

# A Model for the Performance Monitoring and Evaluation of Organizations to Migrate to the Cloud based on System Approach

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## Abstract

In recent years, the concept of cloud computation has been an issue of great importance both for researchers and practitioners. This paper aims to assess the performance of cloud computing from the business perspective, when the organizations want to migrate to the cloud environment. In this paper, the criteria related to performance evaluation are extracted by a system approach, based on content analysis and Shannon entropy research methods. The results show that financial, technological, operational and strategic outcomes are important parameters for strategists to plan for migrating to the cloud environment.

Keywords: *Cloud Computing, System Approach, Performance Evaluation, Shannon entropy, E-readiness*

## 1 INTRODUCTION

Businesses have always been seeking ways to increase their business agility, availability and accessibility while reducing their operational costs and time to market. Cloud computing is the technology through which businesses can gain their desires. According to the National Institute of Standards and Technology, cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (NIST, 2011).

In this article a framework is proposed for the systematic monitoring and evaluation of businesses which want to migrate to the cloud environment with the aim of improving their performance through system approach. In addition, the model proposed here could be a basis for strategists to help them

identify the issues that they should pay attention to in terms of business goals, IT strategies, actions, and resources that are needed.

A system is a collection of elements or components that are organized for a common purpose (Rouse & Margaret, 2005). System approach is one of the most favorite methods in scientific investigation, which can organize work and break down problems to sub processes, which are more controllable (ZiaeiPour, Taghizade, Bazazan, Khoshalhan & Mohammadian, 2009). These sub processes are input, process, output, outcome, and impact. Performance evaluation is a tool to measure progress towards the achievement of the goals of the comprehensive plans, which is accomplished through constant monitoring and evaluation. Monitoring is a routine process of data collection and measurement of progress towards the objectives. Evaluation is the non-routine use of information to systematically investigate the effectiveness of a program. The progress of the plan is monitored as it unfolds, and the achievement of the organization's plans to migrate to cloud computing is periodically evaluated.

The paper is organized as follows, in the second section different aspects of cloud computing adoption dimensions are explained. In the third section, based on system approach, content analysis, and Shannon entropy, a new classification has been proposed. In the third section, based on system approach, a model has been proposed to help businesses to monitor and evaluate the performance of the migration to cloud computing.

## 2 LITERATURE REVIEW

The IT environment evolved from mainframes to client servers, the Internet, virtualization and cloud computing (Carroll & Kotzé, 2011). Cloud computing is a network-based environment and shared resources in the form of hardware or software. The virtualization is the technology, which all providers employ in cloud computing, and provides abilities to

resources through network infrastructure (Azarnik, Shayan, Alizadeh&Karamizadeh, 2012). Buyya, Yeo, Venugopal, Broberg andBrandic(2009)defined it as follows, “Cloud is a parallel and distributed computing system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers”. Different types of cloud computing are provided ‘as a service’ to consumers, and most of them fall under one or more of three categories: software as a service, platform as a service, and infrastructure as a service (Williams, 2010). This article is going to look at cloud computing from a business perspective. Then, for the purpose of measuring its performance, system approach is used to consider different aspects including inputs, processes, outputs, outcomes and impacts. To do so, the works of other researchers on these dimensions were reviewed. Finally, a new model was proposed that can be used by businesses to assess their performance if they want to migrate to the cloud environment with the aim of improving their performance.

## 2.1 Cloud Computing Inputs

It is important for businesses to consider some resources as inputs when they intend to migrate to the cloud environment, in fact this dimension should be carried out based on resource-based views. According to Rashmi, Mehruz andSahoo (2012), organizations need to consider some factors as the inputs for the whole system. Such factors are business factors and technical factors. In this dimension, they need to consider what the organizations own in terms of their existing IT investments, existing IT infrastructure, IT professionals and etc.

## 2.2 Cloud Computing Processes

The next dimension that should be considered is activities. This is the dimension where businesses should move forward as slowly as possible if they want to make the most of the cloud. In this aspect, based on the activity-based theory, the activities that need to be taken before moving to the cloud were proposed. In this respect, many activities should be measured to see if the organization can move some parts of its businesses to the cloud.

As stated by Marston, Li, Bandyopadhyay, Zhang and Ghalsasi (2011), some of the activities that organizations should take into account for are security and regulations at the local, national, and international levels. Azarnik et al. (2012) also believed that businesses should take time to consider factors such as geopolitical issues, and functional risks. In Figure 1, the activities are divided into three groups which are governance, vendor management and control.

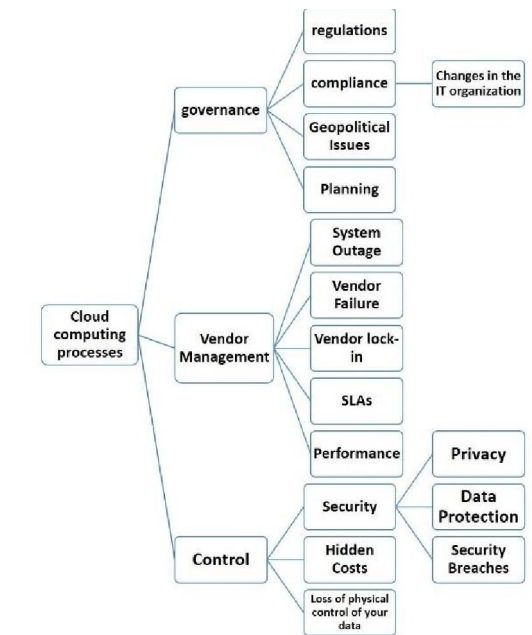


Figure 1: Cloud computing processes.

## 2.3 Cloud Computing Outputs

In this dimension, different types of cloud computing are provided ‘as a service’ to consumers, and most of them fall under one or more of three categories: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) (Williams, 2010). SaaS provides complete business applications delivered over the web. Examples of SaaS include enterprise-level applications such as Salesforce, Netsuite or Google Apps and personal applications such as Gmail, TurboTax Online, Facebook, or Twitter(Marston et al., 2011). PaaS provides consumers with a stable online environment where they can quickly create, test and deploy web applications using browser-based software

development tools. Examples of PaaS include Microsoft's Azure Services Platform, Salesforce's Force.com, Google App Engine, Amazon's Relational Database Services and Rackspace Cloud Sites. IaaS provides consumers with administrative, web-based access to fundamental computing resources such as processing power, storage and networks. Amazon's S3 storage service and EC2 computing platform, Rackspace Cloud Servers, Joyent and Terremark are some prominent examples of IaaS.

## 2.4 Cloud Computing Outcomes

Enterprises that want to take up cloud computing would like to gain some features within a short time. By adopting cloud computing, businesses can achieve a wide range of benefits. As mentioned by Marston et al.(2011), cloud computing can have outcomes like scalability, business agility, cost reduction, and reduced time to market as soon as organizations move their data into the cloud. In addition, Velte, Velte andElsenpeter(2010) believed that businesses will benefit from improved security and are able to gain some security related advantages such as centralized data, security access, and improved software security. As shown below, a new grouping of cloud computing outcomes can be expected from adopting it within a short period of time. In Figure 2, the outcomes of cloud computing are divided into four parts which are technological, financial, operational and strategic.

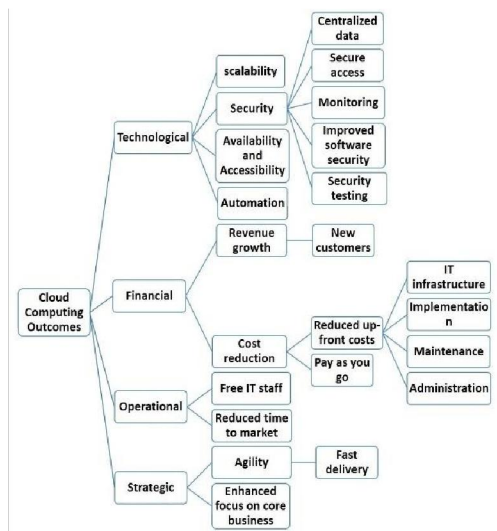


Figure 2: Cloud computing outcomes

## 2.5 Cloud Computing Impacts

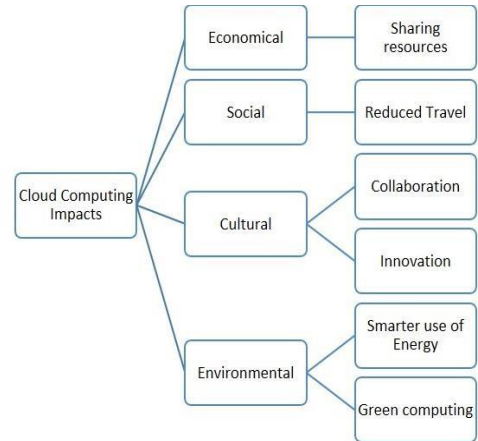


Figure 3: Cloud computing impacts

In this dimension, based on value-based view, the impacts that cloud computing can have on the society within a long term are expected. According to Azarnik et al. (2012), green computing is a benefit that is achievable by adopting cloud computing since environmental issues are increasing and businesses care more about running their firms in an environmental friendly way. In addition Mona and Pillutla(2014) explained how cloud computing can increase collaboration in organizations. In Figure 3, the impacts of cloud computing on the society are divided into four parts from a business perspective which are economical, social, cultural, and environmental.

System Approach		Articles/ Books	Marston, S., IIZ., Bandyopadhyay S., Zhang, J., Ghalsasi, A., 2011	Avram(Olaru), M., 2014	Azeemi, I., Lewis, M., Tryfonas, Th., 2013	Bouyer, A., Arasteh, B., 2014	Rashmi, Mehruz, Sh., Sahoo, G., 2012	Azarnik, A., Shayan, Sh., Alizadeh, M., Karamizadeh, S., 2012	Velte, A., Velte, T., Elsenpeter, R., 2010	Williams, M., 2010
Inputs	Existing Investment		✓				✓		✓	
	Existing IT Infrastructure		✓			✓	✓			
	IT skills						✓			
Processes	Governance	✓	✓				✓	✓	✓	✓
	Vendor Management	✓	✓	✓				✓	✓	✓
	Control	✓	✓				✓	✓	✓	✓
Outputs	SaaS	✓	✓	✓	✓			✓	✓	✓
	IaaS	✓	✓	✓	✓			✓	✓	✓
	PaaS	✓	✓	✓	✓			✓	✓	✓
Outcomes	Technological	✓	✓	✓	✓			✓	✓	✓
	Financial	✓	✓	✓	✓			✓	✓	✓
	Operational	✓	✓	✓	✓			✓	✓	✓
	Strategic	✓	✓		✓			✓	✓	✓
Impacts	Economical	✓	✓	✓	✓				✓	✓
	Social								✓	✓
	Cultural	✓	✓	✓	✓			✓	✓	✓
	Environmental	✓						✓	✓	✓

Table 1: Cloud computing dimensions based on a system approach

### 3 RESEARCH METHODOLOGY

Content analysis and Shannon entropy methods are used in this article. Through the use of content analysis, articles related to the organizational issues of cloud computing were reviewed and the factors were identified and lastly a new classification was proposed as shown at the end of this section.

Most of the related articles have been reviewed and the necessary factors have been identified to provide a new dimension of e-readiness for those organizations which want to migrate to the cloud. Content analysis was done through different steps which are as follows; (a) Before analysis: The first step is to specify the number of questions that the researcher intends to answer, (b) Content review: By doing a preliminary study in this phase, in each category, the common dimensions as the analysis units are identified and the number of times that each is repeated are counted and (c) Analysis of data: the last step is to process the codified data by the Shannon entropy formula. In information theory, entropy is a measure of the uncertainty in a random variable. In this context, the term refers to the Shannon entropy, which quantifies the expected value of the information contained in a message.

$$w_j = \frac{-K \sum_{i=1}^m [P_{ij} \cdot L_n P_{ij}]}{\sum_{i=1}^m -K \sum_{i=1}^m [P_{ij} \cdot L_n P_{ij}]}$$

### 4 ANALYSIS

Based on a system approach as shown in Figure 4, systems are divided into five distinct parts; inputs, processes, outputs, outcomes, and impacts. They are surrounded by an environment and often include a feedback mechanism. In order to consider all dimensions of the performance evaluation of businesses to migrate to the cloud, the model in Figure 4 has been proposed. The model is based on system approach, different kinds of performance and e-readiness models. In this model, existing investment, existing IT infrastructure, and IT skills have been considered the input part of the system. In this dimension, we should see what organizations use to do the work.

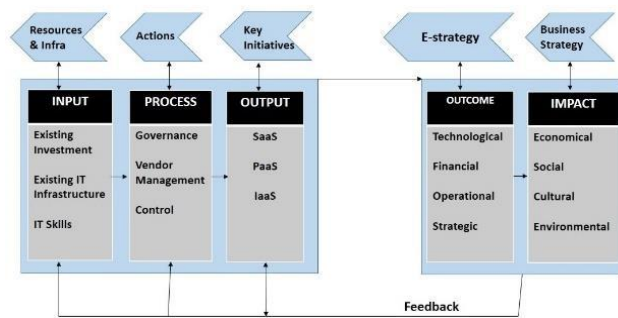


Figure 4: The proposed model for determining different types of indicators based on system approach.

In the next dimension which is process, the activities needed to have the job done are identified. Some factors like governance, vendor management, and control are considered here. The next dimension is output in which the services that businesses want to deliver are listed. The most common services that are provided here are, SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a

Service). Outcome is the next dimension which lists the short-term goals that businesses can achieve by adopting cloud computing, which are divided into four categories, which are technological, financial, operational and strategic. Finally, in the last dimension, the benefits of cloud computing for the society that will be delivered within a long-term as impacts are listed. These can be put into four categories, which are economical, social, cultural, and environmental. It is worth mentioning that the feedback can be used to control and adjust all other dimensions to be aligned with the environmental changes.

Furthermore, Shannon entropy has been used for determining quantitative proportion of past research in supporting each of the dimensions and factors. As shown in Figure 5, cloud computing outcomes for businesses are the most important dimension which have been mentioned in the cloud computing literature while the resources of cloud computing have been determined as the minimum contributor in migrating to cloud. So, based on the results of this research, it is necessary for organizations to consider the value-based perspective instead of resource-based view in migrating to the cloud.

Rank	Wj of dimensions	Wj of factors	Ej	$\sum_{i=1}^{23} [P_{ij} \cdot L_n P_{ij}]$	iterations	Factors	Dimensions
4	0.08	0.04	0.53	-1.10	3	existing investment	inputs
		0.04	0.53	-1.10	3	existing IT infrastructure	
		0.00	0.00	0.00	1	IT skills	
3	0.20	0.07	0.86	-1.79	6	Governance	processes
		0.07	0.86	-1.79	6	vendor management	
		0.07	0.86	-1.79	6	control	
2	0.22	0.07	0.94	-1.95	7	SaaS	outputs
		0.07	0.94	-1.95	7	IaaS	
		0.07	0.94	-1.95	7	PaaS	
1	0.28	0.07	0.94	-1.95	7	technological	outcomes
		0.07	0.94	-1.95	7	financial	
		0.07	0.86	-1.79	6	operational	
		0.07	0.86	-1.79	6	strategic	
2	0.22	0.07	0.86	-1.79	6	economical	impacts
		0.03	0.33	-0.69	2	social	
		0.07	0.94	-1.95	7	cultural	
		0.05	0.67	-1.39	4	environmental	

Figure 5: Obtained weights for each of the factors and dimensions by the Shannon entropy

## 5 CONCLUSION

Considering the importance of migrating to the cloud environment, businesses are more concerned on whether they are ready to make the big change. In this article, the focus is evaluating organizations with the aim of improving their performance. To do so, a new model through system approach and content analysis is proposed in which five dimensions were discussed in detail. The dimensions were inputs, processes or activities, outputs, outcomes, and impacts that businesses need to consider if they want to migrate to cloud.

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