Cloud Computing Financial and Cost Analysis: A Case Study of Saudi Government Agencies

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Keywords: Cloud Computing, Return on Investment (ROI), Total Cost Ownership (TCO), Data Centre Variable Cost (DCVC), Data Centre Fixed Cost (DCFC).

Abstract: Cloud computing is an innovation in world technology. It is used to provide organization services as a utility service through internet and the innovative uptake of cloud for improved effectiveness and efficiency. There is an absence of academic studies about the financial feasibility and implementation cost government agencies to take up the cloud by government agencies. This paper seeks to identify the cloud computing financial indicators and implementation cost variables which are relevant to public organizations. The proposed model consists of Saudi case study findings based on analysis of evidence from Saudi government organizations. Random samples from different categories of professionals in Saudi Arabia participated in the questionnaire to extract and confirm the financial indicators and implementation cost variables. The results indicate a return on investment (ROI) and total cost ownership (TCO) are the main financial indicators to study cloud adoption. Also, data centre variables and fixed cost parameters play a main role in calculating the cloud implementation cost.

1 INTRODUCTION

Improving the public sector's services is one of the top priorities for many governments and organizations. Most of the transactional systems in government agencies in the Kingdom of Saudi Arabia are not fully operable because the idea of applying and implementing government services is not practical and a large budget is needed to implement agency services such as email. Thus, cloud computing and its elastic commercial model of information technology possession, such as data storage or providing computing power on the mandate, promises to provide assistance and many rewards for governments and organizations.

There are financial benefits for Saudi public organizations if they decide to adopt cloud computing. First, reducing capital investment is the transformation which spent on IT infrastructure "capital expenditure "to operational expenditure (Herbert and Erickson 2009). Second, costs are reduced costs as infrastructure maintenance costs are Lower and more efficient than traditional computing (McDonald, MacDonald et al. 2010). Third, decreased energy consumption due to moving IT infrastructure to cloud providers, can leading to greener organizations. Fourth, decrease in physical space requirements leading to reduced real estate expenses. Finally, it enables organizations to create on-demand pricing models for their products.

However, there are no studies until now about the feasibility of adopting cloud computing in Saudi Arabia. Thus, it is necessary to study the feasibility of adopting cloud computing and the cost of implementing in Saudi Arabia public sector. This paper will focus to identify financial indicators attributes and variables cost of implementation.

2 ADVANCES IN CLOUD COMPUTING

2.1 Cloud Computing

Cloud computing (CC) has been defined in a variety of ways. It can be explained as a system that enables resource sharing management by using fewer resources and efforts (Wen and Chen 2010). Alharbi asserts that CC facilitates changing software,

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infrastructure, and platforms and allows them to be offered as services to users (Ahuja, Yang et al. 2009). The US National Institute of Standards and Technology (NIST) defined CC as "a model for enabling convenient, on-demand network access to a share pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management afford or service provider interaction"(Mell and Grance 2010). Figure 1 represents the NIST cloud computing concept schema. Industries such as banking and health care are moving towards cloud technology because it increases efficiency and provides accessibility through any portable device(Morgan and Conboy 2013). The lack of resources in some countries can be handled using cloud technology (Misra and Mondal 2011) since because it costs less than traditional infrastructure installations, CC allows higher user accessibility. Cloud computing delivers many benefits to organizations. The biggest of these are high elasticity and huge cost reserves due to the on-demand provision of services and its charging model (Bhisikar 2011). Cloud computing also provides an extensive range of advantages such as increased flexibility, access anywhere, elastic scalability, pay-as-you-go charging, simplicity and distributed data centers.

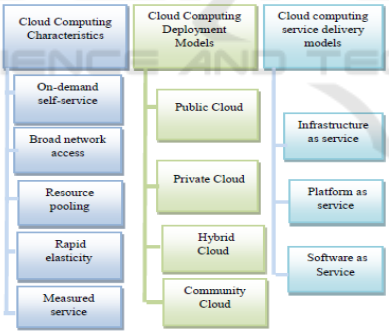

Figure 1: NIST cloud computing concept schema (Alharbi et al. 2015).

2.2 Cloud Computing Platforms

Industry investigators have made strong forecasts on how Cloud technology will change the industry. Buyya et al. (2009) recognized Cloud technology as one of the noticeable innovation patterns (Buyya, Yeo et al. 2009). As the assuming business shifts to giving Platform as a Service (PaaS) and Software as a Service (SaaS) for ventures and buyers to access on interest paying little attention to area and time, there will be a growth in the quantity of Cloud stages accessible. As of late, a few modern associations have started creating and exploring innovations and bases for Cloud Computing. There are many of providers for cloud platforms. For example Amazon, Microsoft, Sun network, Aneka, HP, Oracle, Citrix, and Scaleway. In this area, we explore famous and oldest Cloud platforms.

Amazon Elastic Compute Cloud (EC2) (Amazon, 2016) offers Machine Image (AMI) having the libraries, applications, information and related design settings or select from a library of all around accessible AMIs. It has a virtual environment that allows a user to run Linux-based applications. The user can consider his needs to transfer to this platform by choosing AMIs.

Google App Engine (Google, 2016) allows a user to run web applications by utilizing the Python programming language. Google App Engine also supports Application Programming Interfaces (APIs) for the Google Accounts, data store, and picture control and email administrations. Additionally, Google App Engine gives an online Administration Console for the user to deal with the user running web applications dynamically.

Microsoft Azure (azure, 2016) intends to provide a coordinated improvement, facilitating, and control Cloud figuring environment so that product designers can without much of a stretch, make, have overseen and scale both The Web and non-web applications through Microsoft server farms. To accomplish this point, Microsoft Azure backings a far-reaching accumulation of restrictive improvement apparatuses and conventions which comprise Live Services, Microsoft.NET Services, Microsoft SharePoint Services, Microsoft SQL Services, and Microsoft client relationship management CRM Services. Microsoft Azure additionally bolsters Web APIs, for example, SOAP and REST to permit programming engineers to interface between Microsoft or non-Microsoft instruments and advances.

Aneka is being supported through Manjra soft, is a.NET-based administration (Chu, Nadiminti et al. 2007). It is planned to bolster different application models and security arrangements. To create an Aneka Cloud, the administration provider just needs to configure Aneka platform, facilitating necessary administrations on each selected desktop PC. The motivation behind the Aneka platform is to in state administrations and operates as a private point for communication with whatever remains of the Aneka Cloud. Aneka gives service level agreement SLA with full support to help the client to indicate quietly

of services QoS prerequisites. Finally, the client can to arrange and correspond on the QoS necessities to be given by the administration provider (Venugopal, Buyya et al. 2006).access the Aneka Cloud remotely through the Gridbus website. The Gridbus is an intermediary to allow the client to arrange and correspond on the QoS necessities to be given by the administration provider (Venugopal, Buyya et al. 2006).

2.3 Cloud Computing Adoption in Saudi Government

According to International Data Corporation (2016), Saudi Arabia individuals, private and small organizations invested on cloud services about $50.4 million in 2014. And they expect to reach $77.4 million in 2016. Most of their requirements were email, communication and collaboration, and content management. However, government entities are the biggest resistors to adopt cloud (IDC 2016). Because there is no visible plan to implement any cloud computing solutions in the government sector due to the overly bureaucratic structure of the multiple sectors and layers of the existing government machinery. The major push and initiative from someone in a position of authority or a member of the royal family is a prerequisite before the Saudi government would take a strategy to discover the essential benefits offered by cloud computing solutions to stakeholders. Also, the lake of awareness and security issues other reasons for this resistance.

Cloud computing is still in its beginning stages, There is a few studies conduct in the Saudi context. Chanchary and Islam (2011) observed a phenomenon of striking inefficiency in Saudi Arabia during their research on existing e-government systems. They recommended that incorporating a software-as-a-service (SaaS) layer would greatly improve e-governance efficiency and help users in their decision-making processes. They suggested that this additional layer would facilitate better access to information. The study concluded with the assertion that this integration would help improve any e-government services provided. Moreover, the technology acceptance model (TAM) proposed by Alharbi (2012) can be used to assess acceptance levels in an organization. A study found that the acceptance rates for cloud computing were highly dependent on users' ages, attitudes, jobs and educational backgrounds (Alharbi 2012). Yamin (2013) completed a survey of cloud computing awareness in Saudi Arabia from an organization level view. The study showed that cloud technologies will be a new trend for Saudi's organizations. Alkahter (2014) was identifying the factors with the most influence on the intention of private organizations in Saudi Arabia to adopt cloud services. This study found that the factors of reliability, complexity, availability, privacy and others had a significant impact on the decision to adopt cloud computing.

By critiquing the previous studies, there was the absence of theoretical and empirical studies concerning the adoption in government sector in the developing countries specify in Saudi Arabia. Public organizations' business initiatives are different and more complex than a private organization. Researchers have emphasized the need for an increased focus on how organizations adopt innovations (Mohammed and Ibrahim 2014). Some researchers recommended applying theoretical models and empirical studies for cloud adoption decisions because there is a shortage of research in this area (Mohammed and Ibrahim 2014). Furthermore, no study to date has investigated and analysed the financial data to invest in cloud computing implementation. Thus, more financial data analytics is important to contribute to the research.

2.4 Proposed Financial Cloud Computing Model for Saudi Government

The author addresses the need to find the main financial indicators and implementation cost variables which impact on the organization to adopt the cloudbased on survey analyses. The author conducted one case of participants' who responded to the survey to clarify their responses.

2.4.1 Case Study

I analyzed one of the Saudi government organization's stories regarding the adoption of cloud services. This organization is a part of the education and training sector in Saudi Arabia. They have recently implemented the cloud email service package of Google "Google Apps Suite." This organization manages about 32 faculties over the Kingdom of Saudi Arabia. They have more than 1000 staff. I interviewed an IT lecture's who was working as an IT senior in this organization's data center to clarify his survey responses. He told me

about their obstacles in providing email services to all the staff in this organization. The main obstacles were: availability, they could not guarantee the availability of email service. Also, this service remained offline for a long time until they fixed it. The reasons behind that were that had no qualified people to manage it, shortages in support contracts and lack of financial resources. Sometimes, they had asked IT academic staff to work with them as IT supports staff to help them.

Also, they faced many issues with security patches and limitations in storage. Finally, they faced an issue with data centre space and the growth in a number of servers. This negatively impacted on the environment and space. Moreover, the increasing maintenance and upgrade costs were too high for the organization.

Based on these issues and the increasing demand for email services of organizational staff, the organization thought seriously about adopting a cloud to provide this service to its employees. This decision required costs to implement such as hardware and software platforms, licenses, and storage and network devices. Also, they paid for additional services such as consultation and migration services and maintenance contracts. But the return on the investment in the long term was better than the current situation.

After adopting the email service via the cloud, they noted the difference between in-house email and cloud email. They achieved many benefits: efficiency in their services; availability 24/7, greater mailbox size, and good security management with advanced hardware. Also, they gained many of the financial benefits. For example, decrees in TCO and ongoing support cost compared with in-house solution. Maintenance and development costs decreased.Also, increase on ROI percentage. They also gained competitive support via qualified people from the provider and saved the organization space to use as its training centers for students. Also, by transferring this headache to qualified providers simplified their business model and saved the organization budget. Finally, by decreasing the number of servers, the organization contributed to a cleaner environment.

2.4.2 Analysis of Case Studies

A closer look at the case study from a financial angle, the decision to adopt Google's cloud computing services through a cloud provider was a result of major organizational changes to help them face financial and growth challenges. Thus, the organization fixed the challenges by migrating their services to the cloud. This impacted financially on the organization budget.

The key points that can be understood from this case study are the following:

- - Cloud computing is an optimal option when the budget is not going well in the organization
- - The organization achieved some of the financial indicators such as ROI, TCO.
- - There was a positive ROI of adopting Google's cloud computing services.
- - The TCO for organization data center decreased. This impacted on ongoing support cost for the data center.
- - The hardware requirements such as servers can be simply configured and adjusted to meet the organization's growth and demand under the cloud computing model. And cloud providers can provide hardware platform services with least amount of management overhead.
- - The cloud computing facilitates "pay per use" capability to organizations. This lead to the organization having the flexibility to use appropriate bandwidth based on their objectives.
- - The Software requirements such as email can be scale up or down in relation to the current demand by applications hosted on the cloud platforms.
- - Cloud computing can support decreasing variable and fixed infrastructure costs significantly. Thus, the saving cost is one of key tipping point parameters to adopt cloud.
- - The organization decision to adopt cloud Leeds to reducing the creating a new data centers. This impacted positively on saving fixed costs.
- - The organization decision to implement cloud needs a specific budget. But the return on the investment in the long term was better than their previous situation.
- - It can conclude some of their data center implementation costs such as hardware and software platforms, licenses, storage, network devices, consultation and migration services and maintenance contracts (SLA).
- Finally, it can conclude the following equations to calculate data center fixed and variable implementation costs.

$$\sum_{n=0}^{N} DCVCost$$

DCVCost= DCVCost1+ ……..+DCVCost n

$$\sum_{n=0}^{N} DCFCost$$

DCFCost= DCFCost1+…...+ DCFCost n

The previous equations can help the organization to calculate any cloud services cost in both approaches private and public cloud. If the organization decide to implement private cloud to provide any service, then it should be responsible for the whole cost for different delivery models such as infrastructure, platform, and software to make this service workable. Thus, in this case, the cost will be expensive.

However, the public cloud will be cheap, and the organization can only pay based on its usability. Also, the previous equation can help to calculate this cost.

Based on above case study analysis, figure 2 clears proposed a model for financial indicators and data centre implementation cost.

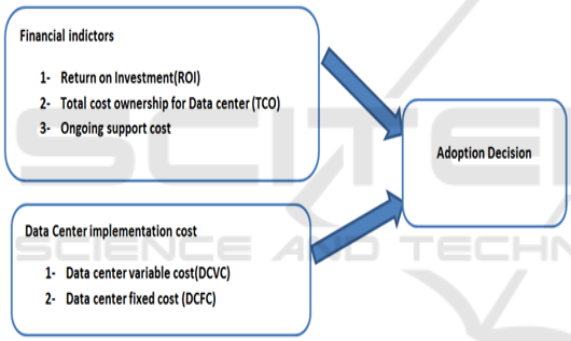

Figure 2: Proposed model.

3 VALIDATING THE CASE STUDIES FINDINGS

The authors continued to validate the proposed models. They have investigated several research methods to complete this. They have decided the survey method is the good instrument to achieve it. They have produced a comprehensive survey. The questions are formatted to use a five-point Likert scale to gather participant's inputs, which ranged from 1 (strongly disagree) to 1 (strongly agree). The survey consists of 46 questions. The collected data was analyzed by SPSS via regression model.

This study was conducted decision makers, information technology (IT) managers and experts at government organizations in Saudi Arabia. The objective of this survey was to validate and improve the proposed financial model. Most of the participants in this survey were heads of IT department and IT managers. Therefore, they had the capability to recognize the future trends and current situation of their organizations.

4 DATA RESULTS AND ANALYSIS

4.1 Data Reliability

The test of measurement model will include the estimation of internal consistency and the convergent and discriminant validity of the instrument items. Cronbach's alpha coefficient, whose value ranges from zero (unreliable) to one (perfectly reliable), is used to examine the reliability of the survey instrument (Hair et al. 2006). The Cronbach's alpha value in this survey is 0.738. Thus, the survey data is reliable and optimum.

4.2 Results

A one-way between-groups analysis of variance (ANOVA) was conducted to explore the Saudi organization's adoption cloud situation of financial indicators and cloud data center implementation cost. Table 2 presents comparisons mean value of financial indicators and cloud data center implementation cost factors according to organizations situations of adopting cloud. There was not a statistically significant difference at the $p<.05$ level for the three groups.

Table 1: ANOVA one way test.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ROI	Between Groups	.116	2	.058	.135	.874
	Within Groups	42.638	99	.431		
	Total	42.755	101			
TCO	Between Groups	.159	2	.079	.188	.829
	Within Groups	41.685	99	.421		
	Total	41.843	101			
VariableCost	Between Groups	.548	2	.274	.926	.400
	Within Groups	29.295	99	.296		
	Total	29.843	101			
FixedCost	Between Groups	.611	2	.305	1.163	.317
	Within Groups	25.978	99	.262		
	Total	26.588	101			
OngoingSupportCost	Between Groups	.050	2	.025	.085	.919
	Within Groups	28.970	99	.293		
	Total	29.020	101			

Regression model in table2 explains the financial indicators influence the cloud adoption in Saudi Arabia. Thus, TCO and ongoing support cost indicators are significant with ROI in cloud computing adoption decision. According to the regression results, TCO and ongoing support cost have a positive linear relationship with ROI.

Table 2: ROI model.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.400	.395		1.014	.313
	TCO	.577	.078	.571	7.361	.000
	OngoingSupportCost	.298	.094	.245	3.162	.002

a. Dependent Variable: ROI

$$ROI = 0.4 + 0.577(TCO) + 0.298\,(ongoing\ support\ cost)$$

Also, table 3 explains the overall model. Thus, the overall model for ROI is significant with TCO and Ongoing Support Cost.

Table 3: ANOVA analysis.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.203	2	10.601	47.239	.000[b]
	Residual	21.544	96	.224		
	Total	42.747	98			

a. Dependent Variable: ROI

b. Predictors: (Constant), Ongoing Support Cost, TCO

Moreover, regression model in table 4 explains the implementation cost to adopt cloud in Saudi Arabia. Thus, data centre variable cost and fixed costs are significant. Also, they are significant with TCO financial parameter in cloud computing adoption. According to the regression results, data centre variable cost has a positive linear relationship with TCO.

Table 4: TCO model.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.157	.543		2.132	.035
	FixedCost	.017	.102	.013	.164	.870
	VariableCost	.698	.096	.589	7.250	.000

a. Dependent Variable: TCO

$$TCO = 1.157 + 0.017(fixed\ cost) + 0.698(variable\ cost)$$

Also, table 5 explains the overall model. Thus, the overall model for TCO is significant with data centre variable and fixed cost.

Table 5: ANOVA analysis.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.562	2	7.281	25.891	.000[b]
	Residual	27.278	97	.281		
	Total	41.840	99			

a. Dependent Variable: TCO

b. Predictors: (Constant), Variable Cost, Fixed Cost

5 DSCUSSION

Peiris et al. (2010) proposed cost equation to calculate the cloud data centre implementation cost. They calculated email service cost for the in-house model and cloud model for the small and medium organization in Australia. The output from that calculation used as tipping point parameter to compare between in-house model and cloud model cost and to select the best model for the organization. This paper agrees with previous work cost equation. But this paper adds value for previous work by linking the data centre cost to an appropriate financial indicator (TCO) and represent this relationship by following equation TCO= 1.156+0.017FC+0.698VC.The earlier study ignored that. TCO is an important parameter to calculate direct and indirect costs. This parameter will give decision makers full vision about a different type of costs for this solution.

Moreover, the previous work ignored to link data centre cost to the return on investment (ROI) financial parameter. This will help decision makers to decide about their situation to invest in a cloud or not.

The previous equations can help the organization to calculate any cloud services cost in both approaches private and public cloud. If the organization decide to implement private cloud to provide any service, then it should be responsible for the whole cost for different delivery models such as infrastructure, platform, and software to make this service workable. However, the cost of implementing this approach will be high.

However, the cost of public cloud may be cheap, and the organization can only pay based on its usability. Also, the previous equation can help to calculate that cost.

Related to the previous tables, ANOVA one-way test confirmed there was not a statistically significant difference between comparisons of financial indicators and cloud data center implementation cost factors mean value according to organizations situations of adopting cloud. Thus, the participants from different organizations situations which adopted some cloud services or planned for the next three years or do not think about cloud agreed about the financial indicators and cloud data center implementation play the main role to adopt cloud. Also, they agreed about financial benefits of adopting cloud.

The Regression model confirmed the relationship between financial indicators ROI, TCO and ongoing support cost to predict the feasibility of cloud adoption in Saudi Arabia, public organizations. Most of the participants confirmed that cloud model will control the expenditures and improve the long return on investment (ROI).

Also, the regression model confirmed the relationship between TCO and data center implementation costs. The data center implementation cost consist of variable and fixed cost. Cloud computing model can help the organization to reduce the implementation cost (Craig, Frazier et al. 2009, Rastogi 2010, Sharma, Sharma et al. 2011, Bansal, Sharma et al. 2012, Rosli, Yeow et al. 2012, Alshomrani and Qamar 2013, Bellamy 2013, Zwattendorfer and Tauber 2013).

The cloud computing facilitates "pay per use" capability to organizations. This leads to the organization having the flexibility to use appropriate bandwidth based on their objectives. VC and FC play the main role when implementing cloud data center costs. For example, If VC and FC are high then that negatively impact on TCO. Thus, that will also impact negatively on ROI.

6 CONCLUSIONS

It can be concluded that cloud computing technology has many financial benefits for any organization. The authors explored a case study from Saudi government organizations and their experience to implement cloud to provide their services to their staff. This paper proposed and validated a financial model to adopt and implement cloud in Saudi Arabia. The financial indicators (ROI and TCO) can help decision makers to measure the cost and outcome of cloud adoption. This study used regression method to predict ROI and TCO values. There is a limitation in this paper. The authors could not reach to quantitative financial information about these organizations due to the Saudi government policy to disclose financial information. Future works will integrate this model with my previous models to give the public organizations in Saudi Arabia comprehensive view to adopt cloud. Also, more investigation is needed to define cloud system in Saudi Arabia to contribute more measurements.

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