

Exploring Cloud Computing Adoptions in Public Sectors: A Case Study

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Abstract—Despite the number of benefits cloud computing technology has to offer all organizations, both public and private, risk elements to consider still remain. Previously, these elements were used in evaluating if an organization would move towards the cloud or not. Today, it is no longer a question of if, but a question of when. The task of evaluating the benefits and risks is now part of the gap analysis used to determine which vendor to contract with. In the public sector, government entities face a different set of rules and higher scrutiny when it comes to data security and budgeting. By evaluating what steps early adopters have taken in their investigation and analysis processes prior to choosing a vendor, this paper explores the essential information about cloud computing adoptions in public sectors and provides some guidelines that governments can use in their decision making process when considering cloud services.

Index Terms—Cloud Computing, Public Sectors, e-government

I. INTRODUCTION

Cloud computing represents a change in the way organizations do business with regards to technology. It provides flexibility and cost savings to an organization in that they no longer need to invest large amounts of capital to get a software project up and running.

Cloud computing is adopted based on the essential characteristics of the cloud deployment models and the cloud delivery models. The delivery models include Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). IaaS allows consumers the ability to deploy and maintain their software and operating systems using equipment housed at the provider's site. Consumers also have the ability control select networking elements. This eliminates the need for the consumer to purchase and maintain the equipment that runs their applications. In the PaaS model the hardware and operating systems are housed and maintained at the service provider's site while the consumer controls their deployed applications. This allows consumers the ability to develop and test new software applications without investing a large amount of capital for the hardware to run those applications. In the SaaS model, consumers access applications through a web environment. The service provider houses and manages the entire system and related software. Because the application is hosted, there is often

nothing to install on the local machine thus alleviating the burden of maintaining the software the consumer would otherwise face. Web-based email is an example of SaaS. This paper will focus on the Software as a Service (SaaS) model which has been referred to as the core of cloud computing [1].

Cloud computing is an emerging business and technology concept to support an on-demand delivery of computing, storage and applications over the Internet. A recent IDC report shows global revenue in cloud software market reaching \$22.9 billion and it will grow to \$67.3 billion in 2016 [2]. This projection includes revenue generated by the shift from on-premise to on-demand providers as well as by the planning and architecture behind the shift. Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of applications and resources.

As high-speed internet has become more accessible to organizations, cloud models have helped organizations with limited IT resources take advantage of technology to improve business processes. Typically, an organization would rent licenses or access the software from an application service provider (ASP) that actually runs on servers or devices owned and maintained by the ASP. These large datacenter facilities with redundant layers of power and data security are often too expensive for many organizations to have under the on-premise model. Also, the ASP is generally responsible for maintaining and updating the software, and often includes some level of support for users in the monthly fee. This model has certain benefits for organizations that can attenuate some of the problems associated with maintaining purchased software in-house. For example, SaaS allows ASP to maintain their offerings consistently by automating testing, monitoring, maintenance and upgrades without sending out constant updates that need to be applied by end users. Also, SaaS allows smaller organizations with limited (or no) IT staff to benefit from the economies of scale and efficiencies implemented by the ASP. Equally important, SaaS allows organizations to pay to use the software they need, without making a huge investment in IT infrastructure for servers, software, etc., by "renting" access to what they need and paying monthly, quarterly or annually.

As the benefits become too remarkable to ignore and the shortcomings are worked out as the technology evolves, current literature focuses on how organizations, both public and private, can take advantage of what the cloud has to offer through case study analysis and predictions for the future of cloud computing. In early 2011, realizing that the federal IT budget could be reduced drastically by utilizing cloud computing, the U.S. Chief Information Officer, Vivek Kundra, released his “Federal Cloud Computing Strategy” report which discussed the newly implemented “Cloud First” policy. This policy requires federal agencies to “evaluate safe, secure cloud computing options before making any new investments [3]. The strategy sped up the process of federal government agencies moving toward the cloud, thus provided researchers many case study opportunities [4],[5] [6]. Many of the cloud case studies that have been previously published are reviews of what the organizations have implemented and how they have been benefited. The case study literature lacks in reviewing the steps taken in the analysis and investigation stage of the process, prior to choosing a vendor. This paper aims to fill that gap.

II. LITERATURE REVIEW

Cloud computing is an emerging business and technology concept to support an on-demand delivery of services over the Internet. Governments, who are planning to implement e-government strategies, have begun to adopt cloud computing technologies in their IT systems. According to the report from Federal Chief Information Officer [5], more than 24 government departments and state government agencies in United States adopted cloud computing solutions in various IT services. Paquette et al. [7] summarize four sections of current adoption of cloud computing technology by the United States federal government as following:

1. Early Use: the early adoption of cloud computing starts from informal use of personal applications, such as instant message and portal services by government employees, agencies, departments, and contractors. At this stage, government is trying to define the cloud computing technologies in public sector environment and identify the essential characteristics of the cloud computing applications [6].
2. Formal, strategic direction: IT directors at different government levels realize the benefits of cloud computing and try to explore cloud computing as a strategic component in government transformation. President Obama [8] emphasized the adoption of cloud computing by the Federal IT for a more transparent government to the public, advanced technology of government IT, and a better innovation environment.
3. Current applications for information sharing: today, cloud computing applications adopted by public sectors are more focused on information sharing and communications, such as using YouTube hosting services and mobile cloud services.

4. Applications and information processing: recently, the federal government is attempting to utilize cloud computing applications in data/information processing rather than just data storage or data sharing. For example, The Air Force is a 3-D virtual recruiting and training application on cloud [9].

Government acceptance of cloud computing has been growing fast. Wyld [6] lists 10 benefits of cloud computing on e-government, such as rapid scalability, low maintenance/upgrades cost, improved resource utilization, improved economies of scale, improved collaboration capabilities, usage-based pricing, reduced IT infrastructure needs,, computational power, green-friendly factor, and improved disaster recovery capabilities. Pokharel and Park [10] also identify “Expertise” as one of the benefits of cloud computing on e-government. At the same time when we talk about the advantages of cloud computing on public sectors, there are researchers who concern the risks of the technology. Outage/Accessibility is rated one of the highest factors [11]. It is obvious that system outage is closely correlated with on-demand adoptions. After the outage issue of Microsoft Azure, CIOs realized the importance of system accessibility for on-demand solutions. Security is another emphasis concerned by several researchers in their studies of cloud computing [11], [7], [12].

Most of the current studies about cloud computing applications in e-government have been focused on benefits, concerns and challenges of cloud computing adopted by government. There are several studies emphasizing on architectures of cloud computing in e-government [13] and policy issues of cloud computing applications [14]. However, relatively little research attention has been given to the early stage of cloud computing adoption by public sectors, such as assessment and planning processes. This study seeks to provide a better understanding of system analysis and selection during the early age of cloud computing adoption for public sectors.

III. RESEARCH METHODOLOGY

Carr et al [15] propose a useful system adoption model for a successful Information System. They advocate a four-step process which is designed to assess the present position, decide on an appropriate change process, establish a sound theoretical framework for the change and ensure that aims are shared and personnel are involved and committed. This is achieved through the stages of:

- Assessment: justification, objectives and broad characteristics.
- Planning: the entire change process is laid down.
- Action: commitment, dissemination, training, change.
- Renewal: monitoring, feedback and evaluation.

In this study, we believe the first phase is extremely useful to explain and guide what we need to complete in system analysis and selection of cloud computing for public sectors.

In *Assessment phase*, for the manager, the change process begins when questions are asked about what the originators of the proposal actually want to do. At this stage, no one is looking for answers to all of the questions, and the process should not begin with consideration of the change itself. It begins with a general review of the organization, and it is relevant to organizational health, which is itself to do with motivation. Starting with examining motives, managers should identify both positive and negative reasons for introducing change by asking all kinds of questions related to the change, such as what are the desired outcomes? What are the problems? How does the project fit with the strategy of the organization? What is the likely effect on the organization? What is to be the role of the manager? The organization has to investigate the details of the proposed change:

- Identify what changes are required
- Analyze changes
- Identify resources required

In the case study analysis in section V, we will adopt this model to discuss and identify the issues and challenges during the cloud computing adoption processes in the two case studies in section IV.

IV. CASE DESCRIPTION

Case study is a qualitative and descriptive research method to explore issues and factors from an individual or small participants and draw conclusions only about that participants or group in that specific context [16]. This method is an ideal methodology when a new concept or system needs holistic and in-depth investigation [17]. It has been proven a useful research tool in investigating system adoption studies [18], [19]. Therefore, in this study, we use case study method to identify important factors during cloud computing adoption processes in public sectors from the following two cases.

A. *The City and County of San Francisco*

1) *Background*

The City and County of San Francisco, CA was established by charter in 1850 and is the only legal subdivision in the State of California with the governmental powers of both a city and a county. A Board of Supervisors exercises the City's legislative power and the Mayor exercises the executive power (Rosenfield, 2011). In 2008, the Citywide IT Plan: Current State Assessment for the City and County of San Francisco reported that the City consisted of more than 50 departments in addition to other organizations. It also reported that the city had seen a movement away from a central IT shop with a number of departments maintaining their own IT staff. In addition to the complex technology organizational structure, the city had a complex technology governance structure as well with a Committee on Information Technology (COIT) made up of 11 members and 4 subcommittees made up of 37 members, charged with providing the necessary technology policy, procedures, and oversight to ensure that the City meets its goals and objectives.

2) *Feasibility/Strategic Email Study*

The 2008 COIT Email Policy stated that the Department of Technology and Information Services (DT) was in charge of managing all email systems with the exception of the City Attorney's Office. Six other departments were noted as maintaining their own e-mail systems. Following the adoption of the email policy, the city began a Citywide Strategic E-Mail Study with three goals: (1) confirm the City policy of single e-mail standard, (2) determine which City entity should manage the central system and (3) select a single standard. At the time the city email setup consisted of a mix of Microsoft Exchange and IBM Lotus Notes email systems. The citywide email options outlined in the study consisted of:

- maintain the current hybrid approach
- migrate all departments to Lotus Notes
- migrate all departments to Microsoft Exchange
- migrate all departments to a hosted solution

The hosted solution was listed as a future option. After reviewing the study, the COIT Director stressed that the fundamental issue at hand was whether there should be a single citywide email system or whether departments should be allowed to use independent email systems. The City CIO asked the Architecture and Standards Sub-Committee (ASSC) to make recommendations for the city's e-mail platform based on the four options listed above.

3) *Investigation*

The Citywide Strategic E-Mail Study provided the City with four email options to choose from, one of them being to continue operating as they had in the past. In order to make a recommendation to the COIT the ASSC had to develop system functional requirements and a performance metrics. To accomplish this, the Committee sent out an e-mail requirements survey to all the city departments. Based on the responses of 16 departments, representing approximately 15,000 users, the ASSC developed a list of tentative requirements on each of the survey items. They then compared the list of recommendations to the offerings of the potential service providers, IBM and Microsoft. The combined results indicated that there were not many functional differences between the competing vendors. The ASSC also developed an Email Evaluation Metrics based on the survey responses. The Metrics showed that, on average, the ability of the selected email systems to meet the functional requirements was most important, followed by the ability to meet the service requirements, annual costs and finally start-up costs. The ASSC then proceeded to obtain cost estimates for the following options: (1) Lotus Notes maintained by the City; (2) Lotus Notes hosted by IBM; (3) Microsoft Exchange maintained by the City; (4) exchange hosted by Microsoft and (5) Google's enterprise email system hosted by Google. Initial cost analysis indicated that the hybrid environment was the most expensive option. Cost analysis for the Google option was not presented at that time.

4) *Recommendations*

Based on their overall analysis, the ASSC provided the following recommendation to the COIT:

- All City Departments should be on one e-mail platform

- The platform should be managed by a central entity

At the following meeting on February 25, 2009, after watching presentations delivered by IBM and Microsoft and detailed discussions of both systems, the ASSC unanimously voted in favor of recommending a hosted Microsoft Exchange system. The sub-committee members’ average ranking for each option is located below in Table 1.

Table 1. Committee Rankings
Committee Rankings (ASSC, 2009e)

	Lotus Notes		Exchange		Current
	On-Prem	Hosted	On Prem	Hosted	Hybrid
Arch SC Member Group average	3.5	3.1	2.8	1	

Following that recommendation, the COIT determined that “within the next 2 years, general and non-general fund departments (will) move to a hosted Exchange solution (COIT, 2009b).” In a February 2010 meeting the justification for choosing Microsoft was explained by the Acting City CIO, Jon Walton in response to questions from the public Analysis

Once the decision had been made to go with a hosted Exchange solution, the focus switched to a needs analysis in an effort to decide who would host the system. In November, 2009, the ASSC decided to request a quote for consulting services that would provide the email technical business requirements necessary to construct the Request for Proposal (RFP) for the new hosted exchange systems. The basic scope of the project was defined to include email only for approximately 22,000 users with 25GB of space per box and needed to include training and current mailbox conversion. They had specifically decided against any advanced collaboration feature as in LA Google Deal.

In the requirements and gathering stage, the COIT worked closely with the staff that managed the behind the scenes technical requirements on email in order to get their input. They wanted to make sure that email administrator understood what systems they were getting or giving up. The COIT also decided to create a pilot program that the Police Department would be a part of in order to identify security issues. The goal was to have the pilot program for the conversion up and running by the end of the fiscal year. The Police Department was later pulled out of the pilot and replaced by the Department of Technology.

5) *Hosting*

In a March 2010 meeting, a proposal was made to have the Airport host the citywide email system creating a Center of Excellence. The following arguments were made in favor of this proposal:

- Quicker implementation in that they could avoid the RFP Process and start immediately
- Reduction in costs compared to outside vendors
- No consulting or professional services required

- High probability of success due to the fact that the Airport had previously migrated from Lotus to Exchange
- Existing investments in software and hardware protected

The following month, in analyzing the Airport Hosted option vs. the vendor Hosting option, the committee discussed the costs associated with each options as well as the capital involved. It was mentioned that many of their current systems had no recovery or refresh plans and that the aged equipment they were running had more downtime. The COIT Director also pointed out that one of the reasons a hosted model was considered was to get out of the business of owning equipment and licenses.

When comparing the two options side by side, the committee summarized that the Airport option relied more on in-house staff to implement the projects and had a large capital investment that required ongoing equipment replacement charges, while the vendor option relied more on professional services and had had a relatively constant cost over time. In addition, a side by side comparison of per mailbox cost indicated that the vendor option would be more cost effective over time. Industry standard was also considered noting that more governments are going with hosted vendor options.

Based on their analysis, the COIT decided to begin the RFP process in the search for a vendor hosted solution. The Airport was still able to compete in the RFP process.

After months of security testing and working with Microsoft to amend their standard agreement, the City and County of San Francisco announced on May 18, 2011 that they had signed a contract with Microsoft to host their Exchange solution.

B. *The City of Los Angeles*

1) *Background*

The City of Los Angeles, CA was established and incorporated in 1850 after California became a U.S. state. Since then, Los Angeles has become the second most populated city in the U.S. with a population of nearly 3.8 million according to the 2010 United States Census. The City of Los Angeles has 44 different departments, ranging from the police and fire departments to the department of transportation. The majority of department’s information technology services are maintained by the Information Technology Agency (ITA). The role of the ITA is to manage enterprise applications, infrastructure, telecommunications, and the e-mail system that is used across all departments.

2) *Feasibility*

The Information Technology Agency was in control of approximately 34,000 e-mail accounts spread across the 44 departments of the City of Los Angeles. The e-mail system that was being used was the GroupWise e-mail system. There was a general dissatisfaction among the majority of employees due to two main reasons: e-mail did not universally work on all devices and the e-mail inbox storage limit was too small. Employees were constantly peaking on their storage limit. A major factor contributing to the adoption of the new e-mail system for the City was their \$400 million deficit. Therefore, they decided to adopt a new system that met the following three goals: *Automation, Efficient, and Cost Effective.*

The ITA determined that the new system to be put in place would immediately replace the legacy system of between 17,000 and 30,000 user e-mail accounts. The only exclusion would be the Los Angeles Police Department (LAPD) for security reasons. The entire solution would be implemented across all departments, including the LAPD, several months after the initial implementation. The implementation would require the migration of all historical data (archive and backup) from the existing e-mail system. In 2009, the ITA worked with the Computer Sciences Corporation (CSC), a Nevada based corporation, to determine the best vendor that would fit the City of Los Angeles' needs.

3) *Investigation*

The City of Los Angeles used the GroupWise e-mail system across all departments. According to the Information Technology Agency, the system did not meet the needs of the majority of departments and employees. The system was not portable and universal between devices, the storage space was too small, there was minimal archiving and collaboration tools for employees to share documents, and no disaster recovery plan. The general dissatisfaction with the GroupWise e-mail system was the reason why the Information Technology Agency worked with the Computer Sciences Corporation to determine a new vendor for their City wide e-mail necessities. Because E-mail was vital to all departments of the City the ITA and CSC determined the following items would be taken into consideration when choosing a vendor: (1) Minimal training required; (2) Intuitiveness of the system; and (3) Ease-of-use.

As far as the technical aspects were concerned, the ITA and CSC determined that the requirements for the new platform would include the following: (1) Mobility, portability, and universal to all devices; (2) 25GB storage space; (3) Synchronization; (4) Delegation; (5) Collaboration; (6) Remote access; (7) Disaster recovery; (8) Archiving.

The ITA and CSC compared and contrasted three different platforms for their project. They looked at their current system's vendor (Novell GroupWise), Google, and Microsoft.

4) *Analysis and Recommendations*

The ITA and CSC decided on the platform Google Apps due to its perfect fit with the scope of the project and the cost effectiveness of the application compared to its competitors. This was one of the main concerns since the City is already in a \$400 million deficit. Google Apps could provide all of the implementation and technical requirements while also fulfilling the scope requirement of 34,000 accounts. Google Apps provides an e-mail client with 25GB storage, file sharing services with shared documents and editing, video chat, mobility, archiving and disaster recovery/backup systems, and is portable to all devices.

Google offered different pricing structures for the Google Apps implementation. There were two options in each structure: the number of accounts (17,000 or 30,000) and whether email-archive migration was or was not included in the implementation.

The ITA estimated that the overall cost savings for the five year contract would be \$5.5 million and the project will have an ROI of upwards of \$20 million. Between 65% and 80% of

all of the City of Los Angeles' employees would have their technical productivity needs met solely by Google Apps.

V. DISCUSSION

Following by Carr et al.'s model [15], in the Assessment phase, both cities went through all the processes. They identified changes (new system to solve current dilemma), analyzed those changes, and identified the resources they need for the changes, such as budget for each alternative solutions. Table 2 summarizes the processes for both cities.

Table 2. Summary of Processes in Assessment Phase

Process	The City of San Francisco	The City of Los Angeles
Identify changes	Need a new email system based on the three goals of Citywide strategy: (1) confirm the City policy of single e-mail standard, (2) determine which City entity should manage the central system and (3) select a single standard	Need a new email system to meet three goals: <i>Automation, Efficient, and Cost Effective</i>
Analyze changes	Analyze the four options: <ul style="list-style-type: none"> • maintain the current hybrid approach • migrate all departments to Lotus Notes • migrate all departments to Microsoft Exchange • migrate all departments to a hosted solution Then, analyze the two options of hosting: Airport Vs. vendor hosting	Analyze the three options of platforms: current system's vendor (Novell GroupWise), Google, and Microsoft
Identify resources	Estimate the budget	Estimate the budget

Additionally, we found several interesting issues in the two cases. First, when we compare the two cases, though both of the adoptions are successful, we found a critical difference between them. With 50 departments and 22,000 users, city of San Francisco spent about 3 years before their final decision of vendor selection while city of Los Angeles, with 44 departments and 34,000 users, only spend about a year in decision making. We compared the steps each city completed and found that San Francisco had three more steps: 1. Vote for hosting system between IBM and Microsoft; 2. Develop a pilot program for Police Department; 3. Propose Airport hosting systems competing with vendor hosting systems. Besides the three extra steps, San Francisco also spent longer time on the following steps: 1. analyzing system functional requirements and cost metrics; 2. requesting a quote for consulting services; 3. analyzing the options between Airport and vendor hosting.

Second, many of the differences between the two cases can be linked to cultural differences between the two governmental entities. San Francisco did not have a centralized IT shop at the time of the study; conversely, the city of Los Angeles has an Information Technology Agency to centralize the IT solutions for each department at an enterprise level. Though not enough information is available to assert this claim, the researchers believe that this distinction affected the selection of vendors within the two entities. A collection of decentralized IT sub-departments within San Francisco's many departments would be difficult to coordinate for the successful completion of this system. This could be one of the reasons to explain why San Francisco spent about 3 years to complete the Assessment phase before they actually signed the contract with Microsoft.

Third, when selecting solutions, the City of Los Angeles focused more on cost as a priority. Therefore, they quickly worked with CSC and finalized the best solutions they needed. However, in San Francisco case, the city didn't develop a clear vision at the beginning, so they struggled with the initial four options first, then they came out another options, airport vs. vendor hosting, when they finally decided to go with a single host system. This considerably slowed their processes. This could be another reason to explain the lengthy adoption of San Francisco.

VI. CONCLUSIONS

In past decade, cloud computing has gradually change software infrastructure, services and business models running on the Internet by providing much lower initial cost and extremely supportive data storage and processing functions. This technology attracts all types of organizations, including public sectors, to adoption on-demand solutions in daily business processes. This study analyzed two cases of public sectors, who adopted cloud computing email systems successfully. First, from the project management perspective, all the steps that the two cities completed during cloud computing adoptions are corresponding to the processes proposed by Carr et al.'s model [15]. Therefore, we believe that the Assessment phase is very useful to guide public sectors when they are adopting any cloud computing systems. Second, after comparing the two cases, we found out several key factors that may impact the speed of the system adoption during the Assessment phase, such as centralized IT control, and clear vision. Third, simplifying the processes by reducing the steps or shorten each step in Assessment phase will save much time during the adoption project.

This study has implications for both the research and practice of cloud computing adoption in public sectors. Researchers could use these results to expand valid indicators of successful cloud computing adoptions in their empirical studies. Professionals, such as IT managers, project managers in public sectors, could use the results in their decision making during the cloud computing adoption projects. Vendors and consultants of cloud computing services could offer more effective services for their clients in the system adoption projects.

In the future, we will study more cases and summarize more key factors before we can generalize any theme to enrich the research foundation in this area.

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