pay-per-use business model (Lowe & Galhotra, 2018). This presents real-time data access, lower cost maintenance, and less risk of data loss since the cloud service providers' information is backed up severally. This allows these IT firms to access their information in real-time without geographical limitations once there is internet access. Thus, the main impression of cloud computing is that an organization or user need not worry about geographical location. Cloud computing is defined as "the applications delivered as services over the internet; the hardware and systems software in the data centers that provide those services" (Armbrust et al., 2009). For most users, cloud computing means having access to free picture sharing, e-mail, and productivity tools. For organizations and businesses, the cloud implies having on-demand services rather than having to configure infrastructure, software, and support employees to deliver high-level service (Jabi & Jaaron, 2015).

The majority of cloud computing processes are performed remotely. Organizations employing these solutions do not need to worry about constructing infrastructure for data management. Users only need to connect to the internet to access their information. Cloud computing allows you to focus on how to use information and communication technology services while neglecting many intricacies rather than owning and controlling them (Dureidi & Zein, 2022). The adoption of cloud computing should be strongly encouraged. It has several advantages.

For example, the expense of resources and their upkeep are removed. Users have more freedom since they may access the services from a wider range of devices and places. Scalability is improved through cloud computing. Instead of installing new software and hardware, cloud computing allows enterprises to easily alter capacity based on user demand.

Again, cloud computing enables enterprises to focus on key concerns while managing software programs and running server farms, as well as enhancing speed, efficiency, and productivity when compared to alternative storage devices via its services. (Jabi & Jaaron, 2015; Ali et al., 2020). Hassan et al. (2017) published a study on cloud computing adoption in Malaysian SMEs to identify the link between cloud computing adoption and high management support, IT resources as organizational factors, external pressure as one of the environmental factors, and perceived benefits as one of the technological factors. They discovered that external pressure and IT resources had a significant and beneficial impact on cloud migration. However, perceived earnings and strong managerial backing have not changed. The Partial technique of least squares was employed for applied math analysis throughout this investigation (PLS). (Senarathna et al., 2018) have developed a probe model to examine the cloud computing adoption factors within the Australian micro, small and medium-sized organizations (SMEs); the TOE framework, and diffusion of innovation (DOI) theory derived the analysis. The model was validated through a survey, and the data were analyzed using a regression method. Findings from this study show that quality of service, relative advantage, and awareness of cloud computing has a significant positive relationship with the adoption of cloud computing within the Australian SMEs, it additionally shows that privacy, security, and adaptability were of less significance. Alhammadi et al., (2015) discuss the factors that affect cloud computing adoption in Saudi Arabia, based on DOI theory and the technology, organization, environment (TOE) framework. From the literature, they found fourteen factors influencing the adoption of cloud computing, and then fourteen hypotheses were conducted on these factors. After evaluating this hypothesis through a questionnaire, the following factors were found to be significant in the adoption of cloud computing in Saudi Arabia: firm status, top management support, government support, security, organization readiness, and compatibility.

However, assimilating cloud computing presents some challenges that are related to privacy and security, cost unpredictability, complexity, required expertise, and technological limitations (Asatiani, 2015). (Seifu et al., 2017) demonstrated some problems relating to cloud computing that keep public and personal enterprises in Abyssinia off from cloud computing. The problem was mainly about security, privacy, low awareness of cloud computing, and government policy problems. Researchers collected the info through interviews and analyzed it using the "Glasserian" grounded theory approach. (Phaphoom et al., 2015) address technical barriers and security-related risks as major barriers that negatively affect cloud adoption decisions. Based on data that was collected through a web survey from employees and decision-makers, three stages of analysis were performed, examining data distribution, bivariate analysis, and multivariate analysis. The study focused on six major obstacles namely, data privacy, security, portability, availability, integration, and migration. Study findings reveal three potential adoption inhibitors data privacy, security, and portability.

Most industries, including Ghanaian businesses, have already accepted cloud computing and begun to migrate their work to the cloud. However, few research on how Ghanaian businesses interact with cloud computing have been undertaken. The purpose of this study is to investigate the state of practice for cloud adoption in Ghanaian software development companies, identify the adoption factors that influence the cloud computing paradigm, and outline the challenges that developers in Ghanaian software companies commonly face when using cloud services. Therefore, this research will help Ghanaian companies to be aware of cloud computing adoption factors and challenges. To achieve our objective, the following research questions need to be answered.

- **Q1** what is the current state of practice of cloud computing or its adoption in Ghanaian software development companies?
- **Q2** What factors influence cloud computing adoption in Ghanaian software development companies?
- **Q3** What are the challenges of using cloud computing in software development companies?

We believe that the results of this study can be beneficial for practitioners in Ghanaian companies in terms of framing plans to adopt cloud computing and adding to their awareness and understanding of what adoption factors and challenges of cloud computing. It also can assist the research community by opening new research horizons to introduce strategies to adopt cloud computing. The remainder of this research is structured as follows: Section two is a literature review, we explore previous articles which discussed cloud computing adoption factors and cloud challenges, and then we present the research methodology, research design, data collection, and analysis procedure that we used in section three. In section four, we have results that answer the research questions; the last section is about the conclusion and future studies.

2. Materials and Method

In this work, two research methodologies were employed. We gather exclusive information about the state of cloud

computing in Ghana. We also identify the factors that foster the adoption of cloud computing and the challenges the developers face while using cloud computing. The first approach was a multiple case study, and the other was a survey.

2.1 Procedure and data collection

2.1.1 Case study

A multi-case research was performed out. Multiple-case design is a type of case study research in which numerous integratively restricted instances are chosen to acquire a more in-depth description of the nature than a single case can provide. This is seen to be more concrete than a single-case study. On the other hand, doing a multiple-case study necessitates more resources and time than a single case study, which is regarded as a drawback. (Hollweck, 2016). The research looks into eight industrial instances, each representing a Ghanaian software development firm that uses both local development and outsourcing models. The companies and developers were chosen based on their willingness to participate in the research. Each firm has one or two important respondents who aid response to the research questions. We acquired information through semi-structured interviews with senior and junior staff from eight different software development organizations A1, A2, A3, A4, A5, A6, A7, and A8. Because of the covid-19 problem during the time of this work, the interviews were performed remotely. The interviews were taped, and the conversations were transcribed and saved in a separate document so that they could be examined and evaluated later. The interview questions were separated into four sections: "interviewee and company information," "status of cloud computing in Ghana," "cloud computing adoption considerations," and "cloud computing usage problems." The openness and framing of the questions allowed the interviewees to identify cloud problems and adoption variables that were not identified prior to the interviews. Each of the eight interviews lasted approximately 35-40 minutes.

2.1.2 Survey

The questionnaires were created after determining the three primary study objectives (mentioned in the introduction). The appropriate factors to study and analyze in order to attain the objectives were then determined. Third, utilizing the findings from our case study, we had to create questionnaire items to access each variable.

From May 2021 to June 2021, the questionnaire was circulated through Facebook groups for software and IT professionals. Closed and open-ended survey questions were constructed so that respondents may add extra information to their responses. Several questionnaire responses were 35. Questionnaire 3 is now available as an online survey on Google Docs. The questionnaire is divided into four sections, as follows:

The questionnaire consists of four parts as follows:

- First Part: Demographic data which consists of four items: gender, qualifications, years of experience, and position or job title of the respondents.
- Second Part: It assesses the status of cloud computing in Ghanaian software companies using four Yes/ No questions.
- Third Part: Identifies adoption factors that motivate using cloud computing services by measuring their importance of them using four-point Likert scales. Unimportant, moderately important, important, very important. This part consists of 11 items classified as cloud motivations in literature and interviews, in addition to an open question to give respondents the space to express their motivations to use cloud computing services.
- Fourth Part: Identifies challenges of using cloud computing, by measuring the extent of agreeing or disagreeing using five Likert scales; Strongly disagree, Disagree, Neutral, Agree, and Strongly Agree. This section also includes 11 things defined as cloud obstacles in literature and interviews, as well as an open question to allow respondents to explain the difficulties they encountered when utilizing the cloud.

2.2 Data Analysis

According to (Clarke & Braun, 2013), Thematic analysis is a strategy for developing new ideas by studying and creating themes from obtained data that aid in understanding the phenomena being examined in a specific context. The primary stages of a theme analysis are:

- Read the data multiple times to familiarize yourself with it.
- Generate codes that identify important features of the data by observing the occurrence of themes.
- Generate themes that accurately depict the data.
- Review the themes to make sure that these themes support the study.
- Defining and naming themes.
- Validating themes by building a valid argument.

In our study, we used both thematic analysis stages. We began by reading the interview transcripts numerous times, and after becoming acquainted with them, we developed codes and then grouped similar codes into themes. Finally, we defined the themes. The open questions on the questionnaire were evaluated using thematic analysis. The close questions on the questionnaire were examined using frequencies. The studied data collected from Google forms were represented by percentages.

3. Results and Discussion

In these sections, we discuss the results of our study based on the research questions which have three main aspects of cloud computing in Ghana. Hyperlink InfoSystem was very receptive and aided in our study. It is one renowned software development company in Ghana with about 200+ employees. Other companies like, Hillson Technology Global Limited, JimahTech Limited, Makedu Consult, and Melvic Technologies aided as well with 9, 9, 40 and 9 employees respectively.

3.1 The state of cloud computing in Ghanaian development companies

According to the interviews, all of the organizations have employed cloud computing in recent years. A4 developer mentioned that his organization has used cloud computing operations from its inception in 2016. Another A7 developer noted that his organization began moving to the cloud in 2016. Another A8 software developer mentioned that his organization began utilizing cloud computing in 2014. As in A5, cloud providers make incentives to encourage startups and businesses to utilize their services, and they have an offer from AWS to use their services. The same rationale that prompted A6 to select Azure as a service, the developer stated, "we utilize Azure most of the time since they provided us an offer; we are a Microsoft partner". Many companies used multiple services from different providers since they work on different platforms, also they should test their work with multiple providers, the developer in A2 mentioned "We are working on Amazon AWS and Microsoft Azure services since we are working on different platforms and each one is needed and recommended by authors to use specific cloud".

The second section of our questionnaire has four questions that assess cloud computing status in the Ghanaian software development companies, and these questions are:

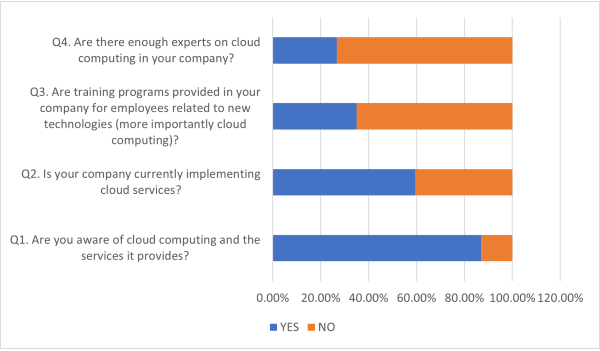

Figure 1. Answers to the state of cloud computing in Ghana's development companies.

3.1.1 Q1: Are you aware of cloud computing and the services it provides?

From the results, it was seen that a substantial number of IT staff are updated and using state-of-the-art technologies as 86.9% of the respondents are aware of cloud computing technology and its services whiles 13.1% are not. Fig 1 elaborates the result on a bar chart.

3.1.2 Q2: Is your company currently implementing cloud services?

From the results, 59.4% of respondents' companies implement and use cloud computing services but 40.6% are not utilizing them. Figure 1 illustrates the results on a bar chart. This depicts that, the majority of Ghanaian companies currently implement cloud services.

3.1.3 Q3: Are training programs provided in your company for employees related to new technologies (more importantly cloud computing)?

From Figure 3, it is seen that only a few Ghanaian companies (35%) of the respondents from the Ghanaian IT sector affirmed that they have been subjected to various training, especially about cloud computing whiles 65% responded otherwise.

3.1.4 Q4: Are there enough experts on cloud computing in your company?

The result was elaborated in a bar chart in Figure 1. It is seen that there are not enough cloud computing experts in Ghanaian companies. Only 26.7% of the subjected companies answered affirmatively whiles the remaining 73.3% of companies responded "NO".

Concerning cloud computing adoption factors, all the representatives interviewed from these companies agreed on the significance of cloud computing and the business value it adds it their companies. Several adoption factors were mentioned and the advantages that motivate their companies to adopt cloud computing. When they were asked, "What are your motivations to use cloud computing services?". A software developer in A2 explained that "Cloud computing prepares all requirements for the platform (technologies, securities, packages, automated backups) and they guarantee to make it all up-to-date". Another software developer in A7 mentioned, "Related to my recent work, doing data analytics on the cloud saves a lot of memory on my local side, and turning everything in the cloud and getting only the results as an interface, motivates more analysis to be conducted without worry about additional space and memory needed. The wide range of services exist at a good price and also motivate the user to use the cloud services". Two questions were asked in the survey about cloud adoption factors, and the first one has 11 variables that affect the adoption of cloud computing in Ghanaian software development companies. Each of the variables has four options as follows: Unimportant, moderately important, important, and very important to see how important are these variables as factors and

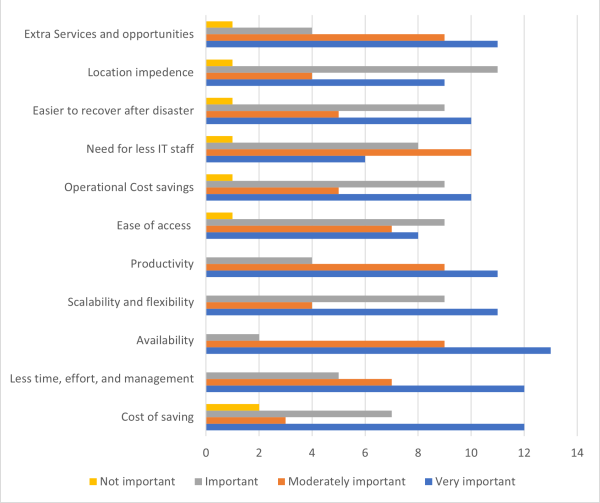

Figure 2. Factors that affect the adoption of cloud computing

motivations to adopt cloud computing in the Ghanaian software development companies. The second question was an open question, to give respondents the space to express their motivations to use cloud computing services. The following are cloud computing adoption factors that we accumulated from interviews and questionnaires:

In relation to cost savings for hardware and software infrastructure, a lot of startup companies are driven to adopt cloud computing mostly because it is cost-effective. With cloud computing, the cost of acquiring certain servers, infrastructures, networks, data centers, and other physical equipment and tools is eliminated. This poses a huge advantage for startup companies which usually do not have a huge budget nor are they sure about their success and continuity. In addition, cloud computing provides the avenue where the companies can buy resources based on their need, and they only pay per their usage. An interviewee from A8 points out that: "Cloud is more affordable, especially for startups. You only pay per use". Results from the questionnaire show that hardware and software cost-saving have a very important effect on cloud adoption as can be seen in Figure 2. In terms of time, effort, and management, IT firms try to manage and coordinate their data needs to purchase hardware and install software patches, operating systems, and other applications. Again, the necessity rises for certain personnel like network administrators. The network administrators need to be stationed at physical places and they may encounter technical problems while working. The capacity problem is another major concern. Cloud computing provides solutions to all these problems by preparing managed information and communication technology services, and the user only needs to focus on how to use them. A software developer from A8 stated that "Cloud makes an abstraction for many layers in manage services so that you don't need to build from scratch or to learn it". Results from the questionnaire show that less time, effort, and management have a very important effect on cloud adoption as shown in Figure 2.

Also, the prompt availability of resources goes a long way to help a company develop. Cloud providers provide servers that work every time and in multiple regions and data centers which make the service available all the time. Also, they solve all related issues and take backups and snapshots manually at a specific time as mentioned by the developer in A8. One of the interviewees from A3 added that" I don't care if the server becomes down. The cloud vendor is responsible for server issues as server down, backup data, data availability, and data consistency". Results from the questionnaire also show that availability is a very important adoption factor as shown in Figure 2. Scalability and flexibility of online services were also observed as the main benefits of cloud computing technology, cloud providers easily adapt to clients' change requests and needs, thus, additional capacity is immediately delivered when the client asked for it. Moreover, if the additional capacity is not necessary anymore, it is reduced and so do the associated costs, this occurs automatically without the interference of a user who requests it, as this has often been agreed upon in advance in a contract (Adelaar, 2020). On productivity, one of the interviewees in A7 mentioned that using the cloud enhances productivity by providing advanced and efficient services. In addition, if the company chooses the right provider, the resources will be more reliable and kept updated which surely leads to enhanced productivity. Other adoption factors include ease of access to software and hardware, operational cost savings, need for fewer IT staff to support systems, easier recovery after a disaster, location independence, and extra services and opportunities also are cloud adoption factors that have an important effect. The advantages of implementing cloud services are numerous which poses reasons for companies to migrate from physical infrastructure to virtual infrastructure as confirmed by (Hughes et al., 2021).

3.2 Cloud Computing Challenges

Through the interviews and questionnaires, the following are the main challenges and barriers that were gathered.

Because the data will be handled outside the corporation on hardware shared with several clients, most companies consider that security and privacy are significant challenges that organizations may face. Security concerns may deter certain enterprises from embracing cloud computing, particularly those that handle sensitive data, such as banking and communication firms. One of the A8 interviewees, a former employee of a large Ghanaian telecom company, verified this. Some suppliers, however, provide solutions and boost security at a higher expense. "Data analysis is done on the provider side, and if we want to raise the security level, we need

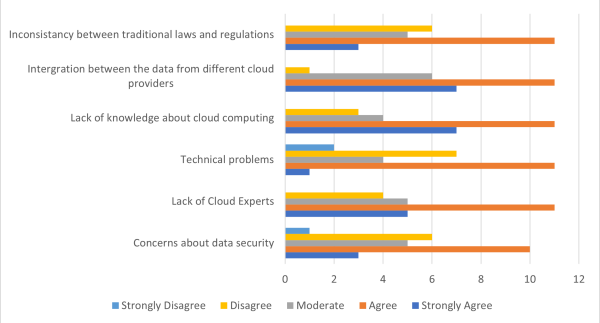

Figure 3. Cloud computing implementation strategies.

more funding," stated an A7 respondent. According to the questionnaire results, the majority of respondents believe that the biggest hurdles for cloud computing in Ghanaian software firms are security and privacy issues, as illustrated in Fig. 3. The level of expertise and skills about cloud services had a significant effect on trust and usage attitude of cloud services, new developers need some time to be familiar with cloud services, supporting this claim, an A7 software developer said "It needs an expert to guide you through the process; there will be a lot of missing points." The level of convenience varies by provider; one A6 interviewee stated, "Cloud services take time to learn to some providers, for example, Azure is more convenient than AWS." As illustrated in Figure 3, the majority of respondents agree that a lack of cloud experts is a significant challenge for cloud computing.

Additionally, developers encounter technical issues when utilizing cloud services. Because the information and programs are hosted on the provider's servers, these issues must be addressed with their support staff. Following up with suppliers takes time to reply and fix the issue, forcing developers to look for and implement workaround solutions. According to the response from A3, "we have long battled technical challenges and technological restrictions that require supplier remedy." "In our instance, the greater data we prefer to use servers (clusters), the servers get slower once we transfer to that," he said. We spoke with the provider, and it had become a tangle in the interaction with the query engine after they switched to a new version, and we were forced to stay on the older version for approximately a month until they upgraded to the new version." "With automatic deployment exploitation AWS service, I had to seek call at Google for python code and tweak it for our situation and utilize it, which took a couple of days," said another A2 respondent. Figure 3 clearly shows that the questionnaire respondents agree that technological issues are one of the cloud obstacles.

4. Conclusion and Discussion

In this research, the multiple case studies and questionnaire-based survey study approaches that investigate cloud computing status in Ghanaian software development companies were presented; to identify the adoption factors that influence the cloud computing pattern, and also to outline the challenges that commonly face developers in Ghanaian software companies in the use of cloud services. The advantages of implementing cloud services are numerous which poses reasons for companies to migrate from physical infrastructure to virtual infrastructure. (Hughes et al., 2021) discussed 8 reasons for cloud migration which are all in concord with the factors discussed in this paper.

This survey revealed that cloud computing services are frequently used by most Ghanaian businesses due to its business value, critical characteristics, and client needs. This study's conclusions expanded on some of the variables that attract businesses to utilize cloud services. These factors include hardware and software cost savings, operational cost savings, less time, effort, and management, availability, greater scalability and flexibility, productivity, ease of access to software and hardware, the need for fewer IT staff to support systems, easier disaster recovery, location independence, and additional services and opportunities. However, Ghanaian software development firms confront several hurdles in adopting cloud computing. Security, privacy, technological concerns, a lack of cloud professionals, the discrepancy between global rules and regulations, integration of data from multiple cloud providers, and a lack of understanding of cloud computing were the most difficult challenges. Other challenges include lack of knowledge about cloud computing, integration between the data from different cloud providers, in addition to inconsistency between transnational laws and regulations are challenges of cloud computing as shown in figure 6. In line with (Gray, 2018), all the challenges that have been discussed in the survey can be termed as misconceptions. The unavailability of knowledge about cloud computing promotes such misconceptions ((Gray, 2018). This blog describes the three main pillars of a cloud platform which are; Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service. (IaaS). SaaS gives the avenue for organizations to run software platforms virtually without installing them on the computing device. Google docs is an example. PaaS provides the avenue for companies to build and run applications virtually and restrict access to a few employees. IaaS, on the other hand, allows you to store, run and develop a wide range of applications. It is a total virtualization effort that makes sure that everything you need can be managed or created online. The technology involved in building all these sectors offers absolute reliability and privacy and be elaborated to any less literate individual to curbs these misconceptions as (Seifu et al., 2017) discovered.

In the future, we want to do a thorough investigation of cloud computing security and privacy concerns, as well as how Ghanaian businesses deal with them.

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