

A Theoretical Research Framework of Open Source Software Adoption in Malaysian University Information and Communications Technology Centers

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Abstract—Open Source Software (OSS) has been an effective replacement for proprietary software in many domains and especially the public ones. The Advantage of OSS led governments around the world to adopt this software and promote aggressively to their public agencies. However, many of the initiatives have failed to adopt the OSS within their organizations. As a consequence of this, it is important to look further from the literature to understand the factors that influence the OSS adoption success in the public sector. Based on a review of more than 100 articles, the study aims to fill the gap by clearing the facts about the current state of OSS adoption in Malaysia and to address the factors that may influence or hinder the OSS adoption. The paper concludes with two issues that need to be clarified before the proposed theoretical framework of the study can be further explored and developed 1) to identify the factors that may influence the OSS adoption decision and process in both the management level and the user level in Malaysian University Information and Communications Technology Centers (ICTCs); 2) by finding a new perspective to investigate the determinants to the OSS adoption.

Keywords – OSS, Adoption; Factors; Conceptual framework; ICTC; Malaysia

1. INTRODUCTION

Open source software (OSS) is a computer program that developed, enhanced and built in a collaborative environment through the internet[1]. Many developers around the world are involved in developing and modifying these programs with licenses that conform to the open source definition (OSD). On the other side, closed source software or what known as proprietary software are the exact opposite to OSS because no one can reveal the source code as it's in binary form and also protected by vendors with many patent laws and copyright for competency purposes [2, 3]. OSS is copyrighted by its authors, and is made available under copyright licenses that comply with the OSD criteria. There are about 66 licenses were listed as being approved by the OSI in 2006 [4]. The list includes, the first open source license, known as General Public License, the European Union Public License, and licenses from major IT companies including IBM, Microsoft, and Nokia. The main purpose of inventing those licenses is to safeguard the commonly developed OSS from individuals or companies that tried to turn the OSS into proprietary software.

OSS has been an effective replacement for proprietary software in many domains and especially the public ones. The spread of OSS led many Governments to adopt OSS and promote aggressively to their public agencies[5]. Because of the uncertainty and lack of knowledge about OSS, most of the scholars were more focused on addressing the influencing factors like cost effectiveness and customization of code. The constraints addressed were lack of support and availability of resources that may lead the governments and public agencies to adopt successfully the OSS. The government promotes for adopting OSS in public agencies and even encourage private sector sometimes like in Singapore, where they offer tax reduction and financial grants for Linux-related projects[6]. Although many governments have implemented their policies to promote for OSS adoption in public agencies[6], still recent studies have shown the low adoption rate within public agencies and didn't replace proprietary software with OSS alternatives. The reasons may vary depending on the factors that may lead to this degradation in OSS adoption like if the government, whether encourage or dictate the policy to public agencies [7], lack of confidence[8], and no professional support [9].

In Malaysia, some studies have also concentrated the OSS adoption within the government agencies in the country [3, 5]. This includes studies that investigate to what extents the OSS have been adopted by examining case studies in public agencies. For instance, Mindel[10] has investigated the OSS adoption within ASEAN members (including Malaysia) to find how much is the OSS adoption rate and what factors seems to be the most influential on OSS adoption process. Other studies [3, 5] have also shown that OSS adoption rate still low in Malaysia. This indicates that there is a need of OSS adoption study to determine the factors affecting and shaping the process. This is an important area since only a few studies have discussed the overall picture of the adoption of OSS products or services by government projects, producing a misleading picture of OSS adoption.

This paper is conceptual in nature and documents the inaugural form of a research project designed to theory building of OSS adoption process in Malaysian University ICTCs. The aim of this paper is to propose a framework of OSS adoption process to guide system development within ICTCs as they embark upon the implementation of OSS. The paper is structured as follows: Section two presents the research method in conducting the study, the third section describes the knowledge body of OSS adoption research; the fourth section addresses the proposed framework of OSS adoption process. The final section concludes the study and provides some possible future research directions.

2. Method

This part outlines the search strategy and selection criteria adopted for this critique, and provide descriptions of the types of studies reviewed. The methodological foundations upon which the reviewed research rest is then hashed out. The beginning phase was the search strategy in which it takes up by identifying relevant research concerning OSS adoption influence factors, by searching several databases (i.e., IEEE, Elsevier and Emerald). With OSS adoption-related keywords was searched. The preliminary search resulted in 238 papers. The second stage was a detailed examination of the papers, and at this point studies were excluded if the OSS adoption influencing factors were insufficiently described, or OSS adoption was only a minor variable in the study, and therefore the study did not contribute important information to this review. Perusal of abstracts resulted in the elimination of 166 articles which did not directly pertain to OSS adoption. This resulted in a list of 72 papers related to OSS adoption. Observing this, the study carefully examined each paper to key out and categorized it into various themes as discuss in the following departments.

3. LITERATURE REVIEW

There are many ways of how governments adopting the OSS. Singapore government, for example, has preferred to provide a tax breaks to companies in private Linux operating system and replace other proprietary software like windows operating system [11]. The government in Germany reached into an agreement with well-known vendors like IBM to supply the government agencies with pre-installed Linux operating system [11]. In Vietnam, the regime opted to encourage OSS adoption and utilization through the OSS master plan [12]. The UK government policy preferred the OSS usage, along with proprietary software because what OSS can offer starting from cost, interoperability, security and return on investment [13].

In another case, the government of Brazil can be reckoned as unitary of the leading developing countries in embracing and implementing OSS, which the government initiated a master plan in 2003 to encourage local governments to begin replacing the proprietary software with OSS [13]. In 2005, the Brazilian government starts mandating the policy to all local government authorities to shift to OSS. China has likewise adopted a standardized approach to Brazil by forcing public agencies to adopt OSS and reject the usage of proprietary software [14]. While France still encourages and recommending government agencies to use OSS within their IT operations [14]. However, some governments like the United States rejects any OSS solution unless it's granted the permission by requiring a security certificate from the National security agency (NSA).

With this regard, the literature on OSS adoption in government can be classified into two areas: 1) the influencing factors that help leading the government agencies and ICTs to adopt the OSS; and 2) the barriers that hinder the OSS adoption process. Many authors have studied to investigate the factors that may lead or not to the right decision for adopting the OSS specifically in the public sector. For instance, Gonzalez and Daddara[15] in their studies have shown that OSS is the most attractive software for business because of its availability to be downloaded free of

charge from the internet. The cost of free factor has also been agreed by Szyperski and Spinellis [16], who believe that this made the biggest contribution to the widespread adoption of operating systems like GNU/Linux. In other studies, Krishnamurthy [17] claims that source code availability is also one of the positive factors that influence organizations to modify the software to meet their specific needs. Other factors, such as the complexity of the license and OSS users had a negative impact on OSS adoption. These two factors are still legally responsible for ensuring the license requirements are met which raise implications regarding the intellectual proprietary rights and competitive advantages [18].

There are also factors that can have both positive and negative impacts on OSS adoption like the government policy which many governments in developing countries have issued policy statements recommending or dictating the use of OSS. Taiwan is one of the examples of how governments have a negative role regarding the adoption of OSS within public agencies which they issue an anti-piracy campaign, which led in the end to lose the promotion of OSS [19]. On the other hand, other studies have recommended the public agencies to adopt the OSS by following the government guidelines and policies and also they recommend to attaching the procurement decision with these guidelines to make more public agencies move toward OSS adoption [20-22].

The literature on OSS adoption also briefly addresses the barriers that hinder the OSS adoption in the government. Nagy [23], for instance, five barriers have been identified that hinder the OSS adoptions which are knowledge barriers, legacy integration, forking, sunk cost and finally the technological immaturity. While studies [24, 25] found the lack of support is one of the challenges of OSS adoption. OSS also bears no guarantee that development will happen. In other words, it is not possible to know if a project will ever reach a usable state. The publicity of OSS is weak and sometimes it's difficult to know that a project does exist, and to track its current status. The lack of advertisement for OSS projects by the OSS community has contributed negatively to the OSS adoption as well [27].

3.1 OSS Adoption in Malaysian Government

OSS has been heavily adopted in Malaysia since 2004 and specifically in the public sector. Malaysian Administrative Modernization and Management Planning Unit (MAMPU) is considered the main driver for OSS adoption for which it's responsible for encouraging and recommending the use of OSS in all government agencies in Malaysia [28]. MAMPU has encouraged the OSS development and implementation. It has been given a great responsibility to lead this initiative within the public sector. The vision for OSS in the Malaysian Public Sector is to create and enhance value by using OSS within the Public Sector ICT framework in providing efficient and quality services [28].

On the other hand, a number of studies show that it's not clear how exactly the current state of OSS adoption specifically in Malaysia is. Although the study by Mindel [10] on OSS adoption in ASEAN countries has approached the issue, unfortunately, the research is severely limited as it only examines whether government agencies in the region used OSS in their web server applications and not what might have been the drivers influencing software adoption. It's too obvious that OSS had an extensive impact on the organization which will lead to economic and social gain if these organizations implement OSS components systematically [29, 30]. A study has also shown that the OSS adoption rate is still low within public sector organizations in Malaysia and the implementation of OSS also is still scant because of the absence of certain factors [22, 31]. This study is aim to fill this gap by clearing the facts about the current state of open source software adoption in Malaysia and to address the factors that may influence or hinder the adoption.

3.2 Factors Led to OSS Adoption

The factors fetched from literature and the comparison was conducted based on the frequency of factors in each paper reviewed, the factors of user resistance, lack of support and lack of Human resources were the most common factors that inhibit the OSS adoption [8, 9, 32,33,34] (refer to Table 1). The study also suggests that cost, OSS champion and top management support were the main positive drivers to initiate the OSS adoption. In addition to the other papers reviewed, five of them deeply examined the influence of each factor on the OSS adoption in public domains.

Table 1: Influencing factors for OSS adoption

	Chau and Tam 2000 [33]	Glynn and Fitzgerald 2005 [34]	Laila 2010 [8]	Johnston 2013 [9]	Qu 2011 [32]
Organization size	(+)	(+)	(+)		
Cost	(+)	(+)	(+)	(+)	(+)
Lack Human Resources	(-)	(-)	(-)	(-)	(-)
Management Support		(+)	(+)	(-)	
Lack of Support		(-)	(-)	(-)	(-)
Lack Financial Resources		(+)		(+)	(+)
OSS Champion		(+)			(+)
User Resistance		(-)	(-)	(-)	
Technological Benefits		(+)	(+)	(+)	
Existing System Unsatisfactory	(+)		(+)		
Total cost of ownership	(+)		(+)		
User Perception		(-)	(-)	(+)	

Table 1 shows the influencing factors that encourage the OSS adoption (shown with a positive sign (+)) or hinder the adoption process (shown with a negative sign (-)). The studies [8, 9, 32-34] chosen the cost to be the most positive factor to the OSS adoption decision regarding the low cost of OSS. Laila and Chau agreed the total cost of ownership is also considered as a factor that helped in OSS adoption. Chau and Tam [33] presents two schools of thought, namely the Technology push (TP) and the Need pull (NP).

The TP force stems from recognition of a new technological means for enhancing performance. It was argued that, with appropriate structure and strategy, adoption of new technology could create substantial and sustainable competitive advantages[35]. The NP proponents argue that user needs are the key drivers of adoption. In an early study, Myers [36] examined innovation within organizations and they reported that more than 70% of the innovations could be classified as need-pull and suggested that organizations should pay more attention to the need for innovation resource allocation, staff training, and operations than to maintaining technical competence. Langrish[37] examined the issue again and concluded that both the TP and NP models existed, but that the NP model was generally more prevalent. Zmud [38] also noted that ‘need-pull’ innovations have been found to be characterized by higher probabilities of commercial success than have technology-push innovations. Their findings show that organization size, migration cost and the unsatisfactory with the existing systems where the main driver to influence the OSS adoption.

Another study by Glynn, Fitzgerald and Exton [34] investigated the commercial adoption of OSS using an innovation adoption theory based on Tornatzky and Fleischer’s model. Investigate the adoption process of OSS in the case of the Beaumont Hospital [39] and found that the support for the general OSS ideology and committed personal championship of OSS were found to be significant. They categorize the OSS adoption into four main components which are external environment, organizational context, technological context and finally the individual factors. The results also showed the inhibitors on OSS adoption, which varies from user and staff resistance due to fear from being disclosed or the IT infrastructure coherent and based on proprietary software and the negative perception of users on OSS in general.

In their study Laila and Bukhari[8] helped organizations in Pakistan to migrate towards OSS. The findings of the study confirm that the low cost is the main reasons for OSS popularity and the inhibitors to OSS adoption were compatible, skilled staff and maintenance/support factors. Johnston, Beggand Tanner [9] findings show positive influences on the adoption of OSS included cost, performance and positive attitudes. The negative influences were compatibility, lack of resources and time, and lack of support. Qu, Yang, & Wang [32] investigated the effect of five country-level factors on OSS adoption process. The study shows that Uncertainty avoidance played an important

role in which the low uncertainty avoidance was found to increase the OSS adoption rate. The authors also found that the increase of uncertainty avoidance will make organizations rely on proprietary software.

5. THE PROPOSED FRAMEWORK

After examining few frameworks to form the structure of OSS adoption studies [8, 9, 32, 33, 34], a decision was made to use Fitzgerald framework [34] because it's considered the most comprehensive framework that include all possible factors found in literature (as discussed in Section 3.2). The identified factors were then integrated with the Fitzgerald framework [34] to form a study of OSS adoption in Malaysia. According to the Fitzgerald framework; there are four components that would affect towards the OSS adoption. This includes managerial intervention, subjective norms, and facilitating conditions which occur at an organizational level. On the other hands, uncertainty avoidance factor is the only component that occurs in a country level that seems to affect the OSS adoption. Figure 1.1 shows the connection of these four components on OSS adoption. The next section shows the details of these components.

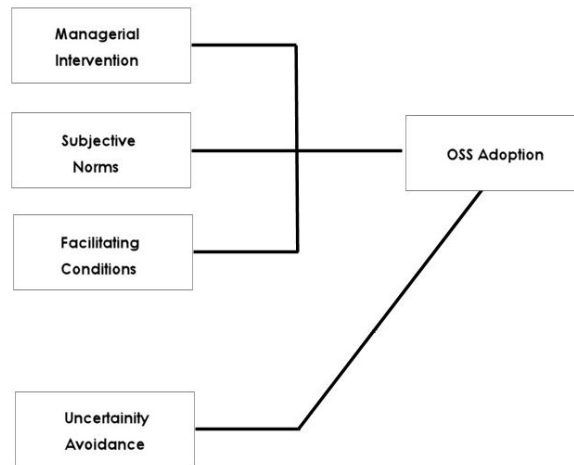


Figure 1.1 The Proposed Framework of OSS Adoption in University CICT.

The first component, managerial intervention refers to the actions taken and resources made available by management for the purpose of expediting secondary OSS adoption [41]. This includes issues such as deciding whether adoption is voluntary or mandatory, providing training and support, hiring new employees or consultants to act as mentors, and championing the OSS adoption initiative. Subjective norms, the second component, refer to how individuals believe their peers and coworkers expect them to behave in relation to technology, which can lead to enhanced efforts to learn about and adopt an innovation or to abandon a technology [41]. The theory of planned behavior which Fitzgerald [34] adopt subjective norms from was based on cognitive processing and level of behavior change. Compared to affective processing models, the theory of planned behavior overlooks emotional variables such as threat, fear, mood and negative or positive feeling and assist them in a limited fashion. In particular in the health-related behavior situation, given that most individual health behaviors are influenced by their personal emotion and affect-laden nature, this is a decisive drawback for predicting health-related behaviors [42]. Poor predictability for health-related behavior in previous health research may be attributed to the exclusion of this variable. Most of the research is correlational, and evidence based on experimental studies is less convincing [43].

The third component, that is facilitating conditions refer to the exact attributes of the innovation that Fitzgerald [41] has integrated from Rogers [44]. It identifies five key perceived attributes of an innovation that influence the outcome of the adoption process which are relative advantage, compatibility, complexity, Triability and observability.

The fourth component, uncertainty avoidance refers to the extent to which people feel comfortable with novel, unknown, surprising, and unusual situations [45]. People in countries with high uncertainty avoidance feel great stress and anxiety when facing uncertain situations; as a result, they usually try to minimize uncertainty by enacting strict laws and rules, as well as safety and security measures [45]. In contrast, people in countries with low uncertainty avoidance are more tolerant of Opinions, that is different from their own. Qu, Yang, & Wang [32] has argued that OSS often has a higher reliability and superior security than the proprietary software, and organizations in countries with higher uncertainty avoidance should be more likely to adopt OSS than those in countries with lower uncertainty avoidance.

Uncertainty avoidance was integrated from Qu, Yang, & Wang [32] and based on the gap found by Khadijah [5] which is the lack of user confidence and perception of OSS products. The uncertainty avoidance will help us understand and investigate the behavior of the stakeholders within UTM CICT. Based on the findings, it shows a positive role and impact of uncertainty avoidance on OSS adoption [32]. It also shows that countries with higher uncertainty avoidance in their organizations should be more likely to reject OSS than those in countries with lower uncertainty avoidance [32].

6. Conclusion

There are two issues need to be clarified before proceeding exploring and developing the proposed theoretical framework for OSS adoption in Malaysian University ICTCs. The first issue is to identify the factors that may influence the OSS adoption decision and process in both the management level and the user level. The factors can be positive to OSS adoption or hinder the decision making to adopt the OSS. The factors discovered by this study found from the literature and it's not reflecting the real factors in Malaysian university ICTCs. The second issue is by finding a new perspective to investigate the determinants to the OSS adoption. Most of the scholars had targeted the technological, organizational and environmental factors to investigate the OSS adoption. The study discovered a new perspective done by Qu [32] that examine the country level which includes the power distance, uncertainty avoidance and individualism. After reviewing many articles we discovered that no studies had investigated these factors into Malaysian university ICTCs.

By addressing the issues mentioned above, the study can go further to the next step into covering the experience of OSS adoption process in Malaysian University ICTC's. The proposed framework hoped to encourage future studies to investigate the factors that might influence the OSS adoption decision positively or negatively based on the new discovered perspective.

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