

# Value-based Adoption of Open-Source Software in Higher Education: An Empirical Investigation

Hazel A. TRAPERO<sup>ab\*</sup>, Cecilia B. LEAÑO<sup>a</sup> & Ma. Rowena CAGUIAT<sup>a</sup>

<sup>a</sup>*De La Salle University, Philippines*

<sup>b</sup>*University of the Philippines Cebu, Philippines*

\*hazel\_trapero@dlsu.edu.ph

**Abstract:** Open-Source Software (OSS) is computer software developed in a public collaborative manner with source codes available under a license that guarantees certain freedom. This includes the right to study, modify, and distribute the source code to any individual for any purpose without constraint or undue cost. It has gained much importance in the academic sector because it is best used for research, derivatives, analytics, statistics, and even the use of the Linux operating system is highly recommended. Academic institutions, particularly in emerging economies like the Philippines, are also under pressure to look for the lowest-cost solutions while having an effective course provision. However, several issues and challenges are identified, especially when it comes to its usability in terms of learnability, efficiency of use, memorability, and subjective satisfaction, among others. Thus, this study was conducted to investigate the different factors that can influence students to appreciate the open-source software's value and adoption in the classroom setting. The results of the study showed that enjoyment, technicality, and attribute have a significant correlation with perceived value while usefulness has no significant correlation with perceived value. Also, perceived value has a significant correlation with software adoption intention, while gender and age have no significant correlation with adoption intention. Therefore, enjoyment, technicality, and attribute are predictors of one's perceived value of OSS. The students' OSS adoption intention is also determined through the positive valuation of it which leads to adoption or continuous usage of it, whether for personal use or classroom use.

**Keywords:** Open-Source Software, Computer Education, Value-Based Adoption, Higher Education, OSS Benefits and Challenges

## 1. Introduction

Open-Source Software (OSS) is computer software with source codes that can be studied, modified, and distributed to any individual and for any purpose (St. Laurent, 2008) since it is developed in a collaborative public manner (Levine and Prietula, 2013). Despite its nature, users must still abide by the license terms upon using it, though the terms differ dramatically from those of proprietary licenses. Concerning the monetary aspect, while most of the OSS is free of charge, programmers and troubleshooting experts can make money by helping others troubleshoot the source codes, install, and use it (Opensource.com, 2018). With usage increase of OSS, it was reported that the revenue of open source services in 2018 has increased to \$14.1 billion from \$11.4 billion in 2017 and is projected to continuously increase to 32.95 in 2022 (Statista, 2018).

The use of OSS in the past several years has grown dramatically. This is because of several benefits of using OSS that have been observed nowadays. One example of this is the free access of source codes which enables developers to improve it if there is a need to, and more interoperable design applications (Hahn, 2014). Using it has also a cost advantage since it does not require a per-seat license. With all the benefits enumerated, as reported by Jon Brodtkin (2011), the National Aeronautics and Space Administration (NASA) has already partnered with Rackspace, an American cloud computing company based in Texas, to design OpenStack and open-source software for building cloud computing networks. Aside from them, the U.S. Department of Defense (DoD) acquired a government-developed

worker management system, which is known as the Open Source Corporate Management Information System, to manage agency personnel.

In the academe, OSS has gained much importance due to the reason that, oftentimes, a course requires a specific version of educational software to reflect the course content and pedagogical approaches. Like for instance, OSS is best used for research, derivatives, analytics, statistics, and even the use of the Linux operating system is highly recommended (Khan and UrRehman, 2012). Academic institutions, particularly in emerging economies like the Philippines, are also under pressure to look for the lowest-cost solutions while having an effective course provision (Attwell, 2005; Nuñez et al., 2017). A University has been implementing courses that promote and use open-source technologies within the curricula (Ebardo, 2018a).

However, despite the benefits that one can get from using OSS, several issues and challenges are also identified, especially in the technical aspect. One of these is its usability in terms of learnability, the efficiency of use, memorability, and subjective satisfaction, among others. This is so because the majority of the users have been using proprietary computer programs for a long time already, thus, consider OSS's usability as one of the reasons that limit its use. Second is its performance because it is frequently compared to the performance of closed or licensed software. Another issue is on security – since the source codes are open for any individual, OSS is vulnerable to security bugs and flaws (Sarrab, Elbasir, and Elgamel, 2013). Lack of technical and administrative support is also identified as one of the major challenges of OSS implementation, together with resistance to change in the educational setting where age was an important issue, especially of the teachers. It is said that young ones were engrossed in learning new skills while older ones resisted changes in teaching (Kisanjara and Tossy, 2014; Howard and Mozejko, 2015; Thankachan and Moore, 2017) which may influence the students. Moreover, OSS products are not always endorsed but there is powerful evidence of the success of its performance which boosts its continued use in the public and private sectors. Despite this advantage, there persist the problem of adoption (Okey and Sam, 2019).

## 2. Statement of the Problem

This study was conducted to investigate the different factors that can influence students to appreciate the open-source software's value and to adopt it in the classroom setting. This study aims to answer the following questions:

1. What are the factors that impact students' perception of OSS value in learning?
2. How students' perceptions of OSS value and worth affect their intention to adopt the software?

Specifically, this study aims to evaluate the hypotheses, listed below, using the Value-Based Adoption Theory lens.

*H1. The usefulness of OSS positively influences the student's perception of its value.*

This study describes usefulness as to how OSS assist users in accomplishing a task (Venkatesh et al., 2003). Information technology, which includes the software and hardware components of information systems, is now recognized as a useful artifact in the information age, thus, there is a need to understand the level of usefulness of the IT, together with users' perception and level of satisfaction in using it (Kim and Part, 2018). Moreover, the value-based adoption theory claims that when students have a positive perception of the usefulness of a specific IT, their level of the perception of its value also increases.

*H2. The student's enjoyment when using OSS positively influences the student's perception of its value.*

Today, academic institutions are already adopting blended learning. This is learning where new technologies, software, and hardware, are integrated into the curriculum to transform the traditional way of teaching and learning into more interactive and enjoyable multimedia pedagogy and therefore, attract the students' attention (Huang, Chen, and Chou, 2016). This is related to the results of numerous studies of human interaction with real ecological environments, like in the academe, that "emotion" is a valuable motivation and learning factor (Reis and Roth, 2009; Rowe and Fitness, 2018; Huang and Hsu, 2019).

*H3. The technicality of OSS positively influences the student's perception of its value.*

OSS customization is seen to be easier than the proprietary or closed software because of the availability of the software source code and its free manipulation and this is one of the challenges observed. This is the reason why it is necessary to formulate and abide by the licensing agreement, local laws, and organization peculiarities (Serrano and Sarriegi, 2006; Zekos, 2016; Ram, 2018).

In terms of OSS usage as an instructional tool, "ease of use" is one of the constructs to be assessed during the technicality evaluation. It is a level of user's belief that using software for a particular task will be free of effort (Venkatesh and Bala, 2008). That software that is perceived to be easier to use is more likely to be accepted by the user compared to other software provided that all other factors are equal. Thus, perceived ease of use is found to greatly influence computer and software usage (Davis, 1989; Teo and Zhou, 2014; Fokides, 2017).

*H4. The perceived cost of OSS positively influences the student's perception of its value.*

The growing acceptance of OSS in both the industry and academe is due to the low cost it offers to the users since there is no need for them to buy licenses and usually it does not need expensive equipment for it to perform well (Gripe and Rodello, 2011). The high cost of proprietary software packages adds up to the financial burden of students, faculty, and administrators, thus, choosing appropriate tools for academic use is identified as one of the challenges (Nehra and Tyagi, 2014).

*H5. The student's perceived value of OSS positively influences their intention to use OSS.*

OSS's zero-fee or low-cost licenses play a significant role in its rapid adoption. Aside from that, the usefulness, enjoyment and manageable technicalities enable users to see the value of utilizing it, especially in the classroom (e.g. using Weka in the Data Analytics class). And when it is perceived to be valuable, users intend to use it more often. This is one of the reasons why, aside from the organizations, it is adopted by an increasing number of academic institutions for it has been observed that more opportunities are available for students to learn and create knowledge (Long, 2009; Blake and Morse, 2016).

*H6. The demographics positively influence the student's intention to use OSS.*

Demographics, such as gender and age, have been used to classify the personality traits and characteristics of groups of participants (Lee et al., 2010). They have been identified as predictors of adoption behavior (Im, Bayus, and Mason, 2003; Rojas-Mendez, Parasuraman, and Papadopoulos, 2017). Demographics are still incorporated in a study, though their effects are known to be weak, because of their considerable presence in adoption literature. Nevertheless, it was found out that age and gender significantly influence the intention to use a particular technology (Lee et al., 2010).

### **3. Review of Related Literature**

#### *3.1 Open-Source Software in the Philippines*

Way back in 2002, members of Open Minds Philippines, which is an open-source advocacy group having Manny Amador as the official spokesman, stated that a lot of very good open-source software can already be used, not just word processors but business packages and suites of applications for different organizations. However, proprietary software vendors like Microsoft Corp. disagreed on its use because they have seen that proprietary and commercial software offer more value for businesses in terms of cost-effectiveness. It was reported that government offices are now beginning to use open source technologies and even consider it as the primary option (Mamuyac, 2017). The Philippines' PHL-Microsat team designed its round receiving station data subsystems of the first earth observation satellite, DIWATA, in 2016. DIWATA is designed to provide information about the Philippines for disaster and environmental purposes (Aranas et al., 2016). Just recently, the Department of Information and Communications Technology (DICT) has already teamed up with Red Hat Inc. The partnership aims to create a community of independent software vendors (ISVs) and developers within the Philippines that can influence open-source innovations. This will also encourage them to create applications that are beneficial for the government agencies and the Filipinos in general (Umali, 2018). But despite the increase in the adoption of these technologies in the Philippines, its adoption is moving slowly because of the challenges like in the case of the academic institutions, there are no clear guidelines on its adoption. Aside from that, proprietary vendors influence the universities' decisions by

donating computers and educational software licenses with the condition that the software should be taught and included in the curriculum (Mamuyac, 2017).

### 3.2 Open-Source Software in Education

With the availability of the Internet, several educational resources and free software are now freely accessible (Gupta and Surbhi, 2018). Several open-source tools have been used in computer science and IT courses (Lipsa and Laramee, 2011; Dundas and Singh, 2014) and some projects are formulated to assist students' learning development through improved educational methods. Thus, the value of Open Source tools has been increasingly appreciated and the number of users continuously increases. This is because it offers the principles of openness, collaboration and interactive knowledge-sharing that are important in the academe. Furthermore, open-source adoption in education would enable stakeholders to have control over its technology resources. However, the big challenge is changing the mindset of users, such as students, faculty, and even staff, to openness and open thinking, not on the change of actual tools like for example from Microsoft Office to OpenOffice or from SPSS to Weka (Oduor, Honkavuori, and Pasma, 2012). As it is observed, teachers usually teach how to use a particular tool rather than teaching students the fundamentals of graphic design or the format and layout for essays or the fundamentals on how data are computed and analyzed. Thus, it is encouraged to teach and learn computing concepts in the classroom instead of products (Bhura, 2018).

## 4. Theoretical Framework

Value-Based Adoption Model by Kim, Chan, and Gupta (2007) as shown in Figure 1 is a combination of the Technology Acceptance Model (TAM) by Davis (Davis, 1989) and the Theory of Perceived Value by Zeithaml (1988). This is mainly because VAM emphasized the significance of “usefulness” and “enjoyment” as the benefits and “technicality” and “perceived fee” as sacrifice which are identified as the primary factors of perceived value leading to the users' intention to use a particular IT, rather than just based on usefulness and ease of use from TAM.

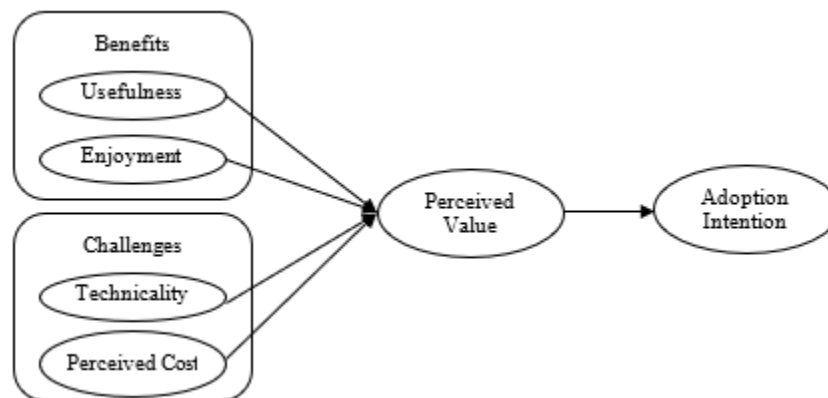


Figure 1. Value-based Adoption Model

## 5. Operational Framework

This study wanted to conduct an empirical investigation of VAM in the Philippine setting. However, some constructs were changed and added to fit into the perspective of the students. First, “adoption intention” is evaluated based on the academic institution’s perspective, thus, in this study, it was changed to “intention to use” due to the nature of the respondents who are students. Second, demographic variables are described as the major factors that may influence the use of IT tools and applications (Aramide, Ladino, and Adebayo, 2015). Thus, this study also investigated whether the demographics such as gender and age, as shown in Figure 2, influence the students' intention to use OSS.

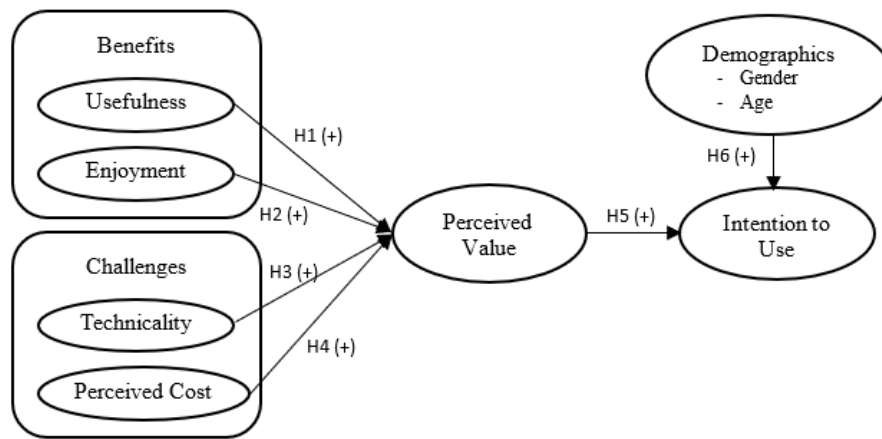


Figure 2. Operational Framework

## 6. Methodology

A survey instrument was constructed through Google Forms. The majority of the questions were taken from the survey instrument by Kim, Chan, and Gupta (2007). A pilot test was conducted using the instrument to sixteen (16) college students on Facebook who have experienced OSS in the classroom. The validity of the said instrument was then analyzed using the Partial Least Squares (PLS) algorithm of SmartPLS 3.2.6 statistical tool, as recommended by Ebardo (2017). After the analysis, a total of six questions (indicators) were removed (one-by-one) since it was found out that they are below the Chronbach's Alpha critical level of 0.7. Two of these are from "usefulness" construct, three from 'attitude', while one from "perceived value".

When the survey instrument was finalized, it was again deployed, but this time, to several student communities on Facebook already. The data were then gathered and all the constructs in the proposed framework were analyzed using SmartPLS bootstrapping technique (Ebardo, 2018b).

## 7. Results and Findings

A total of 167 respondents answered the survey, 62% of them are males while 38% are females. 68% of the total respondents are currently studying while the remaining 32% are already working, however, they stated that they used OSS when they were in college.

Based on test statistics, as shown in Table 1, usefulness has no significant correlation with perceived value. This may imply that students would not appreciate the software's value and worth just because of the assistance that it offers to accomplish a task. This opposes Kim, Chan and Gupta's (2007) claim that the more the students have a positive perception of the usefulness of an IT, the higher their level of perception of its value. This may also imply that they haven't learned to appreciate the OSS that they are using (e.g. OpenOffice) because they prefer the licensed software that they are usually exposed to (e.g. Microsoft Office). This confirms Bhura's (2018) observation that teachers usually introduce software and teach them how to use it, rather than teaching them the fundamentals of concepts regardless of what software is used. Like for instance, teaching the techniques on how to write a comprehensive essay using any word processing tool.

Table 1

*Descriptive Statistics of the Respondents' Characteristics*

Measure	Items	Frequency	Percentage
Gender	Male	104	62
	Female	63	38
Age	< 21	49	19
	21-25	121	73
	>25	14	8
Aware/With experience using OSS	Yes	160	96
	No	7	4
Course	IT	98	57
	Engineering/Math	16	13
	Animation/Design	32	20
	Others (Ethics, Business)	21	10

Based on test statistics (Table 2), usefulness has no significant correlation with perceived value. This implies that students would not appreciate the software's value and worth just because of the assistance that it offers to accomplish a task. This contradicts Kim, Chan and Gupta's (2007) claim that the more the students have a positive perception of the usefulness of an IT, the higher their level of perception of its value. This also implies that the students may not have learned to appreciate the OSS they are using (e.g. OpenOffice) because they prefer the licensed software that they are usually exposed to (e.g. Microsoft Office). This concurs with Bhura's (2018) observation that teachers usually introduce software and teach the students how to use it, rather than teach them the fundamentals of concepts regardless of what software is used, for instance, the techniques on how to write a comprehensive essay using any word processing tool.

Table 2

*Results of Intention to Use Based on VAM*

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	P Values
Usefulness - > Perceived Value	0.020	0.047	0.122	0.161 <sup>ns</sup>	0.872
Enjoyment - > Perceived Value	0.433	0.416	0.142	3.054*	0.002
Technicality - > Perceived Value	0.200	0.203	0.077	2.578*	0.010
Perceived Cost - > Perceived Value	0.349	0.335	0.066	5.297*	0.000
Perceived Value - > Intention to Use	0.849	0.850	0.034	24.771*	0.000

\* Significant <sup>ns</sup> Not Significant

On the other hand, enjoyment, technicality, and perceived cost showed significant correlations with perceived value. This means that students appreciate the value of a software if it is enjoyable, easy to use, user-friendly, and cheaper. This is why academic institutions nowadays are using technologies like OSS since it is one way of transforming the teaching and learning style into a more interactive and enjoyable one (Huang, Chen, and Chou, 2016). This also confirms Davis' (1989) claim that software that is easier to use is more likely to be accepted by the user. Besides, perceived cost influences students' perception of their value. This means that they prefer software that does not add up to their financial burden as emphasized by Nehra and Tyagi (Nehra and Tyagi, 2014).

Lastly, the perceived value had a significant correlation with software adoption intention. This means that the more the students notice the value of OSS, the more they intend to use it over and over again. This supports a finding that an increasing number of academic institutions are using it because it can provide more opportunities for students to learn and create knowledge (Long, 2009; Saini, 2018; Okey and Sam, 2019).

Table 3

*Results of Correlation between Variables*

	$\alpha$	$df$	$X^2_c$	$X^2_{tab}$
Gender - > Intention to Use	0.05	4	2.074 <sup>ns</sup>	9.488
Age - > Intention to Use	0.05	60	36.302 <sup>ns</sup>	79.082

The correlation between gender and adoption intention, as well as between age and intention to use, were evaluated using the chi-square of independence test and the results are presented in Table 2. For “Gender - > Intention to Use”, the computed value ( $X^2_c$ ) of 2.074 was less than the table value ( $X^2_{tab}$ ) of 9.488, thus, not significant. Gender had no significant correlation with students’ adoption intentions with OSS. For “Age - > Intention to Use”, the computed value ( $X^2_c$ ) of 36.302 was also less than the table value ( $X^2_{tab}$ ) of 79.082. This means that the use of the software does not depend on one’s gender and age, but on whether it is enjoyable, it is easy to use and does not burden them financially. This contrasts with Rojas-Mendez, Parasuraman, and Papadopoulos (2017) claim that gender and age have been identified as the predictors of adoption behavior.

## 8. Conclusion

Therefore, enjoyment, technicality, and perceived cost are predictors of one’s perceived value of OSS but usefulness is not. This means that emotion is indeed a valuable learning factor as students appreciate the value of using OSS because they enjoyed interacting with it. In terms of technicality, users more likely to accept and use the software when it is easier to use and the way it is used to accomplish a task will be free of effort. There will also be a higher rate of OSS acceptance if it will be acquired at low cost and will not add up to the users’ financial burden, especially the universities regardless of whether it is useful or not in accomplishing a task.

On the other hand, the students’ OSS adoption intention is not determined through one’s gender and age, but through a positive valuation of it, leading to its adoption or continuous usage, either for personal use or classroom use. It is the users’ perception of OSS value that drives them to use it more often.

This paper contributes to the research on the adoption of OSS, especially in higher education, however, the generalizability of the results of this research may be limited because of the following reasons: 1) small sample size, 2) the survey was conducted online, and 3) the conduct of the study was limited to one semester only.

## 9. Recommendations

In this study, OSS was presented to the students in a generic sense. Because of this, there could have been a tendency for each one to think of different OSS with various levels of applications, hence affecting their responses in the survey. It is recommended that further studies be conducted focusing only on a specific OSS to ensure control of the variables. It is also recommended that future research will be conducted with a bigger sample size using a longitudinal approach and conducting interviews and focus group discussions to improve the results of the study.

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