The Effect of Cloud Computing Adoption on the Sustainability of E-Government Services: A Review

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Abstract

The environment in which public organizations exist changed. Trends such as demographic change, environmental pressures and technological innovation have created significant challenges to how public organizations do their business. Accordingly, public organizations need to have innovative strategies to tackle today's business environment by adopting sustainable business practices. Sustainability governance needs scalable and interoperable technology platform to support analyzing, integration, sharing and monitoring different types of data and sustainability measurements. Cloud computing is the potential candidate platform to support sustainability governance. It gives agility to business and provides a platform for sustainable business with improved services, better environment and resource management. This research revisits the related concepts, and provides an analysis of the previous researches to identify the gap of incorporating cloud computing as a platform of developing sustainable e-services. Results show that research on the role of cloud computing in ensuring provision of sustainable e-government services still scarce. There is a lack of research addresses the challenges in government projects and developing more sustainable e-government services by selecting and applying the appropriate cloud model.

Keywords: Cloud Computing;Sustainable E-services; Survey.

1. Introduction

E-Government services become more integral to the life of people, businesses, and public organizations. Thus, to offer better services, governments need to plan and implement effective e-services. These services are driven by citizen's pressure, innovations in ICT, and the capability and capacity of governments to mitigate environmental, social inclusion, economic growth challenges toward sustainable development. Sustainable e-government development is the use of ICT to enable governments to enhance the efficiency of their internal operations, processes and infrastructures focusing on sustainable development. ICT can be applied to provide accessible services with minimum environmental cost. ICT also can be used to increase participation in government decision and policymaking processes [1]. According to Estevez and Janowski [2], sustainable e-government can support public services, the interaction with citizens, citizens participation in decision making, and promoting social, while protecting natural resources for future

generations. Sustainable e-government services can create economic value (Economic sustainability), cope with technological changes (Technical sustainability), protect the environment (Environmental sustainability), and provide fair access and exchange of information among all parties (social sustainability) [3]. However, despite the advancement of e-government and sustainable development domains independently, there is a lack of awareness of efforts to define, conceptualize the sustainable e-government services to explore how technology innovation could support the sustainable e-services [2].

Cloud computing can realize sustainable e-government system by utilizing varied models of sharing resources. Using cloud computing data centres, data, images and shared application infrastructure for e-government system can be accommodated independent of upper-tier of ICT resources. A proper e-government system utilizing cloud computing and existing telco infrastructure can build up a sustainable e-services which can be favourable for developing countries and emerging economies in many aspects including cost, scalability, resources, integration, expertise, maintenance, and sustainability [4]. This study provides a survey of research related to the impact of cloud computing adoption on the sustainability of e-government services. The related studies are explored and analysed to identify the potential for further research on examining the impact of cloud computing toward sustainable e-government services.

The study is organized so that the concept of cloud-based e-government services is introduced. Then, the state of the art in the sustainability of e-government services is explored and analysed. Next, a summary of the studies, the applied methodology and the results are presented. Finally, a discussion and conclusion is provided.

2. Cloud Based E-Government Services

Cloud computing advantages motivated governments around the world to adopt this technology to offer reliable and sustainable e-services. According to Alonso, et al. [5], e-services can be effectively delivered and sustained with implementing robust, integrated back-end processes using cloud computing with considering appropriate levels of data portability, interoperability, and security. Several cases showed that cloud computing has become a strategic direction for many governments around the world. It already has been adopted to implement many e-government services. Mohammed and Ibrahim [6]studied and analysed different cases from different countries and the results revealed that governments seek to enhance their services and reduce ICT cost by adopting cloud platforms. Some organizations have applied cloud services to resolve real existing ICT related problems, while others adopted cloud computing to save cost, enhance scalability, availability and accessibility. Also, it has been adopted to improve the efficiency and the quality of e-services, and increase transparency and people participation [6].

Cloud-based government system allows sharing common ICT facilities, systems and business process of services among partner organisations which leads to reduce the operational cost for each organisation [7]. It was reported that cloud-based government system had tremendously improved resource utilisation [8, 9]. Cloud computing provides high capacity storage space which enables the analysis of larger data which helps the government to make powerful decisions [10]. Furthermore, using cloud services, easier access and ubiquitous provision of services can be offered, regardless of time and location, which enables more integrated and timely feedback on various public services [7, 11]. Further, as resources can be managed and distributed automatically on the cloud based on the business requirements, the deployment and upgrading of applications becomes more faster and agile [7, 12].

3. State-of-the-Art: Sustainability of Cloud based E-Services

E-Services have become more integral to our life, businesses operations, and governments tasks and responsibilities, which make it more critical to be sustainable. E-Service sustainability is the ability to provide continued and high quality services, as well as maintaining customer satisfaction. Sustainability is defined by Brundtland, et al. [13] as the development that ensures meeting the needs of current generation with considering future generations' needs [14].

According to [14], for any organization, to adopt cloud computing, sustainability assessment is applied as a practical approach to assess the viability of this technology. Issues related to sustainability dimensions (economic, environmental, social and technology) should be addressed before the making cloud migration decision. Economic dimension considers the cost of cloud migration including cost of maintenance, training and consultant. Environmental practices are also considered in order to address issues related to energy and resources utilization. Social and technological aspects are also received considerable attention when cloud migration decision is made [14].

Walterbusch, et al. [15] proposed a decision model to evaluate and select appropriate cloud computing services with considering the economic, environmental and social sustainability dimensions. A Mixed method was applied to expose the main characteristics of cloud computing and its economic, environmental and social impacts. The model was verified by experts as well as the results of a scenario based simulation study and a statistical analysis. The findings illustrate that to evaluate and select cloud computing services, the attributes of sustainable systems should be considered.

Yoo and Kim [16] used Delphi method and AHP (Analytic Hierarchy Process) to analyse technological, organizational, and environmental factors as well as other decision factors and attributes of cloud computing. The study suggested several important factors to be considered when deciding to adopt cloud computing services including top management support, competitive pressure, and compatibility. Further, compatibility and competitive pressure were identified as the high priority factors from the demander perspective, and relative advantage and top management support were considered factors with high priority from the provider perspective.

Truong and Dustdar [17] examined how cloud computing can support emerging requirements for the sustainability of public services. The basic elements and common features of cloud computing for sustainability were identified by reviewing the industrial platforms and research works. It was concluded that cloud computing is a potential candidate to support sustainability by providing several techniques which support several stakeholders and complex analysis.

Stamenkov and Dika [18] proposed a model for sustainable quality of services in e-banking industry from the perspective of internal users. Sustainable quality of service was defined as the organization capability of delivering e-services with sustainable quality while managing and maintaining customer satisfaction and loyalty. An interview based qualitative study was conducted to develop a theoretical model. Five factors were defined including quality of e-service, IT and infrastructure capabilities, quality management system, business/ICT alignment, and ICT service environment. Exploratory factor analysis and structural equation modelling was applied to empirically examine the proposed model. Results supported the effect of quality management system, business/ICT alignment, IT and

infrastructure capabilities, ICT service environment, and e-service quality on sustainability of e-service quality which predicts satisfaction and loyalty.

Chou [19] analysed the risk and the value of cloud computing by proposing a value creation model. To help organizations to evaluate the value of cloud computing, a set of components were identified. Further, the effects of adopting cloud computing in organizations were analysed. The proposed cloud computing value creation model included four main stages; awareness, translation, comprehension, and cloud computing value creation with the purpose of reaching a sustainable computing.

Estevez, et al. [20] analysed ten cases of existing e-government initiatives with explicit sustainable development objectives. The results illustrated that e-government contributes to a variety of sustainability goals. The most common sustainability addressed issues include social (empowerment), economic (business opportunities), environment (man-made activity) and institutional (capacity building). Moreover, a clear difference between the nature of e-government for sustainable development in the developed and developing countries was identified.

Estevez and Janowski [2] introduced the concept of e-government for sustainable development (EGOV4SD). First, an EGOV4SD conceptual framework was presented which helps defining the boundaries and dimensions of E-Government (EGOV) and Sustainable Development (SD). Then, a technique to analyse EGOV4SD based on the conceptual framework was defined. This technique was used to present the landscape of EGOV4SD research based on the review of related literature.

According to Razavian, et al. [3], e-services are not considered sustainable unless they are specifically implemented considering sustainability dimensions. Designing e-services to be sustainable is complicated, and communicating and assessing sustainability is a complex process. Razavian, et al. [3] proposed a conceptual model to identify the essential elements of sustainable e-services. Enhancing the shared understanding of sustainability amongst stakeholders, and providing sustainability assessment tool was targeted. The value of the proposed model was illustrated using a real case study.

Larsson and Grönlund [21] investigated the sustainability concept in e-government research. Reviewing the literature indicated that the use of the sustainability theory in current e-government research is to a large extent arbitrary and shallow. In addition, related researches focus only on some of sustainability dimension (social, economic, environmental, and technical), while researches that included and integrated all four dimensions are sparse. Social aspect of sustainability was the focus of the majority of researches, while other aspects were less highlighted. There was a limited perception on what should to be sustainable. There was more highlighting on project or e-service sustainability, with less attention to general and applicable factors of public sector values, such as trust, participation, and economy.

Table 1 represents a summary of the most related studies showing a brief description, the methodology and the key results.

Table 1. A summary of related literature.

The study	Brief description	Methodology	Main Results
Walterbusch, et al. [15]	Proposed a model which helps to evaluate and select cloud computing services with considering the economic, environmental and social sustainability dimensions.	Mixed Method	In addition to economic aspect,other sustainability dimensions need to be considered when evaluating and selecting cloud computing services.
Yoo and Kim [16]	Analysed technological, organizational, and environmental factors as well as other important decision factors affecting cloud computing adoption.	Delphi Analysis	Compatibility and competitive pressure were identified as the high priority factors from the demander perspective, and relative advantage and top management support were recognized as key factors from the provider perspective.
Truong and Dustdar [17]	Examined the impact of cloud computing on the emerging requirements for sustainability governance of services.	Quantitative	Cloud computing can provide techniques to support multiple stakeholders and complex analysis towards sustainable governance.
Stamenkov and Dika [18]	Examined sustainable quality of services and proposed a model for ensuring sustainable quality of e-services in banking industry from the perspective of internal e-service users.	Interview	Quality management system, ICT alignment, IT and infrastructure capabilities, service environment, and e-service quality affect sustainability of e-service quality which predicts users' satisfaction and loyalty.
Chou [19]	Analysed the risk and value of cloud computing through a value creation model. Furthermore, the effects of cloud computing adoption in organizations were	-	Cloud computing value creation model for sustainable computing.

			discussed.
Estevez, et al. [20]	Analysed ten cases of existing e-government initiatives with explicit sustainable development objectives.	Quantitative	There is a clear difference between the nature of e-government for SD initiatives in the developed and developing countries.
Estevez and Janowski [2]	Applied the e-government concept to support the sustainable development.	Review	A conceptual model for EGOV4SD was proposed which helps defining the boundaries and dimensions of EGOV and SD.
Razavian, et al. [3]	Proposed a conceptual model to identify the key elements of sustainable e-services.	Case Study	4D sustainable e-services conceptual model which enhances the shared understanding amongst stakeholders and make sustainability assessment easy.
Larsson and Grönlund [21]	Investigated the literature of sustainability concept in the context of e-government research.	Review	The use of the sustainability theory in e-government research is weak.Researches that include and integrate all four sustainability dimensions are sparse.

4. Discussion and Conclusion

Governments, to plan and implement effective e-services, need to mitigate environmental, social inclusion, economic growth challenges toward sustainable development. Cloud computing enables governments to enhance the efficiency of their internal operations with innovative ICT strategies, processes and infrastructures focusing on sustainable development. Cloud computing can be applied to provide accessible services to the small enterprises with minimum cost. Moreover, cloud computing has positive impact economically and environmentally. These impacts are driven by the tendency to reduce total infrastructure, increase efficiency, maximize server utilization, and improve data center efficiency.

Related literature showed that cloud computing provides better performance, reliability and scalability of e-services. The related studies applied different methodologies to investigate the potential of cloud computing, and proposed frameworks/models to identify the influencing factors. However, the diversity of cloud models makes it complex to decide which service model is more suitable for the specific requirements of an organization and through which model it should be deployed. Moreover, selecting the combination of cloud service model and deployment model which fit with the organization needs may improve the sustainability of organization e-services. This makes cloud migration a complex decision making process. It is subjected to many factors such as government policies change, budget, suitability of the cloud environment for specific services, and the emerging of new technology.

There is a lack of studies proposing decision models that help to select the appropriate cloud model which fit with the specific requirement of e-services to improve the sustainability. Therefore, researches can be conducted to address the challenges in government projects and developing more sustainable e-government services by selecting and applying the appropriate cloud model using Multi-Criteria Decision-Making Models.

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