

Open Source Software Adoption: Motivations of Adopters and Amotivations of Non-adopters

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Abstract

Adoption of an information system could be reflected in two ways: through the adoption intentions of the non-adopters and the extent of adoption for the adopters. This study seeks to identify the motivational factors influencing individuals' adoption intentions and the extent of a system adoption within the context of Open Source Software (OSS). Building on the theoretical underpinnings of the Self-Determination Theory, we proposed and empirically assessed two conceptual models to examine OSS adopters' extent of adoption (based on intrinsic and extrinsic motivation) and OSS non-adopters' intentions for adoption (based on amotivation). Results from the survey collected from 264 OSS adopters and 212 OSS non-adopters reveal that strategy belief amotivation is the major factor for not using OSS (i.e., non-adopters) while identified regulation is the major extrinsic motivation affecting the extent of adoption (i.e., adopters). Interestingly, intrinsic motivation to accomplish and capacity beliefs amotivation do not significantly affect adoption extent and adoption intention respectively. Theoretical and practical implications are discussed.

ACM Categories: K.6.1: Project and People Management. K.6.3: Software Management.

Keywords: Open Source Software, Self-Determination Theory, Technology Adoption

INTRODUCTION

Due to the rapid development of Open Source Software (OSS), it has been touted to challenge the dominance of the proprietary software in the \$300 billion software market (Khalak 2000). While the adoption of OSS by organizations is picking up its momentum (e.g. Linux server market share has reached 12.7%¹ in 2008), its popularity with individuals still remains low (e.g. Linux desktop market share is merely 0.96% in 2009²). Why does an individual user choose to adopt or not to adopt OSS as opposed to traditional proprietary software? While important, this topic of individual adoption of OSS has received significantly less academic attention as opposed to that of organizational adoption of OSS, which focused on identifying

¹<http://tech.blorge.com/Structure:%20/2008/05/26/linux-buys-a-big-green-lollipop-snickers-at-windows-vista/> (last accessed: January 4th, 2010)

² <http://marketshare.hitslink.com/operating-system-market-share.aspx?qprid=8&sample=35> (last accessed: January 4th, 2010)

factors influencing managers' adoption decisions such as availability of internal and external support of OSS, switching cost, institutional pressures to adopt OSS, software's reliability, source code availability, avoiding vendor lock-in (e.g., Fitzgerald 2009; Goode 2005; Morgan and Finnegan 2007; Ven and Verelst 2008; Ven et al. 2008; Li et al. 2005, 2006).

Besides the research on organizational adoption of OSS, much of the extant literature on OSS has focused on **three** research streams, namely, the identification of an individual developer's motivation to contribute to an OSS project (e.g., Roberts et al. 2006; Lakhani and Wolf 2003; Hann et al. 2002; Markus et al. 2000), the organization and coordination of activities in an OSS development community (e.g., Sharma et al. 2002; Jorgensen 2001; Koch and Schneider 2002), and the comparisons between OSS and proprietary software, their different developmental styles and the impact of the OSS developmental model on the traditional software industry (e.g., Comino and Manenti 2003).

According to Moore (1999), innovations which can only garner the support from minority groups of "enthusiasts" and "visionaries" (such as the 0.96% of individuals who are using Linux) may fall into the chasm of adoption and never reach the critical mass for success. In other words, OSS can be deemed as a successful innovation only when it can attract the critical mass of users to actively use it. To the extent that the existence and success of OSS depends on whether there is significant number of users, it is imperative to have a complete and holistic understanding of the factors influencing an individual's adoption of OSS. However, although there are a number of researches examining organizational adoption of OSS, with few exceptions (i.e., Gallego et al. 2008), there has been limited empirical work examining individual adoption of OSS in current literature. It is this gap of individual adoption of OSS that we attempt to fill through current research.

Individual innovation adoption has been well investigated by Information Systems (IS) researchers. The most widely-accepted model, Technology Acceptance Model (TAM), suggests that perceived usefulness and perceived ease of use are the two most important factors in explaining individual's technology adoption at job. While TAM has been upheld as a parsimonious model (Hwang and Yi 2002), Davis, its creator, also criticized his own model (Davis et al. 1989) by highlighting that the omission of the social psychology constructs

from TAM was perhaps a weakness of the research. Taking into consideration of this drawback in previous research, our study attempts to capture the individual's behavioral and psychological underpinnings in technology adoption by applying Self-Determination Theory (SDT) (Deci and Ryan 1985), one of the most prominent theories of motivation.

According to SDT, motivations can be classified into three types, namely intrinsic motivation, extrinsic motivation and amotivation (Deci and Ryan 1985). Our review of the limited studies on the individual adoption of OSS suggests that the factors identified, such as cost-saving and flexibility in modifying the software, can be attributed to the extrinsic motivation; seldom do the extant studies consider the other types of motivation such as intrinsic motivation and *amotivation* (Deci and Ryan 1985).

From this viewpoint, this research seeks to provide a more nuanced theoretical understanding of the type of motivations and their influence on the individual's propensity for OSS adoption by explicitly considering three forms of motivational factors, i.e., intrinsic motivation, extrinsic motivation and amotivation. Distinguishing among the three forms of motivational factors also enables us to perceive how different motivational sources could influence a user in OSS adoption. To differentiate between individuals who are adopters and others who have not adopted OSS, we propose two conceptual models delineating 1) the influence of the intrinsic and extrinsic motivational factors on a user's extent of OSS adoption, and 2) the influence of amotivation factors in influencing an individual's intention to adopt. By examining both adopters and non-adopters of OSS, we are able to present a crisp understanding of the motivational factors influencing an individual's usage of OSS. This study will contribute to the limited research on individual adoption of OSS and research on amotivation in innovation adoption.

Self-Determination Theory and Innovation Adoption

Motivation refers to an internal state of desire that directs goal-oriented behavior (Franken 1994). Three broad categories of motivations are identified: intrinsic motivation, extrinsic motivation, and amotivation (Vallerand 1997; Deci and Ryan 1985). Intrinsic motivation deals with behavior performed for itself, in order to experience pleasure and satisfaction inherent to the activity. Extrinsic motivation involves performing behavior to achieve

some separable goal, such as receiving rewards or avoiding punishment. Amotivation is defined as a loss of motivation that results from the belief that one's actions have no effect in bringing about desired outcomes (Deci and Ryan 1985). In other words, it refers to the absence of intent or drive to pursue an activity due to one's failure to establish contingencies between their behavior and the activity (Vallerand et al. 1992).

While this classification was well-accepted, Deci and Ryan (1985) pointed out that it was not sufficient to distinguish between intrinsic and extrinsic motivation in a dichotomy. Furthermore, amotivation is not the opposite of intrinsic and extrinsic motivations. Rather, these constructs must be considered on a **continuum** in which different types of motivation range from a high to a low level of self-determination underlying the behavior. Based on this argument, they developed Self-Determination Theory (SDT) (Deci and Ryan 1985) which focuses on the degree to which human behaviors are volitional or self-determined. It is the degree to which people endorse their actions at the highest level of reflection and engage in the actions with a full sense of choice. Based on SDT, the continuum of subtypes of motivation ranging from a high to a low level of self-determination is: Intrinsic Motivation (to know, to accomplish, and to experience stimulation), Extrinsic Motivation (identified regulation, introjected regulation, external regulation) and Amotivation.

Theory of intrinsic and extrinsic motivation has been applied in the IS field (e.g., LeDuc 1980; Davis et al. 1992; Atkinson and Kydd 1997; Venkatesh and Speier 1999; Thatcher et al. 2006). For instance, Davis et al. (1992) studied the determinants of intrinsic and extrinsic motivation of people to use computers in the workplace, and Venkatesh and Speier (1999) investigated the effects of mood (during technology training) on the motivations, intentions, and, ultimately, usage of a new technology.

Comparatively, research on amotivation and its influence on technology adoption has been scarce. In research on motivation, amotivation, which is an experience of lack of control, has been compared with learned helplessness (Abramson et al. 1993). Even though helplessness is seen as most likely to make a valuable contribution to our understanding of why certain people fail to carry out certain behaviors, Pelletier and his colleagues (1999) propose that individuals also feel helpless or amotivated for more specific reasons. They deduced that individuals could develop amotivation for different reasons. First, they believe the proposed strategies are not

effective in producing the desired outcomes. Second, they believe they do not have the capacity to implement these strategies effectively. Third, even if they perceive that the strategies are effective, they may not be able to maintain the effort necessary to execute the behavior, or to integrate it into their lifestyles. It is imperative to note that amotivation is not the opposite of intrinsic and extrinsic motivations. An amotivated individual is neither intrinsically nor extrinsically motivated. Instead, the individual is unable to foresee the consequences of her behavior and therefore unable to understand the motives underlying it (Pelletier et al. 1999). As her actions are mechanical and meaningless, the individual could constantly doubt her actions and is likely to give up the behavior eventually. Essentially, amotivation is a state in which people lack the intention to behave. A related concept studied by researchers of psychology and personality is "external locus of control" (Rotter 1966, Robert and Robert 1991). It has been shown that individuals with an external locus of control, those who attribute success or failure to factors outside of one's control, tend to have lower levels of motivation (Rotter 1966).

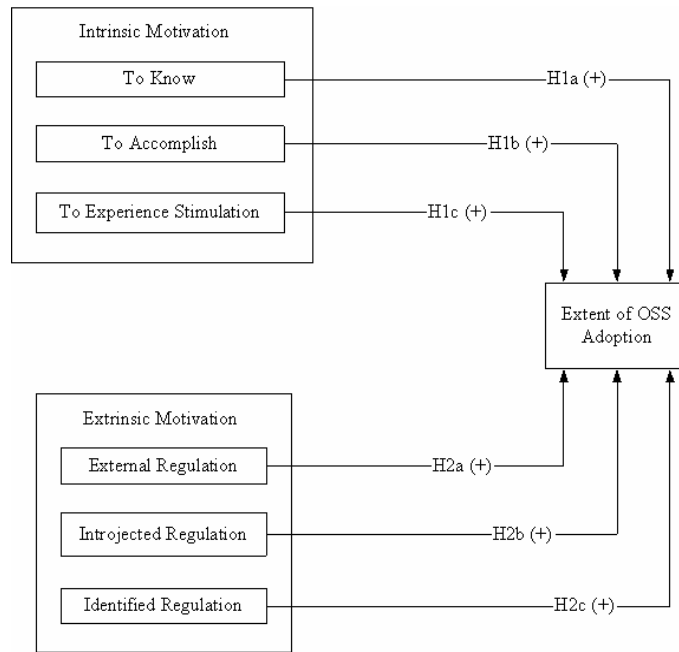
Research Models

With an understanding of the three motivation categories, we next identify the pertinent factors within each category. Our review of literature presents the Academic Motivation Scale (AMS), which anchors on the tenets of SDT (Vallerand et al. 1992; Deci and Ryan 1985) and decomposes the three types of motivation as follows: (1) the intrinsic motivation to know, to accomplish, and to experience stimulation, (2) the extrinsic motivation to identified, introjected, and external regulation, and (3) the amotivation of strategy beliefs, capacity beliefs and effort beliefs. Given that an individual could choose to adopt or not to adopt OSS, this study proposes two research models for both adopters and non-adopters.

Model 1 - Extent of OSS Adoption

For the OSS adopters, the intrinsic motivation (to know, to accomplish, to experience stimulation) and extrinsic motivation (identified regulation, introjected regulation, external regulation) are included in the research model (Figure 1). We would not include the amotivation tenet for adopters. From theoretical background and justification, if an individual experiences amotivation towards a behavior, they would not be adopting that behavior in the first place.

Figure 1: The Research Model – Adopters



Therefore having amotivation in our research model for adopters is deemed unnecessary. The dependent variable to be measured is the adopter's extent of OSS adoption (Figure 1). We do not use the adoption intention as dependent variable for OSS adopter's model in order not to force subjects to recall the situation before their adoption which could happen long time ago.

Intrinsic motivation - to know is exhibited when one performs an activity for the pleasure and satisfaction that one experiences while learning, exploring, or trying to understand something new (Vallerand et al. 1992). It relates to constructs such as exploration (Berlyne 1971), learning goals (Dweck and Legget 1988), intrinsic intellectuality (Lloyd and Barenblatt 1984), intrinsic motivation to learn (Brophy 1987) and intrinsic curiosity (Harter 1981). For instance, OSS is something new which is developed in a totally unique way, under an unconventional license scheme, and with its source code open for modification. Users exhibit intrinsic motivation to know if they use OSS in order to broaden their knowledge about the different types of software available to them and different approaches they may use the software in order to benefit from it (e.g. modifying the source code to satisfy personal needs if necessary). This type of software users may use OSS more simply because they are longing to know more about it. Therefore, individuals who are more intrinsically motivated to

know are likely to be extensive users of OSS. Hence, we hypothesize:

H1a: *Intrinsic motivation - to know* would positively influence an adopter's extent of OSS adoption.

Intrinsic motivation - to accomplish is exhibited if one engages in an activity for the pleasure and satisfaction experienced when one attempts to surpass oneself, or to accomplish or create something (Vallerand et al. 1992). It relates to constructs such as intrinsic challenge (Harter 1981) and task orientation where individuals seek to experience competence (Nicholls 1984). For instance, compared with proprietary software, OSS, which originates from the "hacker culture" (Hippel and Krogh 2003), may have a less intuitive user-interface and may come with limited user support. These unique features of OSS will challenge its users for more sophisticated skills in software usage. Users who use OSS could derive satisfaction (part of an intrinsic motivation) by conquering the difficulties during the OSS adoption process. This type of users who want to obtain the feeling of accomplishment may also use OSS more often. Therefore, individuals who are more intrinsically motivated to accomplish are likely to be extensive users of OSS. Hence, we hypothesize:

H1b: *Intrinsic motivation - to accomplish* would positively influence an adopter's extent of OSS adoption.

Intrinsic motivation - to experience stimulation is operative when someone engages in an activity in order to experience stimulating sensations, such as sensory pleasure, aesthetic experiences, fun and excitement (Vallerand et al. 1992). For instance, due to the unique development style of OSS, users may need to explore unconventional resources for support (e.g., leverage on the communication with other users or developers on the OSS forums) when adopting OSS. Users who use OSS because they feel a sense of excitement or because it is intellectually stimulating due to this highly explorative style of usage, represent examples of individuals who are intrinsically motivated to experience stimulation. Software users who seek more stimulation through a unique way of using the software may spend more time on OSS. Therefore, individuals who are more intrinsically motivated to experience stimulation are likely to be extensive OSS users. Hence, we hypothesize:

H1c: *Intrinsic motivation - to experience stimulation* would positively influence an adopter's extent of OSS adoption.

Extrinsic motivation - external regulation refers to behavior that is regulated through external means such as rewards and constraints (Vallerand et al. 1992). An individual pursues an activity for external reasons such as earning rewards or avoiding punishment (Deci and Ryan 2000b). According to SDT, externally regulated behaviors show poor maintenance and transfer once contingencies (e.g. rewards or punishments) are removed, thus are labeled as contingency dependent (Deci and Ryan 1985a). For instance, a student could indicate "I am using OSS because my lecturers require us to use it." Similarly an employee may use OSS because that is required by the corporate policy and he does not want to disobey the corporate rules. Therefore, individuals who are motivated by external regulation are likely to have a high extent of OSS usage if they face large amount of external regulation for adopting OSS, as they would with a supervisor in the case of an organization and with a lecturer in the case of an educational institution. Hence, we hypothesize:

H2a: External regulation would positively influence an adopter's extent of OSS adoption.

Extrinsic motivation - introjected regulation With introjected regulation, the individual begins to internalize the reasons for his actions. However, this form of internalization, while internal to the person, is not truly self-determined since it is constrained by external contingencies (Vallerand et al. 1992). It is because when an individual replaces the external source of control with an internal one, he may start to

impose pressure on himself to ensure that the behavior will be exhibited. Self-imposed pressure is the source of this type of motivation. In other words, behavior is engaged due to pride or threats from feelings of guilt or shame. For instance, if the corporate policy encourages the usage of OSS, although informal and not obligatory, it may create the OSS culture in the organization that will help the employees internalize the reasons of using OSS. An employee might say: "*I am using OSS because an IT employee of modern time should know how to use it.*" Or a student who uses OSS because he thinks being a university undergraduate of today, he will feel shameful if he is not able to use it. In both cases, individuals display the self-imposed pressure to use OSS which is an internalization of external influences such as encouragement to use OSS by companies, universities or governments. Therefore, individuals who have a high level of introjected regulation towards using OSS tend to have a high extent of OSS usage. Hence, we hypothesize:

H2b: Introjected regulation would positively influence an adopter's extent of OSS adoption.

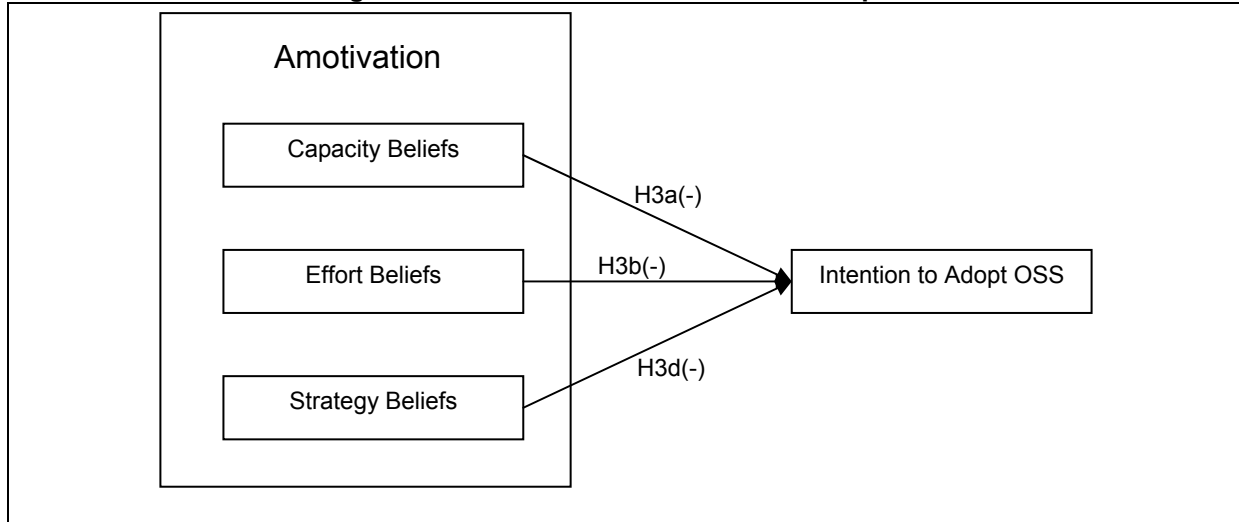
Extrinsic motivation -Identified Regulation refers to a behavior manifested out of choice. When a behavior is identified, it becomes highly valued and is judged important for the individual (Vallerand et al. 1992). It will thus be performed freely even if the activity is not pleasant in itself. In other words, it is performed NOT because the individual is intrinsically motivated for the pleasure and satisfaction inherent to the activity. The activity is performed simply because individuals have more fully identified and accepted the importance and value of the behavior. For instance, an individual who deems it extremely valuable to use software with its source code available will probably adopt OSS for this reason. An OSS user might also say: "*I have chosen to use OSS because it is more secure and software security is most important to me when choosing software.*" Therefore, it is posited that individuals with a strong sense of identified regulation toward OSS usage are likely to be extensive users of OSS. Hence, we hypothesize:

H2c: Identified regulation would positively influence an adopter's extent of OSS adoption.

1.1 Model 2 – Intention to Adopt OSS

For non-adopters, we base our research model on the relationship between individual's amotivation toward OSS and their intention to adopt it.

Figure 2: The Research Model – Non - Adopters



We do not consider intrinsic and extrinsic motivations for non-adopters since we are specifically interested in the negative impact of motivation so that we decided to focus on prohibiting factors that cause individuals not to adopt OSS. An individual's intention to adopt is defined as the strength of conscious plans to perform the target behavior, i.e., adoption of OSS (Harrison et al. 1997). Building on AMS, we examine four sources of amotivation: capacity beliefs, effort beliefs, and strategy beliefs (Figure 2).

Capacity Beliefs Amotivation is derived from Bandura's (1986) concept of self-efficacy expectancy. Self-efficacy refers to one's judgment of one's capability to organize and execute courses of actions required to attain a desired level of performance (Bandura 1986). Such judgment could affect activity choice, activity preparation and effort expended during performance. Moreover, the stronger the perceived self-efficacy, the higher the challenges people set for themselves and the firmer their commitment to their goals (Bandura 1991). Therefore, in addition to the required skills, action calls for beliefs in personal capacity. In other words, people may know that doing something is desirable, but may not believe they have what it takes to successfully carry out the required behaviors (Pelletier et al. 1999). For instance, due to its unique development style, there may not be proper customer support for OSS and the user interface may not be as friendly as most of the proprietary software. Individuals might not adopt OSS because they believe OSS is more advanced and more difficult to use, and they feel they do not have the competence to deal with it without support. Therefore, the more one feels that one does not have the capacity to adopt OSS, the less likely is for one to adopt OSS. Hence, we hypothesize:

H3a: *Capacity beliefs amotivation* would negatively influence a non-adopter's intention to adopt OSS.

Effort Beliefs Amotivation refers to the non-desire to expend the energy required by a particular behavior. In a study on how children's motivation in school can be enhanced, Skinner and his colleagues (1990) found that children had to believe they could generate the effort required to carry out the necessary actions, and maintain the effort in face of difficulties. Likewise, adults might have trouble performing a behavior if they are unable to sustain the necessary effort, or if they find it is difficult to integrate the behavior into their lifestyle (Pelletier et al. 1999). For instance, to use software such as OSS, individuals need to spend more time and energy figuring out its features and sourcing for support from OSS forums. Users might not adopt OSS because they cannot seem to try hard enough or expend the time and effort needed in order to use OSS. Therefore, the more an individual believes he cannot expend the necessary effort to engage in OSS, the less likely he would adopt OSS. Hence, we hypothesize:

H3b: *Effort beliefs amotivation* would negatively influence a non-adopter's intention to adopt OSS.

Strategy Beliefs Amotivation refers to a person's belief that the proposed strategy or activity will not bring about the desired outcome. This behavioral belief is weighted by the evaluation of favorable outcomes that result from performing the behavior (Venkatesh and Brown 2001). Individuals are more likely to undertake behaviors they believe will result in valued outcomes than those which they do not see as having favorable consequences (Compeau and Higgins 1995). If individuals cannot appreciate

the values brought by OSS such as availability of source code, lower acquisition costs, better performance (claimed), they may not deem it different from proprietary software in the aspect of the software's relevance with their work and life. For instance, students may not want to adopt OSS if they do not value the differences between OSS and proprietary software and feel that using OSS particularly will not help them in their school work or improve their grades. Therefore, the more an individual feels that adopting OSS is not going to bring about a desired goal, the less likely he would adopt OSS. Hence, we hypothesize:

H3c: Strategy beliefs amotivation would negatively influence a non-adopter's intention to adopt OSS.

Research Methodology

The survey research method was chosen to assess the proposed research model. University undergraduate students were chosen as subjects in the survey as they are believed to be more adventurous when it comes to new technology adoption. Also, university undergraduate life is usually the stage in life just before the individual starts working life. If we could find out what they feel about OSS at this stage, it would most likely reveal what new employees in the industry feel about OSS. The subjects were chosen from all disciplines so as to maximize the generalizability of the results and to avoid selection bias.

Table 1: Scales and their Corresponding Literature

Intention to Adopt OSS	<i>Taylor and Todd 1995</i>
Capacity Beliefs	<i>Pelletier et al., 1999</i>
Effort Beliefs	
Strategy Beliefs	
Extent of OSS Adoption	<i>Self-developed</i>
Intrinsic Motivation to Know	<i>Vallerand et al., 1992</i>
Intrinsic Motivation to Accomplish	
Intrinsic Motivation to Stimulate	
Identified Regulation	
Introjected Regulation	
External Regulation	

As far as possible, constructs were measured using tested questions from prior studies to enhance validity (Table 1). Some of them were modified accordingly so as to fit the context of our research. To ensure construct validity and to identify any ambiguous items, we used the card sorting

procedure proposed by Moore and Benbasat (1991). All questions were anchored on a seven point Likert scale with 1 being the negative end indicating "Strongly Disagree" and 7 being the positive end representing "Strongly Agree". The survey questionnaire is shown in Appendix A.

1.2 Survey Administration

University students from different faculties were recruited for the survey. A cover letter was included with the survey instrument that explained the purpose of the study and gave a description about OSS to improve the validity of the responses. As an incentive for their participation, respondents were informed of monetary benefits upon completion of the questionnaire. Respondents were instructed to complete the appropriate version of the questionnaire, depending on whether they were adopters or non-adopters. Out of 1000 sets of questionnaires distributed, 492 responses (49.2%) were received from students from six faculties in the university, over a span of three weeks. 212 non-adopter entries and 264 adopter entries were recorded as 16 returned questionnaires were incomplete and hence, were removed. Respondents were asked to fill in their demographic information such as gender, age, year of study, nationality and ethnic origin. Table 2 depicts the demographic information of the respondents who are adopters.

Table 2: Profile of Undergraduate Adopters who Responded

Demographics	Category	Frequency (N=264)	Percentage
Gender	Male	181	68.6%
	Female	83	31.4%
Year of Study	1	33	12.5%
	2	92	34.8%
	3	117	44.3%
	4	22	8.3%
Age	17 – 19	7	2.7%
	20 – 22	151	57.2%
	23 – 25	104	39.4%
	26 – 28	2	0.8%
Nationality	Malaysia	12	4.5%
	PRC	24	9.1%
	Singapore	193	73.1%
	Thailand	2	0.8%
	Vietnam	11	4.2%
	Others	22	8.3%
Ethnic origin	Chinese	219	83.0%
	Indian	14	5.3%
	Malay	4	1.5%
	Others	27	10.2%

Table 3 depicts the demographic information of the respondents who are non-adopters.

Table 3: Profile of Undergraduate Non - Adopters who Responded

Demographics	Category	Frequency (N=212)	Percentage
Gender	Male	83	39.2%
	Female	129	60.8%
Year of Study	1	94	44.3%
	2	59	27.8%
	3	44	20.8%
	4	15	7.1%
Age	17 – 19	31	14.6%
	20 – 22	132	62.3%
	23 – 25	44	20.8%
	26 – 28	5	2.4%
Nationality	Malaysia	17	8.0%
	PRC	8	3.8%
	Singapore	170	80.2%
	Thailand	3	1.4%
	Vietnam	7	3.3%
	Others	7	3.3%
Ethnic origin	Chinese	195	92.0%
	Indian	6	2.8%
	Malay	2	0.9%
	Others	9	4.2%

Results

The means and standard deviations for the latent variables for adopters and non-adopters are reported in Table 4 and Table 5 respectively. The mean values of all variables fall between 3.6 and 4.7 with standard deviation values ranging from 1.0 to 1.6.

Table 4: Descriptive Statistics of Variables – Adopters

Construct	Code	Items	Mean	Standard Deviation
To Know	KNOW	4	4.6117	1.17172
To Accomplish	ACCOMPLISH	4	4.2699	1.20610
To Experience Stimulation	STIMULATE	5	4.0523	1.15932
Identified Regulation	IDENTIFIED	7	4.5714	1.04087
Introjected Regulation	INTROJECTED	4	3.7945	1.19892
External Regulation	EXTERNAL	4	3.6051	1.37540
Extent of OSS Adoption	EXTENT	4	3.9962	1.59326

Table 5: Descriptive Statistics of Variables – Non Adopters

Construct	Code	Items	Mean	Standard Deviation
Capacity Beliefs	CAPACITY	4	4.2854	1.41941
Effort Beliefs	EFFORT	4	4.4976	1.40812
Strategy Beliefs	STRATEGY	5	4.2962	1.35303
Intention to Adopt OSS	INTENTION	4	3.8667	1.20509

To evaluate the proposed research model, this study applied the Partial Least Square (PLS) based structural modeling technique that is capable of assessing the causal relationship among independent and dependent variables (evaluation of the structural model) as well as measurement item loadings on their expected constructs (evaluation of the measurement model). Analysis using PLS was conducted in two stages: in the first stage, the measurement model was evaluated to assess the reliability and validity of the measures; in the second stage, the structural model was evaluated to determine the nature of relationships between the constructs. The measurement model was tested by examining the convergent validity and discriminant validity of the items pertaining to each construct (see Table 6, 7, 8 and 9).

Convergent validity can be determined through three tests: (1) the Item Reliability Test, (2) the Composite Reliability Test and Cronbach's Alpha of the construct, and (3) the Average Variance Extracted (AVE) of the construct. It can be observed in Table 6 and Table 7, that all items have reliability scores above 0.707, which implies that half the variance of each item is captured by its construct. Thus, items measuring each construct had sufficient reliability.

The composite reliability of the various constructs was also above the requisite minimum of 0.7. It is known that Cronbach's alpha for constructs should be at least 0.6 and 0.7 for exploratory and confirmatory research respectively. This criterion was also met by all the constructs. Lastly, the Average Variance Extracted (AVE) of each construct was also above the required threshold of 50 percent. From these results, it is evident that the measurement model possesses adequate convergent validity.

Table 6: Assessment of Convergent Validity – Adopters

Dimensions	Item Reliability	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
To Know		0.895	0.929	0.768
Know1	0.9281			
Know2	0.9047			
Know3	0.7907			
Know4	0.8748			
To Accomplish		0.909	0.903	0.703
Accomplish1	0.7229			
Accomplish2	0.7966			
Accomplish3	0.9960			
Accomplish4	0.8140			
To Experience Stimulation		0.928	0.890	0.622
Stimulate1	0.7317			
Stimulate2	0.9351			
Stimulate3	0.6861			
Stimulate4	0.8052			
Stimulate5	0.7622			
Identified Regulation		0.834	0.911	0.595
Identified1	0.7223			
Identified2	0.8111			
Identified3	0.8063			
Identified4	0.7915			
Identified5	0.7333			
Identified6	0.7536			
Identified7	0.7763			
Introjected Regulation		0.856	0.858	0.602
Introjected1	0.8162			
Introjected2	0.7616			
Introjected3	0.7827			
Introjected4	0.7415			
External Regulation		0.832	0.864	0.615
External1	0.7756			
External2	0.8675			
External3	0.7353			
External4	0.7512			
Extent of OSS Adoption		0.923	0.946	0.815
Extent1	0.9088			
Extent2	0.8746			
Extent3	0.9071			
Extent4	0.9197			

Discriminant validity was assessed using two tests: (1) Item Loading, and (2) Item Correlation. The factor analysis performed showed no cross-loading factors. The factor loading of every item on its intended construct was greater than the commonly accepted value of 0.5. The second test for discriminant validity involved assessing the correlations between variables in any two constructs using PLS Graph Version 3.00. Each indicator should correlate more closely with other indicators measuring the same construct than with indicators measuring other constructs. This can be determined by examining whether the squared correlations between constructs (shared variances) are less than the average variance extracted for a construct (Igarria et al 1994). The results highlighted in Table 8 and Table 9 show that all constructs in the study satisfy the requirements for discriminant validity. Generally, the results provide strong evidence of the validity of the constructs.

Table 7: Assessment of Convergent Validity – Non Adopters

Dimensions	Item Reliability	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Capacity Beliefs		0.919	0.944	0.807
Capacity1	0.9039			
Capacity2	0.9171			
Capacity3	0.9175			
Capacity4	0.8535			
Effort Beliefs		0.887	0.919	0.740
Effort1	0.8198			
Effort2	0.8975			
Effort3	0.8602			
Effort4	0.8608			
Strategy Beliefs		0.900	0.917	0.690
Strategy1	0.9632			
Strategy2	0.8569			
Strategy3	0.7761			
Strategy4	0.8160			
Strategy5	0.7208			
Intention to Adopt OSS		0.893	0.926	0.759
Intention1	0.8906			
Intention2	0.8759			
Intention3	0.7995			
Intention4	0.9145			

Table 8: Discriminant Validity of Constructs – Adopters

Construct	Know	Accomplish	Stimulate	Identified	Introjected	External	Extent
Know	0.876						
Accomplish	0.535	0.838					
Stimulate	0.420	0.474	0.789				
Identified	0.367	0.253	0.301	0.771			
Introjected	0.258	0.390	0.334	0.215	0.776		
External	0.041	0.080	0.225	0.017	0.351	0.784	
Extent	0.355	0.331	0.377	0.391	0.339	0.216	0.903

Table 9: Discriminant Validity of Constructs – Non Adopters

Construct	Capacity	Effort	Strategy	Intention
Capacity	0.898			
Effort	0.339	0.860		
Strategy	0.092	0.360	0.831	
Intention	-0.208	-0.402	-0.472	0.871

With assurance of good psychometric properties in the measurement model, the PLS structural model was next examined to assess its explanatory power and the significance of the hypothesized paths. Testing of hypotheses was performed by examining the size, the sign and the significance of the path coefficients. Since PLS does not generate an overall goodness of fit index, the primary assessment of

validity is conducted by examining R^2 and the structural paths. The bootstrap re-sampling technique was employed to obtain the T-statistic for each path. Results of the PLS analysis of the research model for adopters and non-adopters are presented in Figures 3 and 4 as well as Table 10 and Table 11 respectively.

Table 10: Results of Testing of Hypotheses – Adopters

	Hypothesis (Path)	Path Coefficient	t-Value	Standard Error	Supported
H1a	To know → Extent of OSS Adoption	0.126	2.0862 *	0.0604	Yes
H1b	To Accomplish → Extent of OSS Adoption	0.070	0.9336	0.0750	No
H1c	To Experience Stimulation → Extent of OSS Adoption	0.142	2.0359 *	0.0697	Yes
H2a	Identified Regulation → Extent of OSS Adoption	0.253	3.8320 ***	0.0660	Yes
H2b	Introjected Regulation → Extent of OSS Adoption	0.135	2.1488 *	0.0628	Yes
H2c	External Regulation → Extent of OSS Adoption	0.122	2.0378 *	0.0599	Yes

Note: * denotes significance at the $p < 0.05$ level; ** $p < 0.01$; *** $p < 0.005$

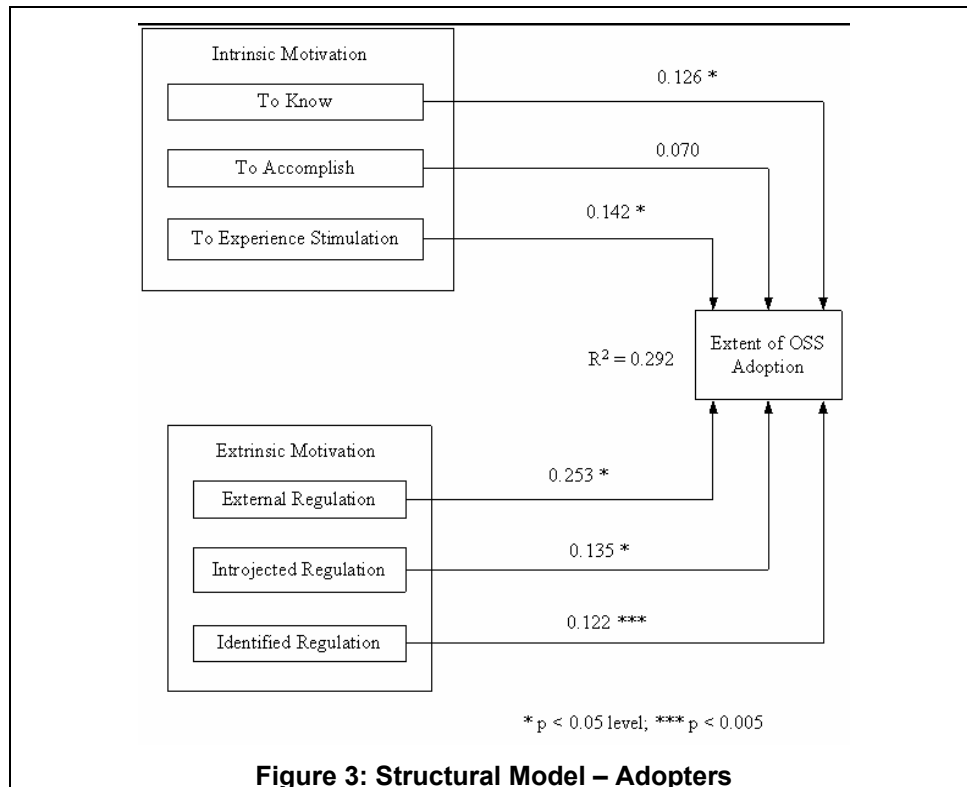


Figure 3: Structural Model – Adopters

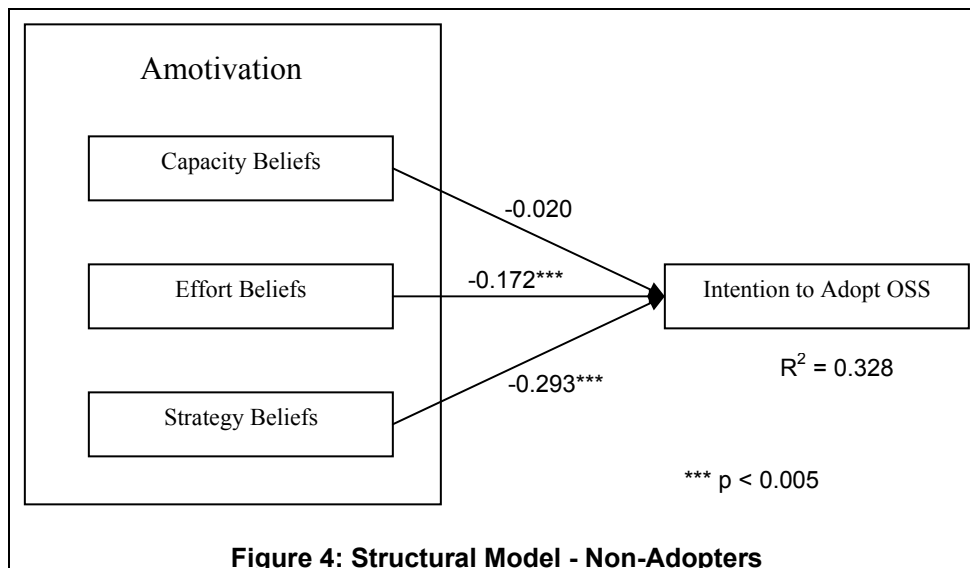


Figure 4: Structural Model - Non-Adopters

Table 11: Results of Testing of Hypotheses– Non Adopters

	Hypothesis (Path)	Path Coefficient	t-Value	Standard Error	Supported
H3a	Capacity Beliefs → Intention to Adopt OSS	-0.020	0.2800	0.0750	No
H3b	Effort Beliefs → Intention to Adopt OSS	-0.172	3.0611 ***	0.0560	Yes
H3c	Strategy Beliefs → Intention to Adopt OSS	-0.293	4.3064 ***	0.0677	Yes

Note: *** denotes significance at the p < 0.005

Discussion

The determination of the explanatory power of the structural models was based on the amount of variance in the endogenous constructs, which could be accounted for by the models. Approximately 29.2% of the variance in the extent of OSS adoption was accounted for by the variables in the adopter's model [$R^2 = 0.292$]. Results show that all of the respective hypotheses, except for H1b (intrinsic motivation to accomplish), were supported. Identified regulation was a significant positive predictor for the extent of OSS adoption (H2a). The path coefficient from identified regulation to the extent of OSS adoption was significantly stronger ($t = 3.8320$, $p < 0.005$) than the other types of motivation which had almost similar significance. The relationship between intrinsic motivation to

know and the extent of OSS adoption was positively significant (H1a) at $t = 2.0862$, $p < 0.05$, so was the relationship between intrinsic motivation to experience stimulation and the extent of OSS adoption (H1c) at $t = 2.0359$, $p < 0.05$. The two factors of introjected regulation (H2b) and external regulation (H2c) as predictors for the extent of OSS adoption were also both significant at $t = 2.1488$, $p < 0.05$ and $t = 2.0378$, $p < 0.05$ respectively. On the other hand, intrinsic motivation to accomplish (H1b) was not a significant predictor for the extent of OSS adoption. This may be due to the fact that being human beings in the 21st century; with so many challenges in life to accomplish such as educational and career goals, it would take more than the usage of certain software like OSS for them to feel an intrinsic motivation to accomplish. While previous researchers (e.g. Li et al. 2004) have shown that intrinsic motivation to accomplish is a significant factor for program developers to contribute to an OSS project development, the mere usage of OSS might not be challenging enough for normal users to feel intrinsically motivated to accomplish.

Approximately 32.8 percent of variance in the intention to adopt OSS was accounted for by the variables in the non-adopter's model [$R^2 = 0.328$]. Results show that all of the respective hypotheses, except for H3a (capacity beliefs amotivation), were supported. Strategy beliefs amotivation was a significant negative predictor for the intention to adopt OSS (H3c). The path coefficient from strategy beliefs amotivation to the intention to adopt OSS was significantly stronger ($t = 4.3064$, $p < 0.005$) than the other two types of amotivation which had similar significance. The hypothesized negative relationship of effort belief amotivation (H3b) as the predictor for the intention to adopt OSS was observed to be

significant ($t = 3.0611$, $p < 0.005$). On the other hand, capacity belief amotivation (H3a) was not a significant negative predictor for the intention to adopt OSS. This may be due to the fact that most young people of today, with high education qualifications in this information era, are armed with the basic knowledge and skills required to apply different types of computer software. They generally believe they have the ability and capacity when it comes to using OSS. Thus amotivation arising from lack of capacity belief may not exist in this scenario.

A number of limitations in this study need to be highlighted before approaching the discussion of implication. First, given the fact that this study has been conducted with university students in an Asian country, care and caution must be exercised when generalizing the findings to other economic, social and cultural contexts.

Second, there is a possibility of common method bias in this study. We have collected our data on both independent and dependent measures through self-reporting at a single point in time. This approach might have given rise to respondents giving answers they believed the survey researchers expected to receive. We minimized this effect with the anonymous nature of the survey which would mitigate the likelihood that respondents provided self-serving answers or answers they believed we expected.

Third, our model for non-adopters did not include intrinsic and extrinsic motivation. We conceptualized the model this way because our specific interest lies in investigating prohibiting motivational factors for individuals to adopt OSS. We also experienced an operational problem in our pilot study when we did not differentiate adopters from non-adopters and requested them to answer questions related to all the three types of motivation. That research design has greatly confused the subjects since part of the questionnaire would appear to be irrelevant depending on whether they were adopters or non-adopters. We thus decided to separate the model for adopters and non-adopters. However, we admit this to be a limitation of current study because according to Vallerand, a complete analysis of motivation must include intrinsic motivation, extrinsic motivation and amotivation (Vallerand, 1997). A better research design is needed in the future research in order to replicate the importance of intrinsic and extrinsic motivation for non-adopters.

Fourth, this study did not investigate the antecedents of the different types of motivations. It would be worthwhile to see what factors affects these motivations which in turn affects the intention and

extent of OSS adoption. Seeing that identified regulation has been the most significant positive predictor for adopter's extent of OSS adoption and strategy belief amotivation being the most significant negative predictor for non-adopter's intention to adopt OSS, future research could be done to examine the antecedents of these tenets.

Several theoretical implications can be derived from this study. First, our study extends the applicability of the Academic Motivation Scale (AMS) to a technological innovation adoption context like OSS. Previous studies on the AMS have focused only on an academic setting like the motivations for a student to go to school. Second, our study explores adoption from existing theoretical perspectives, i.e., the Self-Determination Theory (SDT) and the Amotivation Theory, in order to gain a richer understanding of the extent and intention of OSS adoption. The amotivation perspective highlights the importance of studying individual innovation adoption from the aspect of negative factors. Third, previous OSS adoption studies are mainly based on the organizational perspective. This study would therefore contribute by investigating this issue from the individual's perspective and thus add to the cumulative literature on OSS adoption. Fourth, this study has looked at both adopters and non-adopters in order to eliminate the bias in the sample population. Previous studies have mainly focused on the adoption intentions of either adopters or non-adopters. Furthermore, by looking at the extent of OSS adoption for adopters and the intention to adopt for non-adopters, we have looked at two measurement variables that best suit the respective groups of individuals.

This study provides several practical implications for OSS vendors and developers. First, our results suggest that OSS vendors like RedHat should work on promotional programs and strategies that target the enhancement of the motivations of individuals to raise awareness of OSS since it has been shown that the motivations of individuals do affect their intention to adopt OSS and the extent of adoption. Second, seeing that strategy belief amotivation is the major factor for non-adopters not to use OSS and identified regulation is the major factor affecting the extent of adoption by adopters respectively, vendors should especially look at strategy belief amotivation (e.g. by emphasizing the usefulness of OSS) as well as identified regulation motivation to further prioritize their implementation strategy for the more significant motivational factors. Third, this study confirms the importance of the user's perspective in the adoption of a technology. Developers should therefore improve their OSS products with end-users in mind since both

developers and users can have different expectations of software. Such differences may prevent the users from adopting the software. We hope that this study can also serve as a call for OSS developers to better communicate with and understand users' needs.

Conclusion

This study adopted the Self-Determination Theory to investigate the motivational factors for adopters' usage of OSS and non-adopters' intention to adopt OSS. Through this study, we hope to enhance our understanding of how certain motivations could affect an individual's OSS adoption and usage. It is hoped that this research will serve towards the objective of providing insights and calling for more research attention to a full understanding why the individual adoption rate of OSS has been lower than expected and how to improve the awareness of OSS among individuals.

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Appendix A Survey Questionnaires

Demographics

1) Gender

Male Female

2) Year of Study

1 2 3 4

3) Age (in years) _____ years old

4) Nationality _____

5) Ethnic

Chinese Malay Indian Others: _____

6) Which of these OSS have you used before?

a) Linux

b) Mozilla FireFox Web Browser

c) Mozilla ThunderBird Email Client

d) OpenOffice / StarOffice

e) MySQL Database

f) Others: _____

g) I have never used OSS before

If your answer to the above question is (g), please turn to page 6 and answer the **NONADOPTER** section of the questionnaire. Otherwise, please turn to page 3 and answer the **ADOPTER** section of the questionnaire.

ADOPTER Section

Part 1 (Please select the most appropriate choice for each question.)

WHY DO / DID YOU USE OPEN SOURCE SOFTWARE (OSS)?

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
A1) Because it is something new and I experience pleasure and satisfaction while learning new things.	1	2	3	4	5	6	7
B1) Because it is something new and I experience satisfaction when I discover new things never seen before.	1	2	3	4	5	6	7
C1) For the pleasure that I experience in broadening my knowledge about the different types of software available out there.	1	2	3	4	5	6	7
D1) Because I love trying out software that I have never tried before.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
A2) For the personal satisfaction I experience while trying to master something as complex as OSS	1	2	3	4	5	6	7
B2) Because it is an accomplishment for me to be proficient in many different types of software available.	1	2	3	4	5	6	7
C2) For the satisfaction I get while surpassing myself in my software knowledge.	1	2	3	4	5	6	7
D2) Because it allows me to experience a personal satisfaction in my quest for excellence in my software knowledge.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
A3) Because I feel a sense of excitement when using it.	1	2	3	4	5	6	7
B3) Because I like the feeling of being totally immersed when using it.	1	2	3	4	5	6	7
C3) Because it is intellectually stimulating.	1	2	3	4	5	6	7
D3) Because of the enjoyment I experience when using it.	1	2	3	4	5	6	7
E3) Because it gives me a feeling of delight when using it.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
A4) Because it is more compatible with the way I do my work and software compatibility is important to me.	1	2	3	4	5	6	7
B4) Because it is more secure and software security is important to me.	1	2	3	4	5	6	7
C4) Because it is more reliable and software reliability is important to me.	1	2	3	4	5	6	7
D4) Because it is easier to use and ease of use of software is important to me.	1	2	3	4	5	6	7
E4) Because its source code is open and it is important to me that source code of the software is open.	1	2	3	4	5	6	7
F4) Because it is free and it is important that the software I use is free.	1	2	3	4	5	6	7
G4) Because it is more customizable and it is important that software is able to provide functionality that matches my unique and specific needs.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
A5) Because that is what a university undergraduate of today should know.	1	2	3	4	5	6	7
B5) Because being a university undergraduate of today, I would feel guilty if I was not taking time to do it.	1	2	3	4	5	6	7
C5) Because it is something I should try, if not, I would feel bad.	1	2	3	4	5	6	7
D5) Because it is something a university undergraduate who is in this digital era should do.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
A6) Because my classmates are using it and I would feel out of place if I did not use it.	1	2	3	4	5	6	7
B6) Because my friends are using it and I would feel left out if I did not use it.	1	2	3	4	5	6	7
C6) Because my lecturers require us to use it.	1	2	3	4	5	6	7
D6) Because it is critical for me to get my school work done.	1	2	3	4	5	6	7

Part 2 (Please select the most appropriate choice for each question.)

Note: For those adopters who have stopped using OSS, we require you to provide information PRIOR TO YOUR DECISION to stop.

	Strongly Disagree		Neutral			Strongly Agree	
A7) I have been using OSS regularly.	1	2	3	4	5	6	7
B7) I have been using OSS extensively.	1	2	3	4	5	6	7
C7) I have been using OSS everyday.	1	2	3	4	5	6	7
D7) I have been using OSS frequently.	1	2	3	4	5	6	7

NON-ADOPTER Section

Part 1 (Please select the most appropriate choice for each question.)

WHY HAVE YOU NOT TRIED TO USE OPEN SOURCE SOFTWARE (OSS)?

	Strongly Disagree		Neutral			Strongly Agree	
A2) Because I feel that I do not have the competence to use OSS.	1	2	3	4	5	6	7
B2) Because I lack the capability to adopt OSS as it is not easy to use.	1	2	3	4	5	6	7
C2) Because I do not have what it takes to use OSS.	1	2	3	4	5	6	7
D2) Because I don't seem to have the ability to use OSS even though I know that it exists.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
A3) Because I can't seem to try hard enough to use OSS.	1	2	3	4	5	6	7
B3) Because I just can't seem to make the effort to use OSS.	1	2	3	4	5	6	7
C3) Because I can't seem to find the time to learn more about OSS.	1	2	3	4	5	6	7
D3) Because I do not want to make an effort to use OSS as it is too demanding.	1	2	3	4	5	6	7

	Strongly Disagree		Neutral			Strongly Agree	
A4) Because using OSS will not help me in my school work.	1	2	3	4	5	6	7
B4) Because using OSS is not going to improve my grades.	1	2	3	4	5	6	7
C4) Because using OSS is not going to make my life any better as if I am using commercial software.	1	2	3	4	5	6	7
D4) Because using OSS will not make me a better student.	1	2	3	4	5	6	7
E4) Because using OSS is not going to improve my computing skills.	1	2	3	4	5	6	7

Part 2 (Please select the most appropriate choice for each question.)

	Strongly Disagree		Neutral			Strongly Agree	
A5) I would like to use OSS today, if possible.	1	2	3	4	5	6	7
B5) I would try to use OSS as soon as I can.	1	2	3	4	5	6	7
C5) I will use OSS if given the chance.	1	2	3	4	5	6	7
D5) I would like to use OSS as soon as possible.	1	2	3	4	5	6	7