

Exploring the factors influencing the adoption of Open Source Software in Western Cape schools

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ABSTRACT

Open Source Software (OSS) presents many benefits to both the private and the public sectors, and has proven to be a viable solution in schools. Although a policy mandating the use of OSS exists in the Western Cape province of South Africa, very few schools in the province have adopted OSS. The education system in South Africa is currently facing a crisis because of its inability to provide quality education, and its lack of funds. The Western Cape recently signed a Microsoft Schools Agreement.

This study aimed at gaining insights into the factors influencing or inhibiting OSS adoption within the Western Cape Schools Environment. In-depth interviews were conducted with senior staff in the Department of the Premier, and the Department of Education, as well as users at school level. The Technology-Organisation-Environment (TOE) framework was employed to organise the data, while thematic analysis was used to uncover themes and patterns in the data.

Significant factors that emerged as positive influences on the adoption of OSS included cost, performance and positive attitudes. The negative influences that emerged included compatibility, lack of resources and time, and lack of support. Recommendations for the negative influences were highlighted, and include research and development, employment of additional resources, on-going support, and training. The study contributes to existing knowledge, by extending the TOE framework through the inclusion of the "Individual" element.

Keywords: *Adoption, negative influences, Open Source Software (OSS), positive influences, schools environment, Western Cape.*

1. INTRODUCTION

Since its emergence, Open Source Software (OSS) has become a well-known topic amongst researchers and users (livari, 2010). Documents such as "The Cape Town Open Education Declaration and other visionary documents seek to unify and challenge educators in the creation and use of open learning resources" (Deacon & Wynsculley, 2009, p. 117). OSS has matured and its acceptance and market growth have increased to the extent that it is considered a viable solution and a serious contender to Proprietary Software (PS) by some (Weller & Van Belle, 2007). OSS is particularly relevant in developing countries such as South Africa as it reduces licensing costs, promotes technological development, and bridges the digital divide (Camara & Fonseca, 2007). In the area of government, OSS benefits include: cost effectiveness, no vendor lock-in, improved security, flexibility, and the development of people (Mtsweni & Biermann, 2008b).

The South African (SA) government has acknowledged OSS at a strategic level, and policies are in place to mandate and promote its use (James & van Belle, 2008). However, the adoption of OSS has been relatively slow or non-existent in SA (Mtsweni & Biermann, 2008b). In 2010 the Western Cape Education Department (WCED) signed a Microsoft Schools Agreement worth

approximately \$500,000 (Western Cape Government, 2011). This three year agreement is, however, unsustainable because of dependencies on foreign exchange rates, and the fact that the education system in South Africa is currently facing a crisis because of lack of funds and an inability to provide quality education to the learners (Modisaotsile, 2012).

In response to this situation, the objective of this research was to determine the factors that influence the adoption of OSS in the Western Cape Schools environment (WCSE). Based on a literature review, areas requiring research to broaden our theoretical understanding of OSS adoption in Western cape schools were identified, these gave rise to the following research questions:

1. What is the state of OSS adoption in the WCSE?
2. What are the Technological, Organisational and Environmental factors that could influence the adoption of OSS in the WCSE?
3. What individual factors could influence the adoption of OSS in the WCSE?

In order to achieve the research objectives, a qualitative research approach was chosen. Thirteen interviews with senior staff members were conducted in the Department of the Premier of the Western Cape, and the Department of Education, as well as teachers at school level. Students were excluded from the sample as they did not have any decision-making power or influence on OSS adoption. The data were organised through the use of the Technology-Organisation-Environment (TOE) framework and analysed using thematic analysis.

The study supported the literature in finding the factors hindering OSS adoption as being lack of support, resources and time, and negative attitudes. Factors found which contradicted the literature included compatibility, skills, technology support and services. Unexpectedly, the Microsoft Schools Agreement appears to be the main impeding factor. The study proposed possible mitigating strategies to these issues relating to change management, training and roll-out strategies. It is hoped that these will provide the WCED with relevant guidance and awareness of the influential factors that might impact on future decisions.

The paper is structured as follows. A summary of the literature review is presented, followed by the methodology used in the research. The findings include comparisons with literature, and answers to the research questions. The paper is then concluded.

2. LITERATURE REVIEW

The definition of Open Source Software (OSS) varies across the different sectors of business and government (Han, Wu & Lee, 2009). The definition debate is extensive and the two different interpretations that are most often used are “free software” and “open software” (Fuggetta, 2003). The terms ‘free’ and ‘open’ refer to the software source that allows access for anyone freely to use, analyse, modify and redistribute whether in its original form or in a modified form (Almarzouq, Zheng, Rong, & Grover, 2005). The idea behind OSS is to share the knowledge or product in question, more or less free of charge, thus enabling improvements to be made upon what has been shared (Mtsweni & Biermann, 2008c). However, OSS does not necessarily come at a zero price, as costs for software adoption are not confined to licence and upgrade fees which are free for OSS, but include support costs, operation costs and switching costs (Guliani & Woods, 2005).

2.1. OSS in Developing Countries

Besides bridging the digital divide in developing countries, literature emphasises that OSS is a cost-effective solution and presents developing countries with many benefits (Camara & Fonseca,

2007; Dudley-Sponaugle, Hong, & Wang, 2007; Simon, 2005). In particular, OSS can be utilised to gain software development skills, as well as be used as an instrument for social change (Camara & Fonseca, 2007). OSS therefore plays an important role as it supports the countries' development goals by for example enabling application leverage (Camara & Fonseca, 2007), increasing national security by less dependence on foreign countries, and changing the developer-consumer relationship (Dudley-Sponaugle, Hong, & Wang, 2007). Camara and Fonseca (2007) added that information, learning and adaptation are important for economic sustainability, and technologies need to be well chosen in order to serve the goals of social and human development of countries. OSS also helps promote diversity, allows flexibility, and allows for the digital era to spread to rural areas (Kshetri, 2004).

However, although many benefits are cited, the negative impacts of OSS in developing countries should not be overlooked (Dudley-Sponaugle, Hong, & Wang, 2007). Maintaining software quality and updating software in countries where skill sets are limited can be challenging (Dudley-Sponaugle, Hong, & Wang, 2007). Mengesha (2010) added barriers such as staff turnover, financial resource limitations and limited awareness, all of which can be present, but conquered.

To demonstrate commitment towards OSS, governments in developing countries such as Brazil, China, India and South Africa have enacted policies towards OSS adoption (Dudley-Sponaugle, Hong, & Wang, 2007; Kamau & Namuye, 2012). As the spread of OSS continues, government agencies worldwide have adopted or have already considered adopting policies that require adherence to open source software (Simon, 2005). Many governments have documented the benefits OSS brings to citizens, businesses and government counterparts (Kamau & Namuye, 2012). Kshetri (2004) emphasised that governments should support and encourage low-cost, minimal-infrastructure developments as offered by open source software to avoid implications such as disadvantaging the poor and not reaping the many alleged benefits OSS offers. Furthermore, Mtsweni and Biermann (2008a) state that the adoption of OSS by government sectors is seen as one of the enablers to OSS adoption by private sectors, as well as an enabler for the creation of new markets and business opportunities (Johnston & Seymour, 2005).

2.2. OSS in SA Government

Governments play a key role as potential users of OSS, by promoting the benefits and philosophy behind OSS as well as driving strategic change through society (Dyson, 2005). South Africa (SA) was the first African country to draft a policy to adopt OSS, and the SA government is seen as one of the more progressive governments when it comes to strategising and advocating the use of OSS within the public sector (Kamau & Namuye, 2012; Mtsweni & Biermann, 2008a). Although many governments have formulated OSS policies, research shows that substantial differences in scope and focus can be found (Bruggink, 2003). In 2002, a policy that mandated and encouraged SA government departments to choose, use, promote, develop and implement OSS solutions was drafted by the Government Information Technology Officers Council (GITOC) (GITOC, 2003). This policy was later approved and adopted by the SA government in 2006 (DPSA, 2006). Cabinet resolved that the SA government should move towards OSS utilisation, and the decision implied that, unless alternatives were superior, OSS should be adopted in government departments (DPSA, 2006). The SA OSS policy detailed five key points (choose, use, promote, develop and implement OSS) (GITOC, 2003), and further reports mentioned that government's implementation plans would not be big bang, but rather a gradual process (DPSA, 2006).

Even with the existing policy, minimal SA government OSS implementations exist, and adoption has been slow (Mtsweni & Biermann, 2008b). A 2008 study of OSS implementations in SA government departments revealed that usage was focused on the server and network side, and excluded desktop migrations (Mtsweni & Biermann, 2008b). Mtsweni and Biermann (2008b) studied 40 SA government departments, and found that usage was not as extensive as required

by the OSS policy (Mtsweni & Biermann, 2008b), and that, despite departments being aware of OSS, the majority still used proprietary software (Kamau & Namuye, 2012). Subsequent actions by government departments undermined the OSS policy, such as the SA Teacher Laptop initiative project launched by the SA Education Department in 2010, whereby laptops are subsidised for all teachers (Otter, 2010). The laptops in the laptop project explicitly favour Proprietary Software (PS), and exclude OSS options (Otter, 2010).

This led to the first research question, what is the state of OSS adoption in the WCSE?

2.3 OSS Adoption Model – Technology-Organisational-Environment framework

The Technology-Organisational-Environment (TOE) framework has been used for many years to understand organisational adoption of technology (Morgan & Finnegan, 2007). The TOE model defines a “context for change” consisting of the three main elements as depicted in Figure 1, which interact with one another to influence technological innovation decision-making (such as the adoption of Open Source) and impact on organisational performance (Dedrick & West, 2004). TOE is a useful tool for distinguishing between the inherent qualities of an innovation, and the capabilities, motivations and environmental context of the organisation adopting the technology (Dedrick & West, 2004).

The Technology context refers to both the internal and the external technologies available to an organisation which may be useful in improving productivity (Lippert & Govindarajulu, 2006). Technology factors listed by Dedrick and West (2004) are: Relative advantage, Compatibility, Complexity, Triability and Observability, and these are in line with those mentioned by Rogers (2003). These factors may negatively or positively influence the decision to adopt a technological innovation.

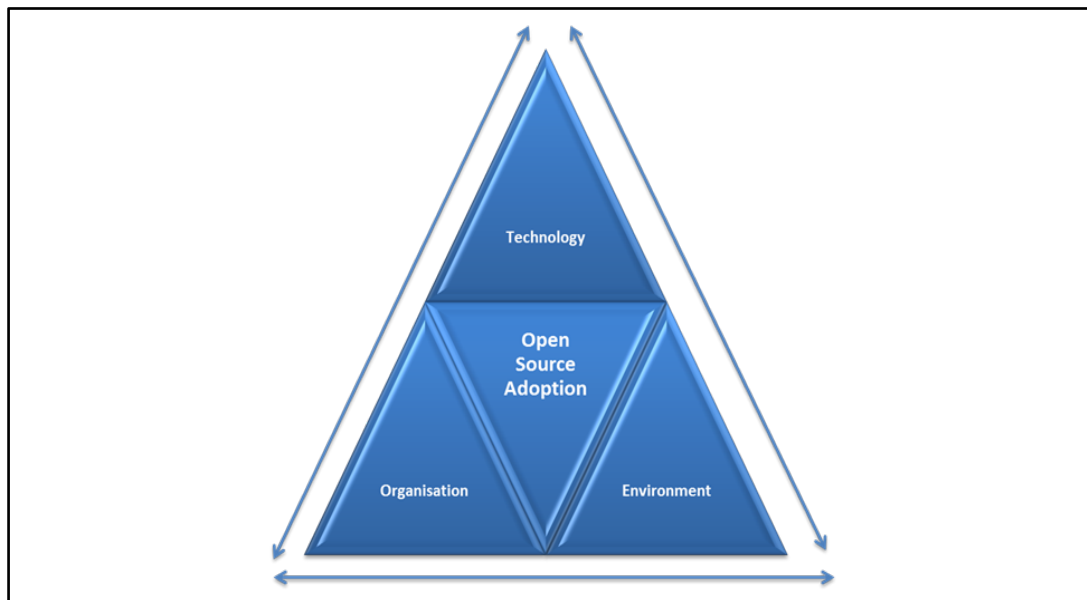


Figure 1: The TOE model (Dedrick & West, 2004)

The Environmental context refers to the way an organisation conducts its business, its relationships with external parties and government, access to the industry, competitors and regulations (Dedrick & West, 2003), which may present constraints or opportunities in terms of technological innovations (Morgan & Finnegan, 2007).

The Organisational context refers to the structure, resources and processes of the organisation (Morgan & Finnegan, 2007), which are required to support the acceptance of an innovation (Dedrick & West, 2003). The organisational context is characterised by criteria such as firm size and scope, complexity of the managerial structure, and quality and availability of resources (Dedrick & West, 2003).

The second research question was developed from the TOE model, namely, what are the Technological, Organisational and Environmental factors that influenced the adoption of OSS in the WCSE?

2.4 Individual factors

Individual factors which are not part of the TOE framework are cited as being an important aspect of OSS adoption (Morgan & Finnegan, 2007). These factors include aspects such as staff fear, uncertainty and doubt, skill obstacles and OSS champion presence (Morgan & Finnegan, 2007). Individual factors could positively or negatively affect an adoption decision and influence the Technology, Organisational and Environmental factors. User resistance for example is seen as a major challenge in government OSS implementation (Mtsweni & Biermann, 2008c). In addition, Johnston and Seymour (2005) mentioned that the South African public sector finds it difficult to up skill staff members because of costs and resistance to change. This led to the third research question; What Individual factors influenced the adoption of OSS in the WCSE?

“There is need to conduct surveys in African counties in order to obtain recent empirical data on OSS adoption levels and the barriers to its adoption” (Kamau & Namuye, 2012, p. 48). This research explores the factors influencing the adoption of OSS in a particular setting, namely the schools of the Western Cape province of South Africa, based on the three research questions developed. The TOE framework was used as a lens to analyse the data. After the data analysis the TOE framework was extended to include ‘Individual’ as a core element.

3. METHODOLOGY

The research was interpretive and exploratory in nature. In addition, an inductive approach was followed to allow for themes pertaining to the factors influencing OSS adoption in the WC schools to emerge from the data collected (Saunders, Lewis, & Thornhill, 2009). The time horizon of the study was cross-sectional as it studied the factors influencing the adoption of OSS at a particular point in time (Saunders, Lewis, & Thornhill, 2009).

3.1. Sampling

A purposive sampling method was used for this research (Saunders, Lewis, & Thornhill, 2009). Thirteen interviews were conducted with individuals from three identified groups, namely the Department of the Premier of the Western Cape, and two groups from the Department of Education, the first from the Head Office and the second from schools.

Within the Department of the Premier, ICT Services Managers and ICT Policy and Strategy Managers were responsible for the policy formulation and ICT advisory services to the departments in the Provincial Government of the Western Cape. Four of these managers were

interviewed as they played a strategic role in ICT decision-making within the Education department, and more specifically the schools environment.

In the Head Office of the Department of Education, five strategic role-players and decision-makers were identified and interviewed. These managers were selected as they played an active role in terms of equipment rollout to schools, decision making and policy enforcement, and they provided guidance for ICT implementations to schools. These nine respondents played an active role in the schools environment and were all involved in the decision to sign the three year licence agreement with Microsoft for schools in 2010.

Within the schools environment a total of four schools with a quintile status of four and five was identified. The quintile status of a school is classified by the Department, and groups schools according to literacy rate, income, school resources and school composition. The decision for choosing quintile status four and five was based on the fact that these schools were in the mid-category of schools in the province, as they did not form part of the advantaged or the disadvantaged school categories. At these schools either the IT specialist, principal, or an ICT teacher was interviewed.

In order to ensure anonymity and ease of reading the respondents were coded with pseudonyms starting with the letter of the group they reside under (e.g. P for Department of the Premier, H for Head office and S for School). Table 1 details the participants and the code names used in this paper.

Table 1: Respondents with pseudonyms

RESPONDENTS	PSEUDONYMS
Department of the Premier IT Respondent 1	Paige
Department of the Premier IT Respondent 2	Paul
Department of the Premier IT Respondent 3	Peter
Department of the Premier IT Respondent 4	Patti
Education Head Office Respondent 1	Harry
Education Head Office Respondent 2	Howard
Education Head Office Respondent 3	Helen
Education Head Office Respondent 4	Hadley
Education Head Office Respondent 5	Hilda
Education School Respondent 1	Susan
Education School Respondent 2	Sam
Education School Respondent 3	Simon
Education School Respondent 4	Steve

3.2. Data collection

Data were collected through semi-structured face to face interviews; where open-ended questions were asked in order to gain insight into the environment and the factors influencing the OSS adoption in WC schools. The flexibility of this method allowed the respondents initially to be guided and directed with questions, but also allowed for the omission of questions as well as follow-up questions to be posed depending on the respondents and the nature of the responses to the questions (Saunders, Lewis, & Thornhill, 2009).

In order to achieve standardisation and guide the data analysis, the interviews comprised a list of themes and questions structured according to the constructs described within the three contexts of the TOE framework. The interview protocol was tested on two people in the Department of the Premier and Head Office unit respectively, and after this exercise the protocol was slightly adapted by removing some irrelevant questions and rewording a few questions to avoid confusion. The interview questions varied in terms of order and type as not all were considered to be relevant to all respondents and their roles.

3.3. Data analysis

All interviews were digitally recorded using an Olympus recorder and transcribed using a free transcription tool namely Express Scribe. QDA Miner, a data analysis software package, was used for coding the textual data, and allowed annotating, retrieval and reviewing coded data and documents.

The researchers decided not to code all interviews in QDA Miner at once, but instead followed an iterative process to allow credibility and conformability. The first set of coding was completed on six of the transcribed interviews. Coding was achieved by reviewing the transcribed information line by line and appropriately coding the relevant text. This first exercise resulted in the development of 29 categories, and then simple code merging was done, resulting in codes such as “top down” merging to “approach”. The second coding exercise on four of the interviews resulted in 30 categories being developed, whilst the third coding exercise on the last three interviews resulted in 19 categories. QDA Miner then allowed the researchers to do a merge of the three different exercises which automatically combined all the interviews and merged the categories into one codebook. An initial cleanup was then completed where for example the code “reliable” was merged with “reliability”, and “user friendliness” merged with “user ability”. This process resulted in an initial total of 30 categories being established for the 13 interviews that were completed.

Thematic analysis was used to uncover themes and patterns in the data (Braun & Clarke, 2006). This allowed rigour to be added to the factors or constructs described within the three contexts of the TOE framework as well as the individual factors. Because the interview questions were linked to the constructs within the TOE framework and individual factors, standardisation to some degree was achieved and allowed additional factors to be uncovered, if any.

The query function was used to query the frequency per code and the data were then exported into Excel. Once in Excel, further groupings took place to allow easier analysis and data manipulations to take place. The query function was then used to extract the text linked to the codes identified. This was exported to Excel and analysed further.

Prior to the start of each interview respondents were reminded that their participation was voluntary and that they would remain anonymous. Approval to complete the research was obtained from the Department of the Premier, the Department of Education, and the Universities Research Ethics Committee.

4. FINDINGS

4.1. State of OSS adoption in the WCSE

In exploring the OSS adoption status in the Western Cape schools environment, the first research question posed was - What is the state of OSS adoption in the WCSE? This research question is answered in the following two subsections.

4.1.1. Usage of OSS in the WC Education sector

Ten of the 13 respondents are using OSS products as a result of individual choice, whilst three of them stated they had tried an OSS product in the past. The majority of OSS usage is focused on the backend products including the popular operating systems Linux and Ubuntu, and only two of the respondents were actively using OSS office products. The main reason cited for OSS usage was cost saving, Paul stated that he used OSS *“because [he] did not have to pay for it”*. Peter and Hadley respectively used similar phrases, concurring that cost drives their decisions: *“In the end this is a financial decision for me”* (Peter), and Hadley mentioned *“Why I use it is because the open source software is free, and freely available”*.

Paige, the IT respondent using the most open source products, did not mention cost, but stated that functionality was more important to her: *“Well in terms of how it operates it’s seamless, it’s better than Windows 7, in terms of manageability, ease of use, transparency, speed, many things”*. Helen was also not concerned with cost, and gave philosophical reasons why she personally uses open source: *“What made me decide to use open source, I think there are two main reasons. One is the age old debate of whether the world should allow Bill Gates and Microsoft to rule what happens in the computer field, and that one should look at supporting other initiatives. And so open source software and Ubuntu specifically”*.

Table 2 illustrates the results in terms of the usage of open source products used and tried per respondent. Blank spaces indicate that the respondent was not using open source products, or has not tried any open source software.

Table 2: Respondents: Open Source Software usage

IT Respondents	Using Open Source	Tried Open Source
Paige	Linux / Ubuntu / Libre Office / Thunderbird / Mozilla	
Patti	Linux / Ubuntu / Joomla	
Peter	Linux / Ubuntu	
Paul		Free Blackberry software
Head Office Respondents	Using Open Source	Tried Open Source
Howard		Linux / Ubuntu
Harry		Linux / Ubuntu
Hilda	Joomla / Moodle / Tux Paint / Tux Typing	
Helen	Linux / Ubuntu / Open Office / Libre Office / Express Scribe / Infra Record	
Hadley	Moodle / Authoring tool	
School Respondents	Using Open Source	Tried Open Source
Susan	Present / Open Office / Graphics tool	
Steve		Linux / Ubuntu / Open Office
Simon	Linux / Mozilla	
Sam	Email / Java	

All respondents were using Microsoft products on a daily basis (not shown in Table 2) as this is the provincial standard and is prescribed by the province (Western Cape Government, 2011). In addition, a three year Microsoft schools agreement exists where costs are covered by the Education Head office unit (Western Cape Government, 2011). Therefore all public schools in the Western Cape have access to Microsoft products without financially contributing themselves. Because of this, all schools are using Microsoft on the desktops for administration purposes. Schools do not pay for Microsoft products and benefit as the agreement extends to home usage as well.

According to respondents, because Microsoft software was previously offered free to schools, signing the Microsoft schools agreement was the most logical and natural thing to do. After the original free agreement expired in 2010, the use of any Microsoft software would have become illegal. The risk of not signing the agreement and having schools use Microsoft software illegally was too high.

All the school respondents explained that they have no reason to look at alternative software. Although all the school respondents were aware of Microsoft's schools agreement, none were aware of the costs involved. They use what is prescribed to them, and what they are familiar with.

"I use it because that is what is there, or that is what the department is asking us to use. But given a choice I will try some other software" (Sam). Similar views were expressed by Simon: *"Because we get Microsoft products free, everybody is okay with Microsoft so they only use Microsoft. Microsoft agreement extends to teachers, so teachers can have it at home"*.

All the respondents were aware of the Government's OSS policy; however, none of the respondents considered the alignment or compliance to be a factor for OSS usage. This is in contrast to the research conducted in 40 government departments by Mtsweni and Biermann (2008c), where compliance and alignment to the OSS government policy were indicated as a main reason for OSS usage.

4.1.2. Reasons for the Microsoft Schools Agreement

Respondents revealed that one of the reasons for signing a three year agreement was the fact that prior to 2010 Microsoft was offered free to all schools. The 'free' offer expired in 2010 and the risk of having schools use the products illegally, because of no official licence agreement, was high. As noted by Howard, *"We [Head Office] were worried about the schools, and we did not want to be in breach of contract"*, and *"There was no time to look at alternatives"*. After consultation between the Education Head Office unit and the Department of the Premier, the decision was made to sign the Microsoft agreement for three years to buy the time required to investigate alternative solutions for the schools environment.

However, the agreement is not sustainable and respondents indicated that no budget exists to sustain the Microsoft schools agreement. Paul mentioned, *"The new agreement is not reasonable ... completely unreasonable; in the 3rd and 4th year it is full price"*. Howard agreed by saying: *"The model is not sustainable."* In addition, all the school respondents indicated that, should the department stop paying for Microsoft, the possibility of them funding the agreement was almost impossible. To substantiate the importance of an alternative solution for the schools environment, the Education Head Office unit officially tasked the Department of the Premier, who is seen as their service provider in terms of technology support and advisory services, with research and development into OSS solutions for the schools environment. It is important to highlight that all the respondents agreed that the Microsoft agreement was signed in 2010 only because of pressure and in order to buy time, to allow for a comprehensive investigation to take place. With

the exception of one respondent, all the respondents agreed that the Microsoft agreement was an impediment to the adoption of OSS and was not sustainable.

The respondents made it clear that there was no formal adoption of OSS in the Western Cape, as Microsoft software was freely available following the signing of the Microsoft agreement. Thus the first research question was answered.

4.2. Technological, Organisational and Environmental Factors influencing OSS adoption in the WCSE

This section answers the second research question which was linked to the TOE adoption framework - What are the Technological, Organisational and Environmental factors that influence the adoption of OSS in the WCSE?

4.2.1. Technological Factors

- **Relative Advantage**

The relative advantage of reduced cost emerged as the most prominent factor positively influencing OSS adoption in the schools environment. The reduced costs linked to software licenses, upgrades and hardware costs were mentioned by respondents, who also felt that education funds should not be used for technology, but for their core function.

Howard strongly expressed the Education Head Office position by stating,

“I think the trigger of this whole process is the cost, so if open source is cost effective compared to proprietary software then also that freedom of having open source software because there is I mean, there’s less contractual obligations”.

With similar views, but differently phrased, Harry said,

“So obviously there would be a cost benefit analysis that would prove in the long run that it would be a sustainable method of savings funds ... At some point we will need to cross that threshold because proprietary software is too costly. Over the long run it is not sustainable”.

Respondents who have researched OSS products, and who have experience in using OSS products, strongly felt that for a schools environment, an equivalent OSS solution can be put in place. *“The open source equivalent costs you nothing and it’s rock solid. You should be able to replicate that environment using open source much more cost effectively than the Microsoft environment”* (Patti) and *“Processing documents is there, it’s free, email, it is there, it’s free, so, yes, you can achieve that goal with the proprietary or non-proprietary, costly or non-costly”* (Paige).

In terms of hardware, Hilda mentioned a concern regarding rolling Microsoft out to the schools environment.

“If they [are] going to roll out 2010, for example, in the schools environment they [are] going to sit with a problem, because in most cases those schools’ hardware will not meet the requirement, but, if they had to go the open source route, OS is not resource hungry like Microsoft.”

This finding is comparable to what was uncovered in a study of 40 government departments where cost was highlighted as an important factor influencing OSS adoption (Mtsweni & Biermann, 2008c). It is also in line with Brink, Roos, Weller, and Van Belle (2006), who stated that financial savings were the primary reason for OSS migration. Similarly, looking at the developing nations, lower costs were the most common reason for OSS migration in schools (Richter, Zo, & Maruschke, 2009).

- **Compatibility**

Product compatibility was highlighted as the most problematic technological factor owing to the provincial standard being Microsoft. Respondents explained that, if the Education Department decides to implement OSS in the school's environment, the same implementation needs to take place at the Education Head Office department, and other government departments. Cognisance is therefore taken that changing only the schools environment may be problematic in terms of compatibility. According to Helen, *"Compatibility can be an issue, certainly from file format perspectives. If a decision is taken by the WCED to move schools into an open source environment, it has an implication for the department here. There would have to be a decision in terms of what happens at the interface level between the interface in the head office, district office and schools"*. Peter concurred and mentioned that processes could be put in place to overcome the issue. Peter suggested that *"We will need to be very rigid and say the governance of say, if I send a document it must be in the open document format"*.

It was also highlighted that schools run a variety of non standardised software packages. Compatibility can therefore be seen as a complicated and huge influencer on OSS adoption in schools in the Western Cape. Howard said *"This is major,"* as *"You might have good open source software, but that might conflict with certain programs that we are not aware of. So it's quite an extensive task."*

Contrary to the studies by Dedrick and West (2003), and Weller and Van Belle (2007), who during their research confirmed that system compatibility was not normally the issue, respondents were concerned about compatibility in the schools environment. This concern, however, corresponds with the research completed in 40 South African government departments where the number one concern was compatibility with proprietary software (Mtsweni & Biermann, 2008c).

- **Skills of Existing ICT workers**

This factor is concerned with the staff's ability to use a new technology and according to the TOE framework this factor increases adoption if existing staff members have the relevant skills sets (Dedrick & West, 2004). All the school respondents did not see skills as an important or an influencing factor at all, and they all expressed confidence in the ability of their staff members to adapt to OSS with training and support. Simon who is responsible for IT at one school mentioned that *"Staff members normally follow the expert and are accustomed to adapting to new things in a school environment"*. Steve explained that decisions should be driven by *"economic imperatives and, although staff members are not skilled in open source, they will warm up to the idea and get used to the OSS products"*. This is contrary to the findings by Ellis and Van Belle (2009), who highlighted that the lack of knowledge was a fundamental factor in the slow diffusion of OSS.

Some respondents highlighted the possible exposure to OSS as being beneficial and great for the learners at the schools. Susan mentioned that *"Parents have a strong influence over the learners as the majority of parents are using Proprietary Software and this is what the learners are exposed to at their homes"*. However, respondents mentioned that it is important for the learners to be given the exposure to and the opportunities of OSS.

- **Fit to task**

All respondents expressed confidence in open source software products' ability to work in a school environment, and thus this factor was not seen as an influencing factor in relation to OSS adoption. Besides the possible compatibility issues, school respondents were not concerned about OSS software's fitness to work in schools.

- **Product Performance**

Product performance is not a construct covered in the TOE framework, however, according to literature the perceived performance of a product has an effect on people's attitudes towards technology adoption (Venkatesh, Morris, Davis, & Davis, 2003). Respondents raised issues of performance in terms of stability, usability, maturity, reliability and security. All the respondents agreed that, in terms of reliability, stability and security for administrative purposes, OSS products were better than proprietary products. Respondents who have been using OSS backend products such as Linux strongly expressed a view that in terms of reliability OSS is superior. Hilda mentioned that OSS was *"120% reliable, more reliable than your Microsoft"*, Patti stated, *"There are major problems at schools now 90% of the time it's viruses ... We would not have to worry about viruses, updates and patches all the time to keep the system running, like what we are having with Microsoft now"*.

In terms of stability, based on their experiences the two respondents expressed that OSS outperforms proprietary software. Patti stated that *"So the open source is running like a bomb, no problem, does not need any updates, does not need technical support, never really needed technical support It shows how rock solid it runs in the background,"* and Hilda mentioned, *"I know of webservers that have run for years without being touched. And on the Microsoft side you have to currently I mean constantly check"*. Howard was in agreement, and said, *"It is quite stable. Because I know Corporates who are using Open Source for some time now and they have no problems"*. Simon mentioned, *"I think especially Linux, I have found it to be much more stable than Microsoft and less easy to pick up viruses ... We don't run any virus protection and we never had any viruses"*. However, one respondent, Sam, expressed a different view, *"I would still say proprietary software seems to be more stable; that's my personal view"*.

The technology factors of cost savings and compatibility appear to be factors influencing the adoption of OSS in the Western Cape schools environment. The technology factors of skills, fit to task, and product performance did not appear to influence the adoption of OSS in the WC schools environment.

4.2.2. Organisational Factors

Currently the schools and the Education Head Office department receive IT support and services from the Department of the Premier. The IT services in the province is therefore centralised, however, dedicated resources are assigned to service the Education sector on Microsoft. According to Dedrick and West (2003), the organisational context is made up of the structure, resources and processes which are required to support the innovation. Several influential factors relating to the organisational context emerged during the study.

- **IT Innovativeness**

The innovativeness of the Department of the Premier did not emerge as an important or influencing factor in relation to the adoption of OSS in the schools. Although head office respondents expressed that the current IT staff members are not innovative, the views expressed confirmed that the lack of innovation is not linked to the individuals or the unit, but to time and bureaucracy instead. Hadley mentioned,

"I would say the Department of the Premier is as innovative as the bureaucracy allows them, because I am certain that they can be extremely innovative but working in the Government sector I am sure they committed to the service level agreement they signed 2 years ago".

There was overall confidence from the Education head office and the Department of the Premier respondents that, should resources and time be made available to the Department of the Premier, more innovation would surface.

- **Boundary Spanners**

Under the organisational factors, boundary spanners refer to staff members who have the relevant knowledge of the new technology, thus enabling a positive influence on the environment (Van Beulen, Van Belle, & Madhusudhan, 2009). Respondents revealed that, although staff with OSS knowledge and expertise currently don't exist in the environment, there is confidence that the staff members are able to upskill themselves if and when required. This factor therefore is not seen as influencing the adoption decision for the Western Cape schools environment.

- **Slack**

Slack resources can be subdivided into two categories: financial and human (Dedrick & West, 2003). An important factor that emerged was the lack of human resources, with particular mention of skills and time, in the Department of the Premier. There was agreement amongst all the Department of the Premier and the Head office respondents, who explained that there are currently too few resources to effect a technology change at the moment. Expressing her concern Patti mentioned, *"We are down to 50%"* of budgetted human resources. Helen said, *"One of the reasons now why there wasn't that move was because the support staff, Keith [name changed] and his people, said they do not have enough people to look after Microsoft. Now you want to train us in Linux and we got to start supporting Linux as well"*. It is evident that OSS skills are lacking. Peter commented, *"I have been sitting on interview panels for a long time now and you don't get open source technologists"*. Sharing a similar experience, Patti commented, *"People with open source experience find greener pastures very quickly, especially if they are teachers. It is an attractive and a highly lucrative environment for people with skills and big companies are prepared to pay for them"*. Helen mentioned that *"There might be an initial problem because we might be looking for scarce resources"*.

There was agreement amongst most respondents that the lack of human resources is more of an issue than the skills level of the resources. The IT respondents were of the opinion that, if their human resource base was increased, the support to schools with OSS would not be an issue. Harry added *"We want to strive to increase that number, not from one third to two thirds suddenly, but to get to a point where we can start doing the transfer of skills which stay inside the school"*. This supports the findings of Ellis and Van Belle (2009), who in a South African context found that there were few skilled human resources.

The organisational factors of innovativeness and boundary spanners were not seen as factors influencing the adoption of OSS in the Western Cape schools environment, whereas the lack of slack resources was seen as a major factor influencing the adoption of OSS in the Western Cape schools environment.

4.2.3. Environmental Factors

- **Technology support and services**

Typical concerns around technology support were raised during the interviews, as, although an IT support structure exists, the lack of resources as discussed above impacts on the support in the schools environment. All the respondents were of the strong opinion that, should a decision be made to change a technology, support needs to be available. Helen said that on-going support is essential: *"The support becomes very, very important. Because when you start to get hiccups in*

the new things there should be support to assist on the fly. Support is the major one – pre and post implementation.” The presence and importance of support is therefore seen as an important factor influencing OSS adoption in the schools environment. This finding supports that of Mtsweni and Biermann (2008b), who found that the lack of support is a critical factor to OSS adoption.

The school participants Sam, Simon and Steve expressed the same sentiment that support is important and will be required at their respective schools. Sam mentioned, *“I feel if they going to change they should give the necessary support. If the support is provided then it’s not a problem”*. Steve explained that schools do not necessarily have dedicated IT educators, and therefore require support structures. According to Steve, teachers who play a double or caretaker role for IT are a reality at many schools: *“The geography teacher who has a full load teaching his academic subjects has to also double up as the IT teacher. Support is the main thing”*. Brink, Roos, Van Belle, and Weller (2007) added that a post implementation review and on-going user support provide the extra guidance that may be required by organisations that implement OSS. Similarly in the schools environment, the findings revealed that this will provide the guidance and hand holding school users require to succeed.

Seven of the respondents used the OSS community for support, and even though all of their experiences were positive they did not think this was ideal for the schools environment. Paul mentioned, *“The forums, the open source forums, they are a lot quicker to answer and more to the point and more successful and they are really good”*. Helen shared her satisfactory experiences, but then added, *“but if this department decided that they are going to go open source, there is no way I would say use the community. There has to be a formal agreement in place with somebody - an organisation that will take responsibility for the types of support”*. Many respondents shared the opinion that structured vendor support should be in place to complement the existing IT support structures and this is in line with literature about large organisations where the requirement for structured support because of accountability and reliability is an important factor (Dedrick & West, 2003).

Both Paige and Patti added that the availability of OSS vendor support in South Africa has increased, and they were of the strong opinion that, should Education Departments make the decision to implement OSS in schools, the market will become flooded with support options. Patti stated, *“There are a couple of formal organisations you can approach. If the thing is big enough, there will be big enough players who we can rely upon”*. Paige mentioned, *“There are already companies who have approached us who are willing to provide support”*. The existing OSS support structures did not appear to be a concerning factor in relation to OSS adoption in schools. This contradicts Ellis and Van Belle (2009), who stated that lack of vendor support or the OSS communities posed a risk to potential OSS adopters in South Africa.

- **Legitimacy**

Legitimacy refers to the fear of a new technology being abandoned, and according to Ellis and Van Belle (2009) this factor emerged as an enabler and a barrier in their research concluded in Micro and Small Enterprises in South Africa. No respondents mentioned this or a similar issue, and therefore it is not seen as a factor for the OSS adoption in the schools environment.

- **Product Awareness**

All of the respondents were aware of OSS and many of the OSS products available. This was confirmed by the definitions of OSS provided by the respondents, as well as various products that were discussed. Peter raised a concern about OSS knowledge at schools, saying that there are *“few people that understand open source, so you are sitting with a large number of teachers and people knowing at least something about Microsoft”*. This, however, did not seem to be a major

factor as many respondents agreed that the users at school level do not necessarily need to be aware of the OSS products, as they rely on the IT experts or the head office unit to make the technology decisions.

However, lack of OSS awareness surfaced when the respondents were asked to compare various features of OSS and Microsoft software products. Many participants were hesitant to answer and reserved their views in terms of the security, reliability, stability and maturity of OSS products. As an example, when asked about compatibility, Sam commented, *"We don't know because we have not really used open source to such an extent to be able to answer that satisfactorily,"* and Howard stated, *"It would be unfair to compare with something I am not knowledgeable about"*. This, however, presented no impact on the adoption or diffusion of OSS in schools, as the head office respondents expressed their view that the Department of the Premier will guide the decisions for OSS implementation in schools.

Compared to OSS, the awareness of Microsoft is high in South Africa owing to the marketing strategy employed (Johnston & Seymour, 2005), and is seen as an influencing adoption factor in many organisations (Ellis & Van Belle, 2009). Besides marketing, Susan added that an important aspect of the schools environment would be literature resources. Although this was raised only by one respondent, Susan expressed a strong opinion that for the schools environment printed literature is an important factor. *"I have not found advanced books in the shop on Open office or Libre office ... There is a lot of people who like stuff in print. They want a book and I have not seen books on open source material"*. This factor is similar to that found in India, where the challenge experienced with the spread of OSS in schools was the lack of training materials (Hariharan, 2010).

The environmental factor in relation to technology support and service was seen as a major factor influencing the adoption of OSS in the Western Cape schools environment, whereas legitimacy and awareness were not.

4.3. Individual Factors that influenced the adoption of OSS in the WCSE

The third research question, what individual factors influenced the adoption of OSS in the WCSE, is answered in this section.

4.3.1. Attitudes

One of the strongest issues to emerge from the study was the attitude towards OSS and the adoption of a new technology. Attitudes of individuals are either positive or negative and normally fear and resistance are observed when individuals are familiar with a particular technology that may change. Many respondents spoke about the comfort zones people are in, as well as the familiarity with Microsoft which plays an important role in the decision to adopt any other technology. In the schools environment individual attitudes towards Microsoft are positive. Typical comments include, *"Microsoft already won the hearts and minds of people, so it's hard to beat down at this stage"* (Patti); *"By and large the teachers are more comfortable with Microsoft because Microsoft is the company that is out there and they all have Microsoft products"* (Steve); and *"Microsoft has been around and made their mark, and we have been using Microsoft for some time now"* (Howard).

The IT respondent who was involved in piloting open source software in his unit disclosed the reaction of people when they were told that open source software products had been installed on their machines. Without these people examining or using the products, a negative attitude was revealed: *"When you tell people you are actually using open office and it's not Microsoft Word*

they say is it open source take it out please ... It is not the functionality; it's the perception of what it does" (Paige).

Paige added that she is aware of a government organisation where open source was used for six months, and when new management was appointed they reversed the decision without reason: *"They [new management] said what is this? I don't know this. At home I use Windows 7. It's faster; it does this and that and then you had a corporate decision that changed the whole thing"* (Paige). Furthermore, three respondents agreed that people generally tend to have a negative attitude and perception when it comes to open source software. Paul firstly mentioned that *"People have a negative feeling towards open source"* and later during the interview added that the response or reaction he thinks will be most forthcoming will be in line with *"No, I grew up with Microsoft, I am not going to change"*. Hadley stated, *"I think they will tend to say no before they actually try it,"* and Susan commented, *"It will be perceived as being inadequate"*.

Peter's attitude was that the status quo should be maintained, and said *"The investment we made in the past, we can't just leave that and change 180 degrees now"*. Harry said, *"If you look at the education system it is a very large ship. And to change direction, 180 degrees from proprietary to non-proprietary would become a very difficult thing to implement. And we're not saying it's a 0 to 100 or 180 degrees change from proprietary to non-proprietary. There may be hybrid solutions that are available"*. Susan suggested that a hybrid solution should be explored. She simply stated *"You can use both"*. A hybrid approach is in line with that suggested by Brink, Roos, Van Belle and Weller (2007), who stated that a combination of OSS and PS in an organisation is a suitable solution.

4.3.2. Resistance to change

The individual factors found during this study that inhibit OSS adoption in the schools environment are in line with those of Morgan and Finnegan (2007). According to Morgan and Finnegan (2007), fear, uncertainty and doubt are factors that negatively impact on OSS adoption. All three factors were mentioned by the different groups interviewed during the study. The issue of user resistance as mentioned by Mtsweni and Biermann (2008c) was highlighted during this study, as well as staff resistance as cited by Johnston and Seymour (2005). Both user resistance and staff resistance were raised by respondents.

User resistance was not seen as a major factor in this study, contrary to findings by Mtsweni and Biermann (2008c), who during their research in government departments found user resistance to be a major challenge. Many respondents spoke about countering user resistance with change management processes. Howard mentioned change management on more than one occasion. *"Change control is a major factor for the school environment"*. Peter used similar phrases to express his views: *"I think it is also a mindset, and in your change management process you could address these things and, yes, you will have problems, but I think, if it is well thought out, the problems will be minimised"*. These findings are in line with those of James and Van Belle (2008), who found that the lack of social interaction between people can negatively impact on the adoption of OSS.

According to Paige who has worked with technologists who serviced the schools environment, staff resistance is a much bigger issue than user resistance. Paige stated, *"The mindsets of the IT personnel [are anti OSS], so they are the biggest stumbling block in the change"*. During their research in the public sector Johnston and Seymour (2005) found that the staff resistance to change was affected by their training and certification by proprietary software companies. However during this study, the findings specific to the resistance of the IT staff for the schools environment are associated with time. All the IT participants agreed that the lack of time plays an important role in their environment and affects the staff skills and innovation. Patti mentioned:

"The scope of our work out there is far too much to have time to really skill themselves [the IT technologists/technicians] up during work time", Peter added, "It's also limited to time. If we have the time to explore what is available. – it's time, time, time".

Some respondents stated that top management buy-in and a top-down approach are also positive influences on OSS adoption. Two respondents felt that a solid policy for the schools environment and broader government departments is vital for success. Paige mentioned: *"Unless you have a central governing policy decision - saying this is what is going to happen in schools - it's not going to happen".* Helen said, *"If there is a policy shift, let's say in the province, we are not going to go Microsoft; we are going the Linux route say in five year's time - the industry will start to take note of that".*

4.3.3. OSS Champion

The findings at two schools support the findings of Morgan and Finnegan (2007) that the drive of an OSS champion is a significant factor influencing open source adoption. Susan and Steve explained how their schools benefited from an open source laboratory; however, in both cases when the OSS champion left, the lab become non-functional soon thereafter: *"Mr Barry [name changed] left and that whole system came to an end. And there was no pioneer to take the baton where he left off"* (Steve). Susan added, *"The network administrator about 10 years ago at the school was an open source lady. The network software was Linux ... I do not know what happened to that lab"* (Susan).

An important responsibility of the IT division of an organisation is to champion an adoption initiative or project as they are the key drivers of successful implementations (Johnston and Seymour, 2005). Similar views were clearly articulated by two Education Head Office participants, who felt that the IT employees have the responsibility and expertise to take the lead and move the department into a direction that meets their objective. Harry said, *"I think our quick wins would be to get our business champions [IT technologists] in the field to field test and to be our sort of voice to the rest of the schools".*

Individual factors such as negative attitudes, lack of top management buy-in and policy appear to have influenced the adoption of OSS in the WCSE. Resistance to change by IT staff appears to have influenced the adoption of OSS in the WCSE, while resistance from users does not appear to be a major issue. OSS champions positively influence adoption of OSS while they are in place.

5. CONCLUSION

The aim of this study was to explore the current situation in the Western Cape Schools of South Africa in relation to OSS adoption, and to determine the factors that influence the adoption of OSS in the WC schools environment.

The study found that, since the Microsoft schools agreement has been in place, there is no adoption of OSS in the Western Cape Schools environment.

The cost benefits of OSS, strong technology support and service, and OSS Champions were revealed as the key positive influences on the adoption of OSS in schools. The key factors that hinder the adoption for schools included compatibility with proprietary software, lack of slack resources, insufficient human resources and lack of time, IT staff resistance, lack of top management buy-in, lack of clear policy, and negative individual attitudes. Factors such as OSS skills, fit to task, product performance, innovativeness, boundary spanners, legitimacy and

awareness appear to have a weaker influence on the adoption of OSS in the Western Cape Schools environment.

Confidence exists that with top management buy-in, a clear policy, and the employment of additional resources OSS could be successfully adopted. An important factor, however, is the Microsoft schools agreement which is valid until 2013, and is considered as the main impeding factor in relation to OSS adoption in schools. Because of this agreement, current employees' expertise and time are used to support proprietary software in schools, and little time is available to look at alternatives or to be innovative. It is interesting to note that this agreement is considered unsustainable, and therefore could be seen to have a positive influence on the adoption of OSS in schools.

The TOE framework was used as the conceptual framework and was useful in organising the factors. However, the findings revealed that the 'individual' factors played an important role in OSS adoption. The findings showed that, although OSS adoption is considered to be an organisational adoption, the individual factors are strong influences. These include the presence of a champion and positive attitudes which play a major role in adoption.

The findings also showed that the 'Organisation' context of the TOE framework was the most influential. Although the factors are not directly linked to those of the TOE framework, the additional factors uncovered can be indirectly linked to the organisational context. These include top management buy-in, policy, change management, allocation of resources and training. If these factors are included in the OSS adoption strategy of the Education Department, it is expected that the OSS implementation in WC schools would be smooth and successful. The study contributes to existing knowledge, by extending the TOE framework through the inclusion of the "Individual" element.

It is hoped that this study would provide the WC Education Department with some guidance about and awareness of the factors that may impact on their future decisions. Possible areas for future research would be to repeat the study by including more schools in the sample to confirm if the findings can be generalised. A limitation of this study was the exclusion of OSS for curriculum purposes at WC schools.

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