

ENABLERS OF OPEN SOURCE SOFTWARE ADOPTION: A CASE STUDY OF APS ORGANISATIONS

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ABSTRACT

Despite a considerable body of literature investigating factors involved in the Open Source Software (OSS) adoption process, there is little research into adoption of OSS by public sector organisations. So it was important to reassess the factors enabling OSS adoption in order to enhance OSS utilization within public sector organisations. This study explored various factors that may enable OSS adoption within Australian Public Sector (APS) organisations by interviewing those involved in software procurement. The findings were analysed through the lens of administrative complexity associated with OSS adoption. Success of OSS in government agencies was found to be contingent on critical aspects such as availability of support and maintainability of OSS products, ability to meet organisational business needs in a cost effective manner, economic value associated with OSS such as maintenance and training costs, and attitude of staff toward OSS. The findings suggested that value for money and fit for purpose criteria described in Commonwealth Procurement Guidelines were the major enablers of OSS adoption.

INTRODUCTION

Open Source Software (OSS) is increasingly acknowledged as a viable alternative to proprietary products, with significant software reliability and value for money benefits for businesses of all kinds (Haider and Koronios, 2009). Consequently, OSS has gained substantial attention from public sector organisations all over the world. As a result many public sector organisations are investing in OSS research such as assessing availability and potential of OSS based solutions in public sector organisations (Lorraine and Patrick, 2007). In Australia, public sector organisations are also taking significant steps to promote OSS adoption (AGIMO, 2011). Although there has been some research on the success and failure of OSS projects, additional research was needed to provide better insights into the OSS adoption process, which help to narrow the gap between organisational requirements and the ability of OSS applications and services to meet those requirements. It would be beneficial to understand better the factors that enable OSS adoption particularly in an Australian Public Sector (APS) context. This research seeks to resolve the research question: *What are the enablers of OSS adoption for Australian Public Sector organisations?* The paper is organised as follows. It starts with a discussion on the OSS literature and technology adoption theories. Next, the paper proceeds with a discussion on research design and methodology. Then, the findings are examined and discussed.

Finally, practical contributions and theoretical implications are assessed and the conclusions are presented.

LITERATURE REVIEW

Open Source Software

The term OSS was first coined in 1998, although the idea has a much longer history. Open Source Software (OSS) licensing agreements allow users to use, modify and redistribute software free of cost. The growing prominence of OSS has led to the development of a significant body of research investigating OSS issues. There has been substantial research focus on factors that enable OSS adoption within organisations (Dedrick and West, 2004; Lorraine and Patrick, 2007). While other research identified inhibitors to OSS adoption within organisations (Goode, 2005; Haider and Koronios, 2009). Literature based on OSS research has identified OSS adoption depends on critical factors such as licence fee (Hwang, 2005), budgetary reasons (Ghosh, 2005), cost reasons (Holck et al., 2005; Mtsweni and Biermann, 2008), availability of source code and security (Ven and Verelst, 2006), availability of external support (Lorraine and Patrick, 2007; Mtsweni and Biermann, 2008; Haider and Koronios, 2009), maintenance and economic benefits to the nation (Haider and Koronios, 2009).

Previous research conducted in Australia at state government and commercial organisations have shown the OSS adoption rate in Australia is lagging behind compared with the rest of the world (Higgins et al., 2005; Haider, 2008). Despite these figures, Australia's interest in OSS adoption is increasing. The Australian Government perceived a growing market for companies that implement and support open source solutions in business and government (AGIMO, 2011). Consequently, in Australia both federal and state governments are promoting the use of OSS (AGIMO, 2011). In order to achieve the Government's goals on OSS and to maximize the benefits of using OSS, the Government needs to know the public sector organisations' experiences with OSS as well as administrative complexity on OSS adoption

RESEARCH METHODOLOGY

Case study

This research employs case study approach to investigate the factors that enable OSS adoption in APS organisations. Case study is the appropriate method to investigate the situations in which limited knowledge exists concerning a particular phenomenon (Siggelkow, 2007). Yin (2003) also suggested that case study is appropriate for exploratory investigations where research questions mainly focus on "What" question such as *What are the enablers of OSS adoption by Australian Public Sector organisations?*. The depth of enquiry possible through the case study method is significantly greater than other research methods (Remenyi et al., 1998). This study used a multiple case design approach. Evidence from multiple cases is often considered more compelling and robust. Yin (2003) suggested that 9 to 12 cases are sufficient to provide substantial support for the development of a theoretical framework. This theoretical framework later becomes the vehicle for generalizing new cases. Because case study methodology can be used to test or contribute to theory (Bryman, 1989; Darke and Shanks, 2002), information technology innovations have been investigated using this approach (Niederman and Davis, 2006) to identify factors involved in information technology adoption (Dedrick and West, 2004; Pease and Rowe, 2005). Therefore, it is appropriate to apply the case study approach in this research.

Unit of analysis

In case study research, the unit of analysis may be an individual, a group, an organisation, or it may be an event or some other phenomenon. It is related to the way the major research question is initially defined and is likely to be at the level being addressed by the question (Darke et al., 1998). Unit of analysis determines the limits of the data collection and analysis (Yin, 2003). As this research aims to explore factors enabling OSS adoption within APS organisations, the unit of analysis for this research is APS organisation. Unit of analysis can be different from data collection source (Yin, 2003). This research used individuals involved in ICT processes and software procurement as study subjects. Participants included CIOs, CEOs, CTOs, Policy Officers, ICT Managers, IT Support Staff and System Analysts. This research collected information from people in these roles as they are involved in various stages of the OSS selection process.

Data collection technique

The proposed data collection technique for the case study is through semi-structured interviews. Bryman (1989) suggested that semi-structured interviews were valuable in organisational case studies, particularly to collect the rich data that this research needs. Interview is the best technique to collect in-depth and rich qualitative data (Pease and Rowe, 2005; Williamson, 2002), especially in a case study setting (Tellis, 1997). Yin (2003) also suggested that one of the most important sources of case study information is the interview as interviews focus directly on the case study topic and provide greater insight into the problem to be investigated. Semi-structured interview techniques provide opportunities to clarify both the questions asked and the answers given. Furthermore, additional details can be gleaned through follow-up questions. Previous research on identifying factors involved in technology adoption has employed semi-structured interviews as the data collection technique (Dedrick and West, 2004).

Data analysis technique

Analysing the data is one of the most difficult parts of the case study as strategies and techniques are not well defined (Yin, 2003). However, Miles and Huberman's (1994) book is among one of the more useful sources to guide researchers in the qualitative data analysis process. This research uses the pattern matching technique to analyse the case study evidence along with Miles and Huberman's (1994) three concurrent activities. Pattern matching is a technique which links two patterns when one is a theoretical pattern and the other is an observed or operational pattern (Trochim, 2006). Miles and Huberman (1994) defined data analysis as having three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification. Data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in field notes or transcriptions. Data display is an organized, compressed assembly of information that permits conclusion drawing. Conclusion drawing is the process of drawing meaning from the evidence by noting regularities, patterns, explanations, possible configurations, causal flows, and propositions.

Administration of the interviews

Interview questions were developed based on the factors identified from the OSS literature. Survey findings (a survey within APS organisation was conducted prior to case study) were considered while developing the interview instrument because it provided an opportunity to unveil problems in using OSS. Interview questions were grouped into relevant categories in advance to help interviewees answer questions with minimal confusion. As a nature of semi-structured interviews, additional questions were emerged (asked) wherever necessary to gain in-depth understanding of the problem. However, attention was given to keep the study's goal and structure of interview instrument while asking additional questions. The interview instrument was pre-tested by both academic and industry professionals. A pilot interview was conducted to test the length of the interview and clarity of the

questions used in the instrument. Nine face-to-face and one telephone interviews were conducted with individuals working in nine different APS organisations. Among them seven participants were from consumer (OSS adopters but not contributors to the OSS community) organisations; two were from developer (main role is to develop and distribute OSS applications to the world) organisations; and one from consumer as well as developer (OSS adopters and also develop and distribute OSS applications to the other organisations) organisation. The interviews were conducted in the period November 2008 to January 2009 and the duration of each interview session varied between 30 to 60 minutes. People who were likely to have high knowledge about the decision to use OSS were selected as the participants. These included CEO, CTO, Policy Officer, ICT Manager, Architect, Strategic Change Manager and Assistant Director. These individuals were involved in OSS selection process within their organisation. Table 1 provides details of the number of people employed in the participating organisations.

Interview	Size of the organisation	Type of the organisation
Int1	1000	Consumer
Int2	5	Developer
Int3	22000	Consumer
Int4	3000	Consumer
Int5	22000	Consumer
Int6	35000	Consumer
Int7	45000	Consumer
Int8	300	Developer
Int9	30000	Consumer
Int10	750	Consumer and Developer

Table 1: Organisational profile – case study

FINDINGS

Enablers of OSS adoption are defined as those benefits or features that motivate OSS adoption. Based on the case study interviews, organisational issues concerning OSS adoption include tangible factors such as economic benefit, but also a range of intangible factors such as alignment with organisational needs, availability of support, better security, availability of source code, characteristics of the software, software quality, OSS community involvement, software freedom, staff appreciation, ease of maintenance, belief in OSS principles and political pressure, and communication channels. Although some of the issues may be different facets of the same issue it is important to discuss each issue separately as they have unique characteristics and different levels of influence on OSS adoption. For example, both security and availability of source code could be described as different aspects of software quality. However, from an organisational perspective they play different roles in adoption. Consequently, the remainder of the paper discusses each of these facets as a standalone factor.

Economic Benefit

Economic benefit was expressed in different ways by organisations. Most participants reported that cost savings were achieved through OSS adoption. Some organisations adopted OSS because it was

free and it allowed them to directly experience OSS. For example, respondent ten (interviewees are identified as respondent one through ten) reported:

“...Eclipse started in the Organisation because it was free and that is what allowed us to start. Then after that it did work, it didn't cost anything, it worked really well. So there was no reason to move...” - Respondent 10.

Having none or minimal licencing cost plays an important role in OSS adoption. In comparison, licensing costs for proprietary products tend to increase over time and be charged on the basis of number of processors or user seats. This can motivate organisations to consider OSS as a cost effective alternative to proprietary software. For example, respondent four reported:

“...we are actively looking at OSS because of licensing, and cost is not a straight line increment. Additional seats don't cost that much more to support. So the cost curve is much flatter than the proprietary software...” - Respondent 4.

In most cases, OSS adoption was not mandatory and organisations did not explicitly differentiate between OSS and proprietary products. However, cost savings associated with OSS applications enabled organisational adoption of OSS. For example, respondent eight reported:

“...We had not had to spend money on Open Source Software. But the organisation makes no distinction between open and closed source in budget terms. So I still have a software budget, I haven't spent it for the last several years. So I am supposed to spend it but I don't. Tax dollars being saved...” - Respondent 8.

Organisations recognized that OSS was a cost effective option because of the lack of licence fees and low maintenance costs. Respondent five reported:

“...Another example is where the lack of licences and low maintenance cost for a binary distribution made it a cost effective option to scale across 25,000 desktops...” - Respondent 5.

On the other hand, organisations tried to maximize the benefits by adopting OSS in situations where there were low risks and high potential return on investment. Generally, their experience was that OSS offered value for money and sufficient return on investment. For example, respondents four:

“...I think what drives us is that we get better return for each dollar...” - Respondent 4.

Further, OSS provided an opportunity to substantially test OSS products with little upfront cost. This feature is not associated with proprietary products as respondent eight reported:

“...In addition to the no acquisition cost is that there are 2, 3, 5 or 10 different types of software which can do the same thing, the cost to try them all is close to zero. In proprietary terms if there are 2, 3 or 10 software the cost is huge to try them all. That is a big difference...” - Respondent 8.

Training costs for OSS products were reported to be significantly less than for proprietary products.

Manuals and documentation developed for OSS products are estimated to cost two thirds of commercial world products.

Economic benefit was identified as an enabler in OSS adoption. Organisations achieved economic benefit by using OSS due to minimal or no licensing cost, low maintenance cost, high return on investment and the ability to trial OSS products with little upfront cost. In some cases economic benefit came through training and manual preparation costs for OSS applications as they are comparatively lower than proprietary products.

Organisational Needs

Most organisations reported that the main reason for OSS adoption was because OSS products satisfied organisational business needs. The selection of software tended to be based on how well the software met organisational requirements irrespective of whether it was a Commercial Off The Shelf (COTS) product or an Open Source product. For example, respondents seven and four reported:

“...We are looking at products that meet our requirements regardless of where they are sourced from...” - Respondent 7.

“...partly it is cost. The other big thing that is important for us is that it fits into our strategic directions around the national statistical service...it allows us to achieve strategic outcomes....There is also a fit to what we are trying to achieve...” - Respondent 4.

Occasionally OSS was adopted because proprietary software was not suitable for organisational business needs. For example, respondent ten reported:

“...The proprietary software did not do what we wanted it to do. So we were going to change the product anyway and we picked an Open Source product that suited our needs...” - Respondent 10.

A number of participants looked to OSS first for their business needs. In these cases, proprietary software was only ever sought if a suitable OSS product was not available or was not a good organisational fit. Generally, OSS allowed organisations to deliver at low cost a fully functional set of infrastructure. Further, the functionality available with OSS applications was generally comparable with proprietary ones. In some cases organisations found that OSS functionality was superior to equivalent proprietary products. Finally, fitness for purpose was considered an important selection criterion.

Availability of Support

Most participating organisations reported that having better support was one of the reasons for OSS adoption. Better support was realized through commercial and/or in-house support. In some cases commercial support for OSS applications was perceived to be better than for proprietary products. For example, respondent four reported:

“...(OSS support)is very strong. Better than proprietary. Better than what we have experienced with proprietary contracts...” - Respondent 4.

Although there were perceptions of good support being available for OSS applications, some participants reported that their in-house support was better than commercial support. For example, respondent one reported:

“...there are commercial organisations which provide services. So the support is available. But we didn't buy support. Because we have our senior staff managing OSS, they might be better than those people that provide the support...” - Respondent 1.

In contrast, lack of external support for some proprietary products provided a motivation for organisations to adopt OSS applications. Some organisations perceived that there would be better service and support available to OSS applications because of the extensive OSS community network which provided an opportunity to deal with different service providers rather than relying on one proprietary vendor. This sentiment could be seen in comments made by respondent six:

We have reported a problem to a vendor (proprietary) that has never been answered. We just found a work around and lost interest to tell them. They never came out with fix or told us what caused the problem. It is a major tier one vendor. Where as you know with Open Source Software when you have a problem you get an explanation and fix from the community, it all depends...” - Respondent 6.

Some participants reported that the potential for support from the actual person or persons who wrote the code was an enabler for OSS adoption. It would seem that in critical situations OSS provided an opportunity to talk directly to the code authors to help correct application problems. This facet of support is generally not possible with the proprietary products. For example, respondent eight reported:

"...The fact that you can directly talk to the person who wrote it. It is a very good experience. It is much better than proprietary..." - Respondent 8.

Availability of support is important for the adoption of OSS by organisations. Most of the respondents acknowledged that there were better commercial and in-house support options available for OSS applications over proprietary software which favoured the adoption of OSS. Consequently, availability of support was identified as an enabler for OSS adoption.

Security

Security issues play an important role in OSS adoption with many participants reporting that security issues experienced with commercial software was one of the reasons for OSS adoption. For example, respondent ten reported:

"... (OSS security is) equal to or better than any commercial software we have. We have no particular concerns about that. We have more security patches and security fixes that we need to apply to commercial software than Open Source by a long way..." - Respondent 10.

Because of perceived superior security features, organisations tended to adopt OSS applications in sensitive application areas. For example, respondent three reported:

"...We do use OSS for some security related purposes. Certainly the fact that we are using them for a sensitive application confirms that we are happy with the security and quality of the software..." - Respondent 3.

Although respondent four reported not wanting to use OSS in security sensitive areas, their organisation was experimenting with OSS in those kinds of application areas. Respondent six reported that there was little difference between OSS and commercial software in terms of security risk. OSS was seen as being more secure because the open code facilitated inspection. According to respondent six:

"...I don't think it is much different to commercial software. There are security vulnerabilities in both camps. Both can fix them or not. Open Source arguably is more secure because the code is open to inspection... Probably at least in theory Open Source is slightly more secure. But it doesn't necessarily have same level of testing like commercial products like Windows for example..." - Respondent 6.

It would seem that some OSS products offer better security than equivalent proprietary applications. For example, respondent eight reported:

"...We use Firefox because it is standards compliant, it is secure, and has far better user features quite frankly than the competing types of browsers..." - Respondent 8.

Most of the organisations claimed that OSS products provided better security than proprietary software. Consequently, these perceptions of greater security provided a strong argument for OSS adoption.

Availability of source code

Organisational perception on source code varied according to the type of the organisation (consumer, developer, consumer and developer). As a result availability of source code had different levels of impact on OSS adoption with respect to the organisation type. Most of the consumer organisations were not interested in modifying the source code. It did not necessarily mean they never modified the source code. They did very limited modifications when necessary. But their preference was not to modify the source code. For example, respondents one and three reported:

"...We hardly modify the software. But we do occasionally. With source code we know we can make changes. But only rarely..." - Respondent 1.

"...Depending on the scenario we are careful about how we manage the source code of FOSS components. But prefer not to modify the source code. And we are conscious in mixing the source code...We are avoiding it. As part of the risk strategy, we have not modified the code..." - Respondent 3.

For developer organisations access to source code was the major reason for OSS adoption. It provided them an opportunity to enhance software quality as well as contributing back to the OSS community. For example, respondents eight and ten reported:

"...(one) driver is the freedom to be able to change it (OSS)...you make a modification and does the job that you want and you can share that with the upstream provider of the source as well, so other people can benefit from it..." - Respondent 8.

"...It (OSS) did what we wanted it to do (after modification). We modified the source code because we wanted additional capabilities and it worked..." - Respondent 10.

Seven of the ten respondents reported advantages of source code modification. The remaining three respondents had not done any modification of the source code. Some consumer organisations reported that software problems with OSS could be easily fixed as the source code was available for modification. For example, respondent four reported:

"...when things go wrong, with source code it is easier for us to find a solution. And also most of the time it is better than a vendor's solution..." - Respondent 4.

Both consumers and developers either benefited or expected some benefit from modifying the source code. The common advantages identified by both consumers and developers through availability of source code were as follows: it allowed organisations to add additional features if required; better satisfied organisational business needs after source code modification; provided opportunity for alternative ways of finding support and service which led to cost savings. Benefits exclusively mentioned by the consumer organisations included expectation of quicker bug fixes in comparison with proprietary software because of the availability of source code; and easy integration with the existing systems. Contribution made to or by the OSS community was cited as an adoption enabler by developer organisations.

These findings show that source code was viewed differently by different types of organisations. From the point of view of consumer organisations, source code was not an enabler for OSS adoption. In contrast, for developer organisations source code was a major enabler. However, the option provided by availability of source code was viewed positively by both consumer and developer organisations as they believed there were attached benefits. Consequently, availability of source code was identified as an enabler of OSS adoption.

Characteristics of the Software

Software features were expressed in different ways by organisations. Some respondents reported that better software characteristics associated with OSS applications was an enabler for OSS adoption. The feature sets available from OSS products are comparable with proprietary products but without the same cost. One of the main characteristics of OSS is that it allows users to add features that better meet their business needs. This is possible because of the availability of source code. For example, respondent four reported:

“...people said well it (wiki) is not like Notes so I don't want to use it, it is hard to use. But wiki did not have wysiwyg editor and clients are very used to using wysiwyg editors. It is not such an issue in Open Source communities...in wiki case we added wysiwyg functionality...”- Respondent 4.

Maturity of OSS products was an enabler for OSS adoption as organisations tended to adopt mature OSS products. For example, respondent ten reported:

“...Most of the Open Source Software we use is very mature, well documented...” - Respondent 10.

OSS features such as emerging capability, rapid evolution, and product status had a positive impact on OSS adoption. For example, respondent five reported:

“...One (OSS) was chosen because of the nature of the software - an emerging capability, evolving quite rapidly, where the type of development is academic, with the academic community contributing quite rapidly to it...” - Respondent 5.

Further, OSS products provided an opportunity to fix discovered bugs in a relatively short time frame as the source code is open for inspection by the wider community. For example, respondent four reported:

“...benefit in terms of time to fix. Bugs in Microsoft products have been around for many years. With Open Source I believe bugs will be fixed within the time of six months cycle or you can fix them yourself...” - Respondent 4.

Characteristics of the software were identified as an enabler and were represented by the ability to add new features, prompt fixing of software bugs, availability of source code, and product maturity.

Software Quality

Some organisations reported that software quality was an important factor in OSS adoption. OSS quality was perceived to be better than equivalent proprietary products thus enabling OSS adoption as respondents two and ten reported:

“...It is fantastic considering we pay nothing for the Open Source. It is really nice and sometimes we can get it from the Open Source community. Really professionally written good quality code...” - Respondent 2.

“...Why they (OSS products) are successful is because they work. Why did we use it over an alternative in some cases? Because they are the best products in a particular space ...” - Respondent 10.

OSS Community

Some participating organisations reported that the OSS community's contribution to OSS products and the opportunity to contact the main code contributors were important enablers of OSS adoption. Organisations were interested in improvements, enhancements and various versions published for OSS products. Active community involvement helped to further develop and improve OSS products. For example, respondents four and six reported:

“...Things like Apache and Tomcat are classics: they are well known, there are active communities, they are well documented...” - Respondent 4.

“...Apache for example or Samba, knowing there is a very vibrant community, you know stuff will get fixed probably before you even noticed it. There is a lot of development going on towards adding additional features...” - Respondent 6.

Contact with the code contributor was an important enabler for OSS adoption for developer organisations. OSS community is likely to be easily contactable when there is a need to contact the author of a particular piece of code. In those cases the response tended to be faster as respondent ten reported:

“...If the piece of software just works then we never need to touch it, we don't need to talk to anybody. That is probably true for more than 95% of the software we use. We use it and it just works... and we get a much faster response if we need to talk to the developers of the software...” - Respondent 10.

Because of OSS community's contribution, enhancements to products are faster and bugs fixed promptly. Consequently, the OSS community's contribution to OSS products was identified as an enabler in OSS adoption.

Freedom

There was an element of freedom associated with OSS that tended to be an enabler of OSS adoption. Freedom was expressed in two ways: (1) freedom to modify OSS source code; and (2) freedom to access support for OSS without relying on a particular vendor.

Developer organisations adopted OSS because it offered them freedom to change the source code to meet their requirements. For example, respondent eight reported:

“...driver is the freedom to be able to change it, that is critical to be able to make changes, and to get much faster response if we need to talk to the developers of the software...” - Respondent 8.

Some organisations adopted OSS because it reduced their reliance on proprietary vendors. It provided credibility to the organisation because they can own the product and not be committed to or bound by any particular support structure. For example, respondents two and four reported:

“...we don't have to worry about the complicated agreements. You own the product as we do. You are not committed to or bound to any support structure ...” - Respondent 2.

“...It is one of the things we are using Open Source for, to try to manage lock in... Open Source vendors are more flexible in terms of offering support than proprietary vendors. This has positive impact on OSS adoption...” - Respondent 4.

Some consumer organisations reported that the availability of more flexible vendors with OSS was an incentive for adopting OSS. They reported that OSS vendors were more flexible in terms of customising OSS products to meet organisational requirements. For example, respondent seven reported:

“...The Open Source vendors tend to be a lot more flexible in being able to customise the software for our needs...” - Respondent 7.

Freedom to access support for OSS without relying on a particular vendor was an enabler for both consumer and developer organisations while freedom to modify OSS source code was an enabler for developer organisations. Consequently, freedom was identified as an enabler for OSS adoption.

Staff Appreciation

Most participating organisations reported that the positive attitude of staff members towards OSS can lead to its adoption. Staff members can act as a source of information to convey the existence and viability of OSS alternatives during the procurement cycle. Further, staff members' satisfaction with OSS products can influence OSS adoption. For example respondents three and ten reported:

"...People who adopted generally tend to be people who are aware of it. So if the staffs are aware of it then they approach us to use OSS. It is not something the management actively supports or promotes. The adoption is staff driven not management driven..." - Respondent 3.

"...staff members' satisfaction led us to buying more of it (OSS)..." - Respondent 10.

In rare circumstances, staff appreciation had a negative impact on OSS adoption. If IT support were not familiar with a particular OSS or there were perceived incompatibilities with the existing technical environment, then the organisation tended to select proprietary software over an OSS alternative. As respondent four reported:

"...One of the reasons why we moved from Linux back to Windows was fairly strong rejection by the technicians who are doing it. Because we had expertise in Windows then that was the obvious place to go ..." - Respondent 4.

In summary, staff appreciation can enable or inhibit organisational adoption of OSS even though it was not reported as a major factor in selection criteria.

Ease of Maintenance

The ease of maintaining an OSS product plays an important role in OSS adoption. In most cases organisations perceived that the maintenance of OSS products was easier than equivalent proprietary products because of the availability of source code. For example, respondents ten and one reported:

"...It (OSS) is easier to maintain than a lot of commercial software we use..." - Respondent 10.

"...when things go wrong, with source code it is easier for us to find a solution. And also most of the time better than vendor's solution..." - Respondent 1.

The above evidence shows that ease of maintenance enabled OSS adoption.

Political Influence and Belief in OSS Principles

Occasionally OSS was adopted because of political pressure or based on a belief in OSS principles. For example, respondents nine and two reported:

"...There are political pressures to make use of OSS..." - Respondent 9.

"...As a group we believe in the principle of Open Source..." - Respondent 2.

Political Influence and Belief in OSS Principles were not major enablers as there was very little evidence to support these as reasons for OSS adoption. However, these were reported as having a positive influence on OSS adoption.

Communication Channels

Communication channels are defined as the OSS information sources available about the adoption of OSS applications from a range of sources including government, OSS community and OSS industry. The results were not surprising. None of the organisations relied on a single source of information. For example, organisations used government resources like OSS reports from Australian Government Information Management Office (AGIMO), OSS vendor statements, OSS press releases, OSS

publications (conference papers, journals, newspaper reports) and experiences from peer organisations to collect information about OSS. All participating organisations were aware of the existence of the AGIMO guidelines, and most explicitly referred to the guidelines during interviews. The consensus view was that AGIMO guidelines contained helpful material, and some of the organisations also reported that they actively followed these guidelines and created policies which reflected their content. The following reports by respondents six and ten illustrate how guidelines can influence OSS adoption:

“...it (AGIMO guidelines) gives people information about how to use the product, tells us what it does and how to use it sensibly, how to make it successful, what it is, is a formal documentation that might not otherwise have been provided, in a way it is same as white papers, how to do’s and documentation produced by the software vendors It kind of fills that gap. It is quite important I think...” - Respondent 6.

“...It gives some people an understanding of Open Source risks and processes for those who don’t have the understanding of what Open Source Software is, very useful to hand to project managers or other people who don’t know Open Source...” - Respondent 10.

The impact of the AGIMO guidelines on OSS adoption was higher in consumer organisations compared to developer organisations. Most consumer type organisations agreed that increasing the availability of OSS guidelines would help them to better understand OSS benefits and risks, and would help improve the effective utilization of OSS products. This finding showed that the communication channel had a positive impact on OSS adoption for certain types of organisations.

DISCUSSION

The major factors identified as enablers are economic benefits, ability of OSS to satisfy organisational business needs, availability of support for OSS products, high security available from OSS, better software characteristics, software quality, community involvement and freedom associated with OSS. Further, staff appreciation, ease of maintenance, political pressure and belief in OSS principles, and communication channels were also identified as enablers of OSS adoption. These results show APS organisations are motivated to reduce administrative complexity issues while adopting OSS.

Most organisations realized *Economic Benefits* by adopting OSS applications. The attraction of OSS was the low up-front costs. Organisations achieved economic benefits because there were no license fees and also ample opportunity to pre-test most OSS applications with little direct cost. Generally, organisations perceived that OSS offered value for money and sufficient return on investment. Further, maintenance and training costs for OSS products were either similar to or less than commercial products. Economic benefits associated with OSS adoption helped organisations to satisfy the Commonwealth Procurement Guidelines (CPG) “value for money” – an essential principle for all public sector procurements. This shows “value for money” is an important determinant of OSS adoption within APS organisations. Most of the studies conducted in public sector organisations identified cost savings as one of the major reasons for OSS adoption (Deller and Guilloux, 2008; Haider and Koronios, 2009; Lorraine and Patrick, 2007; Management, 2003; Mtsweni and Biermann, 2008a; Schmitz, 2001). This study supports those findings as all organisations in this study reported cost savings by adopting OSS. However, this finding contradicts Riehle (2007) and Ven and Verelst (2006) as they identified cost did not play an important role in OSS adoption. In this study economic value plays a vital role as it was the strongest determinant in OSS adoption among the study participants.

The result concerning the importance of *Organisational Needs* was not surprising as it was earlier identified as one of the major enablers of OSS adoption. Most organisations reported that OSS

products satisfied organisational business needs. The selection of software tended to be based on how well the software met organisational requirements irrespective of whether it was a COTS product or an Open Source product. Organisations generally evaluated different applications including OSS for the same purpose, and OSS applications which rated well against proprietary products where OSS was deployed. OSS products that failed to produce strategic outcomes or satisfy organisational business needs were rejected by the organisations. This highlights the ability of OSS to satisfy organisational needs as a major reason for adoption. This shows that the CPG "fitness for purpose" criterion is also an important determinant of OSS adoption within APS organisations. This is consistent with prior studies that found the ability to perform specialised tasks was a reason for OSS adoption (Dedrick and West, 2003; West and Dedrick, 2008).

Availability of Support for OSS was cited by most organisations as being important, and they reported that having better support was one of the reasons for OSS adoption. Organisations reported that the OSS applications they used had good support either in-house or commercially. In some cases bad experiences with proprietary applications in terms of availability of support led organisations to look at OSS applications with good support structures. It was generally perceived that there was better support available to OSS in comparison to proprietary applications because of the extensive OSS community which provided an opportunity to deal with different service providers. To avoid risks associated with availability of technical support, organisations preferred managed packages that included support and service for OSS applications. This study supports the findings in Haider and Koronios' (2009) study of Australian state government departments that concluded that the sustained utilization of OSS in government agencies relied on availability of support. Further, findings from this study are consistent with prior studies that also found supportability was one of the key drivers in OSS adoption (Dedrick and West, 2004; Kenwood, 2001; Ven and Verelst, 2006; West and Dedrick, 2008). Moreover, the finding from this study regarding availability of support also aligns with the finding of Dedrick and West (2003) that existing skills were important in OSS adoption as they had potential to enable or inhibit OSS adoption. *Availability of Support* enhances OSS adoption only if existing skills and support are compatible.

Security issues play an important role in OSS adoption. Organisations adopted OSS applications where they were satisfied with security. Organisations tended to adopt OSS applications in sensitive application areas because of its perceived superior security features than commercial software. This supports prior findings that concerns about security threats posed by the closed nature of the proprietary products has driven the adoption of OSS in many cases within public sector organisations (Hwang, 2005; Schmitz, 2001). In some cases, organisations had not observed any security differences between OSS and commercial software, while others perceived some OSS products offer better security than equivalent proprietary applications. In general, OSS was seen as being more secure because the open code facilitated inspection. This is consistent with Lorraine and Patrick's (2007) earlier work as it identified that higher security due to availability of source code reduced the threat of virus attack, and was an enabler of OSS adoption. Further, findings from this study support Linus' Law which states "given enough eyeballs, all bugs are shallow" (Fitzgerald, 2005, p-95) as the large community accessing the open code enabled prompt fixing of software problems. Yet, there was no clear literature evidence and there exists strong disagreement from proprietary software vendors regarding the security of OSS products. Proprietary software vendors have argued that OSS is less secure because the disclosure of source code provides important information to hackers (Messmer, 2008; Voth and Stone, 2003) while supporters of the Open Source model claimed that OSS has the potential to solve security issues quicker than proprietary products as the code is viewed by the vast OSS community. Consequently, this study identified security as an enabler of OSS adoption within APS organisations.

This study found that the *availability of source code* did not pose security risks to APS organisations as APS organisations realized OSS could offer better security compared to proprietary applications. Organisations realised OSS offered them freedom to modify the source code to meet their organisational business needs. Organisations found that customising OSS products was easier as the source code was available for modification. This enabled organisations to integrate OSS applications with existing technical environments that met organisational requirements, and reduced IT spend on software procurements. This finding aligns with prior research findings that OSS being more customisable than proprietary software was one of the drivers of OSS adoption within public sector organisations (Hwang, 2005; Mtsweni and Biermann, 2008a). Consequently, this study identified availability of source code as an enabler of OSS adoption within APS organisations.

Software Characteristics associated with OSS were identified as one of the reasons for OSS adoption. Software characteristics included the ability to add additional functionality, OSS's emerging capability, product maturity, and better features than comparable commercial software. Organisations added additional features to OSS if needed due to the availability of source code. This is consistent with the findings of Lorraine and Patrick (2007) that OSS facilitated better customisation, and was identified as an enabler of OSS adoption. Most OSS applications used within APS organisations were more mature and had wider community involvement in their development.

Software Quality also played a role in OSS adoption. The quality of OSS was often perceived to be of better quality than equivalent proprietary products, thus enabling OSS adoption. Enhanced product quality was a result of the contribution from the wider community to the development and testing of OSS applications. This ensured that OSS products were of high quality and up-to-date with latest features. Further, OSS applications were perceived to be better than proprietary products in terms of reliability, interoperability, and compatibility, which attracted public sector organisations to OSS applications. This finding is consistent with prior studies as OSS Product Quality was found to be an enabler of OSS adoption within European Union public sector organisations (Lorraine and Patrick, 2007; Schmitz, 2001).

Community Involvement was also considered in OSS adoption. Organisations interest in software enhancement and quick bug fixing enabled OSS adoption. These were by the wider community accessing the open code and contributing to its enhancement. Further, organisations realized that the OSS community was likely to be easily contactable when there was a need to contact the author of a particular piece of code. Community contribution to OSS products motivated APS organisations to adopt OSS. This supports Haider and Koronios' (2009) findings that concluded software products that had wider community support were often adopted by Australian state government organisations.

Freedom to modify OSS source code and freedom to access support for OSS without relying on a single vendor enabled OSS adoption. Freedom to modify source code allowed organisations to customise OSS products to better meet organisational business needs. This finding concurs with findings by Lorraine and Patrick (2007). Organisations found OSS vendors were more flexible in terms of offering support than proprietary vendors. Further, most organisations realised OSS adoption avoids or eliminates vendor-lock-in. This supports prior findings that freedom of choice facilitated by OSS was an enabler of OSS adoption in Australian state government organisations (Haider, 2008) as well as European public sector organisations (Deller and Guilloux, 2008; Lorraine and Patrick, 2007).

Staff (user) Appreciation also played an important role as it was found to have both positive and negative impact on OSS adoption. Positive attitude of the participants towards OSS source code motivated them to act as a source of information to convey the existence and viability of OSS alternatives during the procurement cycle. Further they perceived finding support for a software problem was easier to rectify because of the availability of source code. Consequently, positive attitudes of staff enabled OSS adoption. This supports Larsen et al.'s (2004) findings that user

appreciation and their subjective attitude play an important role in OSS adoption within an organisation.

Ease of Maintenance also played a role in OSS adoption. Adoption of OSS in government agencies relied on maintainability in order to sustain utilisation. Organisations perceived that the maintenance of OSS products was easier than commercial products. This was due to the availability of source code and freedom to find support and service from different vendors. Further, in some cases the lower maintenance costs of OSS compared to proprietary products facilitated adoption. However, earlier studies reported contradictory results regarding OSS maintenance. Robert and Schütz (2001) found maintainability was one of the obstacles to OSS (Linux) adoption in public administration as it imposed higher cost, while the US census bureau found that low maintenance cost for OSS supported adoption (Management, 2003). Further, Dedrick and West (2003) argued that perceived complexity associated with OSS administration decreased adoption rate. Nevertheless, this study identified maintainability as a critically important aspect of OSS as organisations claimed OSS maintenance was comparatively easier than for commercial products. Hence, this study supports the findings of Haider and Koronios (2009) that maintainability was one of the factors that led to successful adoption of OSS applications within Australian state government organisations. In this study, organisations perceived that OSS maintenance was less expensive.

Political Pressure was not a major enabler of OSS adoption as only a few respondents reported that it had the potential to enable OSS adoption. This supports Schmitz's (2001) findings that political reason was not a major incentive for OSS but still did have some positive impact on OSS adoption in European public sectors. Further, this study supports Haider's (2008) findings that in some cases government departments supported the products of major vendors because of political reasons. Adopters of OSS applications believed in OSS principles that include accessibility of source code and the ability to publish modified work under the same license. This provided an opportunity to make continuous improvements and enhancements to OSS applications to meet organisational business needs. This shows staff members' positive attitudes towards *Belief in OSS Principle* had a potential to enable OSS adoption.

Communication Channels had played some role in OSS adoption. Organisations referred to multiple sources of information on OSS before deployment. AGIMO guidelines were one of the sources referred to by most of the participating organisations. The consensus view was that the information provided in the guidelines was helpful in software procurement involving OSS. Most organisations agreed that increasing the availability of OSS guidelines would help them to better understand the benefits and risks of OSS, and would help improve the effective utilization of OSS products. However, this does not necessarily mean the guidelines should come from the government. If guidelines were available through a well known government agency such as AGIMO then it would have more credibility than other sources.

CONCLUSION

Based on the study findings, OSS provided economic advantages and was a flexible alternative to proprietary software. The adoption of OSS in Australian Public Sector organisations was contingent upon critical factors such as economic benefits, ability to meet organisational business needs, better software quality and features than proprietary products, easy maintenance, and availability of support. These results show that value for money and fitness for purpose are core principles underpinning APS organisation's ICT procurement as prescribed in Commonwealth Procurement Guidelines.

IMPLICATIONS

This study finding provides useful insights into OSS adoption process to OSS industry, OSS community, and public sector policy makers. Based on the study findings, the OSS community can produce better OSS applications that meet organisational business needs; OSS industry can offer better services to organisations; public sector policy makers can develop specific strategies to support OSS. For example, creating awareness of OSS applications, publishing up to date information about OSS, providing funding to educational institutes to promote more OSS specialised graduates, mandating Open Standards as in European Union and Brazil.

LIMITATIONS AND FUTURE RESEARCH

Like all research, this study has limitations in certain respects. The participants in this research were high-level authoritative people from APS organisations who were involved in software procurement. Consequently, their views may differ from end users or other stakeholders in regards to the adoption of OSS applications. It is acknowledged that individual attitudes towards OSS may be different for different groups within the same organisation. This research was not specific to any particular type of APS such as federal, state and territory, and local. Consequently, there may be differences between private and public sector as well as within APS that have not been examined. Another limitation is that the study did not focus on any particular OSS application. Therefore, its generalisation to any particular OSS application may not produce similar results.

All participating organisations in the case study were adopters. So in future research, attention could be given to collect representative data from both adopter and non-adopter organisations. Future research could aim to delineate the concerns of specific type of APS such as federal, state and territory, and local.

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