The Organizational Adoption of Open Source Server Software by Belgian Organizations

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Abstract. This study reports on five case studies in Belgian organizations that currently use open source server software. Respondents were asked about their motivation to use open source server software. Our results indicate that the lower cost, high reliability and availability of external support are the prime reasons why organizations use open source software. The often claimed advantage of open source software of having access to the source code was found relevant only for those organizations who perform development based on open source software. Some factors that were found relevant in previous studies (such as the support of standards) were however deemed less important by the organizations in our sample.

Key words: open source, organizational adoption, innovation, Linux

1 Introduction

The Linux operating system has evolved considerably since its introduction in 1991. Especially in the last 2–3 years, Linux – and open source software in general – has become a viable solution for commercial organizations. Several factors may account for this. First, open source businesses such as RedHat and SuSe (recently acquired by Novell) have gained momentum and are able to provide the necessary resources to support the enterprise versions of their Linux distributions. Second, large software vendors such as IBM and HP have officially declared their commitment to the Linux operating system. These evolutions have enabled other software vendors such as Oracle and SAP to certify their products for the Linux operating system. Third, open source software has received a lot of attention in the media in the past few years. Moreover, many advantages of open source software are claimed by academic as well as professional literature and by open source advocates. Despite this increased attention and the availability of support for open source software, many organizations are still uncertain whether adopting open source software would be beneficial.

Despite the fact that much research has been devoted to open source software, most studies have focused on the software engineering or social aspects of open source software development. Relatively little effort has been devoted

Please use the following format when citing this chapter:
Ven, K., and Verelst, J., 2006, in IFIP International Federation for Information Processing, Volume 203, Open Source Systems, eds. Damiani, E., Fitzgerald, B., Scacchi, W., Scotto, M., Succi, G., (Boston: Springer), pp. 111-122

to studying the adoption decision of organizations concerning the use of open source software. Although some research has been performed on this topic, additional research is still necessary to increase our understanding of the adoption decision. We will therefore build upon the available literature on this topic, and investigate the reasons why Belgian organizations adopt open source server software.

The rest of the paper is structured as follows. We will start in Sect. 2 by describing the research design of our current study. In Sect. 3, we will discuss our findings and contrast them with previous studies. Finally, in Sect. 4, we will summarize our most important findings and describe their theoretical and practical implications.

2 Research Design

2.1 Scope

The field of open source software is very diverse and complex. It is therefore difficult to reach conclusions that are valid for *all* open source projects. Consequently, in order to reach an acceptable level of internal validity, we must narrow the scope of our study to a specific type of open source software and hence make a certain sacrifice with respect to the external validity.

We decided to focus exclusively on the adoption of open source *server* software. We use the term open source server software to refer to both open source operating systems (such as Linux and FreeBSD), as other open source software for server use (for example the Apache web server or the Bind name server).

This choice is motivated by the fact that Linux is generally considered a stable, mature product that is already in use by a significant number of organizations. Furthermore, many important open source Internet server applications such as Bind, Apache and Sendmail are also considered to be mature and have a dominant market share. Consequently, we expect that the reasons to adopt Linux are similar to the reasons to adopt other open source server software. This hypothesis is supported by the FLOSS study that showed that organizations perceived the benefits of open source operating systems, databases and website applications as rather equivalent [1]. A similar research approach has been undertaken by other researchers [2].

2.2 Methodology

We used the exploratory case study approach to study the organizational adoption decision on open source server software. The case study approach is well-suited to study a contemporary phenomenon in its natural setting, especially when the boundaries of the phenomenon are not clearly defined at the start of the study [3, 4]. We conducted a series of in-depth face-to-face interviews with respondents from five Belgian organizations to identify the factors that influence

the decision to use open source server software. Organizations were sampled on the basis of two criteria: the size of the organization measured by the number of employees and the sector in which the organization operated (based on the NACE-BEL classification scheme). Respondents within each organization were selected using the *key informant method*. Since the use of a single respondent has been shown to give inconsistent results [5], we tried to speak to both a senior manager (e.g. the IT manager), and a technical person (e.g. the system administrator) whenever possible.

The interviews took place between July and September 2005. An overview of the cases in our study is shown in Table 1. The interviews were semi-structured, and the format was revised after each interview to incorporate new findings [4]. Each interview lasted 45–60 minutes, was recorded and was transcribed verbatim. In order to increase the validity of the findings, respondents were sent a summary of the interview and were requested to suggest any improvements if necessary. Follow-up questions were asked by telephone or via e-mail. The transcripts were coded by using techniques from grounded theory [6], and were then further analyzed using procedures to generate theory from qualitative data, as described in the literature [4, 7, 8]. Various data displays were used to visualize and further analyze the qualitative data [7, 9].

Table 1. Overview of the organizations in our study

Name	Sector	Employees	Informants	Extent of adoption
OrganizationA	Audio, video and telecommunications	11	2	moderate
OrganizationB	Machinery and equipment	749	2	extensive
OrganizationC	Telecommunications	1346	1	limited
OrganizationD	Publishing and printing	31	1	extensive
OrganizationE	Food and beverages	204	2	moderate

3 Results

Although these case studies are part of an ongoing study, we can already report some interesting results concerning the adoption of open source software. Previous studies have shown that even a limited number of cases can provide a better insight into the adoption decision of organizations [10, 11]. In this section, we will present the most important adoption factors that were encountered during

the cross-case analysis, and contrast our findings to previous studies in this field.

3.1 Cost

While the Free and Open Source movement tries to downplay the (*free beer*) cost advantage, lower cost is one of the most important reasons why organizations consider using open source software. We can distinguish between two cost aspects: software and hardware.

The lower or non-existent license costs associated with open source software was cited by all organizations as an important driver towards the use of open source software. None of the organizations made a formal Total Cost of Ownership (TCO) calculation to estimate the long-term costs of open source software. A respondent in OrganizationA was aware that there were many hidden costs in using open source software and was therefore not sure whether the resulting TCO would be positive. This is consistent with other case studies [11].

Many respondents pointed out that the lower cost of open source software is not a sufficient condition for adoption. In most cases, the lower cost combined with the high reliability of open source server software (see Sect. 3.2) was cited as an important way to reduce the costs of the IT infrastructure. Hence, we found support for the *commoditization of IT* that is predicted by some authors [12]. Consistent with this idea, organizations try to lower costs for systems with a low strategic value, such as operating systems and server software [13, 14].

The use of the Linux operating system is also a way for some organizations to lower their hardware costs. All organizations that used Unix mentioned the fact that using Linux could result in a significant reduction in hardware costs. This can be explained by the fact that Linux can operate on Intel hardware, while Unix hardware from Sun or HP is much more expensive. Moreover, the reliability of Intel hardware is considered to be comparable to that of Unix hardware. Organizations that currently use the Windows operating system however, cannot realize any hardware savings since Windows runs on the same hardware as Linux.

Both hardware and software cost were found to be important factors in the decision making process in previous studies [1, 2, 11, 15, 16, 17]. Although some studies hypothesize that lower license costs are a lesser issue for large organizations who have sufficient financial resources, we found no support for this claim. This might suggest that cost savings are an important reason for small as well large organizations in a time in which IT budgets are increasingly under pressure.

3.2 Reliability

Four out of five organizations in our sample indicated that the high reliability of open source server software such as Linux and Apache is one of the main advantages of open source software. A perception present in two organizations

was that "*[Open source software] just works, and can run years without any problems.*". The high reliability is however not inherent to open source software. OrganizationB clearly indicated that they consider only those open source projects that have already proven their reliability.

The reliability of Linux was also found to be a major factor contributing to the adoption of Linux in previous studies [1, 2, 15, 16]. In comparison with [2], we notice considerable less variability in the perceptions towards the reliability of open source server software. Two factors can account for this. First, our case studies were conducted 1–3 years after those of [2]. In the meanwhile, Linux has matured further, received a lot of attention in the media and received the backing of large vendors such as IBM. Therefore, organizations may perceive Linux to be more mature and reliable compared to two years ago. Some respondents in our sample indeed indicated that they consider Linux to be more mature compared to some years ago, and that the support of companies such as IBM further increases the trust in open source software. Second, given our limited sample it is likely that we did not capture the whole range of opinions regarding the reliability of open source software.

3.3 Trialability

Trialability is one of the factors in the classic Diffusion of Innovations (DOI) theory and refers to the ability to try out a new innovation on a limited basis before making a decision on whether to adopt the innovation or not. Trailability of an innovation is hypothesized to be positively related to the adoption of that innovation [18]. With respect to open source software, it can be argued that open source software is easier to try out than commercial software, because a full version of the software can be freely downloaded from the Internet.

All organizations in our sample emphasize the importance of being able to try software before using it in a production environment. Although the trialability of open source software is not questioned, a wide range of opinions exists on whether open source software is easier to try out than commercial software. OrganizationA, OrganizationD and OrganizationE consider open source software easier to try out, because it can simply be downloaded from the Internet, without cost and without any administration. OrganizationB and OrganizationC however do not distinguish between the trialability of commercial and open source software, because it is possible to obtain demo or trial versions of commercial software. They admit however that using these trial versions may be a bit more cumbersome since most vendors require prior registration. These two latter companies consider the trialability of open source software a less important advantage. This is in contrast to previous studies on the adoption of open source software, where the trialability of open source software was found to be an important advantage [15, 16].

3.4 Access to Source Code

Having access to the source code of open source software and therefore being able to modify or customize the software is one of the main advantages claimed by open source advocates. However, given the technical nature of applications such as Linux and Apache, it is doubtful whether many users will actually examine and/or modify the source code. The term *Berkeley Conundrum* has been introduced to question the value of the availability of the source code when users do not download, examine and/or modify the source code [19].

Of the five organizations in our sample, three of them (OrganizationC, OrganizationD and OrganizationE) have never made use of the source code to improve or customize the open source software they use. These organizations primarily used stable software such as Linux and Sendmail, and respondents indicated that there was no need to make any modifications to these packages. Consequently, the availability of the source code was not a factor during the adoption decision in these organizations and was not considered to be an advantage (or disadvantage).

OrganizationA and OrganizationB did make use of the source code of some open source packages. These organizations developed organization-specific customizations or incorporated open source components in the IT infrastructure. In these cases, having the source code of the open source components was an advantage during integration and debugging. Consequently, it is not the possibility to make modifications that is valued but rather the insight into the inner workings of a component that can be gained by examining the source code that is greatly appreciated.

These findings are consistent with previous studies which also reported that most users found little need for modifying the source code of stable open source server software, or tried to limit their modifications to customizations [2, 11, 17].

3.5 Switching Costs

All organizations except OrganizationD mentioned that the experience of current employees is important when migrating to other platforms. A possible migration from Unix to Linux is perceived to be much easier than the switch from Windows to Linux. This can be explained by the fact that Linux is basically a Unix clone and many tools (e.g. sed and grep) are shared between both platforms. Except for OrganizationE, all organizations in our sample did have some prior experience with the Unix platform. This means that the current installed base will have a great impact on the ability of an organization to switch to Linux. This is consistent with previous studies on the adoption of Linux [15, 16, 20, 21]. This leads us to conclude that the current experience of employees will have a great impact on the migration costs, since training of personnel is an expensive activity.

3.6 Boundary Spanners

Boundary spanners are individuals within an organization who connect their organization with external information and can bring the organization in contact with new innovations [22, 23]. In the case of open source software, it is possible that the introduction of open source software is mainly a bottom-up initiative in which employees are using open source software at home, and introduce it in their work place when an opportunity arrives.

We have found some support for this hypothesis in our sample. In OrganizationA, OrganizationD and OrganizationE, the introduction of open source software was primarily a bottom-up initiative where a number of employees possessed some knowledge on open source software and introduced it in the organization when appropriate. This was most pronounced in OrganizationA. A respondent there indicated that at the time of the organization's foundation, there were many employees (including the organization's founders) that had a "*firm conviction*" in open source software. As a consequence, most software that was used was open source software. During the next few years, several people holding that "*firm conviction*" left the company. As a result, the choice for open source software became more pragmatic. The role of boundary spanners during the introduction of open source software has also been described in previous research [16].

3.7 External Support

The availability of external support for open source software was cited by almost all organizations as being important. Traditional literature as well suggests that the availability of external knowledge and skills may influence organizations to start using innovations [23]. For open source software, the nature of these external skills can however take different forms.

First, certain Linux vendors such as RedHat and SuSe offer enterprise versions of their Linux distributions, including support services such as automatic updates and access to a helpdesk. In our sample, only OrganizationB deliberately uses a Linux enterprise version including a support contract from SuSe. Having support for an operating system was considered to be very important for this organization, although the support contract was seldom used. OrganizationA also uses a SuSe Linux Enterprise edition, but this was requested by the external company that hosts part of the IT infrastructure. OrganizationE initially installed a boxed version of RedHat Application Server, which came with a one-year support contract. This support was however not extended after this period, since there was little need for it.

Apart from Linux vendors, open source consultancy firms also offer support with respect to the installation and maintenance of open source systems. In our sample, only OrganizationD made use of an external service provider to install the hardware and software infrastructure and to provide technical support when requested. The main reason for outsourcing these tasks is that only one person

in this organization is responsible for the IT infrastructure. OrganizationE also relies on an external consultant for resolving technical issues with the open source systems they use.

Hence, having support for Linux is considered by several organizations to be important, especially at the start of the adoption. These results are consistent with the observation that the support for Linux from major companies is an enabler for the adoption of Linux [11, 15, 16, 17, 24]. Moreover, OrganizationC perceives the support for open source software currently as insufficient, which is an important reason for not using Linux. A perceived lack of external support was also found to be an important barrier in other studies [11, 20, 21].

3.8 Vendor Lock-in

It has been argued that one reason why organizations choose Linux and open source software is to be more independent from software vendors and therefore to reduce vendor lock-in [1, 24]. OrganizationA and OrganizationB in our sample indeed mentioned the desire to be independent of a single vendor, and that open source is a way to realize this.

OrganizationC and OrganizationE however minimized the importance of vendor lock-in during software selection. OrganizationC tries to avoid vendor lock-in but opted for the Unix platform where vendor lock-in is considered to be less of an issue, compared to the Windows platform. OrganizationE (the Belgian office of a large multinational firm) does not consider vendor lock-in an issue, since the organization is large enough to negotiate with software vendors.

Although there is mixed support for this factor, we expect that organizations which are trying to reduce vendor lock-in will rather resort to the Unix world, in which Linux is one of the alternatives. Open source software is therefore not the only option to reduce vendor lock-in.

3.9 Open Standards

It has been argued that the adoption of open source software is tightly interconnected with the choice for open standards [11, 13, 24, 25, 26, 27]. The importance of compliance to standards was also found to be a significant factor in a study on the adoption of open systems [28]. We have however found little support for this hypothesis.

OrganizationA expressed no preference for open standards on server level. The other organizations expressed to be in favor of open standards because they ensure data accessability, facilitate integration and result in more enduring platforms. OrganizationB however mentioned that Unix also supports open standards. OrganizationC did not consider the support of open standards an advantage of open source software, although they considered the support of open standards very important during the selection process.

Given the information obtained from this sample, we can deduct that organizations tend to separate the use of open standards from the use of open

source software. In general, open source software does support open standards, but organizations do not seem to consider this a reason for choosing open source software.

4 Discussion

4.1 The Adoption of Open Source Software

By analyzing the data obtained from these case studies, we were able to identify several factors that are important during the adoption decision with respect to the use of open source server software.

The lower license costs, combined with a high reliability of mature open source packages such as Linux were found to be the two most important reasons for adopting open source server software. Organizations will therefore not jeopardize their operations by adopting less reliable open source software, just in order to realize cost savings. The fact that organizations tend to primarily appreciate the "free beer" rather that the "free speech" aspect of open source software has been identified as one of the challenges for the open source community [29]. On the other hand, open source software may be an important driver towards the commoditization of IT, replacing commercial platform software by inexpensive alternatives.

Organizations with a Unix installed base may realize additional savings in hardware costs and may experience lower switching costs. These switching costs will be an important barrier for organizations who have a Windows installed base, requiring retraining of personnel. The availability of external support for open source software was also cited as being an important condition for adopting Linux. The often claimed advantage of having access to the source code of open source software was found to be a much less important factor in the adoption decision.

These previous findings are quite consistent with previous literature in this field. On the other hand, some of the factors that were found to be relevant in other studies, such as the support of open standards, the avoidance of vendor lock-in and the trialability of open source software were perceived as less important advantages of open source software. We are currently conducting additional case studies to verify our findings. This initial set of case studies however already provided us with rich information on the adoption decision of organizations.

4.2 Implications

Our study contributes to both theory as practice. Since the open source software landscape has changed considerably in the last 2–3 years, it is useful to reassess the reasons why organizations choose open source software. We contributed to the existing body of knowledge on the adoption of open source software

by contrasting the findings of our study, conducted in Belgian organizations, to previous studies. Similarities and differences between these results help to further triangulate the data on the adoption of open source software. This leads to a better understanding of the open source adoption decision by organizations. We also contributed to the general adoption theory by examining the adoption of a specific technology, namely open source server software.

The practical relevance of this study is two-fold. First, organizations will be given more insight in why and when adopting open source software may be beneficial, since it has been argued that organizations should know the real benefits and pitfalls of open source software [30]. Hence, a better understanding of these adoption factors may lead to better planning and more informed decision making. Second, the open source community may benefit as well from the results of this study. Insight into the real reasons why organizations use open source software may help the community to emphasize other advantages of open source software that help increase its adoption. This is important since it has recently been noted that open source communities tend to have limited insight into the opinion of its customers [29].

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