

Open Source Software Use in Municipal Government: Is full immersion possible?

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Abstract— The adoption of open source software (OSS) by government has been a topic of interest in recent years. National, regional, and local government are using OSS in increasing numbers, yet the adoption rate is still very low. This study considers if it is possible from an organizational perspective for small to medium-sized cities to provide services and conduct business using only open source software (OSS). We examine characteristics of municipal government that may influence the adoption of OSS for the delivery of services and to conduct city business. Three characteristics are considered to develop an understanding of city behavior with respect to OSS: capability, discipline, and cultural affinity. Each of these general characteristics contributes to the successful adoption and deployment of OSS by cities. Our goal was to determine the organizational characteristics that promote the adoption of OSS. We conducted a survey to support this study resulting in 3316 responses representing 1286 cities in the United States and Canada. We found most cities do not have the requisite characteristics to successfully adopt OSS on a comprehensive scale and most cities not currently using OSS have not future plans for OSS.

Index Terms—City Government, Municipal Government, Open Source Software.

I. INTRODUCTION

All city governments seek to deliver services in the most efficient manner possible. Whether in direct support of service delivery or support of conducting the business of government, Information Technology (IT) has become and integral component of operations at all levels of government.

In the past 5 years there has been a trend by some national, regional, and local governments toward use of open source software (OSS) and open standards as a first choice rather than a curiosity. Recently, The Netherlands has mandated that all national government agencies will use open standards formatted documents by April 2009 [1]. The U.S. Navy has clarified the category and status of OSS to promote a wider use of OSS to provide seamless access to critical information [2]. Congress is recognizing the potential value of OSS in the National Defense Authorization Act for fiscal year 2009. OSS is identified as an objective in the procurement strategy for common ground stations and payloads for manned and unmanned aerial vehicles, and in the development of technology-neutral

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information technology guidelines for the Department of Defense and Department of Veteran Affairs.

Small to medium size cities, populations less than 500,000 [3], may have serious limitations in funding IT efforts. Escalating costs of service delivery coupled with reduce revenue will force governments to seek novel ways to reduce operating costs. With limited revenue their budgets seem to force cities to underfund IT infrastructure in favor of applying resources to increasing labor requirements to deliver services. Careful and deliberate selection of IT solutions can reduce the labor required for service delivery freeing that labor to be harvested for other purposes.

Considerable research has been conducted on the topic of e-government and the development of models to explain e-government maturity. There have also been ample studies of the trends in adoption of OSS by government at various levels. However, little research has been done in the characteristics of regional and local government that would promote adoption and successful deployment of OSS.

The support of city leadership and management as well as the IT staff, are required for successful adoption of any technology, not just OSS. Vision, strategy and government support are important for success of IT projects, while insufficient funding and poor infrastructure are major factors for failure [4].

This research focused on the perspectives of city leadership, management, and IT staff with respect to OSS and its adoption by city government. While OSS was the focus, the approach used in this study can be applied to investigating the adoption of most technologies or practices.

A. Related Research

The literature review revealed little research with similar characteristics of this study. While much work can be found on OSS in a wide variety of topics, the body of research covering municipal OSS adoption is relatively limited. Of the literature found relating to OSS adoption by government, a significant portion of that work examines the adoption of OSS by developing countries.

A fair number of studies have been conducted to examine the extent to which government entities are using OSS. The studies tend to collect, categorize, and report the current state of open source adoption [5],[6]. A study of Finnish municipalities [7] had a methodology similar to the methodology used in this study. While the Finnish study considered only IT managers as survey subjects, our survey considered city leaders, managers, and IT staff for subjects, as our focus is examining organizational behavioral influences on OSS adoption rather than technical and budgetary influences.

Government policies regarding open standards may

influence the rate of OSS adoption. An open standards policy requires a knowledgeable and committed support base [8]. Adopting open standards can help reduce vendor "lock-in" as, in the case of document formats, open standards provides increased application/product choice, while proprietary standards is a limiting factor reducing product choice.

In the current economic climate government at all levels are facing funding crises as costs of operations increase and revenue decreases. The question of what can be done to reduce IT operating costs is now a very important one. There are more benefits to using OSS than just reduced acquisition costs [9]. Restrictive licensing, vendor lock-in, and high switching costs can be eliminated, which, in the long term, also may reduce costs.

B. OSS, CSS, and COSS

The basic difference between OSS and closed source software (CSS) is source code is provided with OSS. Commercial open source software (COSS) is commercial software, which the developer provides the source code under an open source license. For closed source software, usually commercial software, the source code is considered proprietary intellectual property, which the developer must protect to establish or maintain a competitive advantage.

OSS gives users the right to use, revise, change, and improve the software to suit their needs [10]. However, OSS is increasingly becoming feature rich and operationally stable, so much so that the primary advantage is that it is free to acquire. Although users can modify OSS if they choose, it is not necessary in order to benefit from OSS.

OSS may also be commercial software, generally referred to as commercial open source software. Many companies have undertaken strategies to capitalize on the open source movement [11]. While some COSS is made available under the same license models as OSS, many COSS products have restrictions on its use and distribution. Some COSS severely limits the capability of the free version requiring users to purchase an enhanced version of the software or add-on features to experience the full capability of the product.

C. User Knowledge

The level of knowledge of a user with respect to OSS and CSS will influence their decision to use OSS.

There are two topologies of consumers: a) "informed" users, i.e. those who know about the existence of both CSS and OSS and make their adoption decision by comparing the utility given by each alternative, and b) "uninformed" users, i.e. those who ignore the existence of OSS and therefore when making their adoption decision consider only the closed source software [12].

We can apply this observation to municipal organizations. The informed municipal organization, which knows about the existence of open-source alternatives to commercial products, may make adoption decisions based on the value provided by each. The uninformed organization either ignores the existence of open-source alternatives or is unaware of OSS alternatives to commercial products. The uninformed organization may have misperceptions of OSS. These misperceptions may include OSS usability, deployment, and support. A common misperception is that an organization must have a programmer on staff in order to

deploy and maintain OSS. While in the distant past within the open source era, that may have been true, the current maturity of most open source applications may require only a competent IT technician.

D. OSS Adoption and Technology Transformation

The adoption of OSS by municipal government is a technology transformation problem. Technology transformation is not about the technology, but the organization adopting the technology, in this case city governments. Implementation of technologies to support government efforts in its self does not guarantee success [13]. Organizations must change to embrace the new technologies in order to use them effectively [14]. E-Government cannot be achieved by just simply implementing available software [15]. Fundamental differences between the public and private sectors influence the rate at which ICT is employed [16]. The real opportunity is to use IT to help create fundamental improvement in the efficiency, convenience and quality of service [17]. Adopting new or different technology requires an organization to change, with varying degree, at all levels. An organization with a culture that embraces change will be more successful at adopting new technologies than an organization with a strong status quo bias.

Government organizations are not that different from private sector organizations, as they are essentially comprised of similar people and resources [18]. However, the fundamental difference between the public sector and the private sector is the customer. Providing a service or product to the customer at a profit drives the private sector. The public sector is not driven by profit to implement a service, but by directive or law, which sometimes places no requirement on quality of the service, only, that the service is implemented.

II. RESEARCH GOALS

Our approach in this study was to focus on organizational characteristics required to promote OSS adoption instead of OSS as technology needing to be implemented. One fundamental question ultimately coalesced; is it possible for small to medium cities to use only OSS to deliver services and conduct city business? This is not a question of technical feasibility or product availability, but one of organizational characteristics. If we assume OSS products exist in the application domains city government requires for IT operations, then successful adoption and deployment becomes an organizational behavior issue.

Three general domains of interest evolved from the core question; capability, discipline, and cultural affinity. Having the capability to deploy and manage information technology was deemed very important for a city to successfully deploy OSS technologies. A city that has a mature management structure in place that demonstrates forethought in planning and a deliberate approach to budgeting and acquisition will have the level of discipline to deploy OSS on a comprehensive scale. Cultural affinity we define as the predisposition toward or against the use of OSS. The awareness, support, and understanding of OSS by key city personnel (leadership, management, and IT Staff) will

influence a city's affinity toward the use of OSS. From these domains we developed additional questions to guide this research effort; Do cities have the necessary organizational characteristics to adopt and use only OSS to deliver services and conduct city business? What are the basic IT capabilities of cities? Do these capabilities support the adoption and deployment of open source technologies? Do cities plan and budget for IT in a deliberate manner that would support the adoption and deployment of open source technologies? Does the organizational culture of cities promote the adoption of open source technologies?

III. METHODOLOGY

The following sections describe the methodology used for this study. We begin by describing in general the process, followed by the survey design, survey execution, and subject selection.

A survey was conducted to collect data from municipal IT managers, IT staff, city leadership, city management, and city employees. The survey was administered online using SurveyMonkey.com. The collection period was initially scheduled for 30 days from June 1, 2008 through June 30, 2008.

The survey required soliciting responses from subjects to provide insight into the characteristics of their cities with respect to IT capability, organizational discipline, and cultural affinity to OSS. Presenting direct questions would not produce useful data, as subjects may not have the requisite knowledge in the subject areas. One goal in the design of the survey was to reduce the number of aborted attempts by subjects. An aborted attempt is the failure to complete the survey once started.

We identified 6 subject classifications; IT Manager, IT Staff, City Leadership, City Management, City Employee, Other. These classifications were used to tailor the set of questions presented to the subject to keep the set within the knowledge domain of the subject. All survey questions were framed in the context of the subject and their perception of their city. This was an important aspect of the design as the survey questions solicit information that indirectly relates to the research questions.

The survey was divided into four sections. The first three sections address in three interest domains; capability, discipline, and cultural affinity. The fourth section solicited demographic information.

The first section of the survey collected data regarding city IT capability addressing the capability dimension characteristic of cities. The second section solicited responses related to the city's IT strategy addressing the discipline dimension characteristic of cities. The third section solicited responses related to the subject's perspectives and opinions about IT and OSS and the subject's impression of the city leadership, management, and IT staff's perspectives of IT and OSS. These questions were intended to reveal the city's cultural affinity to the adoption of OSS.

IV. SURVEY EXECUTION

For the announcement strategy we used three channels to contact potential subjects; magazines related to city

management, municipal associations, and direct e-mail.

A. Magazines

Announcing the survey through a magazine was deemed to have potential for generating significant level of exposure for those subjects who are more likely to read city government related magazines. Several magazines were contacted for assistance to announce the survey. Two magazines responded, the Next American City Magazine and American City and County Magazine. The Next American City magazine provided a half page ad space to announce this survey. American City and County Magazine announced the survey in an article posted on the front page of its website.

Although the potential exposure was thought to be high, the magazine announcement channel only produced 20 responses of which only one response was valid for analysis.

B. Municipal Associations

Municipal associations were thought to be the best vehicle for reaching the largest number of subjects. The rationale behind this was the assumption that individuals affiliated with municipal associations might be more inclined to respond to a survey announcement received from their association. The expectation was that the greatest number of responses would result from municipal associations. Individuals affiliated with municipal associations may also have greater interest in supporting this research as they may see a potential benefit for their city.

A total of 116 municipal associations were contacted to assist with announcing the survey to their members, 28 associations approved the request for assistance and forwarded the announcement to their members.

The municipal associations were identified via a search of the Internet. Most of the associations found were regional providing representation within a county, multi-county, state, or multi-state area. Each municipal association was sent an initial survey announcement with a reminder sent within seven days of the initial announcement.

We received 207 responses from subjects indicating they learned of the survey through a municipal association.

C. Direct Email to City Personnel

To reach the greatest number of potential subjects a direct e-mail approach was also used. To announce the survey Direct e-mail has proven to be a very effective and economical means of reaching the greatest number of survey subjects [19].

Individuals were contacted via email addresses harvested from municipal websites. A commercial email-harvesting program, Email Spider (www.gsa-online.de), was used to collect the municipal email addresses.

The collection process harvested over 80,000 email addresses from the municipal websites. Invalid email addresses, those not associated with a city government domain name (i.e. yahoo.com, aol.com), were excluded to produce a set of 60,000 addresses to which the announcements were sent.

Survey announcements were emailed to the potential subjects over a two-week period. Reminder emails were sent within seven days of the initial announcements. Survey responses can be increased with a reminder email that

includes more than just a link to the survey [19]. With this in mind the reminder email included the original announcement text with an introductory paragraph explaining the email was a reminder.

D. D. Duration of Collection

The collection period defined in the research design was for one month running from June 1, 2008 through June 30, 2008. Toward the end of the collection period, between 18 and 25 June, the response activity maintained a significant level (an average of 143 per day) prompting this researcher to extend the collection period 15 days ending on July 15, 2008. Additionally, many automated email responses indicated the recipients were on vacation during the month of June. In the days following distribution of the initial survey announcement email and reminder emails increased response activity was observed. We anticipated response activity would increase during the first part of July as potential subjects returned from vacation. During the 15 day extended collection period 1443 responses were collected, 43.5% of the total responses.

V. SURVEY RESULTS

The total estimated exposures to the survey announcement were in excess of 60,000. An exposure for the purpose of this study is defined as the delivery of a survey announcement to a potential subject. Several factors prevent an accurate tally of total survey announcement exposures. We did not have access to the membership numbers for the municipal associations that forwarded the survey announcement or access to the web site page hit counts for the article on the magazine website.

Of the 60,000 emails sent directly to city leaders, managers, and employees, 53,900 may have reached the addressee. 6,100 of the original 60,000 email announcements were returned as undeliverable, a non-existent address, or reported by an email server as potential "spam".

A total of 3316 individuals responded to the survey announcement resulting in a response rate of 6%. There are 1286 distinct cities represented in this response set.

A sample set was created to include cases from cities with populations less than 300,000 and an indicated primary duty of IT Manager, IT staff, City Leader, or City Manager. While the survey data included responses from cities with populations greater than 300,000, those responses were too few in number to permit valid analysis. Responses from city

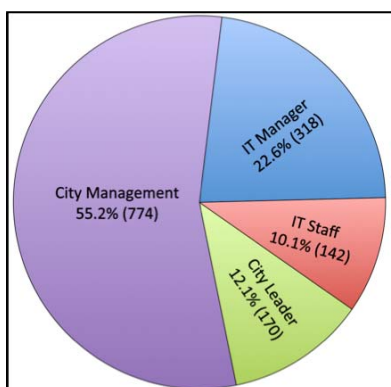


Figure 1. Response by Primary Duty

employees (not city leaders, managers, or IT staff) and individuals not affiliated with a city were excluded from the sample set used for analysis. The responses from city employees had very limited or no value as these subjects had little knowledge of city IT capability, strategy, or the views of the city leadership, management, and IT staff regarding OSS. These criteria produced a sample set of 1404 cases representing 1206 cities.

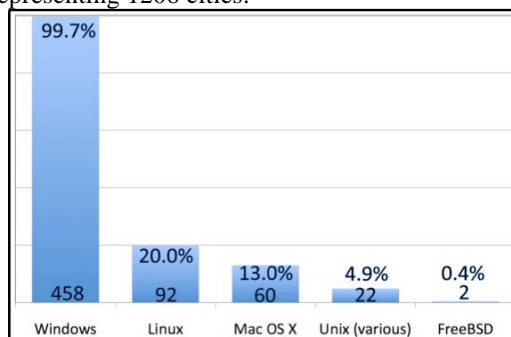


Figure 2. Desktop OS Deployment

Cities use a wide variety of desktop operating systems. Within the IT staff sample sub-set, 15 different operating systems were identified. Virtually all cities (99.7%) deploy one or more versions of Microsoft Windows on desktop computers. 20% of the respondents indicate Linux is used on desktop computers. The survey instrument did not collect the degree to which Linux is deployed on the desktop in the respondents' city.

An interesting observation was 13% of the IT staff indicating that Mac OS X was deployed on desktop computers in their city. Since Mac OS X can only be installed on Apple Inc. hardware [21], we can conclude these cities are using Apple computers to support service delivery or to conduct city business.

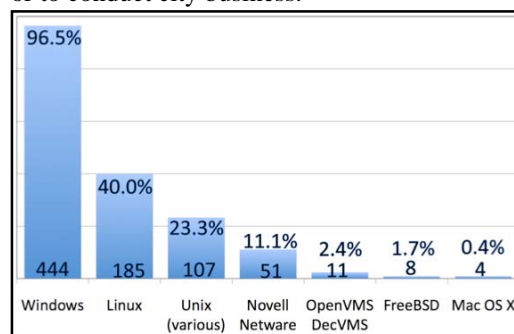


Figure 3. Server OS Deployment

Server side operating systems showed similar deployment rates with Microsoft Windows most widely used at 96.5% and Linux following in second at 40%. A small number of cities continue to use Novell Netware and DecVMS/OpenVMS indicating some cities may be maintaining legacy software to support service delivery or city operations.

VI. ANALYSIS; INTERESTING FINDINGS

This section presents the interesting findings of this study.

A. Few Cities Have All Characteristics

Analysis of the survey data indicates few cities have all the characteristics that would enable successful comprehensive adoption and deployment of OSS. Of the 1206 distinct cities in the sample set, just ten cities satisfied

all characteristics within the three dimensions.

City	State	Population
Balwin	Missouri	30,000
Northglen	Colorado	31,000
Houma	Louisiana	32,400
Ipswich	Massachusetts	12,000
Largo	Florida	73,000
Layton	Utah	64,300
Redding	California	80,800
Santa Monica	California	87,200
Tomball	Texas	10,200
Ulysses	Kansas	5,600

Table 1. Cities Satisfying All Selection Criteria

The above 10 cities satisfied the following criteria; has an IT Department, IT support is handled in-house, currently uses OSS, has well defined IT strategy, has IT line item in budget, IT is sufficiently funded, total cost of ownership acquisition strategy, uses budget for software acquisition,

Largo, Florida is of particular interest. Largo, has embraced the use of OSS. It has deployed Linux as the operating system for its 400 desktop clients saving the city an estimated \$1 million per year in hardware, software, licensing, maintenance, and staff costs [20].

B. Possible Aversion to OSS If Not Currently Using OSS

Of the 460 Municipal IT managers and staff in the sample set, 56% indicated their city was not currently using OSS while 39% indicated their city was using OSS. Considering the widespread use of OSS in the commercial sector, the relatively high percentage of cities in this survey not

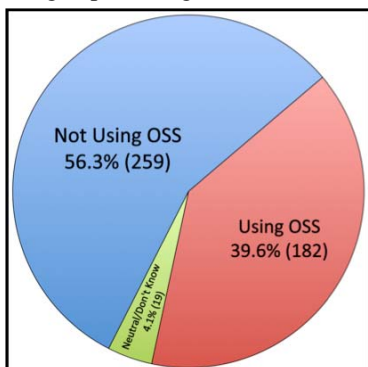


Figure 4. Cities Currently Using OSS

currently using OSS required further investigation.

Of the Cities currently using OSS, 76% are planning to use OSS in the future and 10% have no plans to use OSS in the future. The high percentage of cities planning to use OSS in the future that currently use OSS can be expected. It is more likely an organization will continue to use a software product once deployed and established than to

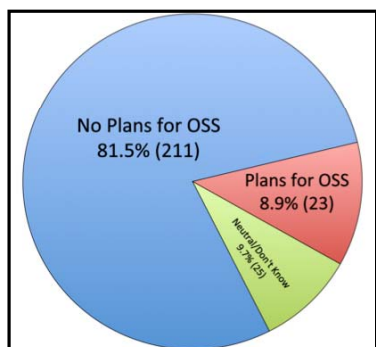


Figure 5. Cities Not Using OSS with No Future Plans

abandon the product.

The cities currently not using OSS provides a more interesting observation. Of the 259 IT managers and staff indicating their city is currently not using OSS, 82% indicated their city has no plans to use OSS in the future, 9% indicated their city did plan to use OSS in the future, and 9.7% (25) did not know.

The number of dedicated IT staff at the respondent cities may not be an influencing factor in decisions to use OSS in the future. While 74% of the cities not planning to use OSS in the future have IT staff numbering 10 or less, 71% of cities currently using OSS also have 10 or less IT staff.

The organizational support for using OSS appears to be a significant influencing factor for a city's future plans for OSS use. The survey design included questions regarding the respondent's perception of the Leadership, Management, and IT staff views of OSS. The subjects were asked if the city leadership, management, and IT staff support the use of OSS. For the cities not planning to use OSS in the future only 6% of the respondents indicated the city leadership supports the use of OSS, 8% of respondents indicated city management supports the use of OSS, and 33% indicated city IT staff supports use of OSS. For cities currently using OSS the responses were 22% leadership, 33% management, and 71% IT staff.

C. Current OSS Support by Leadership, Management, and IT Staff

IT managers and staff report a significant difference in the perceived current support of OSS and the support of OSS if using OSS would reduce IT operating costs. 11% of IT managers and staff indicate they agree their city leadership currently supports the use of OSS. The IT managers' and staff's perception of city management's current support of OSS is similar, if somewhat higher, to their perception of city leadership. 16% agree their city management currently supports OSS. The IT managers' and staff's perception of city IT staff's current support of OSS, that is their perception of themselves, was significantly higher than their perception of city leadership and management support of OSS with 26% agreeing the city IT staff supports the use of OSS.

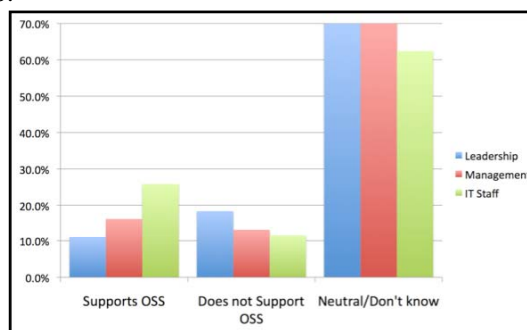


Figure 6. Current Support of OSS

When asked about support of OSS if it meant saving money, 36% of the IT staff agrees their city leadership would support OSS if it would save money, a three-fold increase. 41% agree their city management would support OSS if it would save money, a 150% increase. However, only 36% agreed the city IT staff would support OSS to save money, just a 50% increase. While these results indicate city leadership and management may be motivated to support

OSS given the potential cost savings, IT staff may not share those same motivations.

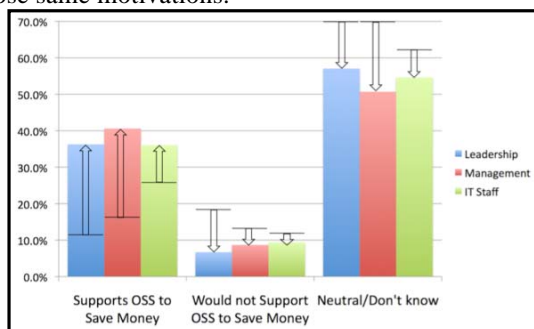


Figure 7. OSS Support If It Would Save Money

Of note is the drop in frequency (from ~70% to ~50%) of respondents indicating a neutral position or those who did not know. The possibility of reducing the costs of information technology is a significant influence on IT strategy and technology adoption.

D. Discrepancy of OSS awareness; Self, others

The survey data suggests a discrepancy between the subject's own awareness of OSS and their perception of city leadership, management, and IT staff's awareness of OSS. Within the sample set 69% of the respondents indicated they are aware of OSS. However, their responses regarding their city leadership, management, and IT staff's awareness of OSS show that most respondents perceive the leadership, management and IT staff as generally unaware of OSS. The high frequency of those individually aware of OSS could be attributed to the survey attracting individuals interested in OSS.

VII. CONCLUSION

The results indicate cities in general do not have the necessary characteristics to successfully adopt OSS to deliver services and conduct city business on a comprehensive scale. The key indicators point to significant deficiencies in the three domains: capability, discipline, and cultural affinity.

While a majority of cities in the study show some characteristics that indicate the adoption of OSS is possible, and indeed on a trivial level (with a few notable exceptions) some cities are using OSS, still most cities lack key characteristics in the three domains to enable a successful comprehensive adoption of OSS.

The data suggest many cities may have an adequate level of discipline to support open source adoption with IT line items in the city budget and sufficient IT funding. However, a significant number of cities make software purchases on an ad hoc basis, indicating potential lack of organizational planning capability.

A city's Culture, with respect to IT decision making, appears to be a significant barrier to open source adoption. City leadership and management of cities that do not support the use of OSS are generally unaware of OSS as an alternative to commercial software. Cities currently using OSS are highly likely to continue to use OSS in the future while cities not presently using OSS have no future plans to use OSS.

Because the cities represented in this study in general do

not exhibit the indicators in the three domains examined we conclude most cities do not have the capability, discipline, and cultural affinity to successfully adopt OSS on more than a trivial level.

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