Jurnal Teknologi

Full paper

Refining E-government Readiness Index by Cloud Computing

Fathey Mohammed[a*], Othman Ibrahim[a]

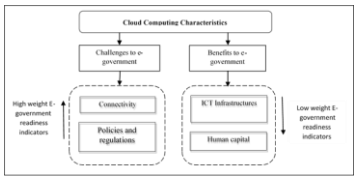
[a]*Department of Information Systems, Faculty of Computing, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia*

*Corresponding author: Fathey2@live.utm.my

Article history

Received :30 May 2013
Received in revised form :
26 August 2013
Accepted :15 October 2013

Graphical abstract



Abstract

Modern ICT heavily impacts and shapes the way government functions. Therefore, the aim of e-government attempts should be using all invented forms of ICT to improve basic duties of government and deliver more interactive services to citizens and businesses. However, an effective e-government program requires information about the readiness of public-sector organizations, in terms of regulatory frameworks, and organizational and technical infrastructures, as well as information about the stakeholders and their demand for e-government. Therefore, measuring e-readiness is vital to adopt e-government successfully. For that reason, several e-readiness assessment models have been developed to help assess the opportunities and challenges facing e-government programs. On the other hand, recently ICT innovation along with Cloud Computing presents significant opportunity for governments to provide effective e-government services. This paper revisits the existing e-government readiness indices to show the main common indicators. Then, it investigates the main drivers of the changes between the various versions of one index. Finally, this paper proposes a preliminary framework to refine indexes' indicators according to the characteristics of the Cloud Computing.

Keywords: E-government; cloud computing; e-readiness assessment; e-government readiness index

Abstrak

ICT moden banyak memberi kesan dan membentuk cara kerajaan berfungsi. Oleh itu, matlamat e-kerajaan perlu cuba menggunakan segala bentuk ciptaan ICT untuk meningkatkan tugas-tugas asas kerajaan dan menyampaikan perkhidmatan yang lebih interaktif kepada rakyat dan perniagaan. Walau bagaimanapun, program e-kerajaan yang berkesan memerlukan maklumat tentang kesediaan organisasi sektor awam dari segi rangka kerja kawal selia, dan infrastruktur organisasi dan teknikal, serta maklumat mengenai pihak-pihak berkepentingan dan permintaan mereka terhadap e-kerajaan. Oleh itu, mengukur e-kesediaan adalah penting untuk menerima penggunaan e-kerajaan dengan jayanya. Oleh sebab itu, beberapa model penilaian e-kesediaan telah dibangunkan bagi membantu menilai peluang-peluang dan cabaran yang dihadapi oleh program e-kerajaan. Sebaliknya, baru-baru ini inovasi ICT melalui Pengkomputeran Awan telah membentangkan peluang yang besar bagi kerajaan untuk menyediakan perkhidmatan e-kerajaan yang berkesan. Kertas ini menyemak kembali indek kesediaan e-kerajaan yang sedia ada untuk menilai penunjuk utama yang biasa digunakan. Kemudian, penyiasatan tehadap pemacu utama setiap perubahan di antara pelbagai versi indek. Akhirnya, kertas kerja ini mencadangkan satu rangka kerja awalan bagi memperbaiki indek petunjuk mengikut ciri-ciri Pengkomputeran Awan.

Kata kunci: E- Kerajaan; pengkomputeran awan; penilaian e-kesediaan; indek kesediaan e-kerajaan

1.0 INTRODUCTION

Governments over the world have begun to recognize the potential opportunities offered by ICT to increase efficiency in internal processes and offer better services to citizens. Consequently governments that ignore the value and the use of the emerging ICT technologies may suffer crucial competitive disadvantages. However, while the benefits of e-government are in theory numerous, global experience to date indicates that they remain much more elusive in reality.

Although e-government initiatives have flourished in many developed and developing countries, other initiatives have failed. Indeed, the failure rate of e-government projects has been estimated somewhere between 60-80%[1,2]. Pudjianto and Hangjung[3] also stated that approximately, 60 percent of the implementation e-government fails or cannot achieve the required results, in some way leading to a massive waste of financial and human resources, and an inability to deliver the potential benefits of e-government to its customers[2]. On the other hand, the potential for e-government in many developing countries remains largely unexploited and different human, organizational and technological factors, issues and problems pertain in these countries, requiring focused studies. E-governments in these

countries may face fundamental obstacles, such as lack of basic IT infrastructures, appropriate IT applications and IT experts[4,5,6,7].

Most of the developing countries have lower levels of readiness to provide e-government services relative to developed countries[8]. Therefore, for developing countries–more specific, countries that still in the early stages or those that haven't begun e-government project yet–as they invest in Information and Communication Technologies (ICT) to developing e-government systems, there is an increasing need to assess their readiness to exploit the opportunities created by the new emerging ICT technologies and paradigms.

E-readiness assessment is important because its output can be a predictor of how well a country can perform in the new economy. It provides policy makers with details of their economy's competitiveness relative to its international counterparts and allows them to pinpoint areas of strengths and weaknesses[9]. Experts pointed out that in order for countries to put ICT to effective use, they must first be "e-ready" in terms of IT infrastructure, the accessibility of IT to the population, and the legal and regulatory framework[10]. Therefore, many development agencies, research organizations, universities and world organizations have created instruments for assessing e-readiness either in the form of self assessment tools or surveys. In addition, many initiatives by individual researchers attempt to improve or develop general frameworks.

On the other hand, Cloud Computing technology can significantly improve the way a government functions, the services it provides to its citizens and institutions, and its cooperation with other governments. It can help address many of e-government challenges by providing elastic scalable, customized and highly available environment[11].

However, based on our investigation in related literature, there is no published works related to Cloud Computing and e-government readiness index. In this article, by reviewing e-government readiness assessment, comparing four common e-readiness indices and studying on the advancing of one index through the last couples of years, we present a framework that reflects the effect of adopting Cloud Computing on e-government readiness indices.

The next section provides an overall view of e-government readiness assessment, followed by discussing four common indices in some details, and comparing their weighting of the indicators. Then, by reviewing the advancing of a selected index through its different versions, we investigate the primary drivers of changes made on its indicators. Finally, by analyzing Cloud Computing characteristics, and its benefits and challenges for e-government a proposed framework to refine the e-government readiness index will be introduced.

■2.0 E-GOVERNMENT READINESS ASSESSMENT

E-readiness assessment is useful in understanding and identifying the most key and relevant IT based development opportunities. Some scholars clearly differentiate e-readiness assessment for particular themes, such as e-commerce or e-government, from e-readiness assessment for general purpose without focusing on any particular aspects of government society. We here in particular will focus on e-government readiness assessment.

E-Government Readiness evaluates how ready a country, city or particular government agency is to develop e-government[13]. It is a measure of the quality of a country's ICT infrastructure and the ability of its consumers, businesses and governments to use ICT to their benefit. Therefore, it is considered to be an advisory tool to initiate e-government projects and a vital step in developing effective e-government. It provides important knowledge to policy and decision-makers for e-government strategic planning and implementation[1]. Through E-government Readiness Assessment, a government can assess its stage of readiness, identify its gaps, and then redesign its e-government strategy[13].

Furthermore, e-readiness assessment enables governments to set, measure and achieve realistic goals for e-government. It is important to develop and conduct an e-readiness assessment so that the results can be leveraged to catalyze action, improve global competitiveness, and use limited resources wisely[10].

Over the last few years, a number of 'e-readiness' assessment models have been developed. Each model measures how ready a society or economy is to benefit from information technology. However, the range of tools uses widely varying definitions for e-readiness and different methods for measurement. Here are some definitions and in the next section we will discuss some existing readiness indices:

CID Harvard University: Degree to which a community is prepared to participate in the Networked World - a world in which everyone, everywhere, has the potential to reap the benefits of connectivity to the network[14].

UNDESA e-government readiness index: It is a composite measurement of the capacity and willingness of countries to use e-government for ICT-led development[1].

Economist Intelligence Unit: The "state of play" of a country's ICT infrastructure and the ability of its consumers, businesses and governments to use ICT to their benefit[15].

World Economic Forum (WEF) network readiness index (NRI): the degree of preparation of a nation or community to participate in and benefit from IT developments[16].

■3.0 EXISTING E-GOVERNEMNT READINESS INDICES

Some pioneer organizations in developing e-readiness assessment tools are the United Nations Department of Economic and Social Affairs (UN-DESA) (with *e-readiness Index)*, World Economic Forum (WEF) (with *network readiness index* (NRI)), International Telecommunication Union (ITU) (with *ICT Development Index* (IDI)) and Economist Intelligence Unit (EIU) (with *e-readiness rankings)*. These tools, to some extent, use different sets of indicators and variables with different weights.

3.1 E-Readiness Index

The UNDESA e-readiness survey considers a relatively comprehensive assessment of e-government including both general and specific indicators[17]. Its E-government Readiness Index is a comprehensive scoring of the preparedness and capacity of national administrations to use information communication technology in the execution of government functions. It is comprised of four indices[18].

1. Online service index: based on a comprehensive survey of 192 countries' national website the survey evaluates countries based on the four-stage of e-government development: emerging online presence, enhanced presence, transactional presence and connected presence.
2. Telecommunication infrastructure index: it is a composite of five indicators: number of personal computers per 100 persons, number of Internet users per 100 persons, number of telephone lines per 100 persons, number of mobile cellular

subscriptions per 100 persons and number of fixed broadband subscribers per 100 persons, all are weighted equally.

3. Human capital index: It is a composite of two indicators, adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratio, with two thirds weights assigned to adult literacy rate and one third to the gross enrolment.
4. E-participation index: It is a supplementary index which focuses on the use of the Internet to facilitate "e-information", "e-consultation", and "e-decision making."

The overall index is calculated by the first three indexes with the same weight for each ((⅓**online service index*) + (⅓**telecommunication index*) + (⅓**human capital index*)).

3.2 Network Readiness Index (NRI)

World Economic Forum (WEF), in their Global Information Technology Report 2013, features the latest results of the Network Readiness Index (NRI), offering an overview of the current state of ICT readiness in the world. NRI framework separates environmental factors from ICT readiness, usage, and impact of the three stakeholders in ICT (individuals, businesses, and governments), and can be used to understand the performance of a nation or even a region with regards to ICT development. That distinction is reflected in the NRI structure, which comprises four sub-indexes. Each sub-index is in turn divided into a number of indicators[16] (Table 1).

Table 1 Network Readiness Index (NRI) indicators

	Indicators (weight)	Variables
Environment sub-index (25%)	Political and regulatory environment (1/2)	Effectiveness of law-making bodies- Laws relating to ICT - Judicial independence - Efficiency of the legal system in settling disputes - Efficiency of the legal system in challenging regulations - Intellectual property protection - Software piracy rate - Number of procedures to enforce a contract - Number of days to enforce a contract.
	Business and innovation environment (1/2)	Availability of latest technologies - Venture capital availability - Tax rate - Number of days to start a business - Number of procedures to start a business - Intensity of local competition - Tertiary education gross enrolment rate - Quality of management schools - Government procurement of advanced technology products.
Readiness sub-index (25%)	Infrastructure and digital content(1/3)	Electricity production - Mobile network coverage - International Internet bandwidth - Secure Internet servers per million population - Accessibility of digital content.
	Affordability (1/3)	Mobile cellular tariffs - Fixed broadband Internet tariffs - Internet and telephony sectors competition index.
	Skills (1/3)	Educational system quality - Quality of math and science education - Secondary education gross enrolment rate - Adult literacy rate.
Usage sub-index (25%)	Individual usage (1/3)	Mobile phone subscriptions per 100 population - Percentage of individuals using the Internet - Percentage of households with computer - Households with Internet access - Fixed broadband Internet subscriptions per 100 population - Mobile broadband Internet subscriptions per 100 population - Use of virtual social networks.
	Business usage (1/3)	Firm-level technology absorption - Capacity for innovation - PCT patent applications per million - Business-to-business Internet use - Business-to-consumer Internet use - Extent of staff training.
	Government usage (1/3)	Importance of ICTs to government vision of the future -Government Online Service Index - Government success in ICT promotion.
Impact sub-index (25%)	Economic impacts (1/2)	Impact of ICTs on new services and products - PCT ICT patent applications per million population - Impact of ICTs on new organizational models - Employment in knowledge-intensive activities workforce.
	Social impacts (1/2)	Impact of ICTs on access to basic services - Internet access in schools - ICT use and government efficiency - E-Participation Index.

3.3 ICT Development Index (IDI)

In 2003, International Telecommunication Union (ITU) introduced a readiness index, namely, the Digital Access Index (DAI), which they claim is an important measuring criterion in boosting new technology adoption. DAI distinguishes itself from other indices by including a number of new variables, such as education and affordability. Then in 2005 ITU created the Digital Opportunity Index (DOI), a framework based on internationally agreed indicators. And in early 2009, ITU launched the new "*ICT Development Index*" (IDI), which combines two existing ITU indices: the "*Digital Opportunity Index*" (DOI) and the "*ICT Opportunity Index*" (ICT-OI) (ITU, 2009). The ITU e-Government Quick-check Tool uses three sub-indices of the IDI: The *ICT access sub-index (40%)*, the *ICT use sub-index (40%) and ICT skills (20%)*. Each sub-index comprises indicators with the same weight; the ICT access sub-index includes indicators on fixed telephone lines and mobile cellular subscribers per 100 inhabitants; international Internet bandwidth per Internet user; proportion of households with a computer and with Internet access. Meanwhile, the IDI's ICT use sub-index is composed of indicators on Internet users, fixed broadband Internet subscribers and mobile broadband subscribers per 100 inhabitants. And finally the ICT skills index encompasses three indicators: adult literacy rate, secondary gross enrolment ratio and tertiary gross enrollment ratio[19, 20].

3.4 E-Readiness Rankings

The Economist Intelligence Unit (EIU) has been publishing an annual e-readiness ranking of 69 countries since 2000. Its model is a weighted collection of nearly 100 quantitative and qualitative criteria, organized into six distinct categories measuring the various components of a country's social, political, economic and

technological development. These, in turn, are weighted according to their assumed importance as influencing factors and each of them has a number of sub-indicators and each variable in the model is scored on a scale of one to ten. According to its report on 2010, EIU changed the name "e-readiness ranking" to be "digital economy rankings" and make some changes to weights at the indicators and sub-indicators (variables) levels[21]. Its indexes (according to 2010 report) are shown in Table 2.

Table 2 EIU e-readiness rankings

Indexes	Weight (%overall weight)	Indicators	Weight (% within the index)
Connectivity and technology infrastructure	(20%)	Broadband penetration	15%
		Broadband quality	10%
		Broadband affordability	10%
		Mobile-phone penetration	15%
		Mobile quality	10%
		Internet user penetration	15%
		International Internet bandwidth	10%
		Internet security	15%
Business environment	(15%)	Overall political environment	11.1%
		Macroeconomic environment	11.1%
		Market opportunities	11.1%
		Policy towards private enterprise	11.1%
		Foreign investment policy	11.1%
		Foreign trade and exchange regimes	11.1%
		Tax regime	11.1%
		Financing	11.1%
		The labour market	11.1%
Social and cultural environment	(15%)	Educational level	20%
		Internet literacy	20%
		Degree of entrepreneurship	20%
		Technical skills of the workforce	20%
		Degree of innovation	20%
Legal environment	(10%)	Effectiveness of traditional legal framework	30%
		Laws covering the Internet	25%
		Level of censorship	10%
		Ease of registering a new business	25%
		Electronic ID	10%
Government policy and vision	(15%)	Government spend on ICT as a proportion of GDP	5%
		Digital development strategy	25%
		E-government strategy	20%
		Online procurement	5%
		Availability of online public services for citizens	15%
		Availability of online public services businesses	15%
		e-participation	15%
Consumer and business adoption	(25%)	Consumer spending on ICT per head	15%
		Level of e-business development	10%
		Use of Internet by consumers	25%
		Use of online public services by citizens	25%
		Use of online public services by businesses	25%

In addition, a number of studies have attempted to improve or expand the index framework for e-government readiness assessment. Some researchers present a general framework which comprises six key factors to implement any e-government initiatives: Organizational Readiness, Governance and leadership Readiness, Customer Readiness, Competency Readiness, Technology Readiness and Legal Readiness[22]. Janssen, Rotthier and Snijkers[23] analyzed 18 international e-government benchmarking studies and proposed five categories of indicators including Input indicator, Output indicators, Usage/Intensity indicators, Impact/Effect indicators, and Environmental/Readiness indicators. Another study identified a number of core e-government readiness indicators, which represent for the wide gap between the 'top ready' and 'not ready' countries. It results show that e-government readiness is determined by online presence characterized by full transactional services, support for citizens' engagement in consultation and decision-making, and availability of the requisite access infrastructure[17]. Shareef, Ojo and Janowski[24] also proposed a component-based e-readiness assessment framework as a basis for developing specific assessment instruments for strategic e-government planning. The proposed framework is characterized by components organized into 8 perspectives: Stakeholders; Demand for e-government; Supply of e-government; Technology; National, Federal, Local, Community and International Context; Enabling Environment; and Perceptions, Willingness and Challenges.

Furthermore, Rahman[25] suggested that, as well as measuring ICT connectivity, ICT use and integration, training, human capacity, government policies and regulations, infrastructure, security and economy, to measure the effectiveness, many consequences of socio-political-cultural economical stages of a country needs to be studied.

In general, by reviewing the literature for e-readiness in e-government in particular, despite the differences that have been discussed, it is possible to identify four major indexes[26]:

- ICT infrastructure mainly relates to the elements of ICT infrastructure that need to be available to citizens if they are to use e-government services.
- Human capital relates to citizens' education and knowledge on how to use computers and the internet.
- ICT usage reflects how citizens use computers and the internet in their daily lives.
- ICT regulations relate to legislative provisions that affect the use of e-government.

Analysis of the previous assessment tools shows that there is no standard model for for e-readiness assessment. Furthermore, there are some differences in the indicators and their weights from index to another depending on the importance of that indicator from the point view of the organization that construct the model. However, in general most of the reviewed models tend to measure the readiness of a country according to deal with infrastructure and technology, people and human skills and accessibility and connectivity. (Table 3).

■4.0 ADVANCING OF EIU READINESS ASSESSMENT MODEL

To show the differences and identify the deriver of changes over the various versions of an e-readiness index, we review, as an example, the EIU e-readiness rankings series.

Since launching the rankings in 2000, EIU has repeatedly upgraded and refined their methodology. The 2000 e-readiness survey was based on two measures: business environment and connectivity. While the rankings for subsequent years (2001 to 2006) were based on six basic measures: connectivity and technology infrastructure (25%), business environment (20%), consumer and business adoption (20%), legal and regulatory environment (15%), social and cultural infrastructure (15%) and supporting e-services (5%)[27, 28, 29, 30, 31, 32].

In 2007, primary categories changed. The ranking criteria of the two categories–connectivity and technology infrastructure (20%), and consumer and business adoption (25%)–significantly was adjusted to to reflect the importance of high-speed internet affordability and the availability of digital public services for both individuals and enterprises. The legal environment category (10%) was refined to reflect a more focused look at the specific government frameworks that influence e-adoption. In addition a new category, government policy and vision (15%), was added to better isolate the effect that policy has on determining a country's overall e-readiness. Social and cultural environment (15%) remained unchanged and business environment (15%) lost some weight for the new category (government policy and vision) while supporting e-services indicator was eliminated in this version[33].

Moreover, at the variable level in each category, EIU reviews the criteria for measuring e-readiness and refines the methodology on a periodic basis. EIU 2004 has made a small but significant change, so that broadband penetration was added as a criterion to measure connectivity[30]. In 2005, the methodology also has undergone significant modification. Many criteria were reweighted to reflect their increasing importance in determining e-readiness. New and more precise means of assessing performance in some criteria have been developed, including in the areas of internet security and connectivity (internet affordability, internet security and the penetration of public-access wireless "hotspots") and in ICT spending and education (degree of entrepreneurship and innovation). The connectivity was weighted more heavily towards broadband penetration (20%) this year to reflect its growing importance in ICT development. On the other hand criteria that no longer accurately reflect the shape of the digital economy was removed[31].

After making several modifications in 2004 and 2005, EIU 2006 had not introduced any major change. Nevertheless, several new ranking variables were introduced and some individual measures were retired or their weighting was reassessed in the e-readiness model in 2007. Regarding to connectivity, broadband internet access enjoys greater influence in 2007—not only its penetration, but also its affordability to households. EIU 2007 also eliminated fixed-line phones as an indicator and increased the weight of mobile penetration, as mobile phones are generally cheaper, easier to access and, with text messaging and mobile commerce applications, increasingly powerful digital devices. EIU 2007 re-focused the consumer and business adoption category to evaluate the utilization of digital channels by individuals and businesses. It also slightly increased its weight relative to connectivity and other categories[33].

The EIU's e-readiness rankings methodology remained largely unchanged in 2008[34]. While in 2009 several changes was made to the methodology. Three new "usage" indicators was added to the "consumer and business adoption" category, use of the internet by consumers, the use of online public services by citizens and the use of online public services by businesses. Two existing indicators assessing the availability of online public services for citizens and businesses was moved to the "government policy and vision" category. Further, the e-participation indicator was added to the government policy and vision category. An indicator of international internet bandwidth per head also was added to the "connectivity and technology infrastructure" category. Elsewhere in this category, some measures were removed (personal computers and WiFi hotspots). The "educational level" indicator in the "social and cultural environment" category was broadened to include data on gross enrolment in education, in addition to the existing measure of school life expectancy. The "electronic ID" indicator previously was in "connectivity and technology infrastructure", moved to the "legal environment" category. Also in this category, the indicator "laws covering the internet" was revaluated to focus exclusively on cybercrime, data privacy and anti-spam legislation. Lastly, in EIU 2009 the 1-5 scoring scale changed to a 1_0 scoring scale for all indicators[35].

In 2010, a few modifications to EIU model were made. Four changes are in the "connectivity" category of indicators, and the one is in "social and cultural environment". For connectivity, broadband quality and mobile quality were added. In measuring "broadband affordability", the lowest connection speed is now 256 kilobytes per second (kbps) (previously this was 128 kbps). The scoring scale for "internet user penetration" was adjusted, with 100% of the population representing the highest penetration achievable in a country (this previously was 75 %). Regarding to social and cultural environment category, the "educational level" indicator was expanded to encompass a third sub-indicator "gross enrolment in tertiary education" [21].

It can be concluded that the advances in technology like the high-speed internet, the availability of digital public services and the penetration and advancing of mobile technologies, has an essential role on the changes made on this index. See Table 4.

Table 3 A comparison of four e-readiness assessment tools

	Indicators Weights																																					
	ICT infrastructure & Connectivity								Business environment & adoption											Human Capital & Social environment						ICT Policy & Regulations					Others							
Assessment Model	Personal computers	Internet users	Telephone lines	Mobile cellular	Fixed broadband	Internet bandwidth per Internet user	Internet security	Mobile broadband	Business use	Macroeconomic environment	Market opportunities	Policy towards private enterprise	Foreign investment	Foreign trade and exchange	Tax	Financing	Labor market	level of e-business development	Others	Adult literacy rate	Gross enrolment	Internet literacy	Degree of innovation	Technical skills	Others	Traditional legal	ICT Laws	Level of censorship	Registering a new business	Electronic ID	Use of online public services	Online service	Overall political environment	Government spend on ICT	Digital development strategy	E-gov strategy	E-participation	Consumer spending on ICT
(UN-DESA) e-readiness Index	**1/3**								**-**											**1/3**						**-**					**-**	**1/3**		**-**			**0**	**-**
	20%	20%	20%	20%	20%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67%	33%	-	-	-	-	-	-	-	-	-	-	100%	-	-	-	-	-	-
(WEF) Network Readiness Index (NRI)	**1/4**								**1/4**											**1/8**						**1/8**					**1/4**							
	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	33%	-	-	-	-	-	-	-	-	33%	33%	25%	25%	-	-	-	50%	23%	22%	23%	22%	-	-	33%	-	-	17%	17%	33%	-
(ITU) ICT Development Index	**4/5**								**-**											**1/5**						**-**					**-**							
	10%	20%	14%	14%	14%	14%	-	14%	-	-	-	-	-	-	-	-	-	-	-	33%	67%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(EIU) e-readiness rankings	**3/10**								**2/10**											**3/20**						**1/10**					**1/4**							
	-	15%	-	15%	30%	10%	15%	15%	-	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	-	20%	20%	20%	20%	20%	30%	25%	10%	25%	10%	20%	20%	3%	2%	20%	15%	10%	10%

Table 4 EIU e-readiness rankings series

Year	No. of countries	Measures							Changes	Drivers & Type of change
		Connectivity & Tech. Infra.	Business Environ.	Consumer & Bus. Adoption	Legal Environ.	Social & cultural Infra.	Gov. policy & vision	Supporting e-services	(+) means" added" (-) means "removed"	
		Weight	Weight	Weight	Weight	Weight	Weight	Weight		
		No. Of Var.	No. Of Var.	No. Of Var.	No. Of Var.	No. Of Var.	No. Of Var.	No. Of Var.		
2000	60	✓ 50% -	✓ 50% -						-	-
2001	60	✓ 25% 8	✓ 20% 70	✓ 20% 5	✓ 15% 8	✓ 15% 4		✓ 5% 4	+(**Consumer & business adoption, Legal Environ, cultural Infra. and Supporting e-services**)	Methodological
2002	60	Almost identical to 2001							2004: **Connectivity**: + Broadband penetration – Telecoms charges as prop. of disposable income	Technology advances
2003	60									
2004	64									
2005	64	✓ 25% 8	✓ 20% 70	✓ 20% 5	✓ 15% 8	✓ 15% 5		✓ 5% 4	**Connectivity:** Broadband penetration (20%) + (Internet affordability, Internet security and penetration of wireless hotspots) - (Competition in telecom, quality of Internet connections and security of telecom infra.) **Cultural environment: (**+ degree of innovation)	Technology advances
2006	64	Identical to 2005							No change	-
2007	69	✓ 20% 8	✓ 15% 70	✓ 25% 5	✓ 10% 4	✓ 15% 5	✓ 15% 4		+ **Government policy & vision** - **Supporting e-services** **Connectivity: (** - fixed-line phones / + Electronic ID)	- Technology advances - Methodological
2008	69	Identical to 2007							No change	-
2009	70	✓ 20% 6	✓ 15% 74	✓ 25% 5	✓ 10% 5	✓ 15% 5	✓ 15% 6		1-5 scoring scale changed to a 1_0 for all variables **Connectivity:** + Internet bandwidth per head - (electronic ID, PC and WiFi hotspots) **Consumer and business adoption:** **+ (**use of Internet by consumers, use of online public services) **Government policy and vision:** + (e-participation, availability of online public services) **Legal environment:** (+ electronic ID) & Internet laws focused only on security	- Technology advances - Methodological
2010	70	✓ 20% 8	✓ 15% 74	✓ 25% 5	✓ 10% 5	✓ 15% 5	✓ 15% 6		**Connectivity**: (Internet speed is 256 instead of 128) + (broadband quality and mobile quality) scoring scale for "Internet user penetration" is 100% of the population instead of 75% **Cultural environment:** "educational level" encompassed "gross 29nrolment in tertiary education"	- Technology advances - Methodological

■5.0 REFINING THE E-GOVERNMENT READINESS INDICES

In related to e-government, the utilization of the latest technologies is vital to reduce the time required by processes to the minimum, aiming at improving the relationships with citizens by providing more effective and efficient services[36]. On the other hand, the shifting landscape of new technologies and consumer preferences means that e-readiness is a fast-moving target, and static measures may fail to capture its impact[15]. Therefore, through the few years ago, the e-readiness indices have undergone some modifications. Further, as shown in the previous section, the main driver for this modification is the advancing of technology. For example–EIU in its e-readiness ranking 2007 eliminated fixed-line phones as an indicator and increased the weight of mobile penetration, as mobile phones are generally cheaper, easier to access and, with text messaging and mobile commerce applications, increasingly powerful digital devices[15].

In this regard, Cloud Computing is fast creating a revolution in the way information technology is used and procured by organizations and by individuals[37]. Even further Tripathi and Parihar[37], and Pokharel and Park[38] stated that to make the e-government system sustain and survive for a long time in entire world, the Cloud Computing is the only solution for today and tomorrow.

Furthermore, cloud-based solutions in the government sector have already established their effectiveness to meet the requirements and the unexpected demands for resources [36]. More and more governments around the world are introducing migration to Cloud Computing as a means of reducing costs, improving services, and increasing effectiveness and efficiency in public organisations[39]. Several examples indicate that Cloud Computing technology has become a strategic direction for numerous governmental agencies and is already being employed in critical areas of the government's IT infrastructure. The United States federal government has already started to implement Cloud Computing within their IT strategies[36]. Furthermore some public sector organizations have made early moves into Cloud Computing. For example, U.S. General Services Administration recently announced moving the government-wide portal usa.gov to the cloud and issued a Request For Information (RFI) for cloud infrastructure services. In Japan, the Ministry of Internal Affairs and Communications has announced plans to shift all government agencies into a private cloud environment by 2015[40].

The characteristics of the Cloud Computing and its expected benefits in the public sector encourage governments to adopt these technologies, especially in the developing countries where the cost is one of the major barriers for implementing advanced IT infrastructures[36].

Therefore, e-government readiness indices could be modified according to the characteristics of Cloud Computing. So, we propose a framework that refines the existing indices by eliminate, add or give different weight to some indicators through analysis the characteristics of Cloud Computing and benefits and challenges of adopting this technology in e-government. Here, we analyze Cloud Computing characteristics to identify its potential benefits and challenges for e-government and then, on the next section, we present the proposed framework.

5.1 Cloud Computing

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[41].

This cloud model is composed of five essential characteristics:

- **On-demand self-service:** computer services such as email, applications, network or server service can be provided as needed. It means that organizations can request and manage their own computing resources.
- **Broad network access:** Capabilities are available over the network and accessed through thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations). So the cloud made it easier for organizations to bring their application closer to users.
- **Resource pooling:** Computing resources are pooled to serve multiple consumers, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. Resulting in higher application density on single hardware, much higher resource utilization, price for resource usage continues to fall and resources can easily be shifted to where the demand is.
- **Rapid elasticity:** Capabilities can be elastically provisioned and released to scale rapidly in proportion to demand. Resources appear to be unlimited and can be appropriated in any quantity at any time. Organizations can easily expand and contract the amount of resources. Thus save money when the application is under light load and doesn't need much resources. So they don't need to spend a great deal of time doing capacity planning.
- **Measured service:** Computing services use a metering capability on the pay-per-use model which enables to control and optimize resource use. This allows organizations to optimize their applications for lower resource utilization, budget for future growth and better budget new projects.

For e-government, these characteristics mean that organizations can easily deploy Cloud Computing without the need to purchase hardware, software licenses, or implementation services (Ease of Implementation). They can reduce or eliminate ICT capital expenditures and decrease ongoing operating expenditures by paying only for the services they use and by reducing or redeploying their ICT staffs (Cost Savings). When user loads increase, organizations need not to secure additional hardware and software, but can instead add and subtract network load capacity (Scalability).Cloud Computing can increase staff mobility by enabling access to business information and applications from a wider range of locations and/or devices (Flexibility). It allows smaller organizations to access to higher-caliber hardware, software, and ICT staff than they can attract and/or afford themselves (Access to IT Capabilities). Organizations can focus ICT staff on higher-value tasks by reducing or eliminating constant server updates and other computing issues (Redeployment of IT Staff).Cloud Computing can make it much easier to reduce or shed functionalities like running data centres and developing and managing software applications, allowing organizations to concentrate on critical issues such as the development of policy

and the design and delivery of public services (Focusing on Core Competencies)[39, 40, 42, 43, 44].

The exploitation of Cloud Computing benefits for e-government projects will make a revolution in the world of e-government and in cost saving, to ensure the actual use of resources, get professionalism in the use and management of applications and also human resources, and the ability for scalability of infrastructure high or low at any time[45].

On the other hand, Cloud Computing like any application on the Internet has challenges. Many challenges of Cloud Computing for e-government relate to its apparent newness and the relative underdevelopment of the marketplace for cloud services. One area of challenge pertains to open standards and interoperability. There appears to be a lack of standards when using and implementing Cloud Computing. Governments will need to promote open, international standards for the cloud so that users will be able to switch cloud service providers with a minimum of cost and risk[46]. Many governments are committed to using ICT systems that conform to so-called open industry standards to reduce the cost or performance risks that can occur when using nonstandard systems.

Security and privacy of information held in Cloud Computing environments is another area of significant concern for governments. Special consideration must be given to using Cloud Computing to handle information that is vital to national security, to maintaining public trust and confidence in government, or to managing certain core government functions such as foreign relations, maintenance of property rights, law and order, and defence. The issues of privacy and security are complicated by the location of data in a number of different jurisdictions with differing levels of protection. Public managers should assure themselves that the security surrounding cloud environments complies with laws, policies, and protocols[46]. As part of this, organizations will need to assure themselves that appropriate service-level agreements (SLAs) are in place, that they have adequate mechanisms and skills for assessing performance against those SLAs.

Another challenge will be assuring business continuity; risk of data loss due to improper backups or system failures are outside your control. Governments will need to understand the business continuity risks that this entails and be assured that effective remedies for those risks (such as strong contracts, effective SLAs, disaster recovery, and business continuity plans) are in place–especially if using offshore cloud services[40]. On the other hand, as Cloud Computing services relies fully on the availability, speed, quality and performance of internet as it works as carrier in between consumer and service provider, Internet dependency–performance and availability will be an issue[47].

Furthermore, additional challenges such as; Leadership (Support/Understanding), the need to establish an appropriate and context-tailored strategy and the needs for a range of new policies, laws, and rules, should be considered[39].

5.2 Proposed Framework

By adoption Cloud Computing in e-government the e-government readiness indices will be affected. So that the benefits of Cloud Computing for e-government will reduce the need for some requirements, while the challenges impose more attention to others. Thus, some indicators will get low weight and others will get high weight or even new indicators or variables can by introduced. (Table 5) shows the relationship between the benefits and challenges of Cloud Computing, and the main e-government readiness indicators.

Table 5 The relationship between the cloud computing and readiness indicators

	Cloud Computing													
	Benefits to e-government							Challenges to e-government						
E-government readiness indicators	Ease of Implementation	Cost Savings	Scalability	Flexibility	Access to IT Capabilities	Redeployment of IT Staff	Focusing on Core Competencies	Open standards & interoperability	Security and privacy	Business continuity	Internet dependency	Leadership	Strategy and policies
ICT Infrastructures	✓	✓	✓	✓									
Connectivity									✓	✓	✓		
Human capital	✓				✓	✓	✓						
Policies and Regulations								✓	✓	✓			✓

ICT infrastructure is considered as one of the main indicators to preparedness of a country to implement e-government systems and it relatively has high weight in the current e-government readiness indexes (as shown in Table 3). However, as infrastructure is hosted on cloud, government does not have to spend on hardware, software, skills resources and maintenance. For example; by moving to the Cloud, General Services Administration (GSA) in USA, saved costs by 72%[48]. In addition, the infrastructure upgrade time reduced in maximum 24 hours, from nine months with on-premises

hosting. Furthermore, the two hour average downtime with the traditional infrastructure, reduced to near zero with the Cloud solution[48]. Therefore, ICT infrastructure as a component of e-government readiness index will get less weight. In addition, its variables may be confined to the factors affect the connectivity and affordability like electricity production, mobile network coverage and secure Internet servers.

In construct, using the Internet to perform computing, government does need to factor the additional requirement of high speed, always on the internet and security and privacy considerations that Cloud Computing demands. Subsequently the more to do on the cloud, the more demand will be placed on Internet connection. Therefore, connectivity as an indicator gets more attention. So we considered it as a separated component to get appropriate weight. Its variables may include internet bandwidth, fixed broadband, mobile-phone penetration, Internet user penetration, mobile broadband and quality broadband.

On the other hand, taking into account the high penetration of mobile devices, ease of use by the public and the possibility of provision Cloud Computing services through these devices, and because clouds provide an excellent backend for mobile phone applications[46] and from the other side Cloud Computing omits the need for many skills. Harris and Alter[49] stated that Cloud Computing is considered as an attractive option when skilled IT staff or equipment is difficult and expensive to come by (Nearly two-thirds of executives asserted they pursued cloud services at least partly for this reason). Therefore human capital as a component of an e-government readiness index may take less weight.

Whilst, to move to the cloud, a government has to ensure that the standards which respond to high priority security, interoperability, and portability requirements are in place for a Cloud Computing environment. For example, in USA, as part of the Federal Cloud Computing Initiative, the National Institute of Standards and Technology (NIST) is leading and facilitating the development of Cloud Computing standards (SAJACC and FedRAMP) which support interoperability, portability, and security to enable important usage scenarios[48]. As can be seen in (Table 5) many of Cloud Computing challenges related to the need for policies and regulations (open standards and interoperability, business continuity, strategy, privacy, rules and policies). Therefore the weight for this component will be relatively high, and the suggested variables may include (Service-level agreements (SLAs) - Business continuity plans - Information security policies - E-government strategy) as well as the traditional frameworks indicators such as laws covering the Internet; level of censorship and electronic ID.

Figure 1 shows the main components of our proposed framework. From the main characteristics of Cloud Computing, benefits and challenges to e-government can be concluded. Benefits of Cloud Computing lead to lowering significantly the weight of ICT infrastructures indicator and partly the weight of human capital indicator. In contrast, its challenges increase the weights of connectivity, and policies and regulations indicators.

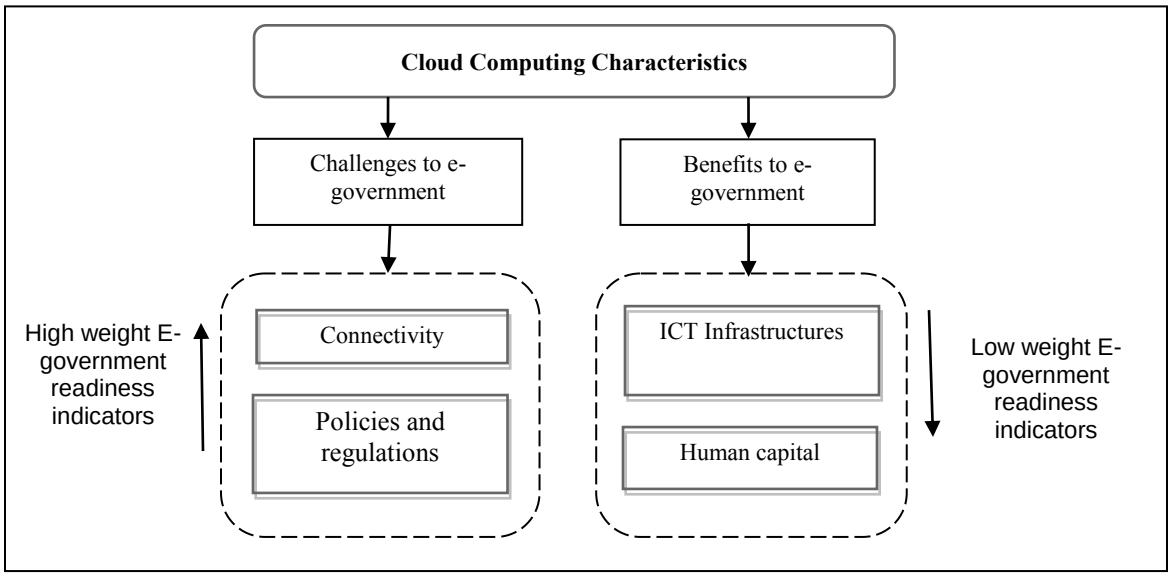


Figure 1 The proposed framework

6.0 DISCUSSION AND CONCLUSION

The advancing of ICT technologies forces the governments over the world reassess their e-readiness in order to identify the most relevant IT based development opportunities to be more efficient in providing services to their citizens. E-readiness assessment is particularly relevant for government at its preliminary or intermediate development stage of e-government. It can serve as a useful starting point, so that a government can assess its state of readiness, identify its gaps and priorities, and then redesign its e-government strategy. By reviewing the e-government readiness assessment, we conclude that, there is no standard model for e-readiness assessment, and most of the e-government assessment frameworks, models or tools are varied in terms of measurements and indicators. Even more, weights or even indicators in the same model may change over the time for different reasons, the most important, emerging new technology or paradigm. Thus, we propose a framework that reflects how Cloud Computing may influence e-government readiness indices. This framework shows how Cloud Computing can refine the existing e-government readiness indices; so that indicators like ICT infrastructure and human capital get less weight, while indicators such as connectivity and regulations acquire more weight. This means that, a country that is considered less ready in terms of ICT infrastructures and skills required to adopt e-government, its readiness with the new viewpoint of our framework will be high.

Acknowledgement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

[1] UNDESA. 2003. UN Global E-government Survey 2003. Available: http://www.unpan.org/egovkb/global_reports.
[2] R. Heek. 2006. *Implementing and Managing E-Government*. Vistaar Publication.
[3] Pudjianto, B. & Hangjung, Z. 2009. Factors Affecting E-government Assimilation in Developing Countries. In: 4th Communication Policy Research, South Conference, Negombo, Sri Lanka.
[4] Gichoya, D. 2005. Factors Affecting the Successful Implementation of ICT Projects in Government. *The Electronic Journal of e-Government.* 3: 175–184.
[5] Shin, S. 2008. Implementing E-Government in Developing Countries: Its Unique and Common Success Factors. American Political Science Association.
[6] Al-Sobhi, F., Kamal, M. & Weerakkody, V. 2009. Current State of E-Services in Saudi Arabia: The Case of Intermediaries in Facilitating Government Services in Madinah City. Proceedings of the European and Mediterranean Conference on Information Systems, Izmir.
[7] Al-Sobhi, F. & Weerakkody, V. 2010. The Role of Intermediaries in Facilitating E-Government Diffusion in Saudi Arabia. European and Mediterranean Conference on Information Systems, Abu Dhabi, UAE.
[8] J. Gant, 2008. Electronic Government for Developing Countries. International Telecommunication Union (ITU), Geneva.
[9] Bui, T. X., S. Sankaran & I. M. Sebastian. 2003. A Framework for Measuring National E-Readiness. *International Journal of Electronic Business.* 1: 3–22.
[10] Ghavamifar, A., L. Beig & G. Montazer. 2008. The Comparison of Different E-Readiness Assessment Tools. In Information and Communication Technologies: From Theory to Applications, 2008. ICTTA 2008. 3rd International Conference on, IEEE. 1–5.
[11] Youssef, A. E. 2012. Exploring Cloud Computing Services and Applications. *Journal of Emerging Trends in Computing and Information Sciences*. 3.
[12] Docktor, R. 2002. E-readiness in 2002: Defining and Achieving Your 6-Fitness Goals. Institute for Public-Private Partnerships Inc.
[13] Zheng, L. & Y. Jiang. 2011. Assessing E-government Readiness of Local Governments in China: Developing a Bottom-up Approach. In Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance, 91-96. ACM.
[14] Sachs, J. D. 2000. *Readiness for the Networked World: A Guide for Developing Countries*. Cambridge, MA: Center for International Development, Harvard University.
[15] EIU. 2007. The 2007 e-readiness rankings: Raising the bar, A white paper from the Economist Intelligence Unit. Available: http://www.eiu.com/site_info.asp?info_name=eiu_2007_e_readiness_rankings.
[16] WEC. 2013. The Global Information Technology Report 2013. World Economic Forum. Available: http://www.weforum.org/reports/global-information-technology-report-2013.
[17] Ojo, A., T. Janowski & E. Estevez. 2005. Determining Progress Towards e-Government-What are the Core Indicators? 5th European Conference on e-Government, Antwerpen. 313–322.
[18] UNDESA. 2012. The United Nations e-Government Survey: E-Government for the People. Available: http://www.unpan.org/egovkb/global_reports.
[19] ITU. 2012. Measuring the Information Society. Available: http://www.itu.int/en/publications/ITU-D/Pages/default.aspx.
[20] ITU. 2009. e-Government Implementation Toolkit, introduction: e-Government Readiness Assessment Framework. Available: http://www.itu.int/ITU-D/ict/publications/idi/.
[21] E. I. Unit, 2010. Digital economy rankings 2010: Beyond e-readiness, A report from the Economist Intelligence Unit. Available: http://www.eiu.com/site_info.asp?info_name=digitaleconomy_2010.
[22] Al-Omari, A. & H. Al-Omari. 2006. E-government Readiness Assessment Model. *Journal of Computer Science*. 2: 841–845.
[23] Janssen, D., S. Rotthier & K. Snijkers. 2004. If you Measure it They Will Score: An Assessment of international eGovernment benchmarking. *Information Polity*. 9: 121–130.
[24] Shareef, M., A. Ojo & T. Janowski. 2008. A Readiness Assessment Framework for E-Government Planning: Design and Application. In Proceedings of the 2nd international Conference on theory and Practice of Electronic Governance, ACM. 403–410.
[25] Rahman, H. 2007. E-Government Readiness: From the Design Table to the Grass Roots. In Proceedings of the 1st International Conference on Theory and Practice of Electronic Governance. ACM. 225–232.
[26] Ismail, H. A. A. 2008. Citizens' Readiness for E-Government in Developing Countries. Middlesex University.
[27] E. I. Unit, 2001. The Economist Intelligence Unit/Pyramid Research e-readiness Rankings. Retrieved June. 8.
[28] E. I. Unit, 2002. The Economist Intelligence Unit e-readiness Rankings, July 2002. Economist Intelligence Unit.
[29] E. I. Unit, 2003. The 2003 e-readiness Rankings. Economist Intelligence Unit.
[30] E. I. Unit, 2004. IBM Corporation. 2004. Scandinavia Consolidates Lead in Fifth Annual Economist Intelligence Unit e-readiness rankings.
[31] E. I. Unit, 2005. The 2005 e-readiness rankings, Economist Intelligence Unit.
[32] E. I. Unit, 2006. The 2006 E-readiness Rankings: Raising the Bar. Economist Intelligence Unit.
[33] E. I. Unit, 2007. The 2007 e-readiness Rankings: A White Paper. Economist Intelligence Unit.
[34] E. I. Unit, 2008. E-readiness Rankings 2008, Maintaining Momentum: A White Paper from the Economist Intelligence Unit. London, United Kingdom: Economist Intelligence Unit and The IBM Institute.
[35] E. I. Unit, 2009. E-readiness Rankings 2009: The Usage Imperative. The Economist. A report from the Economist Intelligence Unit written in cooperation with the IBM Institute for Business Value.
[36] Ishaq, Q. & M. E. Rana Towards Cloud-based e-Government Solutions for Developing Countries: Critical Success Factors and Expected Benefits.
[37] Tripathi, A. & B. Parihar. 2011. E-governance Challenges and Cloud Benefits. In Computer Science and Automation Engineering (CSAE), 2011 IEEE International Conference on, IEEE. 351–354.
[38] Pokharel. M. & J. S. Park. 2009. Cloud Computing: Future Solution for e-governance. In Proceedings of the 3rd international conference on Theory and Practice of Electronic governance, ACM. 409–410.
[39] Kurdi, R., A. Taleb-Bendiab, M. Randles & M. Taylor. 2011. E-Government Information Systems and Cloud Computing (Readiness and Analysis). In Developments in E-systems Engineering (DeSE), IEEE. 404–409.
[40] Craig, R., J. Frazier, N. Jacknis, S. Murphy, C. Purcell, P. Spencer & J. Stanley. 2009. Cloud Computing in the Public Sector: Public Manager's Guide to Evaluating and Adopting Cloud Computing. White

Paper. Cisco Internet Business Solutions Group. Availble: www.cisco.com/web/about/ac79/docs/sp/Cloud_Computing.pdf.

[41] Mell, P. & T. Grance. 2011. The NIST Definition of Cloud Computing (draft). NIST Special Publication. 800: 145.

[42] Rastogi, A. .2010. A model Based Approach to Implement Cloud Computing in e-Governance. *International Journal of Computer Applications*. 9: 15–18.

[43] Brian, H., T. Brunschwiler, H. Dill, H. Christ, B. Falsafi, M. Fischer, S. G. Grivas, C. Giovanoli, R. E. Gisi & R. Gutmann. 2008. Cloud Computing. *Communications of the ACM*. 51: 9–11.

[44] Bhardwaj, S., L. Jain & S. Jain. 2010. Cloud Computing: A Study of Infrastructure as aA Service (IAAS). *International Journal of Engineering and Information Technology*. 2: 60–63.

[45] Galal-edeen, A. a. 2012. Proposed Development Model of e-Government to Appropriate Cloud Computing. *International Journal of Reviews in Computing*. 9: 7.

[46] ATSE. 2010. Cloud Computing: Opportunities and Challenges for Australia, report of a study by the Australian academy of Technological sciences and engineering (ATSE). Availble: http://www.egov.vic.gov.au/trends-and-issues/information-and-communications-technology/cloud-computing/cloud-computing-opportunities-and-challenges-for-australia-in-pdf-format-1367kb.html.

[47] Sahu, B. L. & R. Tiwari. 2012. A Comprehensive Study on Cloud Computing. *International Journal*. 2.

[48] Kundra, V. 2010. State of Public Sector Cloud Computing. Washington. DC: CIO Council.

[49] Harris, J. G. & A. E. Alter. 2010. Cloudrise: Rewards and Risks at the Dawn of Cloud Computing.