International Journal of Engineering & Technology, 7 (4) (2018) 3018-3021

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet.v7i4.14740
Research paper

A cloud based framework for e-government implementation in developing countries

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Abstract

Cloud Computing technology is achieving a significant cost saving, business agility, and high scalability. However, it is a relatively new technology and its successful implementation in the governmental organizations needs careful consideration due to data sensitivity. Success-ful adoption of cloud-based solutions is the key for realizing the expected benefits of cloud computing technologies in the public agencies. The aim of this research is to develop a strategic framework to adopt cloud-based solutions in the public sector to improve e-government processes in developing countries. The purpose of the developed framework is to reduce the time and cost of the processes that contain interaction among governmental agencies and citizens through adopting cloud-based solutions. The framework was formulated based on the collected data analysis and the conclusions from experts' interviews. This study provides detailed guidelines to a successful launch and implementation of cloud-based solutions for e-government initiatives in the public sector.

Keywords: *E-Government Adoption; E-Government Framework; Cloud Computing; Developing Countries; Trustworthiness.*

1. Introduction

Priorities of the government sector globally are inclined towards providing easy to access, cost effective, efficient and timely services to a wide range of people living in urban as well as rural areas. In specific cases, solution which are rather costly in terms of infrastructural requirements will still capture government's attention if the overall benefit to its people is substantial in order to express a strong concern and affiliation with its people [1].
One of the contemporary research [2] indicates that 77% of people prefer to search through internet for information regarding public services and departments. Cloud computing is playing a pivotal role in shaping up the new era of providing public services and infrastructure. Cloud based features like on-demand self-service, broad network access and rapid elasticity has made the deployment of governmental services feasible and affordable. These features also assist in maintaining a strong association with the vast majority of population [3]. Nowadays governments are willing to use modern technological infrastructure keeping in view that common priorities of public sector including efficient response time, affordable cost and trusted solution base are comparatively more achievable by implementing cloud based solutions [4].
Cloud computing provides a wide variety of services suitable for various industries including the SME and large enterprise sector. Many complex problems can be sorted out by utilizing the contemporary technological solutions such as data mining, knowledge management and big data analytics [5]. Many of the well-known solutions used today are utilizing Software-as-a- Service cloud model to leverage services to their large client base.
Cloud computing solutions are being deployed strategically in major federal government agencies in the United States of America as a tool to facilitate the large-scale data storage, application processing, and sharing information in a cost effective manner if compared to other available technological architecture solutions [6].
Cloud computing capabilities can offer a real time network access to technological resources which could be physically located anywhere geographically based on the business demand. Thus, it's a natural host of service oriented software applications that requires high level of scalability due to its flexible and agile environment that can reduces the initial cost through reducing the actual implementation lifecycle of the developed solutions.
International organizations are currently tends to modifying the their processes to be more suitable to be based in the cloud computing in order to get benefit of the variety of services provided, fast access, improving the customer relations, reduce cost and mitigate software risks associated [7].
The future of the public sector agencies lies in adopting cloud computing solutions in order to gain more benefits and achieve similar success.

2. Methodology

As this research involves analysis and integration of both qualitative and quantitative data, a mixed method approach is utilized to carry out research procedure as recommended by Ivankova [8].
The mixed method approach is consistent with the need to understand governmental organizations preferences in the use of cloud computing technologies, and to test and evaluate the effectiveness of various strategies that could improve the expected framework implementation outcomes [9].
Data were collected through utilising in-depth interviews conducted with cloud computing experts, practitioners, and cloud compu-

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ting service providers. To get their point of view regarding cloud computing technologies adoption key drivers and barriers, reliability, current issues they face, and the solutions implemented to overcome these issues.

The purposes of these interviews are to link the theoretical knowledge with the practical solutions, and to get better understandings of the current situation of cloud computing.

Furthermore, up to 250 invitations to participate in a questionnaire survey were distributed via E-mails to potential respondents. The questionnaires were embodied in the e-mail to give the respondents the ability to answer the questions just like answering a usual E-mail, and to save their time as they occupy high positions and always busy; and to avoid any suspicions of spamming or attacking links.

The questionnaires were also published in the common interest share groups using specialized social networking websites that gathered people sharing interests regarding cloud computing technologies.

A total of 41 responses received with participants from all over the world. The response rate was sufficient to provide the required information, because only professional people with experience in cloud computing were allowed to participate, add to that people with high level management in their organizations such as Senior Consultants, Chief Executive Officers, and IT Managers.

The data analysis illustrations were represented by different types of charts such as column charts, pie charts, and bar charts to describe and identify the collected data values.

The analysis of respondents shows the respondents occupying various job titles which are as follows: Senior consultants, Vice presidents, IT managers, Senior Process Architect, Chief Information Officer (CIO), Cloud Support Engineers, Head of Architect, IT specialists and Experts. The cross section of respondents shows a high level of reliability of the survey results and thus providing good inputs for the development of the proposed framework.

The survey respondents highlighted a set of barriers to adopt cloud solutions in their organizations such as security concerns which came in the first place as a major barrier followed by Regulatory, Compliance and IT governance issues then the privacy and confidentially issues. Add to that the concerns of loss of control over data and applications, as shown in table 1.

Table 1: Major Barrier to Adapt Cloud Solutions

Barriers	Respondents	Percentage %
Security Concerns	22	79
Integration issues	9	32
Loss of control over data	15	54
Availability and performance	9	32
Regulatory and compliance	17	61
Cost concerns	5	18
Vendor lock-in	8	29
Privacy and confidentiality	16	57
Liability issues	8	29
Others	4	14

The analysis of the survey indicated the key drivers to adopt cloud services are the need for flexible services that have sufficient scalability to meet organisations demands was selected first as a one of the most important adoption drivers with 81%, followed by cost reduction with 66%, IT resource optimization with 47%, and Diversification of IT systems and resources with 14%.

This result shows that although organisations adopted cloud solutions, but still need more control over their own data and to be managed internally. That's why it's more likely to deploy Private clouds.

For the key characteristics for cloud service provider selection, the results confirmed the security concerns related to cloud adoption as it received up to 75% followed by the concerns of services reliability and availability as the Disaster recovery and business continuity plans came second with 69%, while issues related to regulations and standards compliances came third with 50%.

Other characteristics were added by the participants such as vendor's reputation, pricing of services, ease of use and deployment, and the effectiveness of the offered solutions.

The responses showed that 49% of the respondents using cloud services for non- mission critical process, and mission critical processes received up to 29%, some respondents prefer not to answer this question.

The responses provide an additional evidence of the capability of cloud services to reduce costs and convert the capital investment to low operational expenditures as shown in table 2.

Table 2: Computing Services IT Operational Expenditure

IT Operational Expenditure	Percentage %
1-25%	41
26-50%	32
51-75%	5
76-100%	2

Cloud computing services charged per usage on a flexible baseline, and some organizations still have some concerns related to service reliability, they prefer to use multiple service providers as a backup plan in case of service down, or regarding to pricing issues related to service deployment models which differ from vendors to another

Generally, the responses of the questionnaire survey and the experts' interviews shows a positive response towards moving the government processes and data to the cloud, especially with advances and development of the new I.T. based solutions in the private sector. In addition, adopting cloud computing services in the public sector could influence and increase the usage of those solutions in other sectors in order to provide better services to the public.

Although many barriers and concerns regarding the cloud adoption have been noticed and recorded, but there are many ways to overcome these issues, and there are many successful solutions exist have been implemented already by the private sector.

Cloud computing adoption main drivers and barriers were reviewed within the survey and confirmed by the experts' opinions within the interviews, which will be considered in developing the proposed framework.

The analysis of the collected data shows that there are some issues related to the compliance to various standards legal regulations. While some service providers make it the customer responsibility, others started to have their services certified and meet international standards by annual audit checks.

Public systems are usually a target for various security breaches due to the high value and sensitive nature of the information handled by such systems. Hence, developing a set of security and privacy mechanisms has become high priority need in order to ensure the integrity, authenticity and confidentiality of the data collected and impose more strict control of such sensitive information discloser.

Most of the service providers promise to provide up to 99.9% of service availability in their service layer agreement. Both customers and providers made security on the top of their priorities. However, most of the service providers offering data integrity as an added value service and promote their security practices to satisfy customers' requirements.

3. Results and discussion

The proposed framework for adopting cloud computing technologies in the public sector is based on the analysis of the collected data through questionnaire survey which covered many I.T. industry professionals, and on the findings from the in-depth interviews with experts and service providers. The implementation of the framework strategy comprises of five phases as illustrated in the figure 1.

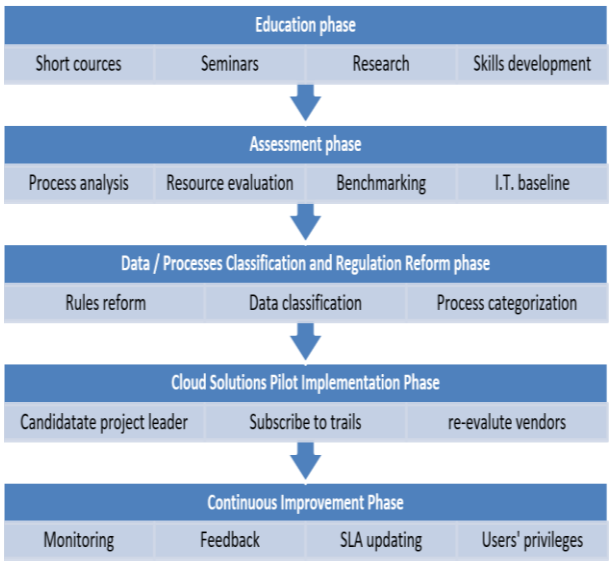


Fig. 1: Proposed Conceptual Framework.

3.1. Education phase

The framework strategy of Cloud adoption starts with educating people about Cloud Computing technologies. This could be implemented through seminars, short focused courses, and reading. It is very important in any technology transformation to educate people who are working in or outside government organizations such as agency executives, personnel, and lawmakers. Government should work with the private sector to educate employee on how to deal with SaaS to make sure that the data is stored and handled correctly. It will be important to devote funding for research to establish the feasibility of cloud computing adoption in different areas at all levels of government.

Training the institutions' (IT and non I.T.) staff to get better understanding regarding the new adopted system is an important success factor to ground and audit policy and practices in regard to governmental use of Cloud Computing services. It is also an added value to the staff to develop and customize applications hosted by the Clouds.

In the Service Layer Agreement (SLA) the cloud vendors should be asked to provide the required training and sufficient information to end users regarding how to work with the cloud based solutions, to ensure that the employee are familiar to work with the new adopted system. Finally, fostering the development of new skills is highly required in order to take the maximum advantages from opportunities afforded by the Cloud Computing technologies.

3.2. Assessment phase

When an organization wants to adopt cloud computing solutions in its processes, it should investigate and analyse the management processes and other supporting processes concerning the growth and existing I.T. infrastructure in order to reduce the constraints of the system design. Lack of common standards, established guidelines and business patterns are among the major hindrances to support this analysis or provide an effective way to modify the procedures in order to adopt cloud based solutions. Nevertheless, organizations could rely on existing best practices and strive to achieve them.

Benchmarking assist to evaluate the current work with the existing best practices. It may serve as a tested pattern for an organization to change its processes for effective cloud adoption. A detailed description of benchmarked practices could be added to the repository in order to refer them for future use. Organizations could use a collection of best practices from several enterprises that suit its specific case.

The aim of the assessment phase is to create a set of checklists about the organization readiness to adopt cloud computing. It is essential to perform an assessment of the current technological infrastructure in terms of the core cloud computing requirements that include compute, storage and network. The assessment must include the capacity for their internally hosted operations in terms of their availability and resource requirements. It will assist them to decide if they really need to host computing resources in premise or to contract cloud vendors to manage services on their behalf in order to meet the ever-increasing and highly scalable infrastructure demands.

More assessments are required to evaluate the organization ability to meet the international security standards regarding the organization physical building location. Another assessment is required to determine the recommended internet speed connection based on the number of connected PCs in the organization LAN and a reliable Internet Service Providers (ISPs) as well.

Cloud computing vendors should be evaluated based on their pricing model, service reliability, reputation, previous experience, disaster recovery plans, security practices, legal and regulations compliances, and the guarantees given in the Service Layer Agreement (SLA). All these characteristics to be considered in selecting the most proper cloud vendor, for example, purchasing some services form one vendor and other services from others such as selecting salesforce.com services for Customer Relationship Management (CRM) applications and Windows Azure platform for software development.

Finally, analysis of the organization business goals and objectives to be performed in order to evaluate the need to adopt cloud-based solutions, the analysis should be based on both organization business strategy and technical aspect to ensure the Return on Invest (ROI) for the long term aspect.

3.3. Data/processes classification and regulation reform phase

In order to migrate to the clouds, organizations have to classify their own data based on their sensitivity and the applied regulations and rules. As well as the processes need to be categorized in two main groups: mission critical process and non-mission critical processes. These categories should be based on many critical factors such as service functionality, uptime, security, and volume of data. The processes/ data classification phase would help to identify the services that need to be deployed locally using private clouds and other services that may be transferred to the public clouds. This phase is suggested and recommended by the experts during the in-depth interviews sessions. It also based on the analysis of the questionnaire results.

In recent study by Hemsoth [10] predicts that by the 2020 there will be only 10 percent of the applications hosted locally using private clouds, and the remaining applications to be hosted by the public clouds. This figure varies depending on the nature of the organization and its services categorization; it is not a target figure. However, dealing with the government data needs to be retained for long period of time and to be accessible. The government should reform the privacy rules and regulations to be updated in order to deal with the shifting from paper based processes to electronic-based data that exist in databases.

Therefore, current rules and regulations have to be modified following a strong leadership in order to overcome possible issues of interoperability such as identifying and separating administrative units that are responsible of data access and handling. The main purpose of such reform is to provide professional and special provisioning services that create an efficient administration with holistic view of the whole developed system.

3.4. Cloud solutions pilot implementation phase

Graphs and other numbered figures should appear throughout the text as close to their mention as possible. Figures shouldn't infringe upon the page borders.

After the data/process categorization phase, it is clear which services to be moved and hosted by the clouds and other critical pro-

cesses and sensitive data to be hosted locally. It is recommended to migrate to the public clouds starting with old services to save costs of software/hardware maintenance, security, and relicensing.
A well-managed pilot project with clear objectives and valuable results can provide the clarity needed from the stakeholders.
In order to achieve a successful implementation of cloud pilot, it is highly recommended to candidate a senior I.T. manager to lead the project.
The project leader should have sufficient understanding regarding the organization strategic business goals and technical context of organization operations. The project leader should have the ability to understand stakeholders' concerns, lead the meetings, and communicate effectively.
The pilot project aims to provide more practical experience and valuable knowledge. It also provides a proof of the cloud ability to overcome the security, networking, and reliability concerns and can be implemented without massive rework.
The pilot project can be implemented by subscribing to trail version of cloud services in order to detect any required corrective actions and to evaluate the quality of vendor's services.

3.5. Continuous improvement phase

This is the final phase, where the organization keeps moving data and processes to the public cloud or to the in-house private clouds depending on the data/process sensitivity. This moving process would encourage more government agencies to adopt the cloud computing solutions. More improvement can be achieved through setting up users' privileges to access or modify data, and the type of the applications to be accessed.
In addition, Service Layer Agreement (SLA) should be updated regularly to ensure the standards and regulations compliance. Organization should keep tracking the usage rates to ensure charges not exceeding the funded amounts.
Finally, Cloud Computing service providers should be re-evaluated periodically in order to ensure business agility and processes efficiency. This can be achieved using performance monitoring application and the feedback from both employee and citizens. Organization should hold competitive bids for cloud services on constant periods.

4. Conclusion

Following a clear framework strategy steps towards adopting cloud computing services in the governmental organization is one of the critical success factors to enhance the efficiency of the e-Government processes. The proposed framework requires a high level of collaboration among customers (government organization) and service providers during the implementation of all the strategy phases, and cannot be overstated. Adopting cloud solutions in the governmental organizations would improve the communication and interaction among governmental agencies and citizens. The proposed cloud adoption framework strategy will transform not only the government I.T. infrastructures, but IT in the private sector as well.

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