

Cloud Based e-Government Services: A Proposal to Evaluate User Satisfaction

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Full Paper

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Abstract

The use of various government legacy systems and infrastructure complicates the continuous maintenance and modernization of electronic government (e-Government) systems. However, the emergence of cloud-based technology is seen by governments as a potential solution to tackle these fundamental challenges. Cloud-based technology delivers hosted services via the internet and enables sharing through demand-based distributions of resources, thus allowing it to be agile, cost effective and scalable. Nevertheless, cloud computing also comes with risks such as security, privacy and reliability issues that pose as barriers for users to adopt these technologies. Against this backdrop, this paper proposes a strategy to evaluate user satisfactions, which is key to facilitate cloud adoptions. The potential contributions are two-fold: (1) The findings will advance understandings on the approach to evaluate user satisfactions gained from using cloud-based e-government services; (2) The strategy can be deployed to generate insights in enhancing the cloud-based e-government services delivery and adoptions.

Keywords:

Cloud computing, e-Government, User Satisfaction, Evaluation, Technical, Behavioural

Introduction

Over the past years, governments have been using information and communication technologies (ICTs) for providing electronic services (e-services) to the stakeholders (Rowley, 2011). The phenomenon then evolved into electronic government (e-government) in the post development era of information society (Liang, 2012). e-Government generally refers to the use of ICT, especially Web-based internet applications by the government to provide and enhance the access of governmental information and services to citizens, employees, business organisations and other government agencies (Irani et al., 2005; Freeman and Loo, 2009; Sivarajah et al., 2015; 2014). The e-government services have grown steadily since its inception, and have been continuously evolving, advancing in both access and features (Zissis & Lekkas, 2011). From an “initial online presence” or individual governmental pages, e-governments have moved towards a “completely integrated presence” or unified pages of departmental or sectional governmental functions (Capgemini, 2009). Despite of bringing numerous advantageous, such evolution underpins the emergence of e-Government systems varieties that currently complicates systems management and deters service quality. Nevertheless, innovative technologies, such as federation of services and cloud computing, can contribute to resolving this problem; cloud distribution offers highly scalable databases for applications, ubiquitous network access, location independent resources, and rapid elasticity (Ali, Soar, McClymont, Yong, & Biswas, 2015; Mell and Grance, 2011). Embracing this aim, European Commission funded research project OASIS (i.e. Openly Accessible Services and Interacting

Society) - a user centric, cloud-based e-government service platform was developed to facilitate access to information, public services and economic promotion by grouping online services in a unified portal. As such, the innovation enhances managerial practices as well as overcomes the technical challenges of information sharing within a complex organizational context (Tassabehji and Hackney, 2016). Beyond that, OASIS also enables the public administrators to better use the citizens and businesses information for the purpose of designing and offering services that meet their needs or expectations, as well as promote flexibility and scalability of public services.

Nevertheless, as a new 'structure', OASIS also entails many organizational and technical challenges such as privacy and security issues, ethical concerns and the most important - adoptions level (i.e. poor take-up level of the services). The latter has always been a critical concern for government, as it risks the policy goals' success (Ebbbers, Jansen & Van Deursen, 2016). As the satisfaction gained by the citizens from using the electronic-enabled services often lead them to reuse the services (i.e. service takes-up), it is important to ensure that any new e-government service is able to deliver the desired satisfaction (Tassabehji and Hackney, 2016). Against this backdrop, the context of OASIS was used to propose an objective approach in evaluating user satisfactions for cloud-based e-government services. Such approach combines sets of technical and behavioural key performance indicators that were extracted from the findings of extensive literatures reviews of e-government adoption and implementation (e.g.: Liang, 2012; Petter and McLean, 2009; Irani et al., 2005; DeLone and McLean, 2002). Using this as a tools, it was suggested for the evaluation to be conducted longitudinally (e.g. more than a year) to assess how the technical changes affect citizen behaviours and consequently influence their acceptance towards the services. The result will inform the significance aspects of cloud-based e-government services that could derive citizens' satisfactions, thus need to be focused. Generally, it will signposts the importance of evaluating and optimising the services over time, to ensure its success (i.e. the end user's take-up of the services).

The rest of the paper is organized as follows. Following the introduction, this paper provides a brief view of the cloud computing within the public sector's sphere. Next, the paper presents a review of the literatures pertaining the existing user acceptance and satisfaction measurement approaches of e-Government services. This is followed by a description of the OASIS context and the e-Government services provided by the platform. The subsequent section then provides the performance measurement approach and the data collection method for this research to evaluate the OASIS platform. Finally, the paper concludes by presenting the future works for the on-going study and highlights its theoretical and practical contributions.

Cloud computing in the context of e-Government

Cloud computing can be defined as a model that facilitates an "ubiquitous, convenient, on-demand network access" to "a shared pool of configurable computing resources", where these resources are able to be provisioned intensively and released without much management effort or service provider interaction (Jones et al., 2017; Mell and Grance, 2011). Cloud computing technology, which allows scalability of computing applications, storage, and platforms, has become an important milestone in the development of information systems, and increasingly important strategy of the government (Lian, Yen, & Wang, 2014; Paquette et al., 2010; Liang, 2012). Many governments had adopted cloud technology as a tool to transform the business processes of their e-Government systems to make it more centralized, improve information sharing, enhance the process effectiveness, and achieve operational efficiency (i.e. better use of resources), as compared to traditional architectures (Shin, 2013; Paquette et al., 2010; Mukherjee and Sahoo, 2010). Evidences from previous studies show that cloud computing was adopted as a new service delivery channel (Smitha, Thomas, & Chitharanjan, 2012), where significance performance improvement and novel service creations were detected across different context of governments, globally (Hashemi, 2013; Liang, Liang, & Wen, 2011). Cloud computing consists of three service models (Jones et al., 2017) as follow:

- 1) **Infrastructure as a Service (IaaS):** this service model offers the end-user outsourced processing, storage, networks, and other fundamental computing resources by cloud service providers such as Amazon, Google etc.
- 2) **Platform as a Service (PaaS):** this service delivery model provides an application platform or middleware as a service allowing the user to deploy user-created or acquired applications (e.g.

operating systems, databases etc.) onto the cloud infrastructure. For instance, in this context the customers are the government IT departments or the third party working on developing and deploying government applications.

- 3) **Software as a Service (SaaS):** this is a software distribution model providing end-users application delivered as a service running on a cloud infrastructure which are made available over the internet and accessible through a web browser, rather than as traditional, on-premises software. For instance, with SaaS, the government staffs would only need to focus on how to use an application rather than worry about the deployment process, etc.

Meanwhile, the deployment models are categorised into four, which are private cloud, community cloud, public cloud and hybrid cloud (Mell & Grance, 2011). The public cloud, or also known as 'government cloud' (G-cloud) allows sharing of services and costs among the partner organisations, thus reducing the operational cost for each organisation (Liang, 2012). Nonetheless, G-Cloud also allows equal distribution of risks among the partners and yielding of profits, due to sharing of common ICT facilities, systems and business process (Gershon, 2004; Simpson, 2011). It was reported that the centrally located, and varying (i.e. situation-led) distributions of resources in G-cloud concept had tremendously improved resource utilisation, especially the ICT budget allocation ((Ali et al., 2015; Sultan, 2014). In terms of capacity to support processing and decisions, the availability of better, sustainable storage space in cloud has enables the analysis of larger dataset, allowing computation of better evidence that can facilitate the government to make powerful decisions (Armbrust et al., 2010). Meanwhile, it also offers easier access and ubiquitous provision of public services, regardless of time and locations from various devices, for more integrated and timely feedback on various public services (Liang, 2012; Bhattacharjee and Park, 2014). Lastly, as the cloud manages and distributes resources automatically for adaptation to changes of business requirements, the deployment and upgrading of applications becoming more faster and agile (Ji & Liang, 2016; Liang, 2012).

User acceptance evaluation of e-Government services

Scholars argue that the implementation of cloud computing entails serious concerns over several implementation and utilisation risks (Alkhanak, Lee, & Khan, 2015; Zissis & Lekkas, 2011). Firstly, concern has been raised on the issue of security and privacy, due to the pooling of government's resources and accumulation of public data in the 'cloud' (Armbrust et al., 2010). Hence, the situation has to be seriously safe-guarded using different privacy and data isolation strategies, without denying the access of authorized users to such data. Next, there is also a need for a new form of legislation to protect the both – user's and government's interest over cloud usage (Catteddu and Hogben, 2009). Finally, the reliability issue was highlighted; where in the event of technical failure (e.g. network paralysis and bandwidth bottleneck), the stability of the data and its access should be possible to maintain sustainability of operations (Liang, 2012). However, acknowledging the infancy stage of cloud based services (Sibya, Venter & Fogwil, 2012), it is common for such platform to be associated with the unknown risks threatening the e-government services adoptions, despite of its distinguishing benefits towards both the government and users. This snapshots warranted a detail study on assessing the user-adoptions related issues to provide meaningful insights.

Several researchers have proposed indicators for evaluating user satisfaction with e-Government services. Information system researchers have applied technology acceptance theories in order to evaluate e-Government services from a citizen's perspective (Tsohou et al., 2014). In this context, many research models have been developed and empirically validated mainly including: The Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), Social Cognitive Theory (SCT) (Bandura, 1986), Technology Acceptance Model (TAM) (Davis, 1989), Theory of Planned Behaviour (TPB) (Ajzen, 1991), Motivation Model (Davis et al, 1992), the Innovation Diffusion Theory (IDT) (Rogers, 1995). Another dominant stream of research in information systems evaluation field focuses on information systems success including several conceptual and empirical studies. As Gable et al., (2003) highlights the development of IS success models such as the DeLone and McLean model has contributed significantly towards the improved understanding of IS management.

Earlier studies in the field of e-government focused heavily on the factors determining the system success (Zmud, 1979). Later thought provokes that user satisfaction is resulted from the belief that the system can

provide the required information, leading to the concept of users' involvement (Bailey and Pearson, 1983; Ives and Olson 1984). Next, the concept linking the 'perceived usefulness and ease of use, attitudes, and behavioural intentions' with the system success i.e. TAM was advocated (Davis, 1989). TAM was widely accepted but gradually superseded by a more comprehensive IS Success Model – that links dimensions of information quality, system quality, use, user satisfaction, individual impact and organizational impact (DeLone and McLean, 2003). Such model was widely used and tested (Petter and McLean, 2009; Wangpipatwong and Chutimaskul, 2005). The IS success taxonomy and its six success categories are based on a process model of information systems (DeLone and McLean, 2002; DeLone and McLean, 1992). Additionally, strong cause and effect relations exist among the six dependent variables. The six major variables of the IS success model are: (1) system quality (2) information quality (3) use (4) user satisfaction (5) individual impact and (6) organizational impact. The six dimensions are interrelated, resulting in a success model which illustrates that causality flows in the same direction as the information process does (DeLone & McLean, 2002). Having realised the importance of e-services, DeLone & McLean (2003) outlined that the frequent use of the system not only indicates more benefits to the users, but also the quality of the system should be considered as well. In response to the call of other researchers who criticized the original model, and due to the advent and growth of e-commerce, DeLone & McLean (2003) decided to add service quality to their new model as an important dimension of IS success noting "especially in the e-commerce environment where customer service is crucial" (DeLone and McLean, 2003). Therefore, in an attempt to contribute towards a universal model, DeLone and McLean (2003) introduced their updated model after ten years of its first induction in 1992. This updated model includes six success dimensions, and holds that the constructs of information quality, system quality, and service quality individually and jointly affect the factors of use and user satisfaction, whereas user satisfaction and use jointly affect net benefit.

Therefore, the updated IS success model is used to investigate the Key Performance Indicators (KPIs) for OASIS from a behavioural view as the acceptance of e-services is defined through the behaviour intention to use of e-Government services. In addition, to the best of the authors' knowledge there haven't been any studies that have focused on the relationship between user satisfaction and acceptance of e-Government services based on the changes of technical performance over a period of time. In this study, the authors seek to add to this void in existing literature by discussing the measurement approach to be used to assess the user acceptance of OASIS from a behavioural point of view and understand if a change in the technical performance of the platform over time has an impact on the user satisfaction. Both the technical and behavioural KPIs identified for the evaluation of OASIS platform is presented in the latter part of this paper after the OASIS context and its e-Government services are discussed.

OASIS: A Cloud-Based e-Government Services Platform

OASIS is a digital platform that relies on cloud-based technologies which allow for efficient access to government services and applications to monitor and to manage the required resources from any Internet access point (Ozwillo, 2017). The objective is to have services that are for instance more accessible, more user-friendly, more efficient to manage by public authorities and less expensive for the taxpayer. The initiative has been launched by hosting thirteen e-Government services that have been deployed in five countries that will serve as pilot sites (see Table 1 and Table 2). Currently each e-Government service is provided only in one pilot site; through OASIS platform each e-Government service will be provided in two or three countries. OASIS therefore promotes and facilitates the migration of utilities and local government business software in the cloud. OASIS is built around three pillars of equal importance:

- **Data:** data is at the core of OASIS where the key objective is to make a data patrimony as a common good. This data is available for users and service providers who use it and enrich it. This is the technical point of view where data is the backbone of the OASIS architecture.
- **Services:** the services being the means to create, update and use data, OASIS is mainly accessible via the services and as such is seen as a system centred on services. This is the economic point of view where the OASIS valuation is made via the services.
- **Users:** the new uses of the IT systems are oriented towards a more social use organized around the users. The user disposes of the maximum possible amount of information (vision centred on data), tools for exploiting them (services) and can organize their work through a portal giving

them access to the resources. This is the functional point of view where OASIS gives the control to the end user.

OASIS is a federation of services and data offering the end-user a complete ecosystem including specific business services. The functionalities required by the end-users (i.e. citizens, employees, IT managers) include job functions managed by federated services which are integrated as such into the OASIS platform. From the functional point of view of this architecture, OASIS is hosted on an IaaS platform in order to provide users a SaaS paradigm/model. A conceptual diagram that illustrates how OASIS works on the cloud platform is presented in figure 1. Each module of OASIS and each federated application relies on a private cloud, and on a single hosting where there is no need for elastic hosting. In a nutshell, OASIS operates over a private cloud, implemented in two datacentres, and virtually extended via Internet.

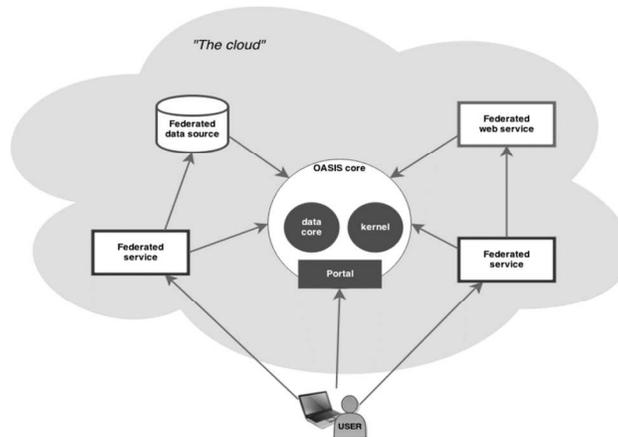


Figure 1: OASIS Concept

OASIS e-Government Services

The types of e-Government services offered by the OASIS platform for the five pilot sites (i.e. the service providers as well as trial sites) are depicted in Table 1.

e-Government Services to be offered in OASIS	Pilot sites				
	France	Bulgaria	Turkey	Italy	Catalonia
A filing system for electronic documents (Archiland)	/				
A user-centric citizen web portal of basic services (Citizen Web Portal)	/	/			/
A crowd-mapping application for public domain management (Ushahidi)	/	/			
A software suite for the internal management of local public authorities (5 services – Open Cimetierie, Open Elec, Environmental Incidents, Public Purchase Management and Subsidy Management)	/				/
Investment Promotion and Business Retention (INVPROM)			/		
Data Collection from Public and Local Authorities (Data Collection)			/		
City Planning	/			/	
Mapping of territorial economic activities (MoTEA)				/	/
Platform that provides static and dynamic public data (OpenData)	/				
Network of Alternative Tourism		/			
Financial Management Software	/				

Table 1. List of deployed e-Government services offered by each pilot site

Performance Evaluation and Data Collection Approach

The measurement approach for this study is based on two key performance indicators i.e. *technical* and *behavioural* for understanding the user satisfaction of using the OASIS platform and its e-Government services. This measurement process seeks to assess how the technical changes in the system over a period of time influences the behavioural aspects for user acceptance of OASIS. Often, the availability of electronic public services (i.e. ‘supply-side’) has been the primary focus of e-Government studies and policymaking, but over the past years, citizen usage of e-Government services (i.e. ‘demand-side’) has also become a priority issue (Irani et al., 2005; Tsohou et al., 2014). The performance measurement therefore should not only focus on the assessment of the e-Government services’ technical capacity and cost-effectiveness, but also the non-technical aspects that include users’ acceptance. Hence, the view is adopted in proposing the measurement strategy, where the technical perspective refers to assessing the operation and performance of OASIS, while the non-technical perspective refers to evaluating the behavioural dimension. Both of these dimensions will be discussed in the following subsections, together with the data collection and measurement approach.

Behavioural Performance Evaluation

The behavioural performance evaluation is based on the De Lone’s updated IS Success model (DeLone and McLean, 2003) as indicated. Table 2 below presents a detailed list of the behavioural KPIs that are to be used for measuring the user satisfaction of the OASIS platform and the services provided.

KPIs Category	ID	KPIs	Description
Information Quality	B1	Completeness	The degree to which the system provides all necessary information
	B2	Accuracy	The user’s perception that the information is correct
	B3	Currency	The user’s perception of the degree to which the information is up to date
	B4	Format	The user’s perception of how well the information is presented
System quality	B5	Accessibility	The ease with which information can be accessed or extracted from the system
	B6	Timeliness	The degree to which the system offers timely responses to requests for information or action
	B7	Flexibility	The way the system adapts to changing demands of the user
Service Quality	B8	Tangibility	The user’s perception of how well the customer service is accessible.
	B9	Reliability	The user’s perception of how accurate the customer service is delivered in relative to their needs.
	B10	Responsiveness	The user’s perception of how fast the customer service is delivered.
	B11	Assurance (Understanding / Knowing the Customer)	The user’s perception of how the service delivered meets their expectation.
	B12	Empathy	The user’s perception of how well the customer service support is personalized and improves their relationship with the organization.
Intention to Use	B13	Frequency of Use	The user’s willingness to use the service in the future.
	B14	Usage Pattern	The user’s motivation to use the service based on their experience with current service.
User Satisfaction	B15	Content	The degree to which the system provides all necessary information.
	B16	Format	The user’s perception of how well the system’s overall functions.
	B17	Timeliness	The degree to which the system offers timely responses to resolve the requests for action
	B18	Accuracy	The user’s perception that the information is beneficial to them
	B19	Ease of Use	The ease with which system and customer service can be accessed and information can be retrieved or extracted from the system.

Table 2. List of Behavioural KPIs

Delone's IS Success model has been widely applied in the information systems research using questionnaire instruments. To measure the proposed behavioural indicators, a questionnaire was developed and will be used as survey instruments during the fieldwork. Among other strategies to ensure validity and reliability of findings, a 5-points Likert scale is used to represent answers for each question. Meanwhile, the questions were also translated to the pilot sites' local language and provided in both - manual and online versions, for each application.

Technical Performance Evaluation

The overall OASIS platform relies mainly on two underlying parts: The Kernel (in particular for authentication, events, logs) and the Datacore (for advanced data management and sharing). The platform also includes a public portal which is the user interface where users (citizens or agents) gain access to services. Service is a generic term that describes the Pilot site demonstrators published on OASIS. The target value indicated represents the common value to be met by all pilot sites. Table 3 below presents a detailed list of the technical KPIs that are to be used for measuring the technical performance of the OASIS platform and the services provided.

KPIs Category	ID	KPIs	Description	Target	Typical Target Value
Fault tolerance and reliability	T1	Service availability ratio	Uptime ratio delivered as a monthly indicator. This ratio (for example 99%) is calculated thanks to automatic tests launched every minute to test the status of typical public entry points (a web page or a web service).	portal, services	99%
	T2	Cloud availability ratio	Uptime ratio delivered as a monthly indicator. This ratio is calculated thanks to automatic tests launched every minute against underlying platform entry points (web services).	kernel, datacore	99%
Performance	T3	Average service access time-1.1	This indicator measures the access time of each service most interesting/typical pages: public landing page, dashboard, etc. As ubiquitous access is a need on cloud, we suggest to measure it for different network and/or devices uses for accessing to the services. This average access time has to be calculated client-side to be more accurate.	portal, services	3 seconds
Scalability and Flexibility	T4	Number of users per month	Considered as a total is not giving any occupancy/load or other information. Useful for creating combined metrics with most part of the list of KPI.	platform, services	depends on service
	T5	Number of requests handled by the platform	Related to performance. Related to usability. Useful for creating combined metrics with most part of the list of KPI.	kernel, datacore	Used to comment or explain other values, no specific value is targeted

Table 3. List of Technical KPIs

The data collection for technical KPIs is supported by the use of external tools and servers to collect and process indicator data, rather than using an internal platform component. There are several reasons for using external tools: First, if the internal component momentarily goes down, it won't be able to track information and therefore this is not acceptable for accurate indicators like T1 and T2; Second, decoupling probes from the platform internals is a good practice to track real usage data; and finally, the external services chosen provide interesting added value since they are specialized solutions. For example the availability of a service can be tested from different European locations. Having said that, the only exclusion is in the case of T5 which can only be measured from OASIS servers.

Service availability ratio (T1) and Cloud availability ratio (T2) Implementation

The principle of both T1 and T2 reliability indicators is the same: ping (meaning check) periodically (i.e. once per minute) if a resource at a given Uniform Resource Locator (URL) is available. Then process an uptime ratio in a similar fashion to Service Level Agreements. The external servers that launch the

periodical pings are called probe servers. These have been started with the experiments with the use of commercial tool “*pingdom*”.

T1 measurement is derived from the followings:

- Its public page if it has one (some services don't if all of their pages require authentication and if their entry point is OASIS portal); and
- At least a dedicated status web service that should always remain accessible to the ping servers. This web service internally checks that a database connection can be opened: if not, it returns an error that is collected by the probe servers. This is a simple implementation that will be enhanced if false negatives happen (undetected downtime).

For T2, the same status web service is implemented for the OASIS kernel and the datacore.

Average service access time (T3) Implementation

The goal here is to measure the average load time of the most interesting web pages of each service, should they require authentication (dashboard) or not (public page). The implementation (provided by the *pingdom* service) consists in including a client-side probe (a javascript program executed in the browser) that measure the total load time (between the initial request and the completed rendering) of web pages, but also three subparts of this duration: (1) Network delays; (2) Back-end processing duration; (3) Front-end processing duration

Number of users per month (T4) Implementation

In terms of T4, a typical analytics service provided by “*piwik.pro*” is used. Its functional scope is similar to *Google Analytics* but *piwik* is released as open source software and the collected data (statistics) is hosted in a European data center. Among useful reports that are to be used are: (1) visits or unique visitors per day, per website, per specific page; and (2) Additional information (e.g. entry and exit points, visitors locations, engagement (i.e. average visit duration) or devices).

Number of requests handled by the platform (T5) Implementation

T5 provides a typical estimation of the system load (the maximum “number of requests per minute” per day). This indicator is processed both for the kernel and the datacore, and will be useful to explain possible problems enlightened by other technical KPIs. This indicator won't be used by pilot sites.

Concluding Comments and Future Research

Despite the claimed benefits of the cloud-based e-government services, its implementation has raised concern among many. Potential risks highlighted were data and system security and privacy, as well as reliability. Nevertheless, as its use in the public sector is considerably green, the availability of useful information that could shield its implementation from the risks remain scarce. Such situation becomes the main motivation for this study, which focused on identifying factors that potentially influence citizens' adoptions of the cloud-based e-government services, and develop a systematic measurement approach that generate meaningful insights.

In this study, the “Openly Accessible Services and Interacting Society” platform, or OASIS was adopted as the research context. A two dimensional metric of technical and behavioural indicators containing measurable sub-indicators was then developed based on the synthesis of an extensive IS adoptions and acceptance literatures. The synthesis also indicates that technology subliminally impact the citizens' behaviours over time, influencing their acceptance towards the cloud service platform. Therefore, their combination in an assessment would enhance rigorously: the technical indicators helps assess the three categories of platform operation and performance; and the behavioural indicators help evaluate five aspects that are linked to perceptions and expectations, as highlighted in the Updated Information System Success Model (UISSM).

This evaluation approach is important to enable the measurement of citizens' satisfaction, which is key in influencing their intention to re-use the system. As the success of an e-government system is generally indicated by its level of usage. Securing citizens satisfaction gained from using such system is pivotal in promoting its take-up level, and ensuring the achievement of its desired objectives or policy goals that

underpin its purpose of existence. As part of future works, this approach will be empirically tested to see its usefulness in determining how the technical changes in the system over a period of time influences the behavioural aspects of the users, which is central in promoting user acceptance (i.e. take-up level) of cloud-based e-Government service platform. Hypothetically, the result will advance understandings on the central role of users' satisfaction-led indicators in assessing and predicting success, and / or elucidate new critical, useful insights pertaining the cloud-based e-government services platform.

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