User Resistance in the Adoption of Open Source Software

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Abstract

The emergence of open source software (OSS) with its successful projects and its most prominent advantages creates a vast interest among academics and practitioners. However, it has been found that focusing on the developments of OSS to be successful is not adequate and the adoption of OSS by uses is also very important. Although there are a great number of useful and easy to use OSS has been developed, the adoption of OSS and usage in the market is very low. Based on the technology equity implementation model (EIM), this study examines user resistance in the adoption of OSS (i.e., switching from the current system to OSS). A survey has done regarding the adoption of Linux as the case of study. We have found that user resistance to change has negative effect on adoption intention, and switching benefits, switching costs and perceived value have significant relationships with user resistance to change.

Keywords:

Open source software; User resistance; Technology adoption; Equity implementation model

Introduction

The emergence of open source software (OSS) with its successful projects such as Linux operating system, Mozilla web browser and Apache web server, and its most prominent advantages such as saving costs, freedom in modification and availability of the source code creates a vast interest among academics and practitioners. The development and implementation of OSS becomes one of the most current topics of interest within the academic, business and political environments.

In the development of OSS, the OSS community and developers have been exerting much effort to produce competitive software against the proprietary software. More developers are motivated to participate in the software development because the OSS project is a good learning opportunity to improve their skills and gain experience. As of March 2008, SourceForge, the world's largest open source development and distribution portal, was hosting over 173, 288 registered projects and 1, 819, 453 registered users.

Linux is arguably the best know OSS project. A large amount of resources and effort have been expended in the development of Linux. A study of Red Hat Linux 7.1 found that this distribution of the OS contained 30 million physical source lines of code (Wheeler, 2001). This was an increase from the 17 million source lines of code of Red Hat Linux 6.2 which was released about a year earlier than this distribution. In comparison Windows 98 contained an approximate 18 million source lines of code. Using the Constructive Cost Model (COCOMO), the study estimated that this distribution of Linux required about 8000 person-years of development time. According to the study, if all this software had been developed by conventional proprietary means, it would have cost about 1.08 billion dollars (year 2000 U.S. dollars) to develop in the United States (Wheeler, 2001).

While the development of OSS like Linux is growing in general, its adoption and usage by users are still limited. Critics consider the features and functionality offered by the two operating systems to be comparable and some have even declared Linux better in areas such as customizability, reliability, and security (Wheeler, 2007). However, the operating system market share for February 2008 indicated that Linux had 0.65% of the market, up from a share of 0.42% in February 2007, and Microsoft Windows had a total of 89.93%, including Windows XP, Windows Vista and Windows 2000.

This creates the interest of study – why does some OSS likes Linux has a low level of usage though Linux has achieved a significant success due to the relatively comparable with Microsoft Windows in the perspective of performance, usability, reliability and functionality. Despite the huge development cost and effort of Linux, mentioned in the development of OSS, Microsoft Windows is still dominating the market share. Though the statistics show that the usage of OSS is growing, the growth rate is slow and the usage level is relatively much lower than the commercial software.

Linux is one of the successful OSS developments, which has been being developed with full of useful functionalities for the users, and invested a large amount of development effort. The development of graphical user interface makes Linux easy to use and user-friendly (e.g., Fedora). Therefore, it is expected that people should adopt Linux based on the two antecedences of Technology Acceptance Model (TAM) – perceived usefulness and perceived ease of use. However, there are many people who still do not adopt and use the useful and easy to use Linux as their operating system in performing their work. Moreover, although there is no doubt that users are quite comfortable with Linux servers due to the reliability, security and licensing benefit, but getting it on the desktop is going to be difficult (Express Computer, 2007). Hence,

this cannot be explained by TAM alone, and we have to observe the factors that make the users difficult to adopt and use Linux on their personal computer.

One of the most viable causes is that most people are currently using an operating system which could be other than Linux. According to the market statistics, Microsoft windows family counts for nearly 90% of the operating system usage. That could be due to the Microsoft's business strategy – bundling up the operating system with the personal computer, and it dominates the operating system market. Hence, it is arguably true that 90% of the computer users have already adopted Microsoft Windows. Therefore, Linux adoption involves switching from the current operating system to the new operating system. Adoption of a specific technology is often accompanied by the discontinuance of an existing technology that's already in place (Desouza, Jha, Papagari & Ye, 2006). In this case, switching introduces the discontinuous use of a current operating system. On the other hand, the system providers hold on to their consumers, and prevent existing consumers from abandoning their products and services, and even prevent them from switching to competitors. As a result, if the users resist switching, they may not adopt Linux regardless of the usefulness and ease of use related to Linux. Therefore, it is imperative to consider the effect of user resistance while studying the adoption of useful and easy to use OSS because few people adopt useful and easy to use OSS though TAM explains that usefulness and ease of use are the two main determinants of OSS adoption.

Therefore, this research aims to investigate the adoption of OSS from the user resistance to change perspective. The Technology Acceptance Model (TAM) (Davis, 1898) and Equity Implementation Model (EIM) (Joshi, 1991) will be used as background theories for our conceptual framework. We will select Linux as a case of OSS for our study.

Conceptual Background

User Resistance

Previous research on resistance has been studied in various fields. In psychology studies, the researches (Oreg, 2003) attribute the individual traits and attitude such as optimism, psychological resilience to the factors that affect the formation and extent of resistance. In management studies, change generally means organizational changes, and resistance commonly has been conceptualized as conduct that seeks to keep the status quo (Pardo del Val and Fuentes, 2003). Piderit (2000) suggested an attitudinal conceptualization of resistance in terms of cognitive, emotional, and intentional dimensions. In marketing studies, resistance is viewed as customer commitment as an attitude (Crosby and Taylor, 1983).

In the literature of IS and IT, user resistance has also been studied, and resistance is conceptualized in the two perspectives: behaviorally and attitudinally. The concept of resistance is adapted from psychology, management and marketing studies in most of the researches. It was behaviorally defined as an adverse reaction (Hirschheim and Newman, 1988) or the opposed intention of users to proposed changes resulting from IS implementation or use of system (Markus, 1983). Apart from the behavioral perspective, resistance also has been conceptualized in attitudinal perspective. Newman and Noble (1990) interpreted the users' attitude due to merely entrenched habit or dislike as resistance attitude towards any forms of change in IS implementation.

In this study, user resistance is conceptualized as the individual's attitude towards adoption intention whether the users have resistance to switch from their current using system (i.e., current operating system) in order to adopt the new system (i.e., OSS, Linux). We attributed the user resistance to change as the antecedent of adoption behaviour whether the users have tendency to accept or reject, or like or dislike adopting the new system (i.e., OSS) while considering to switch from their current system. Hence, this study adopts the attitudinal perspective of resistance because we also aim to study the attitude towards behaviour perspective based on the theory of planned behaviour (TPB). This study thus defines user resistance to change as oppositional attitude towards the use of the new system.

Equity Implementation Model

Equity Implementation Model (EIM) provides a theory-based understanding of information systems users' resistance to change (Joshi, 1991). In this study, we examine the attitude of user resistance when the users have to switch from their current using system to adopt a new system, an OSS. The users may evaluate the inputs and outcomes based on the changes (switching) of their system, and they may resist the changes or switching from their current system. EIM evaluated the net equity by comparing the changes in outcomes and changes in inputs, and the positive or negative net equity influences the user resistance to change (see Figure 1). EIM describes a process of comparison which is absent in TAM. Therefore, we believe that EIM helps us understand the user resistance attitude in adoption of OSS, which the users will have from the changes (i.e., switching operating systems).

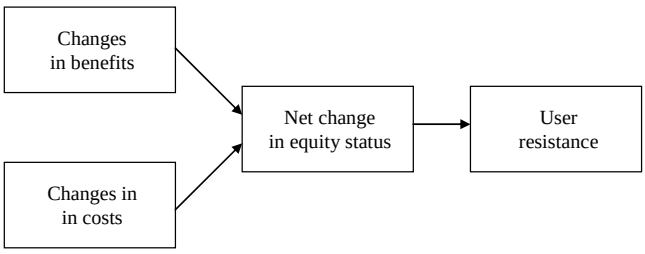

Figure 1 – Equity implementation model

According to EIM, users evaluate the change related to a new system based on the net equity. The net change in equity status is estimated based on the comparison between changes in benefits (i.e., outputs) and changes in costs (i.e.,

inputs). Changes in outcomes refer to the perceived benefits relative to the new system. Changes in inputs refer to the additional effort, skills or abilities a user may need to exert for using the new system. If the net equity due to the change is negative, users would view the change as unfavourable and be resistant to the change. Conversely, if the perception of the net equity due to the change is positive, users would be favourably inclined towards the change.

In this study, the users may have to switch from their current using system in order to adopt the new system, OSS, and switching the systems serve as a change for the users. Hence, there may be a case of user resistance due to the switching (i.e., user resistance to change). As par EIM, there is no fundamental or irrational resistance to a change. Thus, the users may evaluate the switching related to the new system, OSS based on the value perceived by them (i.e., perceived value). The value is accessed by comparing the additional benefits gained relative to the new system (i.e., switching benefits) and additional costs incurred from switching (i.e., switching costs). Therefore, based on EIM, this study identifies user resistance from resistance to change, switching benefits from the changes in benefits, switching costs from the changes in costs, and perceived value from the net change in equity status.

Hypotheses

User resistance to change referred to opposition of individuals to the use of the new system (Hirschheim and Newman, 1988; Markus, 1983). In our study, the change refers to the switching from current system to the new system, and we conceptualize the individuals' attitude on such switching in terms of resistance. Therefore, user resistance to change is defined as the individuals' oppositional attitude towards the use of new system (i.e., OSS). Based on TPB, attitude is defined as an individual's positive or negative feelings (evaluative effect) about performing the target behavior (Fishbein and Ajzen 1975, p.216). As such, user resistance is conceptualized as a negative attitude which will affect the adoption intention according to TPB. In the perspective of TAM alone, the users may adopt the new system based on perceived usefulness and perceived ease of use related to the new system. However, the users may not adopt the new system when they have considered about switching from their current system to adopt the new system because they resist switching. In other words, they may have resistance to switch, and which in turn affect their behavior intention. Thus, the adoption intention to use a new system would be decreased when the user resistance to change is high. Hence, we hypothesize,

H1: User resistance to change has a negative effect on adoption intention.

Value has been conceptualized as the net benefits based on the comparison between benefits and costs (Zeithaml, 1988). In our study, perceived value is defined as the perceived net benefits (perceived benefits relative to perceived costs) of switching to a new system (i.e., new system adoption). According to the EIM, the users' judgments of the change affect their resistance attitude. Further, perceived value evaluates whether the benefits derived from the change are worth the costs incurred in changing from the current situation (status quo) to the new situation. If the net change in the equity status proves to be positive, the change will be welcomed. However, if the net change in the equity status is negative, the new system will be resisted (Joshi, 1991). Therefore, if the perceived value from switching is high (perceived benefits are more relative to perceived costs), users are likely to have lower resistance to switch. Conversely, if the perceived value is low (perceived benefits are less relative to perceived costs), users are likely to have greater resistance to switch. Moreover, people have a strong tendency to maximize value in their decision making and consequently are less likely to resist changes that deliver a higher perceived value (Joshi, 1991). Hence, we hypothesize,

H2: Perceived value has a negative effect on user resistance to change.

The benefits from the change have been conceptualized as the benefits or advantages people perceived from the change (Moore & Benbasat, 1991). In our study, switching benefits is defined as the perceived additional utility a user would enjoy in switching from the current system to the new system. Perceived value is assessed as the overall evaluation of the net benefits of change based on the comparison between switching benefits and costs (Kahneman & Tversky, 1979). According to the EIM, the change in equity status is positively affected by the changes in benefits (Joshi, 1991). As per the rational decision-making principles, higher switching benefits would increase the net benefits or perceived value of the change to users because value is accessed based on the benefits relative to the costs of change (Joshi 1991; Zeithaml 1988). Therefore, the values will be increased when the switching benefits are higher and the switching costs are lower. Hence, we hypothesize,

H3: Switching benefits have a positive effect on perceived value.

Following the previous research, switching costs represent the psychological costs such as uncertainty costs and emotional costs (Whitten and Wakefield, 2006; Guiltinan, 1989), one-time costs in the process of switching such as set up costs and learning costs (i.e., procedural costs) (Burnham et at., 2003) and loss costs such as lost benefit costs and sunk costs (Jones et al., 2002). In our study, switching costs are defined as the perceived disutility a user would incur in switching from the current system to the new system (Chen and Hitt, 2002). As we have mentioned, perceived value is assessed as the overall evaluation of the net benefits of change based on the comparison between switching benefits and costs (Kahneman & Tversky, 1979). According to the EIM, the change in equity status is negatively affected by the changes in costs (Joshi, 1991). As per the rational decision-making principles, higher switching costs in any

forms would lower the net benefits or perceived value of the change to users because value is accessed based on the benefits relative to the costs of change (Joshi 1991; Zeithaml 1988). Therefore, the values will be decreased when the changes in benefits are lower and the changes in costs are higher. Hence, we hypothesize,
H4: Switching costs have a negative effect on perceived value.

Apart from the indirect effects of switching benefits and switching costs on user resistance to change through perceived value. We also expect the direct effects of them on user resistance to change. The switching benefits and switching cots are conceptualized as beliefs according to TPB which adopts from TRA. Based on TRA, a person's attitude toward behavior is determined by his or her salient beliefs (Davis et al., 1989). Therefore, users' beliefs in gaining additional benefits from the switching will affect their attitude towards the switch. In other words, switching benefit (i.e., users' beliefs) has influence on the user resistance to change (i.e., attitude towards the switch). The potential advantages (i.e., benefits) of switching from the current system to the new system provide users with the motivation to switch. In contrast, if the new system provides fewer switching benefits, users are more likely to resist switch from their existing system (Martinko et al., 1996). Higher switching benefits would thus reduce the user resistance to change. Hence, we hypothesize,
H5: Switching benefits have a negative effect on user resistance to change.

Additionally, switching costs may directly influence user resistance to change. Switching costs refer to any perceived disutility (Chen and Hitt, 2002) a user would experience from switching to a new alternative. Based on TRA, a person's attitude toward behavior is determined by his or her salient beliefs (Davis et al., 1989). Therefore, users' beliefs in incurring costs from the switch will affect their attitude towards the switch. Switching costs can be the psychological costs, procedural costs and loss costs which are conceptualized as the perceived disutility. These switching costs will inhibit the users to switch because they generate disutility which is not welcomed by the user. Due to the disutility, people do not want to switch to the new system (Chen and Hitt, 2002). Therefore, higher switching costs would increase user resistance to change. Hence, we hypothesize,
H6: Switching costs have a positive effect on user resistance to change.

Research Methodology

The survey instrument was developed based on the research model by adopting and adapting existing validated scales where possible. The measurement items were anchored on seven-point Likert scales (1 = strongly disagree, 7 = strongly agree). All items were phrased with respect to Linux under study.

We collected data for a period of about two weeks by means of a paper based survey. We selected the potential respondents who do not use Linux as their operating system, own a personal computer or notebook, and have authority to change their operating system of use. A total of 216 respondents were surveyed and collected. Out of them 201 complete and valid responses were returned with 93.06% of response rate. We dropped 15 invalid responses because 6 of the respondents do not have the authority to change their operating system and 9 of the respondents are completely unfamiliar with Linux. The majority of respondents were male (75.1%) with an average age of 24.2 years (s.d. = 4.6), and an average usage experience of their current operating system of 3.4 years (s.d. = 2.2) from the respondents. All the subjects own a computer, and they have at least 2-year experience in using their current operating system. The average familiarity level of Linux (3.60) shows that they know Linux as an alternative operating system.

Data Analysis and Results

To validate the survey instrument, we assessed its convergent and discriminant validity. We first performed confirmatory factor analysis (CFA) suing LISREL. We first confirmed the convergent validity using the three criteria suggested by Gefen et al. (2000). Next, we performed the discriminant validity of the measurement model. The square root of AVE for each construct (diagonal term) exceeded the correlations between the construct and other constructs (off-diagonal terms). Hence, discriminant validity of the instrument was established.

Table 1 - Correlations

	Mean	S.D.	INT	URC	PVL	SWC	SWB
INT	3.31	1.66	**0.84**				
URC	4.49	1.25	-0.50	**0.81**			
PVL	3.65	1.10	0.63	-0.59	**0.85**		
SWC	4.65	1.12	-0.24	0.29	-0.32	**0.89**	
SWB	3.46	1.12	0.51	-0.47	0.60	-0.22	**0.84**

Note: Leading diagonal shows the squared root of AVE of each construct

We examined the structural model using LISREL. The structural model satisfied the threshold for all indices except GFI: Normed χ^2 = 1.66, RMSEA = 0.051, GFI = 0.87, AGFI = 0.83, CFI = 0.98, NFI = 0.95, Standardized RMR = 0.060. However, since the GFI (0.87) closely approximated the recommended threshold, the structural model appears to adequately fit the data. The standardized path coefficients were then used for testing the hypotheses.

The results indicate that user resistance (H1) has a significant effect on adoption intention, explaining 38 percent of its variance. Perceived value (H2), switching benefits (H5) and switching costs (H6) had significant effects on user resistance, explaining 56 percent of its variance. Switching benefits (H3) and switching costs (H4) had significant effects on perceived value, explaining 53 percent of its variance. Hence, all hypotheses are supported.

Implications for Research and Practice

This research offers two main implications for theory. First, this study has examined the relationship between the user acceptance and the user resistance and how they are different and linked. We found that the user acceptance and the user resistance to change are not the totally opposite. The objects of the two are different (i.e., Linux vs. the current operating system). The user acceptance can be evaluated based on the targeted new system (Linux), whereas the user resistance to change may occur when switching from the current system (the current using operating system). We also found that the resistance attitude negatively influence the adoption intention based on theory of planned behaviour (TPB) which explained the concept of attitude towards behaviour.

Another theoretical implication of this study is the development of the user resistance model based on the Equity Implementation Model (EIM) to understand the reasons of resistance. Few theoretical foundations with empirical validation exist in the literature for explaining the user resistance to change. EIM (Joshi, 1991) provides an explanation about the role of net equity in causing user resistance and some examples of inputs and outcomes, but it does not examine the assessment of net equity based on the increase and decrease in outcomes and inputs, and has not been tested. Hence, this study developed and tested a theoretical model to explain appraisal of switching to the new system through survey methodology.

There are also several practical implications. The results of this study suggest OSS community and developers that just developing useful and easy to use OSS is not enough and they need to pay attention on how to alleviate user resistance to change in order to increase the OSS adoption. Although the developed OSS is useful and easy to use, the oppositional attitude of users based on their value assessment of the system may hinder the adoption of the new system. First, OSS developers and advocates should thus be aware of the critical effect of user resistance on adoption intention and aim to reduce it by increasing the perceived value. The user resistance (i.e., the oppositional attitude towards the adoption of OSS) is influenced by the net change in equity status which is perceived value.

Second, developers can attempt to increase the perceived value of switching to reduce user resistance. In evaluating perceived value, users estimate whether or not the cost for change exceeds the benefits associated with the change (Joshi, 1991; Zeithaml, 1988). In this study, the change refers to the switching from current system to the new system. In order to increase the perceived value, the advantages of the OSS over the proprietary software (i.e., switching benefits) should be emphasized from the viewpoint of the user. Therefore, switching benefits need to be stated clearly to all users together with the release of the developed OSS. For instance, by stating the new useful features, easy to use functions, user guides and the advantages of the features or functions of OSS comparing with the similar proprietary software, the users may know the benefits clearly from using the OSS.

Third, developers can further increase the perceived value and reduce the user resistance to change by reducing the switching costs. Although the developed OSS is useful and has some benefits, the users may still resist to adopt it due to the higher switching costs (i.e., costs is greater than benefits) (Joshi, 1991). The user can perceive the switching costs in the form of different classifications such as psychological cost – uncertainty costs and emotional costs (Whitten and Wakefield, 2006), procedural costs – set up costs and learning costs (Burnham et at., 2003) and loss costs – lost benefit costs and sunk costs (Jones et al., 2002). Therefore, developers should aim to reduce these switching costs perceived by the users. Developers should aim to allay the users' psychological costs by informing them clearly about the further changes in technology and feasible solutions for various anticipated issues which may be encountered by the users. Next, developers can attempt to alleviate procedural costs by providing the comprehensive and effective user guide of the OSS so that the users may find it easy to set up and learn how to use it. Again, developers should also try to eliminate the loss costs by providing them the benefits over their existing system so that they will perceive that it is worth to use the OSS.

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Appendix. Measurement Instrument

Adoption intention (Karahanna et al., 1999_
- I intend to adopt Linux within the next 6 months
- During the next 6 months, I plan to experiment with or regularly use Linux
- I predict I would use Linux within the next 6 months

User resistance to change (Pritchard et al., 1999)
- My preference to use my current operating system would not willingly change
- It would be difficult to change my beliefs about my current operating system
- Even if close friends recommended Linux, I would not change my preference for my current operating system
- To change my preference from my current operating system would require major rethinking

Perceived value (Sirdeshm-ukh et al., 2002)
- Considering the time and effort that I have to spend, switching to Linux is worthwhile
- Considering the loss that I have to incur, switching to Linux is of good value
- Considering the hassle that I have to experience, switching to Linux is beneficial to me
- Considering everything, switching to Linux would deliver me good value

Switching benefits (Moore and Benbasat, 1991)
- Switching to Linux would give me greater control over my work than using the current operating system
- Switching to Linux would make it easier to do my work than using the current operating system
- Switching to Linux would enhance my effectiveness on the work than using the current operating system
- Overall, I would find switching to Linux to be more advantageous in my work than using the current operating system

Switching costs (Jones et al., 2000)
- I have already put a lot of time and effort into mastering the use of current operating system
- It would take a lot of time and effort to switch to Linux
- Switching to the Linux could result in unexpected hassles
- I would lose a lot in my work if I were to switch to Linux