Cloud Computing Implementations Challenges, Insight, and the Way Forward: A GCC Study

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***Abstract*—**Organizations view cloud computing as a way to gain competitive advantage by improving performance, reducing cost, and providing better services. With increasing advancement in IT (hardware and software), companies are offered infinite numbers of virtual machines to use with what seem to be unlimited resources. This tempts many companies and governments to move their operations to the cloud. Developing countries align with this trend. Many companies in the Middle East and the Gulf region have started exploring and some have shifted to the cloud. With this shift come concerns and worries that slow this transition. Companies in the Gulf are no different. They are jumping on the Cloud wagon but as they do that they are facing challenges and fears. This paper will set the framework to research the effect, benefits, risks and fears of shifting to the cloud. The research sets the framework to answer the question: What should managers expect when moving their infrastructure to the cloud.

***Keywords*—** Cloud Computing, management, cloud risks and benefits.

I. INTRODUCTION

As hardware advances increased, the concept of hardware as a service began around 2006; in 2007, stakeholders dubbed the newest advance *cloud computing* [43]. Cloud computing may be a dream come true as many made attempts to separate users from computer hardware [45]; in the 1960s users envisioned time-sharing utilities; in the 1990s the commercial grid system was introduced; presently, cloud computing is an architecture that provides a separation between user and hardware. High-performance computers became a reality in the 1990s, and the concept of grid computing emerged [38], [45]. Grid computing enables resource sharing and problem solving in a coordinated manner [13]. Reference [14] considered it as a mean to provide users with "on-demand" computing power. Many researchers viewed grid computing as the beginning of cloud computing [4], [14], [42].

The term cloud computing can be traced to the 1990s when telephone-industry specialists used it as a technical term [18]. However, little consensus exists on how to define cloud computing [14]. Reference [43] defined cloud computing as a set of network-enabled services that provides personalized inexpensive computing structures and services on demand, indicating both the services provided to users over the Internet and the hardware architecture used to deliver these services. [8] defined it as a new emerging computing paradigm in which access to hardware, software, and data is available on demand over the Internet. Reference [18] defined cloud computing as an on-demand computing utility available for anyone who has access to the Internet. Reference [14] added yet another definition of cloud computing: "A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet" (para. 3). The National Institute of Standards and Technology defined cloud computing as an on-demand model that offers computing resources (networks, servers, storage, applications, and services) to users with little management by the provider [15].

Cloud computing transforms the way of delivering and paying for IT services [32], [33]. Through its unique and on-demand delivery model, companies are able to ensure IT agility, reengineer business processes, and revolutionize B2B and B2C relationships and business models. In Europe, the Centre for Economics and Business Research estimated that cloud computing could generate €763 billion ($1.05 trillion) and 2.4 million new jobs by 2015 [45].

Regardless of the differences in the definition of cloud computing, researchers have the following factors in common:

- Cloud computing comprises various technologies including peer-to-peer computing, service-oriented architecture, grid computing, and ubiquitous computing [21], [28], [44].
- Users can use the cloud on a pay-as-you-go architecture. Cloud computing has become a reality due to advancements in technology as well as new business models that recently emerged [15].
- Cloud computing will impact many levels in industry, changing the way people use computers [22].
- Cloud computing is considered a disruptive technology that will have a large impact on the economy as a whole [8].

In general, the cloud computing concept is simple: the host machine runs an application known as hypervisor that simulates virtual machines, which in turn allow users to install and run their own applications [45] [39]. Cloud computing can be categorized as public, private, or hybrid [18]. The goal of this paper is to explore the extent to which cloud computing exists in the Middle East and the Gulf region. We explore the different fears and issues considered by IT managers to determine whether to use the cloud.

II. Cloud Computing Challenges

Even with all the advantages of cloud computing, some concerns about the technology still make the cloud-computing concept slow to disseminate [43]. Some concerns are security, data transmission, data-storage location, authorization, authentication, identity management, reliability and availability, market and technology maturity, and lack of employee skills.

A. Security

Companies and organization panic at the idea and potential effect on customers and business during IT infrastructure downtime or when getting hacked. The impact on business availability, violation of compliance requirements [36], and customer servicing is exponantial. In a 2010 survey [16], IDC found enterprise IT buyers were most concerned about security in cloud computing. In inspite of 4 years working to address the problem, security is still a concern. Business organizations worry about having their data flowing over networks and through organizations' devices and infrastrucurre outside of their reach.

B. Data Transmission

Cloud services transmit customer data across uncontrolled Internet connections that are vulnerable to monitoring and interception. To address this challenge, most cloud-based services use some form of encryption: either through the web or through a proprietary client to the server [12]. However, the effectiveness of the encryption may depend on the actual cryptographic algorithms and protocols. Https, which is a widely used web-based encryption protocol, requires the right web-browser and web-server configurations to be in place. Given that cloud service providers remove control of the web-server component from the client organization, especially in the software as a service-delivery model, organizations only can access web-browser settings to enforce needed encryption mechanisms. This limited access has several disadvantages that may lead to challenges in running some website functions and applications, forcing users and administrators to bypass encryption enforcement by using alternate web browsers or altering the browser configuration. As a result, the best approach is to set the needed server configurations as part of the cloud service, emphasizing the importance of addressing this problem with any potential cloud-service provider, regardless of the cloud-service delivery model.

In addition, organizations that use e-mail servicing and hosting on the cloud face security-related risks. Usually in a private e-mail hosting environment, e-mail transmissions face a risk when transmitting from within an organizational to outside the organizational e-mail system. However, when using e-mail services on the cloud, this risk transcend to a security risk [11]. E-mail systems on the cloud contain two risks: interception and tampering during transmission and storage. Using e-mail on the cloud is likely to increase the risk of malicious e-mail tampering such as changing, deleting, or adding e-mail content. The risk is greater on the cloud than with private e-mail as a result of added infrastructural complexity and potential system compromise by other cloud customers who might have access to the cloud e-mail infrastructure.

C. Data-Storage Location

Data that are logically or physically stored by the cloud service typically resides in a shared infrastructure with multiple customers' data, stored on the same logical and physical storage media [11]. Hence, data stored on the cloud face the risk of modification, deletion, or unauthorized access and disclosure, either accidentally as a result of data leak across logical (customer) boundaries due to administrator error in configuration, or intentional due to malicious manipulation of the shared infrastructure. To mitigate such risk, cloud service providers encrypt data at the logical or physical storage level to limit exposure of customer's data. However, encrypted data are still prone to unauthorized deletion.

In addition, cloud environments usually are spread among various physical storage facilities among which data is mirrored with usually third- or fourth-party staff potentially having physical access [17]. Also, data on the cloud might periodically be moved, either physically or logically, to ensure efficient cloud-service operation and use. These dangers increase the likelihood of unauthorized access or tampering of data.

To mitigate the risks related to data storage and access, cloud-service providers should clearly define and communicate with concerned customers and organizations about the physical and logical storage mechanisms used. Some providers may have an issue with that process, as their storage mechanisms are considered highly proprietary and may include elements considered to be trade secrets [17].

D. Authorization, Authentication, and Identity Management

Cloud services typically consist of a number of technical "layers" from the physical device, usually through a virtualization layer, and potentially multiple application layers (e.g., a web-interface layer, application-processing layer, database layer, etc). The identity management and access authorization functions of a cloud service may either be managed directly by the cloud provider or delegated to one or more individuals on the client side. Cloud services may provide a limited ability to audit the roles and permissions assigned to all accounts in the customer's portion of the cloud service. Cloud-service providers will typically fail to provide customers with information regarding administrative roles held by the service provider or third-party service providers responsible for some elements of the cloud service. The combination of username and password alone are generally insufficient protection for sensitive information that is accessible from anywhere on the World Wide Web. Additional protections in the form of Internet-Protocol address restrictions or multifactor authentication mechanisms may not be available from many cloud-service providers.

In the cloud environment, customers should take responsibility to secure their data. Authentication is crucial in

ensuring data security. Limiting users' privileges, including those of the administrator, are key. In addition, Encryption of data in storage and in motion is critical for guarding against threats. In addition, the use of endpoint security is still important; firewalls, antivirus, VPN connections, and a strict patching policy are standard measures that should be part of a security deep strategy [17], [41].

E. Reliability and High Availability

One strength of cloud computing is its ability to provide the illusion of having infinite resources available, giving users the feeling they can use whatever resources they need to accomplish their task [15]. Furthermore, when signing contracts with cloud organizations, companies tend to ensure availability for their clients [43]. However, several cases arose where the cloud system was not available, causing companies to lose millions of dollars in revenue due to technical issues, network degradation, or even network updating, as in the case when the Microsoft's Azure cloud was down for 22 hours 19. Another issue is with data availability or data sanitization where users lose their data due to being deleted by the cloud hosting company [43]. Other companies like Google Mail and Hotmail also experienced service downtime; in one case, LinkUp, a cloud storage company, lost 45% of its users' data due to a technical error [6].

To improve service availability, companies follow different models. Amazon.com strictly notes in its service agreement that there might be cases when users experience service interruptions [2], other companies tried to overcome availability concerns by duplicating data on more than one cloud, using advanced algorithms and technology like High Availability and Integrity Layer (HAIL) to overcome latency and overhead in data retrieval.

F. Market and Technology Maturity

Maturity is a state where technology has reached its completeness, perfection, and readiness [37]. To reach maturity, a system, or even companies, need to follow a path that helps them achieve this status [23], [26], [27]. For companies to measure the effect of technology on business and its maturity, they have developed different maturity models. The most often cited is Oracle's Cloud Maturity Model.[1] In its model, Oracle measures its cloud technology using 60 capabilities, categorized under eight main domains: business and strategy, architecture, infrastructure, information, projects portfolio and services, operations and administrative management, organization, and governance. Using its maturity model, Oracle is able to assess the progress of its cloud and measure areas of improvement. Researchers published several cloud-maturity models for private clouds [7], [19], [22], [30].

G. Lack of Skills

Advancement in technology and globalization were factors in adopting progressive communication technology skills [5]. The need to create generates experience in technology and using advanced technology (like data mining and business intelligence), predicted by researchers long ago. Educators viewed the introduction of business-intelligence courses to the curriculum as an excellent step toward preparing generations for the technology advancements to come. Computer science programs led in introducing students to data-mining concepts [25]. According to [10], [34] & [40], computer-science curriculum does a good job presenting data-mining and data-warehousing topics. In their research, [3] stated that the introduction of data-mining courses to the curriculum was an excellent way to start introducing computer applications related to various business domains.

Although researchers and universities tried to predict the need to produce employees with excellent technical skills, the industry still demands highly skilled employees, considered a major expense [31]. Due to advancements in technology as well as environmental limitations, developing countries are facing shortages in technology and skilled workers [24], [42]. Reference [35] pointed out that the lack of skilled employees in cloud computing and their ability to innovate on the cloud may lead companies to train and develop employees rather than seeking skilled ones in the market.

III. Research Problem

An online version of the survey was created and sent to 60 organizations. A total of 49 managers and IT professionals responded and filled the survey.

A. Case Study

To address the issue of reasons for switching or not switching to the cloud, the questionnaire asked the following questions:

- Which job sector benefits the most from the cloud?
- Which services do you benefit most from the cloud?
- Which type of cloud seems more interesting to you (public, private, and hybrid)?
- What are some factors and barriers preventing you from using the cloud?

B. Study Objectives

The objectives of this study were to explore the sector that benefits most from the cloud in the Gulf, and to explore factors and barriers preventing companies from moving fully to the cloud.

IV. Research Results and Discussion

A. Business industry domain

Of the surveyed organizations, when asked if their organization is using cloud computing services, 48% use the cloud, 30% do not use it, and 21% were not sure. Of those organizations not using cloud computing services, 61% were considering the use of cloud computing services within 1–2 years, 17% in less than a year, and 6% within 5 years. Considering the relatively young age of cloud computing services, 35% of organization implementing or using clouds

[1] http://www.oracle.com/technetwork/topics/entarch/oracle-wp-cloud-maturity-model-r3-0-1434934.pdf

computing services have been using it for 2–5 years, 29% for less than a year, and 24% for a year.

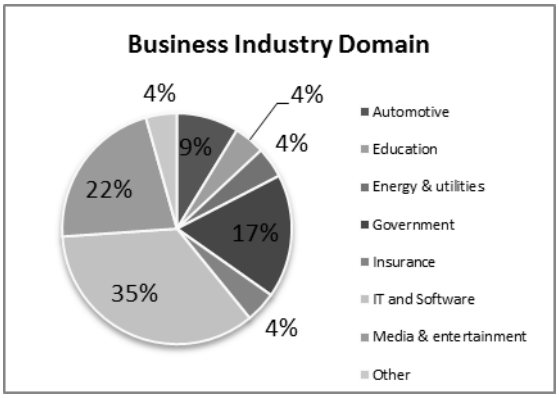

Fig. 1 distribution of cloud usage based on industry domain.

As can be seen in Figure 1, IT companies comprise the majority of companies taking advantage of the cloud. This outcome is logical because their job is to understand, use, and apply the latest technology. Other domains fall behind because of fears of little understanding of new technology. The interesting part of this section is that government comprised a third of cloud users, indicating that it would be normal if future government organizations move to second or first place! Furthermore, insurance companies make only 4% of the organizations using the cloud, which was expected because, as we will discuss next, security is a major concern in moving to the cloud, making insurance companies reluctant to participate.

B. Cloud services used

As can be seen in Figure 2, organizations that opted for a hybrid delivery model were more likely to use the cloud than those that opted for public or private delivery. The number of those opting for the public-delivery model was fewest, which aligns with organizations' security and privacy concerns about using cloud services.

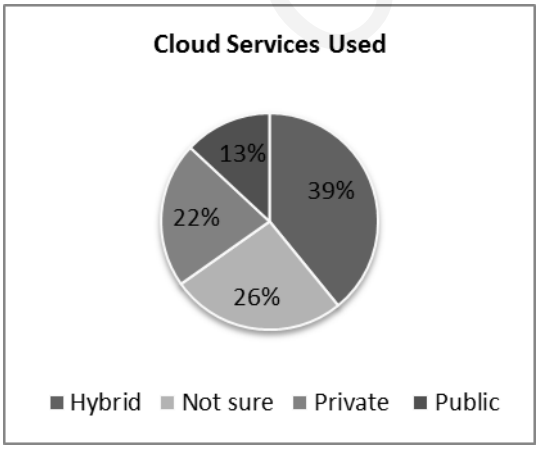

Fig. 2 cloud-computing delivery models for surveyed organizations.

Three cloud-computing service-delivery models exist: private, public, and hybrid. In private clouds, IT activities, functions, and services are provided by the enterprise intranet and behind the organization's firewall. In public clouds, IT activities function over the Internet. As for hybrid clouds, companies integrate internal and external service-delivery methods based on security and architecture requirements and other established policies. The choice of any of these cloud implementations is driven by number of reasons, including a consumer interface featuring ease-of-use, IT efficiencies, corporate policies, security, and new charging models.

Companies prefer putting sensitive information on private clouds because that specific organization operates and accesses such services exclusively [8]. Being able to take advantage of both public and private clouds enables companies to share only what they want without fearing security breaches; hence, the high percentage. When asked about the delivery model used, 39% noted they used the hybrid model. Looking closely at Figure 2, the smallest percentage uses the public cloud, as noted earlier, due to security fears and lack of fully understanding the cloud concept.

C. Cloud-adoption framework

As for the cloud-servicing framework, of the four cloud implementation frameworks—infrastructure as a service (IaaS), platform as a service (PaaS), software as a service (SaaS), and business process as a service (BPaaS)—most surveyed organizations opted for the SaaS implementation framework, whereas the remaining organizations opted for PaaS implementation. No organizations used IaaS or BPaaS. This outcome aligns with the use of cloud computing services by IT organizations to host and provide IT-related services such as software development and testing, hosting business websites or solutions, and pilot or proof-of-concept projects [1]. The high percentage of companies using this service is understandable because this feature saves them money which can be spent elsewhere (see Figure 3).

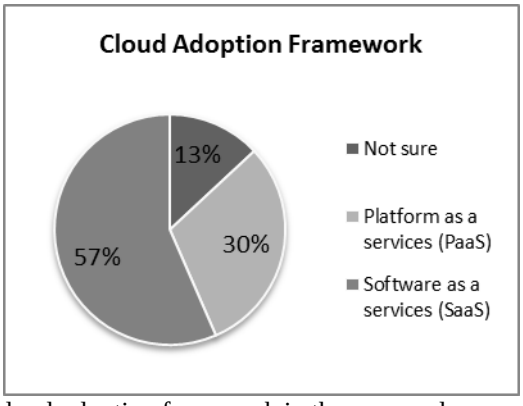

Fig. 3 cloud-adoption framework in the surveyed organizations.

Of the surveyed organizations, 57% used the SaaS cloud-implementation framework. This implementation framework allows organizations the benefit and advantage of using business solutions such as customer-relationship management,

enterprise resource planning, and e-mail applications off the cloud, enhancing performance and providing a better service to users. Software organizations usually choose the platform as a service framework, as it allows them to get database servers, web servers, and development servers such as Microsoft or Unix on the cloud for their corresponding software development, testing, or production environments. IT and software organizations use these cloud platform-ready environments to install all the needed software-related tools or artifacts for their in-house developed or to-be-tested business solutions or pilot projects.

D. Service exposure

Cloud-servicing use results are depicted in Figure 4, showing whether it is used/to be used for internal or customer-facing products/services or websites: 78% of those surveyed use the Cloud to provide customer solutions, services, or websites. This aligns with a survey conducted by IBM Academy [18], which found that cloud usage was dominated by development, tests, and noncritical production workloads, with 50% of usage being for local pilots whereas only 20% of usage was at the enterprise level. As time passes and maturity of cloud servicing increases, this seems to have changed. The use of cloud computing services for production and customer-facing solutions and websites has increased. Of surveyed organizations, 78% use cloud servicing to host and support customer-facing solutions and services.

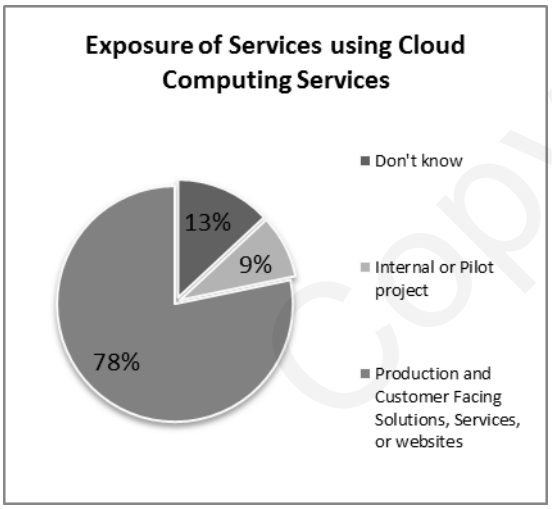

Fig. 4 exposure of application and services

E. Cloud challenges and barriers

We noticed that the two most prevalent reasons for not using the cloud are lack of skills and security concerns. Lack of skills in managing and setting up a cloud environment can easily be translated to security fears because the concept behind the cloud is hidden from users [43]. IT managers do not understand where their data is stored, how it's stored, and who has access to it, making it difficult to fully answer questions about the security level of the architecture. This outcome aligns with other researchers who reported similar results. For example, Reference [17] reported that security concerns are the most important fear among IT decision makers for public and private cloud, and especially for public cloud. Furthermore, the primary concerned reflected in this study is lack of skills: 55% of those surveyed expressed concern over the lack of skilled employees available to handle cloud issues. This supports a finding by [29], indicating that for cloud services to become prominent, employees must be trained and prepared with the proper skills. Other researchers focused on this issue, indicating the importance of maintaining skilled employees to take full advantage of cloud services [33], [41]. We found that for those surveyed, developing a strong value proposition, plus funding, security, and managing complexity were the major barriers to initiating cloud services, as shown in Figure 5.

Next on the list of barriers was the fear of loss of control and licensing. Managers, especially IT managers, run sensitive processes, such as backing up data and systems, making it difficult for them to trust a third party they do not understand. Most of the applications used are not licensed to run on the cloud. Applications with special development and update needs must be installed properly and used on the cloud. Over time, this issue will be resolved because major companies, like Microsoft, IBM, HP, and Intel have already started moving their product to the cloud [43].

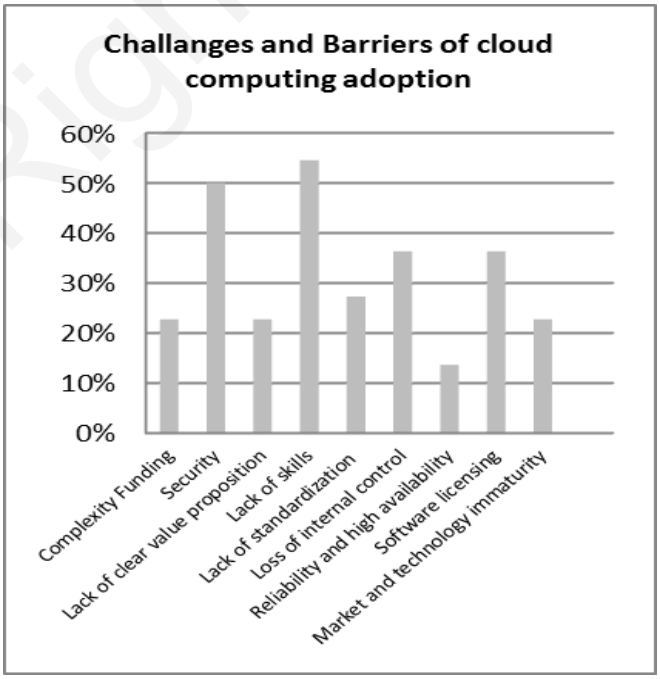

Fig. 5 barriers limiting IT organizations adoption and use of cloud computing.

F. Benefits and incentives for using the cloud

The most attractive feature of using the cloud is the reduction in expenses. This aligns with findings from other researchers who found that low cost is a very important factor for adopting cloud computing [20] and cost reduction is a major goal [8]. Reference [9] predicted that cloud computing would cause a 1% to 5% cost reduction across all sectors. The second incentive to using the cloud is the ability for companies to increase or decrease IT capabilities. The ability to have technology available when needed without the need to

upgrade, expand, or buy new servers is quite tempting. The cloud offers its services in a pay-as-you-go style, allowing companies to increase or decrease any IT elements they need or do not need [15].

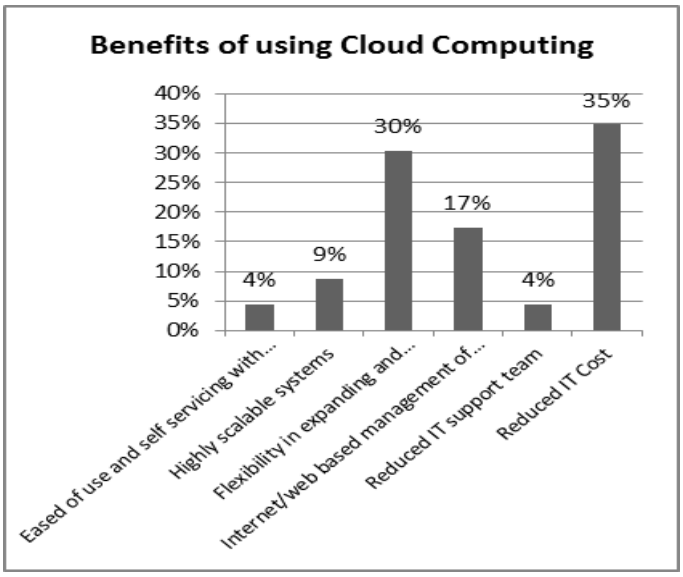

Fig. 6 benefits gained from using the cloud.

V. Conclusion

Companies are shifting toward using cloud services—private, public, or hybrid—realizing that the shift means access to better technology at lower prices, as well as access to an infinite amount of hardware (space) or software. However, companies also realize that this service comes with concerns. The lack of understanding of how the cloud operates, the legal ramifications of data being distributed over several servers and in some cases several countries, privacy, and security concerns are on the rise. Furthermore, many companies find it difficult to find the skilled labor to deal with cloud. This research sheds light on these concerns in the Middle East. Due to advancements in technology, developing countries are facing shortages in technology and skilled workers [24]. This is met by companies offering higher salaries to attract skilled employees and by increasing training to enhance employee skills [29]. Furthermore, we found that the focus on a hybrid cloud model is encouraged over public or private clouds, mainly because IT personnel prefer to place sensitive data on private clouds and everything else on the public cloud. This gives them more flexibility and an extra layer of security. The research also revealed that lack of clear funding is a barrier to using the cloud, even though the cloud-services cost is minimal [20]; companies still do not consider having cloud expenses as a budgetary priority.

Companies in developing countries need to focus on incorporating cloud computing into their infrastructure; to do this, they need to ensure that employees are well trained and knowledgeable in dealing with cloud settings, services, and concerns. Most universities and schools in developing countries have already started incorporating data-mining concepts and knowledge-discovery courses as well as business-intelligence courses [40] to ensure that students graduate with basic knowledge of IT, regardless of their major [3]. This form of education ensures the future workforce will have a minimum of knowledge to engage in new technology such as cloud computing in their work careers [25].

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