Communications of the Association for Information Systems

Volume 28 Article 9

3-2011

An Empirical Investigation into the Assimilation of Open Source Server Software

Kris Ven
Department of Management Information Systems, University of Antwerp, kris.ven@ua.ac.be

Jan Verelst
Department of Management Information Systems, University of Antwerp

Recommended Citation
Ven, Kris and Verelst, Jan (2011) "An Empirical Investigation into the Assimilation of Open Source Server Software," *Communications of the Association for Information Systems*: Vol. 28 , Article 9.
DOI: 10.17705/1CAIS.02809
Available at: https://aisel.aisnet.org/cais/vol28/iss1/9

Communications of the Association for Information Systems

CAIS

An Empirical Investigation into the Assimilation of Open Source Server Software

Kris Ven

Department of Management Information Systems, University of Antwerp

kris.ven@ua.ac.be

Jan Verelst

Department of Management Information Systems, University of Antwerp

Abstract:

In recent years, open source software (OSS) has become widely known and adopted in practice. In academic literature, an increasing number of studies on the adoption of OSS have been published to investigate which factors influence its adoption. However, most of these studies have an exploratory nature, and empirical support based on a large-scale quantitative study is still missing. To address this issue, we present the results of a large-scale quantitative study investigating the factors that influence the assimilation of open source server software (OSSS) by organizations. OSSS refers to open source software products such as operating systems, web servers and mail servers. We developed a conceptual model that describes the factors influencing the assimilation of OSSS. We gathered data from 210 Belgian organizations and analyzed it using PLS to test this conceptual model. The proposed model was able to explain a large proportion of the variance in the dependent variable in the model. Surprisingly, we have found no support for the influence of several widely claimed advantages of OSSS. Our findings further show that the assimilation of OSSS is predominantly influenced by the availability of internal and external knowledge of OSSS.

Keywords: technology assimilation, open source software, organizational adoption, quantitative research, survey

Volume 28, Article 9, pp. 117-140, March 2011

The manuscript was received 6/30/2010 and was with the authors 1 month for 1 revision.

Communications of the Association for Information Systems

I. INTRODUCTION

Over the past decade, open source software (OSS) has had an important impact on the software industry. When the term was first coined in 1998, many people were skeptical toward the use of OSS in organizations. While a community of volunteer developers used to be responsible for the development of OSS, an increasing number of commercial software companies started to offer support and other OSS-related services and products [Fitzgerald, 2006]. Hence, the OSS phenomenon has evolved considerably in recent years into a more commercially viable form [Fitzgerald, 2006]. This increased commercial support had a positive effect on the adoption of OSS [Dedrick and West, 2003; Fitzgerald and Kenny, 2003; Morgan and Finnegan, 2010]. As a result, many OSS products have already widely diffused through organizations.

At the same time, practice and trade publications reported on many claims with respect to the advantages related to the use of OSS [Ven et al., 2008]. Several of the early reports about organizations that were using OSS were journalistic, ambassadorial, or ideological in nature [Feller and Fitzgerald, 2002]. It remains unclear, however, whether the common perceptions, attitudes, and publicized claims with respect to OSS have an influence on the organizational adoption decision. Given the importance of gaining more insight into the adoption process in order to improve upon the evaluation, adoption, and implementation of OSS, several researchers have called for additional studies related to the adoption of OSS [Feller et al., 2006; Morgan and Finnegan, 2010; Niederman et al., 2006].

In recent years, an increasing number of studies have been conducted on the organizational adoption of OSS. Most of these studies had a qualitative and exploratory nature. The aim of these studies was to gain an in-depth insight into the factors that influence the organizational adoption of OSS. These studies have provided various interesting and useful insights into the reasons that may influence the organizational adoption decision in organizations. Unfortunately, empirical support for these factors based on a large-scale quantitative study is still missing. Such a study could provide more insight into which factors play a decisive role in the adoption of OSS across a large population of organizations. Therefore, we wanted to address this gap in literature by developing a conceptual model describing the factors that influence the assimilation of OSS by organizations, and to subsequently quantitatively test this model. Assimilation can be defined as "*an organizational process that (1) is set in motion when individual organization members first hear of an innovation's development, (2) can lead to the acquisition of the innovation, and (3) sometimes comes to fruition in the innovation's full acceptance, utilization, and institutionalization*" [Meyer and Goes, 1988, p. 897].

Since OSS is a common name for software that is distributed under a specific license, it refers to a wide range of technologies. We felt that it was, therefore, necessary to narrow the scope of our research in order to guarantee the internal validity of our study and to allow for a meaningful analysis. We decided to restrict the scope of our research to *open source server software (OSSS)*. We use this term to refer to OSS that is used for server or infrastructural use, including operating systems, Web servers, and mail servers. We made this choice because of a number of reasons. First, OSS has historically been quite strong in this domain with applications such as Linux, Apache, and Bind. As a result, organizations have already progressed well in the assimilation of this type of OSS. Second, this type of OSS is quite mature and well-known by many decision makers. This allows us to obtain meaningful and more reliable perceptions with respect to OSSS. This may have been more difficult for other types of OSS that were still evolving.

The rest of the paper is structured as follows. In the next section, we provide an overview of the literature related to this study. We continue with discussing the theoretical background of our study. Next, we present the conceptual model that was developed in this study. This is followed by a description of the research method, including construct operationalization, validation, and data collection. The subsequent section presents the analysis of our data. We then proceed with a discussion of our major findings, as well as their theoretical and managerial implications. Finally, some concluding remarks are offered.

II. RELATED WORK

In this section, we discuss the literature related to this study. We start by providing a brief overview of previous studies on the organizational adoption of OSSS. Next, we summarize the results of our own previous qualitative research on the organizational adoption of OSSS.

Organizational Adoption of OSSS

In the past few years, an increasing number of studies on the adoption of OSS have been published. However, considerable variety exists in the scope and context of these studies. Studies have, for example, focused on the adoption of open source desktop products such as OpenOffice.org (e.g., Brink et al., 2006; Ven et al., 2007), the adoption of OSS in the public sector (e.g., Ghosh and Glott, 2005; Waring and Maddocks, 2005), or the adoption of OSS in the software-intensive industry (e.g., Hauge et al., 2010; Morgan and Finnegan, 2010). The first studies on the adoption of OSS focused on OSSS products such as Linux and Apache. The main reason for this is that server-side applications were the most mature and well-known OSS products available and were also among the first OSS products to be adopted by organizations on a large scale. Most of these studies had a qualitative and exploratory nature, providing an in-depth insight into the phenomenon. Our main interest in the remainder of this section is on those studies that have focused on the adoption of OSSS.

The studies of West and Dedrick represented the first effort to investigate the adoption of OSSS [Dedrick and West, 2003, 2004, 2007; West and Dedrick, 2001, 2005, 2006]. They performed an exploratory study involving twenty-one informants in fourteen American organizations. Their results indicated that cost was the most important factor that influenced the adoption of OSSS. Other important factors included the presence of boundary spanners, perceived reliability, compatibility with current technologies and skills, the availability of external support, and trialability. The availability of the source code of OSS had little impact on the adoption decision [Dedrick and West, 2004, 2007; West and Dedrick, 2001]. They further noted that organizations tried to minimize their switching costs in the adoption of OSSS. In this regard, the compatibility with the current technologies and skills of the organization is an important consideration [West and Dedrick, 2006].

Another important study is that of Fitzgerald, who performed a longitudinal study on the adoption of OSS by an Irish hospital [Fitzgerald, 2009; Fitzgerald and Kenny, 2003, 2004]. The hospital decided to adopt OSS at various levels in the organization, including StarOffice on the desktop computers, and Postfix at the server level to support the e-mail infrastructure. This study mainly describes the experiences of the organization with the implementation of the OSS products. The results showed that—in terms of user perceptions—the use of OSS at the server level was much more successful than at the desktop level. The main motivation for the hospital to explore the use of OSS (including at the server level) was cost, since the hospital was faced with considerable reductions in its budget. In addition, the trialability of OSS was considered to be an important advantage, since it allowed the IT staff to experiment with various OSS products before deciding which product to adopt [Fitzgerald, 2009].

Larsen and colleagues performed an exploratory case study in three Danish organizations, from both the public and private sector [Holck et al., 2005; Larsen et al., 2004]. They found that cost and the availability of support were important factors influencing the adoption decision. They further determined that the compatibility of OSS with the existing infrastructure was an important consideration, since this determines the switching costs involved with a migration to OSS. If these costs are too high, the organization may decide not to adopt OSS. The availability of the source code was only found to be relevant when integrating various components in the IT infrastructure [Holck et al., 2005; Larsen et al., 2004].

A study conducted by Lundell et al. reported on the perceptions and adoption of OSS by Swedish organizations [Lundell et al., 2006, 2010]. Their study consisted of a telephone interview with respondents in fifty-eight Swedish organizations. Their sample consisted primarily of organizations that already used OSS. Respondents were probed for their initial thoughts regarding the term OSS, their level of—and experiences with—OSS adoption, and their degree of participation in OSS projects. Respondents expressed a wide variety in perceptions with respect to OSS, emphasizing a process view (referring to the process of how OSS is developed), a business view (referring to the fact that the organization based its business model on OSS), an ideological view (referring to the community idea behind OSS), or a pragmatic view (referring to the availability of the source code). It was further determined that most use of OSS was situated at the infrastructure level, with 75 percent of the organizations using a LAMP (Linux, Apache, MySQL, PHP) stack, and 50 percent of the organizations using other OSSS products. Informants reported mainly positive experiences with respect to the reliability and quality of OSS, as well as the responsiveness of the OSS community to development-related questions. Most informants were also aware that the use of OSS is not free of charge, but included additional costs in terms of understanding and supporting OSS. It was also established that 75 percent of the organizations contributed in some way or another to at least one OSS project (by posting bug reports, engaging in discussions on mailing lists, promoting the use of OSS in organizations, translating applications, or by participating in software development).

Prior Qualitative Study

The research described in this paper was part of a larger mixed methods study in which we combined both an exploratory qualitative perspective and a confirmatory quantitative perspective. The aim of the qualitative study was

to generate a number of hypotheses with respect to the assimilation of OSSS, which would then be tested in the quantitative study. The output of the qualitative study—which is reported in Ven and Verelst [in press]—was, therefore, the input for the quantitative study described in this paper. The qualitative study started with an extensive literature review of studies on the organizational adoption of OSS. The aim of the literature review was to determine which factors were identified in previous studies to be influencing the assimilation of OSSS. Next, we conducted a case study in ten Belgian organizations that had adopted OSSS. In each organization, we interviewed one or more informants who were well-informed about the assimilation of OSSS in their organization. During the interviews, we were primarily concerned with determining why the organization had decided to assimilate OSSS. We subsequently coded and analyzed the data obtained from the interviews in order to identify the factors that influenced the assimilation of OSSS. In our analysis, we identified seven factors that have an impact on the assimilation of OSSS. Five of these factors were found to have an important impact on the adoption decision (i.e., software cost, switching cost, reliability, presence of boundary spanners, and external support availability). On the two other factors (i.e., trialability and source code availability) we obtained mixed evidence, thereby suggesting that they have a limited impact on the adoption decision. We will now summarize our findings with respect to each of these factors. For a more detailed discussion, we would like to refer the reader to our previous work [Ven and Verelst, in press].

Concerning *software cost*, all organizations indicated that the lower license cost of OSSS was a factor in their adoption decision. Most organizations indicated that the use of OSSS—instead of proprietary software—was a way to reduce their expenses since there are no, or lower, license fees involved in the use of OSS. Several organizations, however, tried to downplay the importance of cost by mentioning that the use of OSSS implies additional costs (concerning support, implementation, training, and maintenance) and that the difference in license costs is not so large when a commercial OSSS product—which requires a license fee—is used. Therefore, it appears that acquisition cost plays a role in the assimilation of OSSS, although its impact may be rather limited given the existence of additional costs related to the adoption. In addition, most organizations seemed to focus on the initial savings in license costs, and did not try to estimate the total cost of ownership associated with OSSS.

Organizations also considered *switching costs* to be an important concern in the adoption decision. These switching costs are dependent on the compatibility of OSSS with the existing knowledge and IT infrastructure in the organization: the lower the degree of compatibility, the higher the switching costs will be. If these switching costs are high, organizations were found to be less likely to adopt OSSS. Our results further showed that organizations were primarily concerned with whether the knowledge of employees was compatible with the knowledge required by the use of OSSS. Otherwise, the organization needed to invest in additional training. A migration from the Unix platform to Linux was also found to be much easier than a migration from the Microsoft Windows platform to Linux, since the switching costs in the former scenario are lower than in the latter scenario. This can be explained by the fact that many administrative tools are shared between Unix and Linux, and that the design of Linux is based on the Unix platform.

All organizations also indicated that the *reliability* of OSSS was an important factor in the adoption decision. Most organizations were convinced that Linux is at least as reliable as its proprietary counterparts. However, our informants also indicated that not all OSS products are currently sufficiently reliable to be used in organizations. Organizations further indicated that they did not want to risk adopting unreliable software, and, therefore, considered adopting only those OSS products that have proven their reliability in the past. In general, most OSSS products (such as Linux, Sendmail, Bind, and Apache) were found to be sufficiently mature to be adopted by organizations.

The *presence of boundary spanners* was an important factor in the adoption of OSSS. Boundary spanners are individuals within an organization who connect their organization to external information and can bring the organization in contact with new technologies [Tushman and Scanlan, 1981]. In several instances, IT staff members became familiar with OSS in their personal time and developed further knowledge about it. When a suitable opportunity presented itself in the organization, they would recommend the use of OSSS to management. The suggestion to adopt OSS was, as a result, frequently a bottom-up initiative. For several organizations, the presence of boundary spanners was an efficient way to come into contact with OSSS, since their employees were able to suggest the use of specific OSSS products (thereby avoiding a time-consuming search and selection process for the organization), and to—at least partly—support the installation and maintenance of these OSSS products.

The *availability of external support* was likewise considered a very important factor by the organizations in our sample. Some organizations preferred to make use of a support contract offered by vendors of commercial enterprise Linux distributions such as RedHat or SUSE. In some cases, a third party mandated the use of these enterprise Linux distributions. Most commercial software vendors (e.g., Oracle and SAP) only certify their software on the commercial enterprise versions of Linux. Hence, if organizations want to use such applications on top of the Linux platform, a commercial Linux version must be used. Several informants indicated that the organization did not make intensive use of the support contract, but that it was rather considered an insurance that any problems would

be quickly resolved by the Linux vendor when they would occur. Other organizations preferred to make use of a service provider to assist in installing and maintaining the OSS products within the organization. This option was primarily used by those organizations that lacked the necessary in-house resources due to the small size of their IT department. Overall, organizations were reluctant to adopt OSSS in the absence of external support.

Concerning *trialability*—i.e., the ability to try out the software before making an adoption decision—we have found mixed evidence. Most informants indicated that it was important to be able to try out the software before adopting it. On the one hand, all organizations agreed that OSSS was easy to try out, since it can be freely downloaded from the Internet. Organizations could download and try out OSSS products, evaluate how well the software performs, and then decide on whether to adopt the product. On the other hand, organizations did not think that OSSS was easier to try out than proprietary software, since demo and trial versions are also available for the latter. Nevertheless, several informants indicated that using these demo and trail versions may be a little bit more cumbersome, since some vendors require prior registration, provide a trial version with limited functionality, or only allow to try out the software during a limited period of time. Some organizations also mentioned that trying out OSSS may sometimes be time-consuming due to the absence of user-friendly install programs. Hence, although OSSS was found to have high trialability, the impact on its assimilation may be rather limited.

The *availability of the source code* was found to be advantageous in some way or another by the majority of the organizations in our sample. Several organizations mentioned that it provided them with the ability to read and/or modify the source code of OSS products, which can be convenient when integrating OSS products in custom-developed software. Some organizations indicated that the source code provided them with more control over their IT infrastructure. Other organizations indicated that the openness of the source code provided more trust in the software, since by allowing public peer review of the source code, the number of bugs and the risk that the software contains hidden features can be minimized. Half of the organizations indicated to have applied changes to OSS products. Most of these changes consisted of organization-specific customizations. However, when focusing on OSSS products in particular, none of the organizations ever read or modified the source code of products such as Linux and Apache, due to the complexity of these applications. Hence, the availability of the source code was found to be primarily a latent advantage by the organizations in our sample. OSSS provided the ability to view or modify the source code when required, but organizations did not appear to make frequent use of this possibility. Therefore, the impact of this factor on the adoption decision may be rather limited.

In this paper, we will quantitatively test whether each of these factors identified in our prior qualitative study has a significant impact on the assimilation of OSSS.

III. THEORETICAL FRAMEWORK

The theoretical framework used in this study is the *Technology–Organization–Environment (TOE)* framework developed by Depietro et al. [1990]. Since the aim of this study is to conduct a comprehensive investigation into the factors influencing the assimilation of OSSS, the TOE framework allows us to consider the broader context in which this assimilation process takes places. The TOE framework distinguishes between three elements in the organization's context: the *technological context*, the *organizational context* and the *environmental context*. The framework is therefore commonly known as the Technology–Organization–Environment (TOE) framework. The technological context describes the characteristics of existing and new technologies. This context reflects the common expectation that features of a technology itself will have an influence on the assimilation of that technology (e.g., cost and compatibility). The organizational context refers to a number of descriptive measures of the organization such as organizational size, the amount of slack resources, the degree of formalization, and the presence of external linkages (e.g., boundary spanners). The external context refers to properties of the environment in which the organization operates, such as the characteristics of the industry, the availability of skilled workers, the availability of support services, and external regulations.

TOE does, however, not aim to offer a concrete model describing the factors that influence the assimilation process; it is rather a taxonomy for classifying factors in their respective context. The main contribution of this framework is that it encourages the researcher to take into account the broader context in which assimilation takes place. The importance of taking into account organizational and environmental characteristics in addition to characteristics of the technology itself has been supported by several other studies (e.g., Fichman, 2000; Rogers, 2003). Similar to most adoption research, studies that have used the TOE framework focused on a specific technology [Fichman, 2000]. Those studies populate the TOE framework with factors that are idiosyncratic to the technology being studied. Empirical support for the TOE framework has been provided by a large number of studies including studies concerning Electronic Data Interchange (EDI) [Kuan and Chau, 2001], open systems [Chau and Tam, 1997], and e-business [Zhu and Kraemer, 2005].

IV. CONCEPTUAL MODEL AND HYPOTHESES

Based on the results of the qualitative study, a conceptual model was developed [see Ven and Verelst, in press]. This conceptual model describes the factors that are hypothesized to be influencing the assimilation of OSSS and is based on the TOE framework. The conceptual model is shown in Figure 1 and illustrates that seven factors are hypothesized to be influencing the assimilation of OSSS, namely five technological factors, one organizational factor and one external factor.

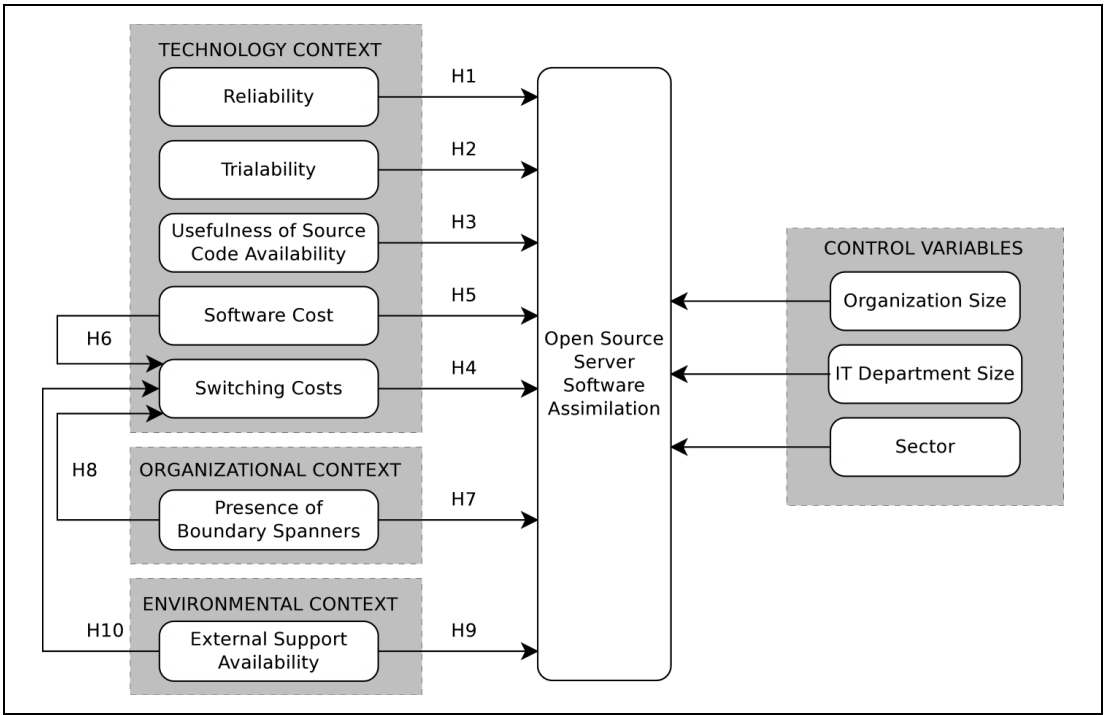

Figure 1. Conceptual Model for the Assimilation of OSSS

Technological Context

The results of our qualitative study suggested that the *reliability* of OSSS was one of the major factors influencing the assimilation of OSSS [Ven and Verelst, in press]. Previous qualitative studies on the organizational adoption of OSSS also suggest that reliability is a factor in the adoption decision [Dedrick and West, 2003, 2004; Lundell et al., 2010]. The importance of this factor can be explained by the fact that there is much uncertainty about the reliability of OSS [Dedrick and West, 2004; Ven et al., 2008]. Some organizations do not consider OSSS to be of a sufficiently high quality to be used in organizations, since they consider it software developed by a community of volunteer developers without the backing of a commercial organization. Although this characterization is representative of the early years of OSS development, it has been noted that in the past few years, the OSS phenomenon has transformed itself into a more professional and commercially viable form [Fitzgerald, 2006]. Contemporary OSS development is increasingly supported by commercial organizations. The concerns with respect to the reliability of OSS within an organizational context also led to the development of so-called open source maturity models such as OpenBRR and QSOS that aim to assess whether a specific OSS product is mature enough to be adopted by organizations. Recent studies have shown that some organizations still consider Linux and other OSSS to be inferior to proprietary systems, while other organizations consider OSSS to be on par with its proprietary counterparts [Dedrick and West, 2004, 2007; Ven and Verelst, in press; Ven et al., 2008; West and Dedrick, 2006]. Hence, a considerable variety in opinions exists with respect to the reliability of OSSS and we expect that organizations that consider OSSS to be reliable will be more likely to assimilate OSSS. This leads to the following hypothesis.

Hypothesis 1. Organizations that perceive OSSS to be reliable will exhibit a larger extent of OSSS assimilation.

Trialability refers to the degree to which a technology is easy to try out before making a final decision on whether to adopt the technology or not. Previous studies have shown that a higher degree of trialability has a positive influence on the tendency to adopt that technology (e.g., Moore and Benbasat, 1991; Rogers, 2003). The influence of trialability on the adoption decision has primarily been studied within the context of an individual adoption decision (e.g., Karahanna et al., 1999; Moore and Benbasat, 1991). Nevertheless, research has suggested that the availability of trial versions of a product increases the market value of the product, which in turn could result in a higher adoption of the product [Gallaugher and Wang, 2002]. OSS offers two advantages over proprietary software

concerning trialability: it can be freely downloaded from the Internet without prior registration with a vendor, and there are no limitations in time or functionality when using the software. Because of these properties, some authors have argued that OSS possesses "unlimited trialability" [Kshetri, 2005]. Previous studies have shown that organizations generally agree that OSSS has a high degree of trialability [Dedrick and West, 2003; Ven and Verelst, in press]. However, the organizations in our qualitative study also mentioned that due to the absence of easy-to-use install programs, trying out OSSS may not be that easy, especially when the knowledge about OSS is limited [Ven and Verelst, in press]. In addition, some organizations mentioned that they noticed little difference with the trialability of proprietary software [Ven and Verelst, in press]. Hence, although the trialability of OSSS is not questioned, it remains somewhat unclear whether organizations really consider trialability an important factor in the assimilation process. Since the results from our qualitative study are mixed [Ven and Verelst, in press], we hope to gain more insight into whether trialability has an impact on the assimilation of OSSS. Since evaluation and trial is one of the first stages in the assimilation process, it can be expected that a higher trialability of the software will contribute to its assimilation. We therefore propose the following hypothesis.

Hypothesis 2. Organizations that perceive OSSS to be easier to try out will exhibit a larger extent of OSSS assimilation.

The *availability of the source code of OSS* is the most distinguishing property of OSS. As a result, it is probably one of the most frequently discussed characteristics of OSS. While the source code for proprietary applications is closed, the source code of OSS is available for everyone to study and modify it. Several authors have argued that the availability of the source code reduces the time required to fix bugs [Raymond, 2001] or results in more secure systems [Payne, 2002]. On the other hand, many of these claimed advantages rely on the assumption that an effective peer review system is in place during which the code is examined by a large number of developers. There are indications that this is not true for all OSS projects [Feller and Fitzgerald, 2002]. Nevertheless, the source code availability is often stressed as one of the main advantages of OSS. We have found that several organizations in our qualitative study considered the availability of the source code of OSS to some extent an advantage [Ven and Verelst, in press]. The source availability provided more trust in the software and also provided the opportunity to read and modify the source code if required. However, none of the organizations actually read or modified the source code of OSSS products, given the fact that examining and modifying the source code of such products is a complex activity. This is consistent with several studies that have suggested that the source code is not used that often [Fitzgerald and Kenny, 2003; Larsen et al., 2004; West and Dedrick, 2005]. It remains unclear, however, if organizations do indeed consider the source code availability to be an advantage that might influence the assimilation of OSSS. Given the mixed evidence on this factor, we decided to quantitatively test whether *perceived usefulness of source code availability* impacts the assimilation of OSSS. This leads to the following hypothesis.

Hypothesis 3. Organizations that perceive the availability of the source code of OSSS to be useful will exhibit a larger extent of OSSS assimilation.

Another important factor that was identified during the qualitative study was the level of *switching costs* involved in the adoption of OSSS. The decision to adopt OSSS cannot be considered in isolation from the existing IT infrastructure and knowledge. Prior to the decision on whether to adopt OSSS, organizations will have invested in their IT infrastructure and in the knowledge of their IT staff. If OSSS is incompatible with any of these two elements, the organization will incur switching costs. These switching costs refer to the costs—both financial and otherwise—that are involved in terminating the use of the current technology, and adopting a new one [Klemperer, 1987]. If the degree of incompatibility between both technologies is high, the switching costs will be high as well and the adoption of the new technology will be less likely. The role of switching costs is well-acknowledged in adoption literature [e.g., Greenstein, 1997; Klemperer, 1987; Shapiro and Varian, 1999]. Organizations will generally tend to minimize their switching costs by choosing a technology that is compatible with their existing IT infrastructure and knowledge [Greenstein, 1997; West and Dedrick, 2006]. Hence, adoption decisions are influenced by investments made in the past. In the extreme case, switching costs can even lead to a situation of vendor lock-in, when the cost of switching to another vendor or platform is too expensive [Greenstein, 1997; Shapiro and Varian, 1999]. In addition, organizations will in most cases seek some degree of standardization in their IT infrastructure since it ensures technical compatibility between their various systems and it requires the organization to acquire less diverse knowledge. In the context of the adoption of OSSS, an important distinction must be made between organizations that standardize on the Unix platform and those that standardize on the Microsoft Windows platform. While the Unix platform is quite compatible with Linux and other OSSS (in terms of technical compatibility and the knowledge required for both platforms), the Microsoft Windows platform is rather incompatible with OSSS. Formulated in terms of innovation literature, the transfer from Unix to Linux would be classified as *incremental*, requiring little learning efforts, while the transition from Microsoft Windows to Linux is *discontinuous*, introducing new ideas and technologies for the adopter [Tushman and Nadler, 1986]. Previous studies on the adoption of OSSS have indeed noted that organizations consider a migration from Unix to OSSS much easier than a migration from Microsoft

Windows to OSSS [Dedrick and West, 2003; Fitzgerald and Kenny, 2003; Ven and Verelst, in press; West and Dedrick, 2006]. This can be explained by the fact that Linux is essentially a Unix clone and many administration tools are shared between both platforms. Organizations that have standardized on the Microsoft Windows platform will therefore have to invest more effort in migration, conversion, and training in order to adopt OSSS. Several studies have therefore concluded that the level of switching costs have an impact on the adoption decision on OSSS [Dedrick and West, 2003; Li et al., 2005; Ven and Verelst, in press]. The results of our qualitative study further suggest that the cost of retraining personnel is the most important component of switching costs [Ven and Verelst, in press]. We therefore formulate the following hypothesis.

Hypothesis 4. *Organizations that expect high switching costs related to the adoption of OSSS will exhibit a smaller extent of OSSS assimilation.*

Another factor that was relevant to the adoption of OSSS is *software cost*. Adoption literature states that the less expensive the technology, the more likely it is that it will be adopted [Rogers, 2003]. This is consistent with the observation that a high cost could be a barrier to adoption for those organizations with limited financial resources. Within the context of the adoption of OSSS, software cost could have a positive effect on the assimilation process. An important difference with proprietary software is that there are—in principle—no license fees associated with the use of OSS. Hence, the acquisition cost of OSSS can be considered lower than for proprietary software. Several studies have noted that the lower license cost is an important reason for the adoption of OSSS, and that organizations adopt OSSS in order to realize cost savings [Dedrick and West, 2003, 2007; Fitzgerald and Kenny, 2003; Larsen et al., 2004; Lundell et al., 2010; Ven and Verelst, in press; West and Dedrick, 2006]. The impact of cost on the adoption decision is, however, more complex. It has, for example, been noted within the context of the adoption of open source desktop software that the low acquisition cost of OSS may lead to the perception that OSS is inferior to proprietary software [Fitzgerald, 2009]. In addition, it remains unclear whether the cost savings are as large as often claimed. In our qualitative study, we observed that a number of organizations tried to downplay the importance of the acquisition cost [Ven and Verelst, in press]. It was noted that since the number of licenses at the server level were limited, the savings in license cost are limited as well. In addition, many organizations made use of a commercial Linux distribution, such as RedHat and SUSE. Since there are also license fees related to the use of those commercial Linux distributions, the cost advantage of OSSS is reduced. Organizations indicated that in such situations, the initial cost advantage of OSSS is rather limited. Hence, the opinions with respect to whether the acquisition cost of OSSS is lower than that of proprietary software vary across organizations. In addition, although many claims have been made with respect to this factor, a clear insight in the impact of this factor on the assimilation of OSSS is still missing. We therefore propose the following hypothesis.

Hypothesis 5. Organizations that perceive OSSS to be less expensive will exhibit a larger extent of OSSS assimilation.

Switching costs are all the costs that are associated with a migration from one technology to another. Hence, the acquisition costs of the latter technology are part of the switching costs. If the license or acquisition costs of that technology are lower, the switching costs will be lower as well, and vice versa. Concerning the adoption of OSSS, it is possible that the lower acquisition and license costs are not a sufficient reason for organizations to adopt. Previous studies have shown that organizations are aware that although the license costs of OSSS are lower, there are additional costs involved in the adoption of OSSS (i.e., switching costs) [Lundell et al., 2010; Ven and Verelst, in press]. These additional costs can render the real cost advantage of OSSS less clear. This would suggest that respondents take switching costs into consideration when making their decision. Hence, the overall impact of the potential cost advantage on the assimilation of OSSS may be mediated by the amount of switching costs involved in the assimilation process. We therefore formulate the following hypothesis.

Hypothesis 6. Organizations that perceive OSSS to be less expensive will perceive the switching costs involved in adopting OSSS to be lower.

Organizational Context

Within the organizational context, the *presence of boundary spanners* was an important factor. Boundary spanners are individuals within an organization who connect their organization to external information and can bring the organization in contact with new technologies [Tushman and Scanlan, 1981]. Boundary spanners are especially important when external knowledge is difficult to obtain by the internal staff [Cohen and Levinthal, 1990]. In that case, knowledge barriers may exist in the organization that could prevent the adoption of a new technology [Attewell, 1992]. The presence of boundary spanners enables the organization to learn more effectively about new technologies, and to acquire in-house knowledge about them [Cohen and Levinthal, 1990]. Boundary spanners play an important role during the adoption of OSSS. Organizations in which boundary spanners are present can learn more easily about the existence of OSS and its potential to be used in the organization. The organization can in that

case rely on the judgment of its employees. These employees have developed their knowledge on OSSS outside the work environment and then introduce this knowledge to the organization. It has indeed been noted in literature that employees frequently use OSSS at home, learn more about it, and then suggest its use to managers within their organization [Dedrick and West, 2003; Lundell et al., 2010; Ven and Verelst, in press]. Boundary spanners can, therefore, be considered advocates for the assimilation of OSSS. Boundary spanners also help organizations in lowering the entry barrier to using OSSS. Organizations in which no boundary spanners are present will experience more difficulties in obtaining information about OSSS and may miss certain opportunities to use it, since their employees may not recognize these opportunities. Hence, we propose the following hypothesis.

Hypothesis 7. Organizations in which boundary spanners for OSSS are present will exhibit a larger extent of OSSS assimilation.

The presence of boundary spanners is an efficient way for organizations to learn about OSSS. The presence of boundary spanners in the organization means that these employees already have OSSS-related skills. As a result, there is less need for the organization to acquire general information about OSSS or specific information about which OSSS products could be used by the organization. It may also reduce the need for training, since some employees already possess knowledge about OSSS and may educate their colleagues. Without these boundary spanners, the organization would have to invest more time and financial resources, thereby resulting in higher switching costs. This is similar to the observation of Li et al. [2005] that the availability of internal human capital lowers switching costs. We therefore formulate the following hypothesis.

Hypothesis 8. Organizations in which boundary spanners for OSSS are present will perceive the switching costs involved in adopting OSSS to be lower.

Environmental Context

An important factor from the environmental context that influences the adoption of OSSS is the *availability of external support*. The availability of external support has been shown to be an important factor in several adoption studies, especially in small organizations [Gable, 1991; Thong et al., 1994]. Within the context of the adoption of OSSS, the availability of external support represents a specific issue, since many organizations are concerned with the fact that it is difficult to obtain support for OSSS products. OSS was originally developed by a community of volunteer developers, and the only means of support consisted of interacting with the members of the OSS community over on-line channels such as IRC or mailing lists. However, it is not guaranteed that all questions will be answered by the community, and the community does not offer on-site services. Hence, the community is not able to provide the guarantees required by organizations. Over time, commercial support services for OSS became increasingly available, especially for well-known OSSS products. Unfortunately, these service providers were often small and local organizations which may raise concerns over their long-term viability. Although this is becoming less of a problem in recent years thanks to the services provided by large international service providers, organizations may still be concerned with respect to the availability of external support. It has indeed been noted in literature that some organizations feel insufficient support for OSSS is available, while other organizations do not feel this to be problematic [Dedrick and West, 2003; Fitzgerald and Kenny, 2003; Larsen et al., 2004; Li et al., 2005; Ven and Verelst, in press]. In addition, most organizations prefer being able to rely on external support since it allows organizations to rely on outside knowledge when a problem surfaces with the OSSS product to which the answer cannot be provided internally [Dedrick and West, 2003; Fitzgerald and Kenny, 2003; Larsen et al., 2004; Li et al., 2005; Ven and Verelst, in press]. The perception to which degree external support is available for OSSS may therefore influence the adoption decision. Hence, we formulate the following hypothesis.

Hypothesis 9. Organizations that perceive external support for OSSS to be available will exhibit a larger extent of OSSS assimilation.

The availability of external support may also have an influence on the switching costs involved in the adoption of OSSS. If organizations feel little external support is available on the market, the organization will need to start a search for service providers that offer services related to OSSS. In the next step, they will have to screen the various service providers to assess which of them will be selected by the organization. This is a process that requires time of the employees and also financial resources. In addition, organization may feel that support for OSSS will be more expensive since only a limited number of OSS service providers are available on the market. However, since boundary spanners may have good knowledge of the market for OSS consultancy services, their presence may reduce the time needed to search and select service providers who can assist the organization in the use of OSSS. As a result, the switching costs for the organization will be lower. This argumentation is similar to that of Li et al. [2005], who also hypothesized that the availability of external human capital for OSS will decrease switching costs. We therefore propose the following hypothesis.

Hypothesis 10. Organizations that perceive external support for OSSS to be available will perceive the switching costs involved in adopting OSSS to be lower.

V. RESEARCH METHOD

The aim of this study was to perform a quantitative validation of the conceptual model presented in Figure 1. To this end, we conducted a field study using the survey method. Before discussing data collection and analysis, we provide details on the operationalization of the constructs included in the conceptual model and the validation of our measurement instrument.

Construct Operationalization

We started the operationalization of our constructs by providing a clear definition of the theoretical concepts we intended to measure. The findings from the qualitative study were an important source for developing these definitions. We will now further discuss the operationalization of the dependent variable (assimilation), the seven independent variables, and the control variables.

The dependent variable in our model is the assimilation of OSSS. We reused the measurement instrument for assimilation developed by Fichman and Kemerer [1997]. A number of studies in IS research have already used this scale (e.g., Fichman and Kemerer, 1997; Ravichandran, 2005). This scale distinguishes among seven possible assimilation stages through which organizations may progress. A Guttman scale is used to classify organizations in the appropriate assimilation stage. Since the instrument was first used to study the assimilation of object-oriented programming languages, we have slightly adjusted the wording of the items to suit the context of the present study (i.e., the assimilation of OSSS).

For the independent variables, a literature review was undertaken to identify previously validated measurement items. For *reliability*, *switching costs*, *trialability*, *presence of boundary spanners*, and *external support availability* suitable measurement instruments could be found in literature which required no, or only a few, modifications. For *cost advantage* and *usefulness of source code availability*, no suitable measurement scales could be identified in literature. Hence, new items were developed based on the findings of the qualitative study. All independent variables were modeled as reflective multi-item constructs. Each item was measured using a 7-point Likert scale ranging from strongly disagree to strongly agree, with each point labeled.

We decided to consider the impact of three additional control variables that may account for some of the differences in the extent of assimilation across organizations. These control variables were organization size, size of the IT department, and sector.

Organization size has frequently been found to have a positive impact on the assimilation of new technologies [Fichman, 2000]. Large organizations are generally more likely to have more resources, which facilitates the assimilation process. On the other hand, it is possible that smaller organizations will be more likely to adopt OSSS. Since they generally have fewer resources, they might look for potentially cheaper OSSS solutions. Organization size was measured as the total number of employees that worked in the organization.

The *size of the IT department* may be an indication of the technical resources available to the organization [Fichman, 2000]. The more technical resources are available to the organization, the larger the technological knowledge base that can be used for assimilating OSSS. The size of IT department was measured by the total number of servers in use by the organization.

The *sector* in which the organization is active may also influence the assimilation of OSSS. Our main interest is in comparing the private and public sector. Lately, many public administrations are undertaking large-scale deployments of OSS, mostly on desktop computers. Therefore, it is interesting to examine whether public administrations are more likely to adopt OSSS or not. The sector was recorded using a dichotomous item indicating whether the organization was active in the private or public sector (0 = private sector; 1 = public sector).

Since the measures of *organization size* and *size of the IT department* were skewed, the natural logarithm of these values was used in subsequent analyses to ensure the data was normally distributed.

It must be noted that it is essential that each respondent interprets the term *OSSS* the same. Hence, we needed a more precise and explicit definition of this term. We accomplished this similar to Fichman and Kemerer [1997] by restricting our study to an exhaustive list of OSSS products. It was decided to restrict the list to the most prominent and mature OSSS products. To this end, we took into account the available academic and professional literature, as well as our findings from the qualitative phase. The final version of this list included seven well-known OSS products

that are typically used on servers, namely Linux, BSD, Apache, Bind, Sendmail, Postfix, and Samba. Respondents were instructed on each page in the survey that the term OSSS referred to this exhaustive list of seven OSS products.

Instrument Validation

We preferred to be conservative, and subjected all measurement scales—even those that were previously validated in literature—to a rigorous validation procedure to ensure the content validity, construct validity, and reliability of our measurement instrument. We conducted a first pretest using five judges, including both academics and practitioners. The aim of the pretest was to reduce the initial item pool generated by the researchers and to identify any issues in the wording and understanding of items. The pretest was divided into two parts: a *labeled sorting exercise* and a *rating exercise*. During the sorting exercise, judges were also invited to report any remarks they had with respect to each item. The rating exercise measured how essential each item was for measuring its respective construct and was based on the procedure proposed by Lewis et al. [2005].

Next, we conducted a second pretest to perform a qualitative review of the survey instrument to identify any issues in the survey design. The pretest involved seven experts, once again including both academics and practitioners. In order to maximize the feedback that could be obtained from the experts, we decided to use the *cognitive interviewing technique* with two of our experts [Willis, 2005]. This pretest did not reveal any major problems.

Finally, we performed a pilot study to conduct an initial quantitative validation of the measurement instrument, based on the responses of thirty-four IT managers in Belgian organizations. The analysis consisted of a number of statistical tests, including a visual inspection of the correlation matrix to assess convergent and discriminant validity, an exploratory factor analysis, and the computation of Cronbach's alpha. Given the limited sample size, the results of these tests were interpreted with caution. Nevertheless, the results indicated that the measurement scales exhibited satisfactory levels of validity and reliability. Only three items that consistently performed poorly across all statistical tests were removed from the measurement instrument.

Data Collection

To collect the data for our research, we conducted a field study using a self-administered web survey. The target population for our study were Flemish organizations that had servers installed. The sampling frame for the study consisted of the Flemish organizations included in the database of a market research bureau that collects IT-related information on a regular basis from 25,000 organizations from various sectors in Belgium, The Netherlands and the Grand Duchy of Luxembourg. Since the penetration of Linux was estimated to be around 8 percent, we used a disproportional stratified sampling strategy to ensure that we would include a sufficient number of OSSS adopters to allow for statistical analysis. Organizations were divided into two strata, based on the fact whether the organization used Linux at the time of the survey (this information was available in the database of the research bureau). We drew random samples from both strata and restricted ourselves to Flemish organizations.

The target audience for the survey consisted of decision makers on IT. In most organizations, this responsibility was delegated to the CIO or IT manager, or possibly the CEO in smaller organizations. All subjects included in the sample were first personally contacted by telephone, and were asked for their cooperation in this study. Upon agreement, subjects were sent an invitation via e-mail. This e-mail also contained a unique identifier that was necessary to complete the survey, thereby preventing organizations outside our sample from completing the survey and participants from completing the survey more than once. In total, we contacted subjects in 622 organizations. Only thirty-eight organizations explicitly declined to participate in the study, while forty-nine organizations were discarded by the researcher, since they did not have any servers installed. If organizations did not complete the survey within fourteen days, they were sent one or more reminders encouraging them to complete the survey. Of the 535 organizations that were sent an invitation, 332 replied, which corresponds to a response rate of 62.1 percent. This is a high response rate compared to similar studies in this field. We attribute this high response rate to the personal telephone contact that was the initial contact with the organizations. It was observed during these telephone calls that this significantly positively influenced the willingness of organizations to participate.

The data obtained from those 332 organizations was subjected to a careful data screening process, in which the data was checked for the existence of missing values and univariate and multivariate outliers. A total of 270 cases remained available for further analysis. We decided to further narrow down our sample to those organizations that had decision authority, or in other words, that were autonomous in making decisions concerning the IT infrastructure. Some organizations may rely on the decision of a parent company, or may have decided to fully outsource their IT. Querying those organizations about their perceptions and use of OSSS may potentially distort our findings. After eliminating those organizations without decision authority, 210 cases remained available for our main analysis. Demographics on these organizations are displayed in Table 1.

Table 1: Demographics of Final Sample		
Organization Size		
Very small (1–49)	26	12.4%
Small (50–99)	37	17.6%
Medium (100–249)	58	27.6%
Large (250–499)	41	19.5%
Very large (>500)	48	22.9%
Total	210	100.0%
IT Department Size		
Very small (1–2)	24	11.4%
Small (3–5)	39	18.6%
Medium (6–10)	55	26.2%
Large (11–50)	67	31.9%
Very large (>50)	25	11.9%
Total	210	100.0%
Sector		
Government	55	26.2%
Non-government	155	73.8%
Total	210	100.0%
Assimilation Stage		
0. Not aware	35	16.7%
1. Awareness	40	19.0%
2. Interest	15	7.1%
3. Evaluation/trial	15	7.1%
4. Commitment	39	18.6%
5. Limited deployment	47	22.4%
6. General deployment	19	9.0%
Total	210	100.0%

VI. EMPIRICAL ANALYSIS

To analyze our data, we decided to make use of structural equation modeling (SEM). Two types of SEM are available: the covariance-based approach (as implemented in, for example, LISREL, EQS, or AMOS) and the partial least squares (PLS) approach (as implemented in, for example, PLSGraph or SmartPLS) [Gefen et al., 2000; Petter et al., 2007]. Our choice for using PLS is based on two main arguments. First, the application of covariance-based SEM requires a strong theoretical foundation, while PLS does not require such a strong theoretical foundation. Our study was the first to quantitatively test a model describing the factors that influence the organizational adoption of OSSS. In addition, our model was based on the results of an exploratory case study. Hence, the model did not have a sufficiently strong theoretical foundation to apply covariance-based SEM. Second, covariance-based SEM is mainly suited for theory development and testing, since its aim is to determine whether the covariance matrix implied by the theoretical model fits the empirical covariance matrix. PLS is used for predictive applications and tries to maximize the explained variance of the manifest variables [Anderson and Gerbing, 1988; Gefen et al., 2000]. In our study, we aim to explain the organizational adoption of OSSS, and essentially try to predict if an organization will adopt OSSS based on its perceptions of a number of latent variables. Hence, based on both considerations, the use of PLS is more appropriate. To support our analysis, SmartPLS 2.0M3 [Ringle et al., 2005] was used.

Measurement Model

We started our PLS analysis with an evaluation of the measurement model in order to assess the reliability and factorial validity of the constructs. In a first step, we assessed individual item reliability by investigating the loadings of the items on their respective construct. Examination showed that some items did not meet the proposed minimum of .707 [Barclay et al., 1995]. Therefore, we decided to eliminate four items from our further analysis. The revised model displayed highly desirable characteristics. A subsequent analysis showed that all items had loadings that were significant at the .001 level, and all but one item (i.e., PBS1) had a loading exceeding .707 (see Table 4 for the results of the PLS factor analysis). However, we decided to retain this item since the loading of this item was very close to the proposed minimum (i.e., .683), was significant at the .001 level, and the examination of the cross loadings identified no issues with respect to this item.

Next, we evaluated factorial validity. Table 2 shows that both Cronbach's alpha and the composite reliability (CR) coefficients of all constructs were above the minimum of .70 recommended in the literature [Chin, 1998]. In addition, the average variance extracted (AVE) was well above .50, as recommended in the literature [Chin, 1998; Fornell and

Larcker, 1981]. These results provide support for convergent validity. Discriminant validity was ascertained by verifying that the square root of the AVE is higher than all the interconstruct correlations [Barclay et al., 1995; Chin, 1998]. As Table 3 shows, our data satisfies this criterion. A second means for investigating discriminant validity is by examining the cross-loadings. The results from the PLS factor analysis are shown in Table 4. As can be seen from this table, each item loads higher on the construct it intends to measure, than on any other construct [Barclay et al., 1995; Chin, 1998]. In addition, the loadings in each construct block are higher than the cross-loadings of the construct with items from other constructs. As a result, both tests indicated that our model has a sufficient level of discriminant validity.

Table 2: Convergent Validity Statistics

Construct	AVE	CR	Cronbach's alpha
PSWC	.60	.85	.78
PREL	.80	.94	.91
TRIAL	.82	.93	.90
ACCSC	.82	.96	.94
PBS	.65	.90	.87
EXTSUP	.71	.92	.90
SWCOST	.73	.93	.91

Table 3: Discriminant Validity of Major Constructs

	ACCSC	ASSIMILATION	EXTSUP	PBS	PREL	PSWC	SWCOST	TRIAL
ACCSC	.90							
ASSIMILATION	.29	1.00						
EXTSUP	.22	.31	.84					
PBS	.31	.59	.27	.81				
PREL	.31	.49	.36	.48	.89			
PSWC	.28	.33	.29	.30	.50	.77		
SWCOST	-.41	-.48	-.34	-.52	-.56	-.45	.86	
TRIAL	.13	.04	-.17	.06	.00	.16	.04	.90
Note: Diagonal elements represent the square root of the AVE								

We also tested for the existence of common method bias by using the approach suggested by Podsakoff et al. [2003]. This method consists of extending our research model with one latent variable representing the influence of common method bias. The structural paths are then examined both with and without the common method factor. Given the fact that the common method factor on average only explained .9 percent of the variance (compared to 85.6 percent for our independent variables), we can conclude that the influence of common method bias is acceptable in this study.

Structural Model

We subsequently assessed the structural model using PLS. We performed a bootstrapping procedure using 500 resamples and construct level sign-changes to assess the significance of the path coefficients. We evaluated the model on the R^2-values and the significance of the paths. Similar to previous studies (see e.g., Fichman and Kemerer, 1997; Ravichandran, 2005; Teo et al., 2003), we estimated three different models, namely (1) the *theoretical model*, (2) the *control model*, and (3) the *full model*. An evaluation of these three structural models is shown in Table 5. It can be seen that the R^2-value of ASSIMILATION in all models is highly significant. Next, we can determine if the addition of the control variables in the model leads to a substantial increase in the explained variance in the dependent variable, by calculating the corresponding F-statistic for including additional variables into the model. Results show that the full model is superior to both the control model and the theoretical model: it explains 32.3 percent and 6.7 percent more variance respectively. In addition, both F-statistics are highly significant ($p < .0001$). Therefore, we continue with the interpretation of the full model.

Table 4: Item Loadings and Cross-loadings in PLS Factor Analysis								
	ACCSC	ASSIMILATION	EXTSUP	PBS	PREL	PSWC	SWCOST	TRIAL
ACCSC1	**.81**	.28	.18	.34	.32	.32	-.38	.20
ACCSC2	**.91**	.25	.14	.29	.35	.30	-.39	.13
ACCSC3	**.93**	.25	.20	.25	.21	.21	-.37	.09
ACCSC4	**.92**	.26	.22	.26	.25	.19	-.33	.09
ACCSC5	**.94**	.29	.24	.26	.25	.21	-.38	.09
ASSIMSTAGE	.29	**1.00**	.31	.59	.49	.33	-.48	.04
EXTSUP1	.09	.10	**.77**	.13	.19	.22	-.21	-.20
EXTSUP2	.22	.24	**.79**	.26	.32	.21	-.38	-.11
EXTSUP3	.20	.30	**.84**	.29	.36	.28	-.29	-.09
EXTSUP4	.18	.29	**.91**	.20	.26	.26	-.24	-.19
EXTSUP5	.19	.30	**.90**	.21	.32	.24	-.27	-.16
PBS1	.14	.44	.34	**.68**	.30	.20	-.38	-.04
PBS2	.28	.47	.10	**.86**	.44	.33	-.37	.14
PBS3	.22	.40	.23	**.80**	.29	.12	-.37	.04
PBS4	.32	.53	.19	**.89**	.47	.31	-.46	.11
PBS5	.29	.51	.25	**.80**	.42	.23	-.49	.00
PREL1	.27	.40	.26	.43	**.89**	.41	-.47	-.02
PREL2	.24	.46	.33	.47	**.91**	.41	-.55	-.04
PREL3	.29	.48	.36	.43	**.90**	.49	-.50	.01
PREL4	.31	.39	.32	.38	**.85**	.46	-.44	.06
PSWC1	.34	.28	.27	.31	.45	**.76**	-.48	.10
PSWC2	.22	.22	.21	.30	.41	**.81**	-.28	.17
PSWC3	.10	.22	.18	.15	.28	**.76**	-.27	.06
PSWC5	.12	.27	.20	.13	.35	**.76**	-.29	.16
SWCOST1	-.31	-.37	-.28	-.40	-.39	-.27	**.77**	.01
SWCOST2	-.36	-.42	-.28	-.44	-.46	-.38	**.88**	.01
SWCOST3	-.42	-.44	-.32	-.50	-.52	-.45	**.94**	.08
SWCOST4	-.40	-.40	-.29	-.48	-.47	-.46	**.89**	.00
SWCOST5	-.28	-.44	-.30	-.40	-.53	-.35	**.79**	.07
TRIAL1	.15	.02	-.13	.06	.04	.15	.08	**.83**
TRIAL2	.10	.04	-.18	.03	-.02	.16	.05	**.94**
TRIAL3	.14	.04	-.14	.09	.00	.13	.01	**.94**
All item loadings in bold are significant at $p < .001$.								

The results of the structural model can be found in Figure 2. The R^2-value of ASSIMILATION, the dependent latent variable of main theoretical concern, is 49.0 percent. This means that our model is able to explain a large portion of the variance in the dependent variable. Examination of the significance of the path coefficients shows that six out of our ten hypotheses were supported. The impact of four variables on ASSIMILATION were not found to be significant: PSWC (Hypothesis 5), TRIAL (Hypothesis 2), ACCSC (Hypothesis 3), and EXTSUP (Hypothesis 9). The results for TRIAL and ACCSC are interesting, but not unexpected, given the results of our qualitative study. Although we expected that PSWC and EXTSUP would have a direct impact on ASSIMILATION, we did not obtain statistical evidence for this. On the other hand, both constructs have significant paths to SWCOST. Both path coefficients are negative, meaning that they are reversely related to SWCOST. Another significant predictor of SWCOST is PBS, which also has a negative path coefficient, as expected. These three variables explain a substantial proportion of variance in SWCOST. The R^2-value of SWCOST is 38.6 percent, which is also highly significant.

With respect to the control variables, sector did not have a significant impact on assimilation. Hence, it appears that there is no significant difference between public and private organizations with respect to the assimilation of OSSS. The other two control variables (i.e., organization size and the size of the IT department) have a significant influence on assimilation. The path coefficient of ORGSIZE is negative, meaning that small organizations are more likely to

Table 5: Evaluation of Structural Models			
	Full Model	**Theoretical Model**	**Control Model**
ACCSC → ASSIMILATION	.078	.035	
EXTSUP → ASSIMILATION	.065	.083	
SWCOST → ASSIMILATION	-.159**	-.128*	
TRIAL → ASSIMILATION	-.006	.028	
PBS → ASSIMILATION	.310***	.392***	
PREL → ASSIMILATION	.160*	.177**	
PSWC → ASSIMILATION	.021	.027	
EXTSUP → SWCOST	-.153*	-.153*	
PBS → SWCOST	-.390***	-.390***	
PSWC → SWCOST	-.292***	-.292***	
SECTOR → ASSIMILATION	-.001		.058
ITDEP → ASSIMILATION	.340***		.564***
ORGSIZE → ASSIMILATION	-.132*		-.365***
R^2 ASSIMILATION	.490	.424	.167
F	19.15	21.22	13.81
Significance	$p < .0001$	$p < .0001$	$p < .0001$
Increase in R^2 ASSIMILATION		6.7%	32.3%
F		8.68	18.02
Significance		$p < .0001$	$p < .0001$
Significance: *p < .05, **p < .01, ***p < .001			

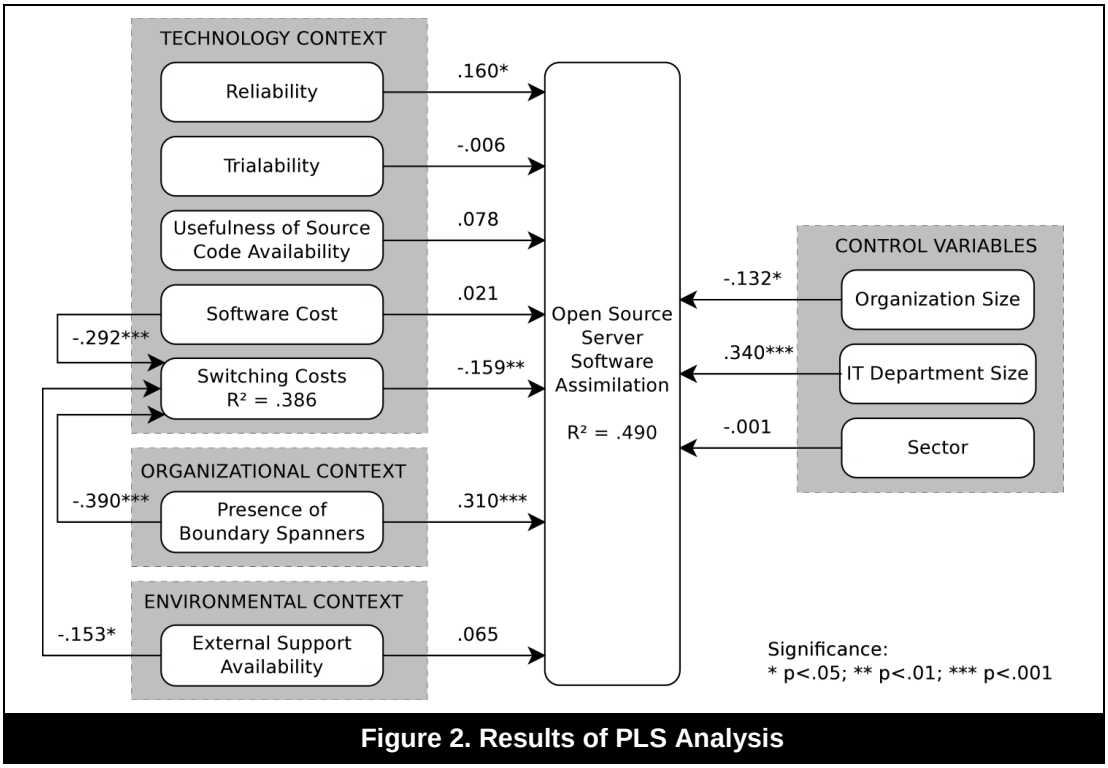

Figure 2. Results of PLS Analysis

adopt OSSS. On the other hand, ITSIZE has a positive path coefficient, meaning that organizations with a large IT department (in terms of the number of servers) are more likely to adopt OSSS. Hence, the size of the organization and the size of the IT department have an opposite effect on assimilation. Based on the significance and size of the path coefficients, it appeared that the size of the IT department was the dominant factor. In order to obtain more insight into the influence of these factors on assimilation, we developed a measure of IT intensity, defined as the ratio between the number of servers and the number of employees in the organization. A higher ratio indicates that

Communications of the Association for Information Systems

the organization makes more intensive use of IT (since there are more servers per employee in the organization). Results from the PLS analysis showed that this measure had a positive path coefficient and was highly significant ($\beta = .305$, $p < .001$). The model explained 50.5 percent of the variance in assimilation, which is 8.1 percent more than the theoretical model. This increase in R^2 is highly significant ($F = 33.01$, $p < .0001$). In addition, the revised model explains 1.5 percent more of the variance than the full model. These results indicate that organizations that rely more strongly on IT will be more likely to adopt OSSS.

VII. DISCUSSION AND IMPLICATIONS

This study is the first to conduct a comprehensive quantitative investigation into the factors influencing the assimilation of OSSS. The PLS analysis showed that the conceptual model explained a large proportion of the variance in the OSSS assimilation stage reached by organizations. This suggests that the factors that were found to be significant in this model are important determinants of the assimilation of OSSS.

A major finding of this study is that typical characteristics of OSS were not found to have a significant impact on the assimilation of OSSS. Many claims have been made in IT trade press publications about various characteristics of OSS that may have an influence on the adoption decision [Ven et al., 2008]. However, contrary to popular belief, we found relatively little support for the impact of these factors on the assimilation of OSSS. For example, two factors that can be considered typical characteristics of OSS, namely source code availability and trialability, were not significantly related to the assimilation of OSSS. With respect to source code availability, it can be expected that organizations do not view or modify the source code of OSSS frequently enough for its availability to be a strong advantage. In addition, there are certain ways to obtain the source code of proprietary software as well. The results for trialability may be explained by a number of reasons. First, given our focus on mature and well-known OSSS products, organizations may not experience the need to try out the software before adopting it, since sufficient information about these products is available. Second, it may be possible that trialability has an indirect effect on assimilation. As mentioned in the summary of our qualitative study, we observed that the adoption of OSS was frequently suggested by IT staff members who had personally built up experience with OSS in their personal time and who act as boundary spanners for the organization. In this respect, the trialability of OSS may help, since employees can download the software for free and experiment with it in their free time. Hence, it is not the organization that will try out the software, but rather its employees in their personal time. Finally, organizations in our qualitative study did not consider OSS to be easier to try out than proprietary software, since trial and demo versions are also available for proprietary software [Ven and Verelst, in press]. This suggests that trialability is not considered an important advantage of OSSS by organizations.

Overall, it appears that the external and internal knowledge on OSSS available to organizations is of primary importance. The influence of external knowledge is reflected by the impact the availability of external support has on switching costs. With respect to internal knowledge, it has been shown that the presence of boundary spanners has both a direct and indirect impact on assimilation. In addition, the level of switching costs not only indicates to which degree the technical resources (i.e., IT infrastructure) of the organization are compatible with OSSS; it also indicates whether the human resources are compatible with the skills required for OSSS. The degree to which this knowledge about OSSS is available to the organization determines the level of switching costs that would be associated with the assimilation. The know-how of the organization on OSSS, therefore, seems to be an important consideration of organizations. This finding is consistent with the concept of *knowledge barriers* [Attewell, 1992]. The introduction of OSSS may face the organization with new skill requirements. The degree to which internal employees and external parties (i.e., consultants and vendors) possess these skills, can help lower the barrier to organizations. Either the organization can already rely on internal human resources, or it will need to buy these skills on the market. Therefore, the introduction of OSSS seems to imply a process of *organizational learning* in which organizations gain know-how on OSSS. Our finding that organizations that make intensive use of IT are more likely to adopt OSSS is also consistent with this observation. These organizations can be assumed to be more involved in IT, and are better able to build up new IT experience. As such, it may be easier for these organizations to assimilate OSSS. Our results indicate, therefore, that the available knowledge on OSSS and the process of organizational learning are more important considerations to organizations than the technical issues and benefits involved in using OSSS.

Literature suggests that the presence of boundary spanners is very important to organizations, as it allows them to more easily acquire external knowledge and thus to lower knowledge barriers [Attewell, 1992; Cohen and Levinthal, 1990]. The presence of boundary spanners in the organization was indeed found to be the most important factor in the assimilation of OSSS. This suggests that technical employees in the organization who are familiar with OSS will suggest the use of OSSS when appropriate in the organization, based on their own experience. This way, these employees are responsible for fulfilling the typical boundary spanning role: bringing the organization in contact with external information and new technologies. With respect to the assimilation of OSSS, it is possible that management does not always consider OSSS a viable alternative. However, when technical employees are able to demonstrate its potential, decision makers may become convinced. In addition, these employees can help lower the switching

costs involved in adopting OSSS. Given their knowledge on OSSS, these boundary spanners can advise decision makers on which OSSS products to use, which can avoid a time-consuming selection process. Especially if decision makers are insufficiently familiar with OSS, finding a suitable OSSS product may require considerable effort. These employees will also require less training, given the fact that they are already familiar with OSSS. The presence of boundary spanners may also help in convincing other staff members to accept OSSS, if it is incompatible with their current knowledge or skills, especially if the opinion of these boundary spanners is valued by the other members of the IT staff.

Theoretical Contributions

This study contributes to theory in a number of ways. First of all, we have made an important contribution to the literature on OSS. Several authors have pleaded for additional studies on the organizational adoption of OSS [e.g., Feller et al., 2006; Morgan and Finnegan, 2010; Niederman et al., 2006]. We have addressed this call in literature by investigating the assimilation of OSSS and offer more insight into this phenomenon. This study represents the first attempt to conduct a comprehensive quantitative investigation into the factors influencing the assimilation of OSSS. The conceptual model was based on the TOE framework, and our measurement instrument was subjected to a rigorous validation procedure. The end result is a parsimonious model that explains how seven factors influence the assimilation of OSSS. The fact that the model exhibits a good model fit suggests that the factors included in this model are strong determinants of the assimilation of OSSS. Investigation of the structural model also showed that the model closely reflects the findings of our preceding qualitative study. Interestingly, our results questions many claims that have been made with respect to the adoption of OSS in IT trade press publications. This indicates that the reasons that influence the assimilation of OSSS may be different from what is frequently assumed.

Another noteworthy fact is that we have found that the assimilation of OSSS is predominantly influenced by the availability of internal and external knowledge of OSSS. This is remarkable, given the fact that OSSS is already well-known, stable, and relatively widely diffused among organizations. It could have been expected that knowledge on these OSSS products would be more readily available to organizations. However, it appears that the skills that are required for these OSSS products may still be rather difficult to obtain by some organizations. Based on this observation, it may be possible that the availability of knowledge will also be very important when adopting other types of OSS products. Adopting open source desktop software (e.g., an office suite such as OpenOffice.org) or open source enterprise software (e.g., ERP and CRM software such as Compiere or SugarCRM) is likely to have a much larger impact on the organization. While the impact of the adoption of OSSS is mainly limited to the IS department, these latter types of OSS have an impact on the whole organization. Adopting and implementing these OSS products may also be more difficult, as relatively few organizations have already adopted them, and thus less knowledge is available on these products.

Managerial Implications

Our study also has several practical implications. First, our conceptual model provides managers with a limited set of factors that have empirically been shown to be important facilitators for the assimilation of OSSS. Managers who are considering adopting OSSS may take these factors into account and take appropriate measures for facilitating the assimilation of OSSS. This way, they can allocate resources more effectively to increase the use of OSSS, instead of focusing on often-cited criteria that are less relevant to the assimilation process. The model also shows which types of organizations are more likely to assimilate OSSS. Managers can take the factors included in the model into account when deciding whether the organization has the ability to adopt OSSS, and why they might do so. In addition, the results are also relevant for consultants, as it may provide them with more information on whether and why to recommend OSSS to organizations.

Second, it was shown that the presence of boundary spanners in the organization is very important for the assimilation of OSSS. This finding has important implications for organizations. Our results suggest that technical employees frequently recognize the potential of using OSSS in the organization. In this regard, the assimilation of OSSS is often a bottom-up initiative. Within the context of OSSS, boundary spanners may be useful in bringing OSSS to the attention of decision makers, especially when management is insufficiently familiar with OSS. By leveraging the knowledge of boundary spanners, organizations may be able to innovate more effectively. Hence, managers may wish to develop procedures as to how the knowledge of boundary spanners can be leveraged, developed and managed. They may, for example, want to decide to encourage the emergence of informal groups of these boundary spanners, if the organization intends to increase its use of OSSS.

Limitations and Future Research

Our study also has a number of limitations. The main limitation of our research is that it focused on Belgian organizations. Hence, we cannot safely generalize our finding to other countries or regions. Future studies could investigate to which degree our findings can be generalized to other settings. A related limitation is that we focused

only on the assimilation of OSSS. As a result, our findings do not necessarily hold for other types of OSS, such as open source desktop software. Therefore, future studies could determine if our results are also applicable to other types of OSS. Since the availability of internal and external knowledge may also be important for the adoption of other types of OSS, the conceptual model developed in this study might provide a foundation for such future studies. Another limitation of this study is related to the theoretical framework used in this study. During the qualitative study that preceded this quantitative study, we decided to use the TOE framework, since this is an appropriate framework for exploratory research. The same framework was used in this quantitative study. However, the use of a stronger theoretical framework could have provided a richer insight in our data. Therefore, it would be interesting for future studies to try to build on the results from this study and study the adoption of OSS using a strong theoretical foundation.

VIII. CONCLUSION

This research addresses the organizational adoption of OSSS. Although OSS has received much attention in the IT trade press, it remains unclear whether common perceptions and widely claimed advantages of OSS have an impact on the organizational adoption decision. To investigate this issue, we have developed and tested a conceptual model that describes a number of factors which were hypothesized to influence the assimilation of OSSS. We collected data from 210 Belgian organizations to test our hypotheses. The results showed strong support for our conceptual model and the proposed hypotheses. The set of identified factors was able to account for a large portion of the variance in the assimilation of OSSS. Surprisingly, our results suggest that the assimilation of OSSS is not driven primarily by the technical characteristics of OSS. Instead, the availability of internal and external knowledge were found to be of primary importance in the assimilation of OSSS. Our findings suggest further that boundary spanners play a crucial role in the assimilation of OSSS by suggesting the use of OSSS in the organization when appropriate and by providing the organization with the knowledge required to adopt and implement OSSS. Further, we expect that the availability of knowledge may also be important when adopting other types of OSS—such as open source desktop software or open source enterprise software—since these types of OSS products have a much larger impact on the organization. Therefore, the conceptual model developed in this study could provide a solid foundation for future studies investigating the organizational adoption of other types of OSS.

REFERENCES

Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. The author(s) of the Web pages, not AIS, is (are) responsible for the accuracy of their content.
4. The author(s) of this article, not AIS, is (are) responsible for the accuracy of the URL and version information.

Anderson, J.C., and D.W. Gerbing (1988) "Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach," *Psychological Bulletin* (103)3, pp. 411–423.

Attewell, P. (1992) "Technology Diffusion and Organizational Learning: The Case of Business Computing," *Organization Science* (3)1, pp. 1–19.

Barclay, D., R. Thompson, and C. Higgins (1995) "The Partial Least Squares (PLS) Approach to Causal Modeling: Personal Computer Adoption and Use as an Illustration," *Technology Studies* (2)2, pp. 284–324.

Brink, D., et al. (2006) "Critical Success Factors for Migrating to OSS-on-the-Desktop: Common Themes Across Three South African Case Studies," In Damiani, E., et al. (eds.), *Open Source Systems, IFIP Working Group 2.13 Foundation on Open Source Software*, Como, Italy, June 8–10, Boston, MA: Springer, vol. 203 of *IFIP International Federation for Information Processing*, pp. 287–293.

Chau, P.Y.K., and K.Y. Tam (1997) "Factors Affecting the Adoption of Open Systems: An Exploratory Study," *MIS Quarterly* (21)1, pp. 1–24.

Chin, W.W. (1998) "The Partial Least Squares Approach for Structural Equation Modeling," In Marcoulides, G.A. (ed.), *Modern Methods for Business Research*, Mahwah, NJ: Lawrence Erlbaum Associates, pp. 295–336.

Cohen, W.M., and D.A. Levinthal (1990) "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly* (35)1, pp. 128–152.

Dedrick, J., and J. West (2003) "Why Firms Adopt Open Source Platforms: A Grounded Theory of Innovation and Standards Adoption," In King, J.L., and K. Lyytinen (eds.), *Proceedings of the Workshop on Standard Making: A Critical Research Frontier for Information Systems*, MISQ Special Issue Workshop, Seattle, WA, December 12–14, pp. 236–257.

Dedrick, J., and J. West (2004) "An Exploratory Study into Open Source Platform Adoption," In *Proceedings of the 37th Hawaii International Conference on System Sciences (HICSS'04)*, Waikoloa, HI, January 5–8, Washington, DC: IEEE Computer Society, p. 80265b.

Dedrick, J., and J. West (2007) "Movement Ideology vs. User Pragmatism in the Organizational Adoption of Open So,urce Software," In Kraemer, K.L., and M. Elliott (eds.), *Computerization Movements and Technology Diffusion: From Mainframes to Ubiquitous Computing*, Medford, NJ: Information Today.

Depietro, R., E. Wiarda, and M. Fleischer (1990) "The Context for Change: Organization, Technology and Environment," In Tornatzky, L.G., and M. Fleischer (eds.), *The Processes of Technological Innovation*, Lexington, MA: Lexington Books, pp. 151–175.

Feller, J., et al. (2006) "Developing Open Source Software: A Community-Based Analysis of Research," In Trauth, E.M., et al. (eds.), *Social Inclusion: Societal and Organizational Implications for Information Systems*, IFIP TC8 WG8.2 International Working Conference, Limerick, Ireland, July 12–15, Boston, MA: Springer, vol. 208 of *IFIP International Federation for Information Processing*, pp. 261–278.

Feller, J., and B. Fitzgerald (2002) *Understanding Open Source Software Development*, London, England: Addison-Wesley.

Fichman, R.G. (2000) "The Diffusion and Assimilation of Information Technology Innovations," In Zmud, R. (ed.), *Framing the Domains of IT Management: Projecting the Future Through the Past*, Cincinnati, OH: Pinnaflex Educational Resources, pp. 105–128.

Fichman, R.G., and C.F. Kemerer (1997) "The Assimilation of Software Process Innovations: An Organizational Learning Perspective," *Management Science* (43)10, pp. 1345–1363.

Fitzgerald, B. (2006) "The Transformation of Open Source Software," *MIS Quarterly* (30)3, pp. 587–598.

Fitzgerald, B. (2009) "Open Source Software Adoption: Anatomy of Success and Failure," *International Journal of Open Source Software & Processes* (1)1, pp. 1–23.

Fitzgerald, B., and T. Kenny (2003) "Open Source Software in the Trenches: Lessons from a Large Scale Implementation," In March, S.T., A. Massey, and J.I. DeGross (eds.), *Proceedings of 24th International Conference on Information Systems (ICIS 2003)*, Seattle, WA, December 14–17, Atlanta, GA: Association for Information Systems, pp. 316–326.

Fitzgerald, B., and T. Kenny (2004) "Developing an Information Systems Infrastructure with Open Source Software," *IEEE Software* (21)1, pp. 50–55.

Fornell, C., and D.F. Larcker (1981) "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research* (18)1, pp. 39–50.

Gable, G.G. (1991) "Consultant Engagement for Computer System Selection: A Pro-active Client Role in Small Businesses," *Information & Management* (20)2, pp. 83–93.

Gallaugher, J.M., and Y.M. Wang (2002) "Understanding Network Effects in Software Markets: Evidence from Web Server Pricing," *MIS Quarterly* (26)4, pp. 303–327.

Gefen, D., D.W. Straub, and M.C. Boudreau (2000) "Structural Equation Modeling and Regression: Guidelines for Research Practice," *Communications of the Association for Information Systems* (4)7, pp. 1–70.

Ghosh, R., and R. Glott (2005) "Results and Policy Paper from Survey of Government Authorities," *Free/Libre and Open Source Software: Policy Support (FLOSSPOLS) Deliverable D3*, MERIT, University of Maastricht, The Netherlands.

Goodhue, D.L., and R.L. Thompson (1995) "Task-technology Fit and Individual Performance," *MIS Quarterly* (19)2, pp. 213–236.

Greenstein, S.M. (1997) "Lock-in and the Costs of Switching Mainframe Computer Vendors: What Do Buyers See?" *Industrial and Corporate Change* (6)2, pp. 247–273.

Hauge, O., C. Ayala, and R. Conradi (2010) "Adoption of Open Source Software in Software-Intensive Organizations—A Systematic Literature Review," *Information and Software Technology* (52)11, pp. 1133–1154.

Heide, J.B., and A.M. Weiss (1995) "Vendor Consideration and Switching Behavior for Buyers in High-technology Markets," *Journal of Marketing* (59)3, pp. 30–43.

Holck, J., M.K. Pedersen, and M.H. Larsen (2005) "Open Source Software Acquisition: Beyond the Business Case," In Bartmann, D., et al. (eds.), *Proceedings of the 13th European Conference on Information Systems (ECIS 2005)*, May 26–28, Regensburg, Germany, pp. 1497–1508.

Igbaria, M., et al. (1997) "Personal Computing Acceptance Factors in Small Firms: A Structural Equation Model," *MIS Quarterly* (21)3, pp. 279–305.

Karahanna, E., D.W. Straub, and N.L. Chervany (1999) "Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs," *MIS Quarterly* (23)2, pp. 183–213.

Klemperer, P. (1987) "The Competitiveness of Markets with Switching Costs," *RAND Journal of Economics* (18)1, pp. 138–150.

Kshetri, N. (2005) "Diffusion Pattern of Linux: An Assessment on Major Technology Dimensions," *First Monday* (10)8.

Kuan, K.K.Y., and P.Y.K. Chau (2001) "A Perception-based Model for EDI Adoption in Small Businesses Using a Technology-organization-environment Framework," *Information & Management* (38)8, pp. 507–521.

LaRose, R., and A. Hoag (1996) "Organizational Adoptions of the Internet and the Clustering of Innovations," *Telematics and Informatics* (13)1, pp. 49–61.

Larsen, M.H., J. Holck, and M.K. Pedersen (2004) "The Challenges of Open Source Software in IT Adoption: Enterprise Architecture versus Total Cost of Ownership," In *Proceedings of the 27th Information Systems Research Seminar in Scandinavia (IRIS27)*, Falkenberg, Sweden, August 14–17.

Lewis, B.R., G.F. Templeton, and T.A. Byrd (2005) "A Methodology for Construct Development in MIS Research," *European Journal of Information Systems* (14)4, pp. 388–400.

Li, Y., et al. (2005) "A Human Capital Perspective of Organizational Intention to Adopt Open Source Software," In Avison, D., D. Galletta, and J.I. DeGross (eds.), *Proceeding of the 26th Annual International Conference on Information Systems (ICIS 2005)*, Las Vegas, NV, December 11–14, 2005, Atlanta, GA: Association for Information Systems, pp. 137–149.

Lundell, B., B. Lings, and E. Lindqvist (2006) "Perceptions and Uptake of Open Source in Swedish Organisations," In Damiani, E., et al. (eds.) *Open Source Systems, IFIP Working Group 2.13 Foundation on Open Source Software*, Como, Italy, June 8–10, Boston, MA: Springer, vol. 203 of *IFIP International Federation for Information Processing*, pp. 155–163.

Lundell, B., B. Lings, and E. Lindqvist (2010) "Open Source in Swedish Companies: Where Are We?" *Information Systems Journal* (20)6, pp. 519–535.

Meyer, A.D., and J.B. Goes (1988) "Organizational Assimilation of Innovations: A Multilevel Contextual Analysis," *Academy of Management Journal* (31)4, pp. 897–923.

Moore, G.C., and I. Benbasat (1991) "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research* (2)3, pp. 192–222.

Morgan, L., and P. Finnegan (2010) "Open Innovation in Secondary Software Firms: an Exploration of Managers' Perceptions of Open Source Software," *SIGMIS Database* (41)1, pp. 76–95.

Niederman, F., et al. (2006) "Research Agenda for Studying Open Source II: View Through the Lens of Referent Discipline Theories," *Communications of the Association for Information Systems* (18)8, pp. 150–175.

Payne, C. (2002) "On the Security of Open Source Software," *Information Systems Journal* (12)1, pp. 61–78.

Petter, S., D. Straub, and A. Rai (2007) "Specifying Formative Constructs in Information Systems Research," *MIS Quarterly* (31)4, pp. 623–656.

Ping, R.A., Jr (1993) "The Effects of Satisfaction and Structural Constraints on Retailer Exiting, Voice, Loyalty, Opportunism, and Neglect," *Journal of Retailing* (69)3, pp. 320–352.

Podsakoff, P.M., et al. (2003) "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," *Journal of Applied Psychology* (88)5, pp. 879–903.

Premkumar, G.P., and M. Roberts (1999) "Adoption of New Information Technologies in Rural Small Businesses," *Omega* (27)4, pp. 467–484.

Rai, A., and R. Patnayakuni (1996) "A Structural Model for CASE Adoption Behavior," *Journal of Management Information Systems* (13)2, pp. 205–234.

Ravichandran, T. (2005) "Organizational Assimilation of Complex Technologies: An Empirical Study of Component-based Software Development," *IEEE Transactions on Engineering Management* (52)2, pp. 249–268.

Raymond, E.S. (2001) "The Cathedral and the Bazaar," In Raymond, E.S. (ed.), *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*, Sebastapol, CA: O'Reilly, pp. 19–64.

Ringle, C.M., S. Wende, and A. Will (2005) "SmartPLS 2.0 (M3) Beta," University of Hamburg, Hamburg, Germany, http://www.smartpls.de (current Jan. 12, 2011).

Rogers, E.M. (2003) *Diffusion of Innovations*, *5th edition*, New York, NY: The Free Press.

Shapiro, C., and H.R. Varian (1999) *Information Rules: A Strategic Guide to the Network Economy*, Boston, MA: Harvard Business School Press.

Srinivasan, R., G.L. Lilien, and A. Rangaswamy (2002) "Technological Opportunism and Radical Technology Adoption: An Application to E-Business," *Journal of Marketing* (66)3, pp. 47–60.

Teo, H.H., K.K. Wei, and I. Benbasat (2003) "Predicting Intention to Adopt Interorganizational Linkages: An Institutional Perspective," *MIS Quarterly* (27)1, pp. 19–49.

Thong, J.Y., C.S. Yap, and K. Raman (1994) "Engagement of External Expertise in Information Systems Implementation," *Journal of Management Information Systems* (11)2, pp. 209–231.

Tushman, M.L., and D. Nadler (1986) "Organizing for Innovation," *California Management Review* (28)3, pp. 74–92.

Tushman, M.L. and T.J. Scanlan (1981) "Characteristics and External Orientations of Boundary Spanning Individuals," *Academy of Management Journal* (24)1, pp. 83–98.

Ven, K., D. Van Nuffel, and J. Verelst (2007) "The Migration of Public Administrations Towards Open Source Desktop Software: Recommendations from Research and Validation Through a Case Study," In Sowe, S.K., I. Stamelos, and I. Samoladas (eds.), *Emerging Free and Open Source Software Practices*, Hershey, PA: IGI Publishing, pp. 191–214.

Ven, K., and J. Verelst (in press) "A Qualitative Study on the Organizational Adoption of Open Source Server Software," *Information Systems Management*, forthcoming.

Ven, K., J. Verelst, and H. Mannaert (2008) "Should You Adopt Open Source Software?" *IEEE Software* (25)3, pp. 54–59.

Waring, T., and P. Maddocks (2005) "Open Source Software Implementation in the UK Public Sector: Evidence from the Field and Implications for the Future," *International Journal of Information Management* (25)5, pp. 411–428.

West, J., and J. Dedrick (2001) "Open Source Standardization: The Rise of Linux in the Network Era," *Knowledge, Technology & Policy* (14)2, pp. 88–112.

West, J., and J. Dedrick (2005) "The Effect of Computerization Movements Upon Organizational Adoption of Open Source," In *Proceedings of the Social Informatics Workshop: Extending the Contributions of Professor Rob Kling to the Analysis of Computerization Movements*, Irvine, CA, March 11–12.

West, J., and J. Dedrick (2006) "Scope and Timing of Deployment: Moderators of Organizational Adoption of the Linux Server Platform," *International Journal of IT Standards Research* (4)2, pp. 1–23.

Willis, G.B. (2005) *Cognitive Interviewing: A Tool for Improving Questionnaire Design*, London, England: Sage Publications.

Wixom, B.H., and P.A. Todd (2005) "A Theoretical Integration of User Satisfaction and Technology Acceptance," *Information Systems Research* (16)1, pp. 85–102.

Zhu, K., and K.L. Kraemer (2005) "Post-Adoption Variations in Usage and Value of e-Business by Organizations: Cross-Country Evidence from the Retail Industry," *Information Systems Research* (16)1, pp. 61–84.

APPENDIX: MEASUREMENT ITEMS

Software Cost (PSWC) [LaRose and Hoag, 1996]
1. OSSS can be used to realize cost savings.[b]
2. OSSS can be acquired at a lower price than proprietary software.
3. Upgrades for OSSS can be acquired at a lower price than proprietary software.
4. OSSS has lower initial costs than proprietary software.[c]
5. The license costs of OSSS are lower than those of proprietary software.[b]

Reliability (PREL) [Goodhue and Thompson, 1995; Wixom and Todd, 2005]
1. OSSS is subject to unexpected down times.[a]
2. OSSS is subject to frequent problems and crashes.[a]
3. OSSS operates reliably.
4. We can count on OSSS to be "up" and available most of the time.

Trialability (TRIAL) [Karahanna et al., 1999; Moore and Benbasat, 1991]
1. Before deciding on whether or not to adopt OSSS, we would be able to use it on a trial basis.
2. Before deciding on whether or not to adopt OSSS, we would be able to properly try it out.
3. We would be permitted to use OSSS on a trial basis long enough to see what it can do.
4. We are able to test OSSS as necessary.[c]
5. We can have OSSS for long enough periods to try it out.[c]

Usefulness of Access to Source Code (ACCSC)
1. The availability of the source code of OSSS provides more trust in the program.[b]
2. The availability of the source code of OSSS is a benefit.[b]
3. We find the availability of the source code of OSSS useful.[b]
4. It is convenient to have access to the source code of OSSS.[b]
5. In general, we find it valuable to have access to the source code of OSSS.[b]

Presence of Boundary Spanners (PBS) [Rai and Patnayakuni, 1996; Srinivasan et al., 2002]
1. OSSS has no strong advocates here.[a]
2. There are one or more people here who are pressing for OSSS usage.
3. Employees make an effort to convince managers of the benefits of OSSS.
4. There are one or more people in our organization who are pushing for OSSS very enthusiastically.
5. Nobody in our organization has taken the lead in pushing for adoption of OSSS.[a]

External Support Availability (EXTSUP) [Igbaria et al., 1997; Li et al., 2005; Premkumar and Roberts, 1999]
1. An external party is available for providing support for OSSS products.
2. Guidance is available to me in the selection of hardware and software for OSSS products.
3. There are businesses which provide technical support for effective use of OSSS.
4. Our organization can access external vendors who can provide support for OSSS deployment.
5. Our organization can access external consultants who can provide support for OSSS deployment.
6. Our organization can access external freelance IT people who can provide support for OSSS deployment.[c]

Switching Costs (SWCOST) [Heide and Weiss, 1995; Li et al., 2005; Ping, 1993]
1. Acquiring OSSS would require significant cost in retraining a large number of our employees.
2. Developing procedures to deal effectively with OSSS would take a lot of time.
3. Generally speaking, the cost to switch to OSSS would be high.
4. Considering everything, the cost to stop using the existing software and start using OSSS would be high.
5. Developing working relationships with new vendors for OSSS would be a time-consuming process.

Legend
[a]: Reversely scored item.
[b]: Item developed specifically for this study.
[c] Item removed based on assessment of measurement model.

All items were measured using a 7-point Likert scale with each point labeled: (1) Strongly Disagree; (2) Disagree; (3) Rather Disagree; (4) Neither Agree Nor Disagree; (5) Rather Agree; (6) Agree; (7) Strongly Agree.

ABOUT THE AUTHORS

Kris Ven received his Ph.D. in Applied Economics from the Faculty of Applied Economics of the University of Antwerp, Belgium, in 2008. He is currently a postdoctoral researcher at the Department of Management Information Systems of the University of Antwerp. His research interests include the organizational adoption of IT and the link between innovation in organizations and the use of information technology. He has performed several studies on the organizational adoption of open source software. He has authored and presented several papers at international conferences on open source software, and has published in several academic journals, including the *Journal of Database Management*, *IEEE Software,* and *Information and Software Technology*.

Jan Verelst received his Ph.D. in Management Information Systems from the Faculty of Applied Economics of the University of Antwerp, Belgium, in 1999. He is working at the Department of Management Information Systems of the University of Antwerp, where he teaches courses on analysis and design of information systems. He is also an executive professor at the Management School of the University of Antwerp. His research interests include conceptual modeling of information systems, evolvability and maintainability of information systems, empirical software engineering, and open source software.

Communications of the Association for Information Systems

ISSN: 1529-3181

Communications of the Association for Information Systems