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A CASE STUDY OF OPEN SOURCE SOFTWARE ADOPTION IN AUSTRALIAN PUBLIC SECTOR ORGANISATIONS

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Abstract

Despite a considerable body of literature on factors involved in the Open Source Software (OSS) adoption process, there is little research into concerns of OSS by public sector organisations. So it was important to reassess the factors inhibiting OSS adoption in order to enhance OSS utilization within public sector organisations. This study explored various factors that may inhibit OSS adoption within Australian Public Sector (APS) organisations by interviewing those involved in software procurement. The findings were analysed through the lenses of technology adoption theories (i.e., Diffusion of Innovation (DOI) theory and Technology Acceptance Model (TAM)) and OSS adoption literature. Inhibitors to OSS adoption in APS organisations was contingent upon critical factors such as perceived lack of availability of support and training to sustain long-term usage, economical disadvantages associated with OSS applications such as higher support, maintenance and training costs, lack of product quality, inability to meet organisational business needs, and legal issues with licensing and intellectual property. The findings suggested Rogers' compatibility and complexity constructs are important factor in OSS adoption.

Keywords: Open Source Software, Technology adoption theories, Diffusion of Innovation theory, Technology Acceptance Model, Australian Public Sector.

1 INTRODUCTION

Open Source Software (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 & Patrick 2007). In Australia, public sector organisations are also taking significant steps to promote OSS adoption (AGIMO 2005). Yet, there is very little in-depth research on inhibitors to OSS adoption in public sector organisations (Goode 2005; Haider & Koronios 2009). It would be useful to reassess the organisational problems experienced in using OSS, as it would be beneficial to better understand the factors that inhibit OSS adoption particularly in an Australian public sector context. This research seeks to resolve the research question: *What are the inhibitors 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.

2 LITERATURE

2.1 Open Source Software

The term OSS was first coined in February 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 & West 2004; Lorraine & Patrick 2007). While other research identified inhibitors to OSS adoption within organisations (Goode 2005; Haider & 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 & Biermann 2008), availability of source code and security (Ven & Verelst 2006), availability of external support (Lorraine & Patrick 2007; Mtsweni & Biermann 2008; Haider & Koronios 2009), maintenance and economic benefits to the nation (Haider & 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 2005). Consequently, in Australia both federal and state governments are promoting the use of OSS (AGIMO 2005). Though there has been considerable research on success factors, there has been little focus on the inhibitors or challenges of OSS adoption within public sector organisations (Haider & Koronios 2009).

2.2 Technology Adoption Theories

Open Source Software adoption in organisations is a form of technology adoption. It is important and would be useful to study, apply and enhance the theoretical underpinnings of technology adoption in organisations to OSS adoption. The two main technology adoption theories used to test the adoption of new technologies are Innovation Theory (Rogers 2003) and Technology Acceptance Model (TAM) (Davis 1989). Innovation Theory identifies a series of factors such as *relative advantage*, *compatibility*, *complexity*, *trialability* and *observability* determine an innovation's rate of adoption. Innovation Theory in IS research has been used in different ways including the examination of factors involved in technology adoption (Tung & Rieck 2005). Tornatzky and Klein (1982) reviewed 75 examples of innovation literature examining the relationships between the attributes of an innovation and its adoption. Even though ten attributes had been cited in studies, only three innovation characteristics (compatibility, relative advantage and complexity) had the most consistent significant relationships with innovation adoption. Rogers (2003) also identified organisational characteristics (*formalization*, *centralization*, *system openness*, *interconnectedness*, *organisational slack* and *size*)

and environmental attribute (*adopter characteristics*) that are related to innovation adoption. The Technology Acceptance Model (TAM) was created by Davis (1989) based on the Theory of Reasoned Action (TRA) to explain individuals' intentions to accept and use computer technology in the domain of Information Systems (Davis et al. 1989). Individuals' attitudes are also important in organisational adoption as identified by Lapointe and Rivard (2005; 2007).

Both technology adoption theories (Innovation Theory and TAM) have been used to study organisational innovation. While there has been a large number of studies that have used TAM to research the attitudes of individuals towards technology adoption, some researchers have attempted to apply TAM's constructs in organisational studies (Handy et al. 2001; Ikart 2005). Rogers' innovation attributes were used to study technology adoption within an organisation (Tung & Rieck 2005; Lorraine & Patrick 2007). Some researchers indicate that the constructs employed in TAM were fundamentally a subset of the perceived innovation characteristics and, if integrated, could provide an even stronger model than if each theory was used on its own (Wu & Wang 2005). Their suggestions align with Moore and Benbasat's (1991) contention that the TAM constructs are similar to Rogers' perceived relative advantage and perceived complexity. This suggests that both theories could be applicable to study innovation adoption in an organisation.

There are different approaches to look at the technology adoption process. For example, Delone and McLean's (1992; 2003) IS success models and Depietro et al.'s (1990) "context for change". However, from the research based on the technology adoption theories and innovation adoption in an organisation, it is evident that both technology adoption theories have played important roles in innovation adoption within organisations. Consequently, this research will use both theories in a case study approach to explore the various factors that inhibit OSS adoption within APS organisations.

3 RESEARCH METHODOLOGY

3.1 Case Study

This research employs case study approach to investigate the factors that inhibit 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 inhibitors 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). Because case study methodology can be used to test or contribute to theory (Bryman 1989; Darke & Shanks 2002), information technology innovations have been investigated using this approach (Niederman & Davis 2006) to identify factors involved in information technology adoption (Dedrick & West 2004; Pease & Rowe 2005). Therefore, it is appropriate to apply the case study approach in this research.

3.2 Unit of Analysis, Data Collection and Data Analysis Techniques

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 inhibiting 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). Following that this research used individuals involved in the OSS selection process as the data collection source.

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. Previous research on identifying factors involved in technology adoption has employed semi-structured interviews as the data collection technique (Dedrick & West 2004).

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).

3.3 Administration of the Interviews

Interview questions were developed based on the factors identified from the OSS literature and technology adoption theories. Survey findings¹ 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. 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.

4 FINDINGS

Inhibitors of OSS are defined as organisational concerns such as problems experienced or perceived that inhibit OSS adoption. In this study organisational concerns were expressed in three ways: (1) problems experienced in the deployment of OSS applications, (2) practical difficulties in using OSS and (3) problems experienced with system migration including migration from proprietary products to OSS products and/or OSS products to proprietary products. The concerns are not common to all OSS applications either not common to all of the participated organisations. Instead, most of the organisations experienced same problems with different OSS applications, and are briefly explained in the following section.

4.1 Deployment Problems

Deployment problems are defined as problems or difficulties encountered at the time of OSS deployment. Based on the case study interviews, typical organisational problems at the time of deployment were: compatibility issues, economic value in using OSS and insufficient documentation.

Compatibility issues - *Compatibility* of OSS products with existing technical environments played a vital role in OSS adoption as OSS applications were often different to the standard working environment in organisations. In such cases, organisations faced difficulties in managing exceptions. For example respondent five² reported:

"...Mainly it's around departures from standards. Where we may have standardized on particular operating systems especially. our support tools are often highly specific to some operating systems and may not extend very well to some of the open source platforms ..."

Economic value - was employed in different ways: OSS applications need different skills (expertise) to install and maintain the software, so the cost is more; longer time taken to train the person to implement OSS than proprietary software ends up with extra cost. These are expressed by the organisations in many ways. For example, respondent five reported:

¹ A survey of factors involved in OSS adoption within Australian Public Sector organisations was conducted prior to case study.

² Interviewees are represented as respondent one thru respondent ten as there are ten participants for this study.

“...they (OSS applications) were different to our standard operating environment. Each time we look at one of these examples we are usually faced with overheads and extra complexity and costs for managing an exception. A different operating system may require different packaging and deployment methods. This in turn drives the need for different skills and tools, so the cost is more and it creates extra effort...”

Further, in some situations training for OSS applications is passed on to internal business groups who must bear the additional cost. In most of the cases economy is associated with finding a skilled person as it is harder for OSS products, maintenance and training.

Documentation - The standard of documentation was sometimes not as comprehensive as for commercial software and not up to date. While participants reported that some OSS applications had comprehensive documentation, the quality of documentation varied depending on the OSS application and was sometimes of little value. This was expressed by respondents six and seven:

“...OSS is a bit harder to install because often the documentation is not good...” - Respondent 6.

“...a lot of the documentation for Open Source Software is not up to date or as comprehensive as commercial... enough documentation to keep you going, but you really work hard to make it work well for you...” - Respondent 7.

4.2 Practical Difficulties in Using OSS

Experiences about practical difficulties in using OSS were perceived in different ways by different organisations, and are as follows.

Organisational Environment - *Organisational Environment* which included a lack of prior exposure to OSS and perceived lack of support caused problems in OSS adoption. There is a belief that if there is commercial support and consultancy available for open source products, then a higher level of quality and testing is assured. This could be seen from respondent seven's response:

“...I suppose it is back to the support, training and consultancy aspect. If there are organisations offering support training consultancy for open source products that I have then by nature they have a high level of quality and testing...”

Lack of knowledge and experience with OSS applications had a negative impact on OSS adoption. For example respondent eight reported:

“...The majority of people working in government IT departments are familiar only with Microsoft Windows and closed source applications. Problems are likely to be caused by a lack of knowledge and experience...”

Legal issues - Legal issues are important organisational concerns regarding OSS adoption. Legal issues were perceived in terms of OSS licence, Intellectual Property (IP), warranty, no ownership of the software and policy. One of the major legal concerns for organisations was OSS licensing. Most participants reported that there was confusion around OSS licensing which had a negative impact on OSS adoption. For example, respondents nine, three and four reported:

“...There is lots of confusion on GPL. Lots of interpretations and confusions around it. So that is a practical issue...” - Respondent 9.

“...Staff awareness and licensing risk...Obviously there are licensing obligations with open source.Licensing issues are a big issue...Staff have a very poor understanding of licensing risks...” - Respondent 3.

“...Open source licenses are different to proprietary licenses and they (who are charged with managing licensing) don't understand the specific terms. People are very concerned about open source licences in terms of IP...” - Respondent 4.

Concerns about OSS liability, and Intellectual Property (IP) played a significant role in public sector organisations contribution to OSS. For example, respondent six reported:

“...there are also issues for the government that if you make changes to open source stuff and it is done by the government all have liability issues or IP issues involved in that...So I think those concerns about liability and IP make governments reluctant to contribute back to the code base. But I think that is changing. I think what happens therefore is individuals in organisations contribute...”

Warranty of OSS products was considered important with OSS applications. In the case of proprietary products, developers have some liability and are responsible for issues with their products. But there is an issue with OSS liability as no one assumes responsibility for issues with OSS products. This is reported by respondent one as:

“...Nobody controls OSS that is good, sometimes nobody is liable for problems. Issues are not related to money. If we use Microsoft products and if there is a security issue then Microsoft is liable...”

In some circumstances, government policy indirectly affects OSS usage in APS organisations. Software products are assessed and accessed based on the Evaluated Product List (EPL³). But in reality there are very few Open Source Software listed in the EPL. This caused problems to public sector organisations in OSS adoption which could be seen from respondent five's comment:

“...I think it is just from government IT standards and point of view we are constrained by government policy. As mentioned before, if a product is not on the EPL, we need a policy exception to use it. This creates a barrier for take up by departments that might otherwise consider using those products...”

Product quality - Product quality is an important organisational concern, and was reported in terms of interoperability, documentation, lack of features, benchmark studies and security associated with OSS applications. Interoperability of OSS products with existing systems often caused problems for organisations adopting OSS. For example, respondent five reported:

“...Interoperability for systems management is often a bit more problematic. It is getting better...”

In one instance, one of the organisations was not able to adopt OSS as their existing software products did not work with OSS applications. Some respondents reported that inadequate OSS documentation caused problems in deployment (see earlier of this section). In some cases OSS lacked features found in equivalent proprietary software. For example, respondent four reported that

“...But you take DBMS like Oracle that has geospatial extensions and XML extensions compare to MySQL and you find that all the high tech stuff that we use on regular basis just isn't available in MySQL...”

Further, lack of benchmark tests available to OSS, and concerns around security of OSS products pose problems to its adoption. This could be seen from the following responses:

“...The benchmark studies are limited for open source. But commercial software vendors are able to provide performance test results for their products...” - Respondent 9.

“The risks are around warranty and there are some concerns around security. So security and support are some of the areas we have concerns...” - Respondent 3.

User impacts - perceptions about OSS applications have significant impact on OSS adoption that includes personal attitude, staff awareness, user interface, staff rejection and familiarity with proprietary products. In some situations users' personal attitude caused problems in OSS adoption if they had negative perceptions about OSS. Although some organisations have policy support for OSS adoption, overall perceptions can still have a bias towards proprietary products. For example, respondent nine reported:

³ EPL – Australian government maintains a list of software products called Evaluated Product List (EPL) which have been tested and assessed for security and encryption features.

“...In my organisation, I think there is a bias towards proprietary software. People may feel it is easier to get support, there is more marketing that is done by the proprietary products than open source products...”

Another difficulty was around convincing financial or procurement personnel about the viability of an OSS solution. OSS has little or no upfront costs. Due to this there is a belief that it has little value. For example, respondent seven reported:

“...one is convincing management (financial or procurement personnel) about the viability of the solution. There is still that belief it doesn't cost anything or has a low cost that is not a valuable commodity for us to look at...”

In some circumstances the user interface of Open Source Software is not of the same quality as the equivalent proprietary product. This created negative perceptions about OSS products. For example, respondents seven and nine reported:

“...Open Source Software tends to be a little bit rough around the edges in regards to usage, user interfaces, that is a generalisation. Some of them are very good and some of them are very poor...” - Respondent 7.

“...My opinion is the user interface part of Open Source Software has to improve significantly, I mean compared to proprietary software, people give less importance to user interface and usability, in general ease of use...” - Respondent 9.

Staff rejection was identified as a concern. In one organisation there was a strong rejection of OSS by the IT support staff because of a lack of compliance with existing standards. For example, respondent four reported:

“...one of the reasons why we move 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 obvious place to go...”

Organisational fit - The ability of OSS products to satisfy organisational business needs was identified as an important factor that affects OSS adoption. In particular, failure to produce strategic outcomes, and unsuitability for organisational business needs were reported as reasons for OSS failure. Respondent four reported:

“...Linux didn't continue to deliver the strategic outcome. So we moved to something else. It is not delivering strategic outcomes so we are considering what we can do in that space. We have a wider choice than just between the open source and proprietary...”

Compatibility issues - Compatibility was previously identified as an organisational concern in OSS deployment (refer deployment problems). Further, compatibility was reported as a practical problem in using OSS because organisations were standardized on particular OSS applications. While introducing OSS there were issues around compatibility between proprietary and OSS products. For example, respondent three reported:

“...We use Visual studio.net, which is an integrated development environment which does not work well for FOSS development. So it is not easy to mix it with open source...the issue for us as for as open source in software development is we would need to be conscious about compatibility between proprietary and open standards...”

4.3 Migration issues

Six of the nine organisations examined in the case study had migrated applications from proprietary software to OSS. An adequate data conversion path needed to be considered while migrating between proprietary and open source systems. For example, in one case the vendors of the proprietary software were reluctant about handing over the data in .csv files. In general they either did not provide the data or charged heavily to do so. For example, respondent two reported:

“...Make sure you got the clear path to accessing the data. So you can convert it from one system to another...getting assistance for data conversions are expensive. My experience is for

those conversions, for proprietary people the difficulty is about handing over the data as .csv files, what you need to convert. They won't do it or will charge you a lot to do it...".

5 DISCUSSIONS

This section discusses study findings in light of technology adoption theories and OSS literature. The relationship between identified factors to theoretical attributes is reported in table 1. The findings show that innovation attributes play an important role in OSS adoption by APS organisations.

Themes explored from case study		Innovation Diffusion Theory			Technology Acceptance Model	
		Innovation attributes	Organisational attributes	Environmental attributes	Perceived Usefulness	Perceived Ease of Use
Inhibitors	Compatibility	√				
	Economic value	√				
	Documentation	√				
	Organisational environment	√				√
	Legal issues		√			
	Product quality	√				
	User impacts			√		
	Organisational fit	√				
	Data conversion	√				√

Table 1. Summary of case study findings against theoretical attributes

Compatibility issues of OSS products with existing technical environments were concerns in adopting OSS applications within APS organisations. The decision to adopt OSS applications appears to be greatly influenced by the *Compatibility* of the software with existing organisational technology. In some circumstances OSS was not able to run on existing operating systems. Organisation support tools were often highly specific to some operating systems and did not extend very well to some of the open source platforms. Consequently, organisations needed additional skills to implement and maintain the software which ended up costing more than proprietary products. This result is consistent with prior studies which found that incompatibility with existing technology (proprietary software) and ICT infrastructure was a barrier to OSS adoption within public sector organisations (Lorraine & Patrick 2007; Mtsweni & Biermann 2008). Based on the above discussion, the innovation attribute *Compatibility* was found to have a negative impact on OSS adoption.

Economic Value associated with OSS applications is one of the major factors that determine its adoption. Costs associated with OSS include the costs for initial implementation, continuing the support, training and acquiring skilled people. Some organisations perceived there was a lack of availability of support as OSS needed different skills for implementation and maintenance than those existing within the organisation. This incurred higher costs. There were differing perceptions regarding training costs as some organisations claimed that there were cost savings while a few reported otherwise. This discrepancy could be explained by the number of OSS applications available and variance in quality, maturity, and community involvement. It generally followed that if an OSS product was mature and had good community involvement then there would be better support and training available at reasonable cost. This study supports prior studies conducted in the European Union which reported that concerns about expensive training and implementation was one of the barriers to OSS adoption (Ghosh 2005; Lorraine & Patrick 2007). The innovation attribute *Complexity* was perceived in terms of economic value, and had negative influence on OSS adoption.

Documentation available to OSS applications was perceived to be an issue in deployment as the standard of documentation was sometimes not as comprehensive as for commercial software and tended to be less up to date. This finding is consistent with Lorraine and Patrick's (2007) findings that poor documentation was one of the drawbacks with OSS adoption within European public sector

organisations. However, participants perceived that some OSS applications had comprehensive documentation, and the quality of documentation varied between different OSS applications and was sometimes of little value. However, issues associated with poor documentation made OSS adoption difficult. Consequently, innovation attribute *Complexity* perceived in terms of *Quality of Documentation* was identified to have a negative impact on OSS adoption.

Organisational Environment such as lack of knowledge and experience with OSS and perceived lack of availability of support had negative impact on OSS adoption. Lack of knowledge and experience with OSS products made it harder for organisations to adopt OSS as they were more familiar with proprietary products. This is consistent with prior research that lack of awareness, customer's uncertainty and unfamiliarity with OSS vendor relationship was a barrier in OSS adoption (Holck et al. 2005; Lorraine & Patrick 2007; Haider 2008). Organisations were less motivated to adopt OSS when there was a perceived lack of support for OSS applications. Organisations perceived that lack of support left them with complex issues in maintaining and using OSS applications. This result is not surprising, as support is an important factor for implementation and maintenance regardless of whether it is OSS or proprietary software. This result is consistent with prior research findings that perceived lack of support was a business drawback or a challenge for OSS adoption (Lorraine & Patrick 2007; Mtsweni & Biermann 2008; Haider & Koronios 2009). Based on the above discussion, innovation attribute *Complexity* which was interpreted in terms of *Organisational Environment* is negatively related to OSS adoption. Also *Perceived Ease of Use* was found to be an inhibitor of OSS adoption in the following ways: Organisational environment such as lack of prior exposure to OSS, and a lack of skilled personnel available for OSS deployment; perceived difficulties in data conversion while migrating to OSS. Consequently, TAM's *Perceived Ease of Use* is important to OSS adoption by APS organisations.

Legal Issues were important organisational concerns regarding OSS adoption, and were perceived in terms of OSS licence, Intellectual Property (IP), warranty, lack of ownership of the software, and policy. Confusion around OSS licensing made OSS adoption difficult for some organisations as they needed more effort and time to understand licensing implications and organisational requirements. Confusion regarding OSS licensing created issues with Intellectual Property (IP), and made organisations reluctant to contribute back to the OSS community. This supports earlier findings that lack of procurement models regarding OSS licensing (Holck et al. 2005) and being uncomfortable with releasing source code (Lorraine & Patrick 2007) were organisational concerns in OSS adoption. Further, lack of control over ownership of OSS applications had a negative impact on OSS adoption. For proprietary products, vendors have some liability and are responsible for issues with their products. This was not the case with OSS, as no entity assumes responsibility for issues with OSS products. This result is consistent with Lorraine and Patrick's (2007) findings that inability to hold someone responsible or accountable for problems was a concern in OSS adoption. Based on the above discussion, organisational attribute *Formalisation* was interpreted in terms of legal issues, and was found to be an inhibitor of OSS adoption.

Poor *Product Quality* was one of the reasons for failure of OSS products. Product quality was seen in terms of interoperability, documentation, OSS features, benchmark studies and security associated with OSS applications. OSS products that were perceived to be of high quality tended to be adopted while those of lesser quality were overlooked. Interoperability of OSS products with existing systems often caused problems for OSS adoption. The results from this study is consistent with Lorraine and Patrick (2007) findings that level of integration with existing systems and poor documentation were important issues with OSS adoption. For organisations that had adopted OSS, complexity associated with OSS *Product Quality* made OSS adoption difficult. Consequently, innovation attribution *Complexity* as interpreted in terms of *Product Quality* was found to have a negative impact on OSS adoption.

User Impacts played an important role in OSS adoption as it was identified as an inhibitor of OSS adoption. Personnel's attitude towards OSS posed difficulties in OSS adoption as they believed OSS might not be a viable option as it had little or no upfront cost, hence it had little value. This result is consistent with Mtsweni and Biermann's (2008) finding, as user resistance was an organisational

challenge in OSS adoption. Environmental attribute *Adopter Characteristics* was seen in terms of *User Impacts*, and was found to have negative impact on OSS adoption.

Organisational Fit was reported as one of the critical factors as the ability of OSS products to satisfy organisational business need as an important factor that affects OSS adoption. In particular, failure to produce strategic outcomes, and inability to meet organisational business needs were cited as reasons for the failure of OSS. On the other hand, OSS products that better met organisational business needs were often adopted. This study supports Goode's (2005) findings that lack of relevance to organisational business needs was one of the reasons for failure of OSS projects. The innovation attribute *Complexity* was perceived in terms of the ability of the software to satisfy *Organisational Fit*. Based on the above discussion the innovation attribute *Complexity* is negatively related to OSS adoption.

Data Conversion from one system to another was perceived as an issue during migration. With data conversion, proprietary vendors were reluctant to provide necessary data files to convert from one type to another. In general, they charged heavily to do so. This made it difficult for organisations to migrate their applications to OSS. This finding is consistent with prior findings that migration was one of the barriers or challenges to OSS adoption in public sector organisations, and it needed higher initial cost (Ghosh 2005; Mtsweni & Biermann 2008). Consequently, *compatibility issues* related to *Data Conversion* to migrate from proprietary applications to OSS were organisational concerns about OSS adoption. This supports innovation attribute *Compatibility* in terms of *Data Conversion* is an inhibitor to OSS adoption. Further, perceived difficulties associated with data conversion during migration made OSS adoption difficult. Hence TAM's *Perceived Ease of Use* was also found to be an inhibitor of OSS adoption by APS organisations.

6 CONCLUSIONS

The findings of this study showed that the failure of OSS in Australian Public Sector organisations was contingent upon critical factors such as economic value, compatibility issues, availability of support, product quality, organisational fit, organisational environment, legal issues, user impacts, documentation and data conversion. Decisions to adopt OSS applications appear influenced by the *Compatibility* of the software with existing organisational technology and skills. *Compatibility* in terms of *Availability of Support* and *Compatibility issues* with OSS was found to be an inhibitor to OSS adoption. Economic disadvantages associated with OSS applications, perceived lack of availability of support, lack of understanding and unfamiliarity of OSS applications, lack of product quality such as interoperability features, failure to produce strategic outcomes all caused difficulties for organisations considering a move to OSS applications. Consequently, *Complexity* was found to be an inhibitor to OSS adoption. Organisational concerns in terms of lack of prior exposure to OSS, difficulty in finding skilled personnel for OSS deployment, and perceived difficulties in data conversion while migrating to OSS shows *Perceived Ease of Use* was an inhibitor of OSS adoption.

6.1 Implications

This study has significant implications for theory and practice. The findings of this research showed that the influence of innovation attributes *compatibility* and *complexity* was comparatively higher than for other theoretical attributes. Further it showed environmental attribute *Adopter Characteristics* and TAM's *Perceived Ease of Use* also had some impact on OSS adoption. 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.

6.2 Limitations and Future Research

Like all research, this study has limitations in certain respects. 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. So 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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