Adoption of free/libre open source software in public organizations: factors of impact

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Abstract
Purpose – In this paper the authors aim to investigate the importance of factors for the adoption of free/libre open source software (FLOSS) in the public sector. They seek to evaluate how different factors impact during the initiation and implementation phases of the adoption process.

Design/methodology/approach – The authors base the methodological approach on two exploratory case studies with a contrasting result logic. They build a multi-level framework grounded both on literature review, and feedback from stakeholders. They then apply the framework to two case studies to better frame the findings. They consider phases of adoption (initiation, implementation) and the levels of adoption (technological, organizational, environmental, individual).

Findings – In the case studies, the authors found the importance of a strong and decision-centric management board to give the impulse for the initiation phase of the process. As perceived by the stakeholders, a strong governmental support is of paramount importance to increase the adoption at the public level, although in the case studies examined the initiation stage started from the impulse of a championing management. Both case studies passed the initiation phase successfully. Continuous employees’ training, organizational objectives consensus, and business process reengineering have been found important for the implementation phase. In the case study in which these factors were not in place, the implementation phase of adoption failed. Environmental factors – although relevant for the initiation of the adoption process – are less significant during the actual implementation of the adoption process, as the contrasting result logic from the case studies shows.

Research limitations/implications – The study refers to two public organizations in a specific environmental setting. No causality among factors has been inferred. Quantitative objective data have been used to determine the success of adoption, for qualitative data multiple sources have been used when possible to limit threats to validity.

Practical implications – The framework can be used by stakeholders in public organizations to better frame their adoption strategies and to compare results across institutions. Lessons learnt from the case studies can be useful to drive future adoptions of FLOSS.

Originality/value – The framework combines phases of adoption and levels making it possible to frame the analysis of the case studies. It has been operationalized with a set of metrics, and with a protocol for the case studies to increase replicability value.

Keywords Adoption, Diffusion theory, Case studies, Diffusion, Open source, Open source software, Public sector organizations

Paper type Case study

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1. Introduction
The advantages of Free/Libre Open Source Software (FLOSS) have been often discussed in recent information systems literature. Customizability, free access to the source code, and costs savings are the major positive aspects reported by various research sources (Feller et al., 2005; Fitzgerald, 2005; Sanders, 1998). The benefits that FLOSS can bring to the public sector are even more compelling, as adopting FLOSS can reduce the digital divide phenomenon, promote local economies, avoid vendor-dependence, and – in a broader view – attack the monopolistic dominance on the market. These are all aspects that increase the importance of FLOSS in the public sector.

Still, organizations in the public sector are reluctant to fully adopt FLOSS, since triggers for the adoption in the public sector are different than for private organizations. Very often, but not always, the public sector is driven by governmental directives rather than single stakeholders’ inclination towards innovation (Huysmans et al., 2008). In some cases, successful and unsuccessful FLOSS migrations were reported even in case such driving force was missing (Valimäki et al., 2005; Ward and Tao, 2009).

More specifically, why is the public sector somewhat reluctant to extensively adopt FLOSS? A first reason concerns an endogenous aspect of innovation. Even technologies that are beneficial to a community can take several years to be extensively adopted, deployed, and used. Some anecdotal cases of problematic introduction of innovations were the Dvorak keyboard (Margolis and Liebowitz, 1999), the AC vs DC current (David and Bunn, 1988), laptop computers (Rogers, 1995), among many others. In all these cases, switching costs and incremental returns in usage played the major role in delaying the adoption process (Arthur, 1994).

There is another reason, though. FLOSS has been described as a disruptive technology. While sustaining innovation improves existing values that customers attribute to products, disruptive technologies revolutionize the way to think about a product (Christensen, 1997). In this sense, three common characteristics of FLOSS are typical of disruptive technologies (O’Reilly, 2005; Arina, 2005):

- software as a commodity;
- network-enabled collaboration; and
- software customizability (software as a service).

First, the introduction of FLOSS poses the organization towards a potential radical shift that considers FLOSS a commodity as public good driven by open standards and open platforms. Then, a given class of FLOSS licenses eases the collaboration among organizations giving them the chance to redistribute customized software through a network. Finally, FLOSS allows a high degree of customization and opens the door to new business frontiers. As such, the introduction of FLOSS can determine a significant change in the organizational business processes, to adapt them to the new software. This makes the adoption of FLOSS compelling, but also problematic: a migration to FLOSS can involve a large deviation from the pre-existent organizational IT infrastructure. This radical shift and the intrinsic mistrust toward innovation typically slows down any FLOSS adoption. Thus, investigating factors of adoption facilitating or inhibiting the introduction of a new technology is of primary importance in recent literature on innovation adoption (Fitzgerald, 2009; Fitzgerald et al., 2011).
In this paper, we follow the idea of a multilevel study for FLOSS adoption (Depietro et al., 1990; Glynn et al., 2005) for which adoption is analyzed under different perspectives and we identify factors that facilitate and inhibit FLOSS adoption in public organizations. In this sense, our research specializes the general framework introduced in (Fitzgerald et al., 2011) in that it focuses only on specific characteristics of adoption, but it further analyses them at different phases of adoption and investigates them in terms of a final measure of success. Specifically, our research question is:

What are relevant factors for a successful introduction of FLOSS at different phases of adoption in a public organization?

To answer the question, we define a theoretical framework for FLOSS adoption inside organizations, we refine the framework with stakeholders’ feedback, and then we apply it to two exploratory case studies in public organizations. We contribute to the research in FLOSS adoption with:

- the definition of a multi-level and multi-phase framework for the characterization of FLOSS adoption in the public sector;
- the characterization of two large case studies, to understand the FLOSS adoption phenomenon;
- the evaluation in the case studies of the factors of FLOSS adoption by means of a set of metrics identified, and the application of an empirical study protocol to evaluate the intra-case study and inter-case studies results.

The article is structured as follows, in Section 2 we overview different studies that identify factors of impact in FLOSS adoption. In Section 3 we propose the research methodology and the process of framework building. In Section 4 we build the research framework to study FLOSS adoption, drawing from the experience of other studies, and we prioritize the factors by letting managers of two public organizations evaluate the framework. In Sections 5, 6 we first define case studies used to draw common lessons and then apply the framework to the two case studies. Discussions, limitations, further works and conclusions end the article.

2. Background: factors of FLOSS adoption in literature

The theory of Innovation Diffusion Theory (Rogers, 1995) provides a basic context of investigation for the adoption of new technologies that comprises several aspects, from the types of adopters to the adoption phases. In this context, the factors of adoption can be discussed at different levels or perspectives. At the personal/technological level, studying motivations that act at the individual level and impact on the adoption decision (among others, Dedrick and West (2004)), at the organizational level, studying the factors inside organizations that act as facilitators/inhibitors for the adoption of new technology (among others, Fichman, 2001), or at the environmental level, studying the business dynamics and the impact of the external environmental factors on the process of innovation adoption (among others, Economides and Katsamakas (2006)). Larger frameworks have been built typically to integrate the three different levels in the analysis of factors of a generic technological adoption: technological, organizational, and environmental factors (Tornatzky and Fleischer, 1990; Swanson, 1994; Chau and Tam, 1997). Fitzgerald et al. (2011) have built a framework of FLOSS
adoption integrating Rogers’ (1995) facilitating conditions with Ajzen’s theory of Planned Behaviour (Gallivan, 2001; Ajzen, 1985; Taylor and Todd, 1995).

The majority of the research in this area is performed from a single perspective. Recent research focused more on multilevel studies (Jones and Gallivan, 2007). Such approach is greatly encouraged, though, as including different perspectives of analysis allows studying a technology introduction in the organization as a whole. A multilevel research would study interactions and similarities across various levels of adoption. In our case, a multilevel approach considers all the four aspects simultaneously:

1. individual;
2. technological;
3. organizational; and
4. environmental.

Among the major contributions in factors of FLOSS adoption, Dedrick and West (2003) developed a grounded theory of the adoption open source platform adoption, the case of Linux Operating System. According to the authors, several factors have been influencing FLOSS adoption decisions such as relative cost advantage perceived by managers, compatibility with existing standards in the organization, trialability of the new system, and complementary skills in the management of the organization. Two environmental factors also played a major role, the perceived availability of FLOSS skills in the external environment, and the support on FLOSS technologies by the major IT vendors as external competences in FLOSS can foster the adoption and organizations need not to rely solely on internal competences. The authors published a second work (Dedrick and West, 2004), in which they administered to IT managers a survey on the relevance of the factors they determined in their first work. With this study they validated their previous work and classified the factors in three of the above four aspects opening the way to a multilevel study. As a result, some of the factors found previously were confirmed, such as relative cost advantage (technological aspect) – also including switching costs (Shapiro and Varian, 1999). Some other factors were added, such as reliability of the platform and compatibility with deployed technologies and skills (technological aspect), IT Innovativeness as the general stance of an organization toward technological innovation (organizational aspect), and availability of external technological resources (environmental aspect).

Kwan and West (2005) examined FLOSS adoption in large enterprises. In particular, they defined four critical attributes, industry context, firm context, organizational attitudes towards standards, and towards open standard. The industry context is considered critical, as it can influence the IT decisions of single companies. The firm context also is determinant as different companies will have different competitive positions and specific roles for the IT department. The organizational attitudes towards standards and open standard are drivers of FLOSS adoption. The greater is the attitude towards open data standards, the larger are the opportunities for the adoption. The latter aspect is concerned in general with companies’ attitude towards the FLOSS movement. Some companies are neutral in this aspect, while others are unbalanced either towards proprietary software or FLOSS, increasing the probabilities of a successful technological change inside the organization.
The framework in Glynn et al. (2005) is the first multilevel study in FLOSS adoption, which has been validated with a large-scale survey. As major relevant factors, the authors included the FLOSS ideology, a committed personal championship of FLOSS, and the network effects that can be exploited when collaborating with the large open source community.

Other factors found relevant in complementary studies are the unfamiliarity of customers with FLOSS vendors’ relationships, and the need to adapt corporate governance and architecture (Holck et al., 2005). The complex interrelations between multiple individual, technical, organizational, and environmental factors, including total cost of ownership (Russo and Succi, 2009), external market support have also been considered as relevant (Morgan and Finnegan, 2007).

The framework of Fitzgerald et al. (2011) integrates the principles of the theory of Planned Behaviour adopted in Gallivan’s (2001) framework with Rogers’ facilitators of innovation adoption. They analyzed the factors in terms of their effects on technology assimilation. The framework is applied to five different case studies in a comparative approach.

Following the initial seminal paper of Depietro et al. (1990) discussed recently in Huysmans et al. (2008), factors have been divided in facilitators and barriers and defined in the same way for the private and the public sector. This approach has been used by many frameworks of FLOSS adoption hereinafter (Bradford and Florin, 2003; Cooper and Zmud, 1990; Dedrick and West, 2003; Huysmans et al., 2008). Huysmans et al. (2008) proposed factors introduced in Morgado et al. (2007) for the specific adoption of FLOSS. In this work, the focus is more on the barriers that are relevant for a specific FLOSS instance (e.g. OpenOffice.org) and at a finer level of detail (e.g. lack of usability).

The tOSSad project identified several barriers to the adoption of FLOSS in the public sector (Groganz, 2007). Examples are human factors such as resistance to change, trust on OS distribution, legal factors as software piracy, lack of business models, and lack of FLOSS branding. Other factors that relate to technology are lack of standardization of formats and compatibility, security problems and system failures, versatility of the operating system installed. Additional barriers in public administrations refer to the lack of a single reference for FLOSS selection (as in proprietary software), and entry barriers for the migration process. Among those, financial barriers are relevant. Crucial issues are difficulty of estimating the Total Cost of Ownership of FLOSS and the organizational increase of costs such as the increase of management costs, the new software compliance costs, etc. All of these factors have to do with the difficulty of having an exact estimate of the resource needed for the adoption and possible fear of unforeseeable expenses and hidden costs. To increase uncertainty legal factors play a fundamental role. There is a lack of regulations in laws about FLOSS use and adoption that relates to contracts and patent issues.

3. Research methodology
To answer our research question, we first build a theoretical framework of factors facilitating/inhibiting technology adoption. We have defined it by following the approach for framework definition of Eisenhardt (1989), and the multiple case study design for research of Yin (2003). In this section, we present how we created the framework. The framework itself will be described in the next section.
According to Eisenhardt (1989), the definition of a framework must follow several sequential steps. In the following, we describe how we implemented each single step of the Eisenhardt’s method.

**Getting started**
In this step, we have defined the research question to build a multi-level, multi-phase framework (Depietro et al., 1990; Huysmans et al., 2008). We considered both the different level of each factor (technological, organizational, environmental, and individual), and the phase on which they impact (initiation or implementation). We also selected the relevant literature on factors facilitating or inhibiting technology adoption.

**Selecting cases**
We selected cases according to a multiple case study design for research (Yin, 2003). In this kind of design, the procedure is replicated across case studies with different context. It is more complex to be handled than a single case study design, but can produce results that are more general. Specifically, we ran two case studies in two different public administrations on which we used a contrasting result logic – or theoretical replication, according to (Yin, 2003). The contrasting resulting logic compares different results from the case studies to ground and refine theory and strengthen findings. With this method, cases are not sampled, but are intentionally selected to provide contrasting outcomes.

**Crafting instruments and protocols**
As means for data collection, we used surveys, interviews, pure observations, and software agents. When feasible, we gathered data from multiple sources. With this approach, we were able to collect both quantitative and qualitative data. Different means and sources can help derive quality data for the analysis. To ensure the quality of the replications, we also defined a case study protocol. Details are given in section 6.2.

**Entering the field**
Questions for interviews and questionnaires were refined iteratively. In particular, we had to integrate questionnaires with interviews as new factors were discovered. This falls into the principle of data collection adjustment (Eisenhardt, 1989), for which data collection is not simply linear and sequential.

**Analyzing data**
According to theoretical replication method (Yin, 2003), we performed the analysis to determine divergent outcomes from the case studies. Specifically, quantitative data collected by software agents was compared by means of box plots whereas qualitative data were interpreted according to the questions linked to the factors from questionnaires, surveys, or observations. In Table I we show all the factors, the type of the data sources, and the kind of question that was used to derive the factor as facilitator or inhibitor.

**Shaping the hypotheses**
Discussion of the findings was made according to tabular data provided by the framework by means of the prioritization and the results of the instrumentation to the case studies. We use two level of analysis. As a first level, we use the comparison of the prioritization made at the management level against the factors evaluated as facilitators or inhibitors in a case study. This analysis will show the understanding of the management of the factors
<table>
<thead>
<tr>
<th>Metric</th>
<th>Target</th>
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<tbody>
<tr>
<td><strong>Initiation phase</strong></td>
<td></td>
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<tr>
<td>Attitude towards change</td>
<td>Interviews/Questionnaires</td>
</tr>
<tr>
<td>Centralization</td>
<td>Observation</td>
</tr>
<tr>
<td>Complexity</td>
<td>Observation</td>
</tr>
<tr>
<td>Formalization</td>
<td>Interviews</td>
</tr>
<tr>
<td>Interconnectedness</td>
<td>Observation/Interviews</td>
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<tr>
<td>Organizational slack</td>
<td>Interviews</td>
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<tr>
<td>Size</td>
<td>Observation</td>
</tr>
<tr>
<td>System openness</td>
<td>Interviews</td>
</tr>
<tr>
<td>Competitive pressure</td>
<td>Interviews</td>
</tr>
<tr>
<td>Governmental rules</td>
<td>Interviews</td>
</tr>
<tr>
<td><strong>Implementation phase</strong></td>
<td></td>
</tr>
<tr>
<td>Technological compatibility</td>
<td>Interviews</td>
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</tbody>
</table>

Table I. Method of evaluation of the different factors selected (continued)
and their relevance in the context of the case studies. As a second level, we compare the factors inside a single case study and between the two case studies, discussing the divergences under the light of the different outcome of the case studies.

**Enfolding literature**
According to this step, the comparison with relevant similar and conflicting literature increases internal and external validity of the study. We compared and discussed our findings against literature in FLOSS adoption focusing on differences and similarities from the determined.

**Reaching closure**
According to this step, more cases should not be added to the case when “incremental learning is minimal” (Eisenhardt, 1989). This means that the introduction of new case

<table>
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<th>Metric</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological complexity</td>
<td>Questionnaires</td>
</tr>
<tr>
<td>Task complexity</td>
<td>Interviews</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Questionnaires</td>
</tr>
<tr>
<td>Business processes reengineering</td>
<td>Interviews</td>
</tr>
<tr>
<td>Top management support</td>
<td>Interviews</td>
</tr>
<tr>
<td>Organizational objectives consensus</td>
<td>Interviews</td>
</tr>
<tr>
<td>Training</td>
<td>Interviews</td>
</tr>
</tbody>
</table>

**Note:** Target can be either (M)anagers or (U)sers, or both

Table I.
studies will not give the theory an adequate benefit compared to the costs of carrying out an additional investigation. We did not follow this step for two reasons: our aim is to cross-check the factors across the case-studies, not to build a causal model. Furthermore, due to the broad research question, the cardinality of factors, metrics, and the size of the organizations adding more case studies would have been infeasible.

Figure 1 illustrates the tasks we achieved in building our framework with the Eisenhardt’s approach. The first step is the definition of facilitating/inhibiting factors for the adoption of FLOSS in public organizations. As we mentioned, we reviewed the literature in the field to create a preliminary list. We started from the recent book of Fitzgerald et al. (2011) and we went back reviewing factors from the major frameworks of Innovation Diffusion Theory (Bradford and Florin, 2003; Dedrick and West, 2004; Rogers, 1995; Cooper and Zmud, 1990). Each factor has been included according to the following rules:

Figure 1.
Methodological approach followed to build the framework and integrate the case studies
• Not included already as a duplicate factor or subfactor. For example we considered software compatibility rather than the more fine-grained factor software compliance to standards. In general, we kept higher level factors.

• Applicability during the subsequent case study research, based on the fact that the factors could be collected in the case studies. For example we did not include a factor such as level of software piracy in an organization, as we thought difficult to let organizations of the case studies disclose this kind of information.

To build the framework, we mapped factors into the adoption phases (initiation and implementation) as suggested by the Innovation Diffusion Theory (Rogers, 1995). Then, we asked managers to review the resulting framework. Managers prioritized factors according to their understanding of factors’ importance in the adoption phases. The final framework is a distribution of prioritized factors across FLOSS adoption phases. To apply our framework, we define a set of metrics that evaluate the factor of a given phase (Table I). Metrics are specified with their type (qualitative or quantitative), the source from which they were collected, and means of collection (surveys, interviews, pure observation, or software agents). For example, we collected objective data on software usage with software agents that collect time of use of software applications, we collected subjective data on attitude toward change with direct questions or interviews to the software users, and we collected objective data organization size by pure observations, as suggested in Hannay and Jørgensen (2008), and in Sjøberg et al. (2005). Finally, we applied the framework to two different case studies, measuring the factors and comparing them in terms of similarities and contrasts.

In this context, we administered a questionnaire on the importance of the factors. We explained the proposed framework, the different interactions, and terms, and asked the respondents to prioritize the factors according to their experience and the two phases of initiation and implementation.

4. FLOSS adoption integrated framework
We followed the research methodology explained in the previous section, and we structured the framework as a multi-level and multi-phase model based on the general innovation adoption framework of Rogers (1995) and the framework of OSS adoption (Fitzgerald et al., 2011). We describe in this section the framework.

The framework has two phases and four levels. The technology innovation process in organizations has several interconnected phases (Rogers, 1995). In our framework, we consider two of the Rogers’ macro-phases initiation and implementation — also called primary and secondary adoption (Zaltman et al. (1973); Gallivan, 2001) — and we do not delve into the single sub-phases. At the initiation phase, the organization takes the decision to adopt a new technology, and at the implementation phase, the technology is adopted inside the organization. Each phase is affected by different factors that might inhibit or facilitate its development. For example, the effects of governmental policies influence mostly the initiation phase as they impact on the decision of the organization to adopt a particular technology. According to (Fitzgerald et al., 2011), the four levels of our framework are technological, organizational, environmental, and individual (TOEI).

The framework consists of factors that inhibit and facilitate FLOSS adoption categorized by phases and levels define the mapping between phases and levels. For
example, the factor “adverse to FLOSS ideology” can inhibits the introduction of FLOSS during initiation at the organizational level as the new software application is not considered appropriate to fit the identified needs or during implementation at the individual level as users consider the application not compatible with previous legacy formats.

The mapping is reported in Tables II and III. In the following, we discuss the mapping by phase.

4.1 Initiation: environmental, individual organizational factors

In this section, we discuss levels that impact at initiation phase. In literature, mostly of the factors that impact during the initiation phase are at the organizational, environmental, and individual level.

<table>
<thead>
<tr>
<th>Prioritized factors</th>
<th>Description</th>
<th>Source</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Governmental rules</td>
<td>Governmental rules that can establish policies towards the adoption of Open Source software</td>
<td>(Grognanzt, 2007; Hahn, 2002; Lee, 2006)</td>
<td>1.62</td>
</tr>
<tr>
<td>2. Attitude towards change</td>
<td>Attitude towards change of the management</td>
<td>(Rogers, 1995)</td>
<td>1.69</td>
</tr>
<tr>
<td>3. Size</td>
<td>Size of the organization (e.g. In terms of number of employees)</td>
<td>(Rogers, 1995; Fichman and Kemerer, 1997)</td>
<td>4.0</td>
</tr>
<tr>
<td>4. Complexity</td>
<td>Heterogeneity of the knowledge of the management</td>
<td>(Rogers, 1995; Morgan and Finnegan, 2010)</td>
<td>4.23</td>
</tr>
<tr>
<td>5. Formalization</td>
<td>How much formalized are the processes inside the organization</td>
<td>(Rogers, 1995)</td>
<td>5.46</td>
</tr>
<tr>
<td>6. Competitive pressure</td>
<td>Level of competition with other organizations (also other public administrations)</td>
<td>(Rogers, 1995; Chau and Tam, 1997)</td>
<td>5.62</td>
</tr>
<tr>
<td>7. Centralization</td>
<td>Centralization of the decisional power in a restricted number of people inside the management</td>
<td>(Rogers, 1995; Dedrick and West, 2003)</td>
<td>5.92</td>
</tr>
<tr>
<td>8. System openness</td>
<td>The level of openness of the organization towards the external environment (e.g. with other organizations)</td>
<td>(Rogers, 1995)</td>
<td>6.0</td>
</tr>
<tr>
<td>9. Interconnectedness</td>
<td>Level of connections between organizational units and social networks that can exist between employees</td>
<td>(Rogers, 1995)</td>
<td>6.15</td>
</tr>
<tr>
<td>10. Organizational slack</td>
<td>Available resources not yet assigned that can be devoted to additional activities</td>
<td>(Rogers, 1995; Dedrick and West, 2003)</td>
<td>9.08</td>
</tr>
</tbody>
</table>

**Table II. Initiation phase**

**Notes:** Prioritization of selected factors, the lower the score the better, Intraclass correlation coefficient (ICC) = 0.53
At the organizational level, we consider factors of innovativeness of the organization, defined as the degree of attitude toward the introduction of innovations in (Rogers, 1995). These factors are further classified as:

- individual (leader) characteristics;
- internal characteristics of organizational structure; and
- external characteristics of the organization.

Each factor can impact positively (+) or negatively (−) in the three levels.

Centralization of the decisional power in few subjects inside the managerial board of the organization has been found to be negatively correlated with the level of organizational innovativeness as internal characteristic of an organization.

Complexity of the set of knowledge and expertise of management will positively impact on the introduction of innovations. This means that a management that has various competences will be more oriented towards innovations.

Formalization indicates the level of formalisms and bureaucracy that are in place inside the organization. Higher formalisms in place will lead to greater barriers to the introduction of innovations.
Interconnectedness signals the level of connections among units in the organizational social system. The more people are connected by interpersonal relationships and social networks, the higher will be the spreading effect of innovations inside the organizational setting.

Organizational slack is the availability of resources inside the organization not yet assigned to specific activities. A larger availability of these resources will lead to a greater attitude towards the introduction of an innovation, especially those that are particularly resource-intensive in terms of implementation.

Size of the organization has been found to be positively correlated with the level of organizational innovativeness. One reason can be that this indicator is in fact hiding several other factors that have to do with organizational size, and those factors are usually connected to innovativeness. Nevertheless, organizational size is easy to measure and compare, and as such has been very often the basis for empirical studies on technological innovation.

As an environmental characteristic, system openness defines how much the organization is open to external influences in the evaluation of those innovations that have been developed by external companies or that have been adopted with success by equivalent organizations. Higher openness increases the knowledge about external innovations that can be potentially beneficial. At the individual level, the attitude toward change impacts positively on the organizational innovativeness: a management that is change-oriented will favor the introduction of an innovation inside the organization. Such management will easily see the potential benefits and impacts of innovations.

The influence of governmental rules, like strategies to support FLOSS diffusion, can facilitate the organizational innovativeness in public organizations (Hahn, 2002; Lee, 2006) and be a facilitating factor for the adoption process.

Some of these factors have a double phase interpretation (Rogers, 1995). For example, as we have seen, a high level of centralization leads to a lower degree of innovativeness in the initiation phase, but the same level of centralization can be beneficial during the implementation of the innovation, as such focused decisional power can better lead the actual deployment of the innovation. This reason has been very often reported as one of the causes for the scarce empirical use of this factor in a real scenario.

4.2 Implementation: individual, technical, environmental factors
We have seen that factors impacting on organizational innovativeness better refer to the initiation of the adoption process; in this section we focus on the users’ acceptance of innovation to determine those factors that impact on the implementation phase, instead. In particular, we discuss the characteristics of Innovation Diffusion Theory (Bradford and Florin, 2003; Dedrick and West, 2004; Rogers, 1995; Cooper and Zmud, 1990). In literature, these characteristics were not clearly related to the initiation and implementation phases of Rogers.

The three major technological aspects discussed in (Bradford and Florin, 2003) refer to:

(1) Technical compatibility, the level of alignment of the innovation with the legacy technology.

(2) Technical complexity, the intrinsic difficulty in applying the innovation and thus being successfully assimilated by users.
Relative advantage, the advantage that users perceive that the innovation has with respect to old technology.

We consider that the implementation of the innovation inside organizations is thus influenced by compatibility and technological complexity. Both task characteristics and task complexity influence the alignment with compatibility and complexity as a more complex task will potentially lead to greater compatibility issues. In this sense, and intuitively, while the effect of increased technological compatibility is positive on the final level of IT adoption, the effect of increased task and technological complexity has clearly a negative impact on the adoption of innovation.

Technical compatibility refers thus to the level of fitting of the new innovation to the existing software infrastructure. Both task characteristics and technology characteristics determine the final level of compatibility. Bradford and Florin (2003) show how technical compatibility can have a positive impact on the success of deployment of a new software solution.

On the other side, technical complexity is defined as how an innovation is difficult to understand and use (Rogers, 1995). Also in this case, the peculiarity of the task has a final impact on the perceived usage complexity of a technology. In the framework proposed, Bradford and Florin (2003) consider how the perceived degree of complexity of IT systems will have a negative impact on success of deployment.

The reengineering of business processes is also considered an important factor in implementation, as the introduction of a different software application may impose changes in the organizations’ business processes to better fit the characteristics of the new system (Bradford and Florin, 2003). In this sense, the introduction of a software requires a radical change in the business processes of the organization so that the actual implementation of the innovation can be slowed down or even hindered. In many cases, reengineering business processes will have a positive impact on the organization, since reengineering will optimize the process and reduce drastically wasted resources.

Bradford and Florin (2003) also included non-technical factors: the organizational and environmental ones.

Organizational factors are constituted by four positive drivers: top management support, organizational objectives consensus, and training, while the environmental ones consists mainly of competitive pressure, for which organizations are confronted with rival and equivalent organizations.

Top Management support refers to the vision and governance of the management board in the technology adoption. As such, such management acts as facilitator.

Organizational objectives consensus, refers to employees that have clear understanding of organizational objectives and are in agreement with them are more motivated and inclines to the introduction of innovation.

Training refers generically to all the supporting and instructional activities performed to decrease the barriers that users face when confronted with innovation.

Competitive pressure is an environmental factor (Porter, 1987; Bradford and Florin, 2003), that we do not consider impacting in the initiation phase. In our framework, we considered it as a factor of initiation as, for example, adopting solutions already used with success by rival organizations.

Figure 2 summarizes the mapping between levels and phases through factors. Figure 2 does not include all the factors we have found in literature. Many of these factors were not
included either because they are sub-factors of other included factors or are too difficult to operationalize in the data collection process. For example, factors such as the level of pirated software inside an organization, the lack of branding, lack of business models, free software perceived as “cheap” by users, were considered as difficult to operationalize in the context of the case studies. We considered security problems and system failures, and universality of the current operating system platform installed (Groganzt, 2007), more related to a server-side installation than our focus on client applications.

Overall, the elements compounding our framework are consistent with the existing frameworks we reviewed in Section 2 and the current research in innovation introduction in the public sector (Raus et al., 2008). The framework does not introduce new factors, but rather allows to discuss them to determine a theoretical mapping
TOEI levels – adoption phases that helps the application of the framework in concrete case of adoption (Figure 3). The novelty of our work will be evident in the application of the theoretical framework on two case studies (Table I) and in the prioritization of the factors by the stakeholders. The final result – that will be presented after the discussion of the case studies – is a representation of the different factors as inhibitors or facilitators by levels and phases in the two specific case studies (Figure 4). The mapping allows to evaluate the results of a single case study (intra-case study) and compare the factors across different case studies (inter-case study).

In the next sections, we describe the results derived from the two different case studies considering both the intra- and inter-case studies analysis.

5. Case studies
The case studies are based on two public administrations that have migrated to FLOSS in the last five years. In the following, we provide information about the relevant characteristics of the two organizations and the study protocol that was applied to both to operationalize the framework.

5.2 Suedtiroler Gemeinden Verein (SGV)
SGV is an Italian public association that provides services to a large set of townships. The administration is a consortium of 116 municipalities, eight public offices supplying social services, and about 30 offices. Nearly all the townships in the consortium are small and have an average of 50 desktop machines, and most do not have on-site technicians so maintenance is largely managed remotely from the consortium headquarters. The budget available for ICT (Information and

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**Figure 3.**
Integrated framework for FLOSS adoption investigation
Communication Technology) services in such small municipalities is generally low. The experience in FLOSS is relevant, acquired mainly server-side.

### 5.3 Autonome Provinz of Bozen-Bolzano (PROBZ)

The Autonome Provinz of Bozen-Bolzano is an Italian northern province that has a so-called “Statuto Speciale”, and as such has many competences that usually are

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>PHASE</th>
<th>SGV CASE STUDY</th>
<th>PROBZ CASE STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Governmental Rules</td>
<td>Initiation</td>
<td>F/I</td>
<td>F/I</td>
</tr>
<tr>
<td>2. Attitude towards change</td>
<td>Initiation</td>
<td>F/I</td>
<td>F/I</td>
</tr>
<tr>
<td>3. Size</td>
<td>Initiation</td>
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<tr>
<td>4. Complexity</td>
<td>Initiation</td>
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<td>5. Formalization</td>
<td>Initiation</td>
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<tr>
<td>6. Competitive Pressure</td>
<td>Initiation</td>
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<td>7. Centralization</td>
<td>Initiation</td>
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<tr>
<td>8. System Openness</td>
<td>Initiation</td>
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<td>9. Interconnectedness</td>
<td>Initiation</td>
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<tr>
<td>10. Organizational Slack</td>
<td>Initiation</td>
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<tr>
<td>1. Technological Compatibility</td>
<td>Implementation</td>
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<tr>
<td>2. Training</td>
<td>Implementation</td>
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<tr>
<td>3. Organizational Objectives Consensus</td>
<td>Implementation</td>
<td>F/I</td>
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<tr>
<td>4. Top Management Support</td>
<td>Implementation</td>
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<tr>
<td>5. Technological Complexity</td>
<td>Implementation</td>
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<tr>
<td>7. Task Complexity</td>
<td>Implementation</td>
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<tr>
<td>8. Relative Advantage</td>
<td>Implementation</td>
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**Note:** The factors with strong differences among the case studies have been evidenced with a gray line.
assigned to the state administration. The administration of the province has a peculiar structure, due to the variety of activities that has to perform: on top of a general direction, there are 12 departments, down to 40 divisions, divided then in 178 offices. While the inhabitants of the province are ~470,000, almost 25 percent of the inhabitants is employed in the Public Administration.

The IT division of the administration is composed of five offices that provide technical services to all other divisions, from software customization, testing, and deployment, to hardware support, installation, and substitution.

Study protocol. Once the organization decided to introduce FLOSS, we defined a protocol to gather data from the various sources and with the various means described above. The protocol defines the steps of data collection and sample definition. The interested reader can refer to the work of Rossi et al. (2006), and Rossi et al. (2007) for further details on the protocol’s implementation.

The first step has been the selection of the participants. Due to the number of employees of the two organizations, we could not perform a full randomization of the sample and employees were selected by the management. This exposed us to the threat of a possible selection bias (Campbell and Stanley, 1966), as it could be that the most change-oriented employees were selected. To mitigate this thread, we selected a large sample of respondents in both the organizations: 1,486 (SGV) and 1,475 (PROBZ) employees. Involving such a large number of employees and given the little knowledge of the users of the FLOSS ideology, the change-oriented employees became a minority and had a more limited impact on the results.

We submitted questionnaires to the users about their attitude towards FLOSS. This was done to evaluate their knowledge about FLOSS, for example to define their attitude with respect to FLOSS.

There were motivational seminars on the reasons of the experimentation that was organized by each organization independently. Installation of the FLOSS solution, OpenOffice.org, deployed by each technician in parallel with the old software. The users could choose which application they preferred to use. We started at this step monitoring the usage of the office suites for employees sampled. A software agent was used to gather data in real-time from each client machine. We used this information to evaluate later the successfulness of the migration.

During the course of the monitoring process, each organization organized training sessions and support to the users. Due to the large number of employees to train, very often organizations preferred to provide guidelines and support through help desks.

We submitted the final questionnaires and performed the interviews for the investigation of the factors. Table I presents the final connections of questions from the questionnaires to the factors.

6. Refinement and application of the framework
To refine and validate our framework we first prioritized the list of factors and then applied the framework with the prioritized list to the two case studies.

We collected overall ten complete questionnaires from managers of public organizations to prioritize the list of factors. Out of those, four were of managers of the two case studies. Managers were either heads of IT departments or heads of specific offices. As a ranking mechanism, we used the average of the position that was identified for a factor by the respondents (the lower the value, the better). In Tables II
and III, we provide the prioritized list of the factors, with the description, literature source, and the average score given by the respondents and that we used for the overall ranking. Some of the factors were selected more often than others as more important (as for example Governmental rules, and attitude towards change, 1.62 vs 1.69, or organizational slack that had a score of 9.08, meaning it was very often selected as the least important factor). To determine the level of agreements among respondents, we also calculated the Interclass Correlation Coefficient (ICC) of the rankings performed. An ICC of 1.0 indicates a perfect agreement in that all the interviewees rank the factors exactly the same. ICC has been calculated as a as a two-way mixed model, prescribing that each question has been evaluated by the set of raters and that these raters were the only ones of interest (Shrout and Fleiss, 1979). ICC calculated for both classes of factors, shows similar and high agreement among the interviewers in both the cases of initiation (0.53) and implementation (0.51).

Table II reports about the prioritization of factors for the initiation phase. Governmental rules, attitude towards change, and size of the organization are considered the top factors for the initiation process. Managers confirm the importance of government support to the policies towards the introduction of FLOSS. Such policies can be a strong factor for the adoption. Managers believed that without a strong attitude towards change, it is difficult to get the initial impulse towards innovation. Organizational size is seen as an important factor for the FLOSS migration. The management has the perception that a larger organization can more easily undertake a migration process.

System Openness, interconnectedness, and organizational slack are not seen as key factors for a migration process. A greater openness towards the environment, a stronger integration among the personnel of the organization, and the availability of extra unused resources, are not seen as key factors.

Prioritization for the implementation level factors is presented in Table III. The top factors for the implementation level are considered technological compatibility, training, and organizational objectives consensus. Indeed, the compatibility with legacy systems and data standards is important for any migration process. The migration process must not pose serious issues of interoperability. Formal preparation for the implementation phase is also considered important for the reduction of the acceptance barriers. Another reason is that training is often seen as way to perform an additional schooling of employees. The adoption is thus a beneficial excuse to enforce this intention. A strong consensus towards the organizational objectives is also considered a key factor: the acceptance of users will be greater in presence of an alignment between their perception of the organizational objectives and their agreement with those long term objectives.

Relative advantage, task complexity, and business process reengineering, are considered less important for the implementation success. This means that the eventual advantage – or disadvantage – of using FLOSS software, or even the complexity of the tasks is not considered relevant: the organization can enforce the implementation. Even the reengineering of the business processes is considered less relevant than other factors, meaning that managers of the case studies consider the introduction of FLOSS not strictly connected to a reorganization of the business processes.

Before applying our framework, we investigated the success of the adoption process in the two phases in each case study. We determined success by using a software agent
to collect information about FLOSS usage in real-time. We found that the adoption in PROBZ reached lower levels of adoption. Data are illustrated in the box plots of Figure 5. In the specific, data for PROBZ show a distribution of usage of documents per user has mean $\bar{x} = 3.26$ and standard deviation $\sigma = 1.48$. For SGV, the distribution of the usage of documents per user has mean $\bar{x} = 12.38$ and standard deviation $\sigma = 6.28$. The time of usage per user yields similar results: in PROBZ the mean is $\bar{x} = 12.66$ min. and the standard deviation is $\sigma = 7.09$, in SGV, $\bar{x} = 115.5$ min. with $\sigma = 66.5$. We can see that FLOSS usage is higher for SGV in the implementation phase. We also run the non-parametric Wilcoxon Rank Sum Test for the comparison of the data distributions of the two case studies. Our null hypothesis is that both the average documents and average time worked by users from the two case studies are independent samples from identical continuous distributions with equal medians. In both cases we can reject the null hypothesis with a 0.05 level of significance, two-tailed (documents: $p = 3.0392e-030$ and time: $p = 6.4333e-039$). This result strengthens the differences in the adoption levels.

Finally, we applied our framework to the two case studies collecting information on phases, levels, and factors as perceived by the users. We collected the relevance of the factors among a sample of volunteered users and the four managers of the two organizations. The second column of Table I indicates the metric that was used to derive the results for a factor in a specific case study. The third column of Table I indicates whether a factor was evaluated by targeting a User (U) or a manager (M) as the data source. Following Yin (2003), we further discuss the factors within the theory of contrasting results in that case study design and protocol have been replicated in the two case studies. We detail the findings in the following and in Tables IV-V, and Figure 4.

6.1 Suedtiroler Gemeinden Verein (SGV)
The introduction of FLOSS in SGV was successful, as both the initiation and implementation phases completed and the usage of the new technology was high. The

![Comparison of PROBZ and SGV case studies, boxplots about the OpenOffice.org (OOo) final usage compared](image)

**Note:** Each boxplot shows the distribution of users for both case studies based on average number of documents per user opened in the period (left) and average time per user in the same period (right).
Initiation phase

Facilitators

Attitude towards change
Informal interviews with the management, showed that there is a strong evidence of attitude towards change from leaders in key positions to drive the change. More sparse was the attitude of local managers in the institutions and users.

Centralization
There is a high centralization of the power, a single person takes the championship role to impose the introduction of the innovation, IT managers have the decision control over packages to install.

Complexity
There are heterogeneous competences in the managing board that allow the evaluation of the deployment of the new technology.

Organizational slack
According to the interviews with the management, resources are available in quantity to grant the opportunity of the introduction of FLOSS.

Size
The size of the organization is large, more than 4,000 users were reported overall, the usage data in the case study considered 1,486 users.

System Openness
Managers report that the organization is in general open to other administrations and to the citizens.

Inhibitors

Formalization
Interviews report that usually the processes inside the organization are highly formalized, this imposed stricter constraints during the migration.

Interconnectedness
The diffusion of FLOSS is spread across many municipalities, communication is heavy only among employees in the same municipality.

Competitive Pressure
Competitive pressure with other administrations is limited, in the sense of competition in the Public Administration context, the competition is heavy among public entities in the same area.

Governmental rules
Still there is not a clear governmental directive about the introduction of FLOSS in public organizations, several managers reported this issue.

Implementation phase

Facilitators

Business processes reengineering
Limited business process reengineering has been performed and has been a facilitating factor for the introduction of the application as IT managers reported.

Task complexity
In some cases, were the complexity was too high, the organization performed an automation of the task, such as automatic generation of certain documents.

Organizational objectives consensus
There was generally a consensus (albeit not extended to the whole employees) about the introduction of the software.

Top management support
Support from managers was constant during the migration.

Training
Training was performed accurately and considered by users as very important.

Inhibitors

Technological Complexity
Users were not completely satisfied with the user friendliness of the application.

Technological Compatibility
The technology, while compatible with old formats had some issues with old formats.

Relative advantage
Questionnaires with employees showed that, generally, they are neutral towards the new software.

Table IV.
Framework applied to the SGV case study
factors of the framework have been evaluated by the users and reported in Table IV, where the positive and negative impact on FLOSS adoption are marked respectively as (F)acilitators or (I)nhibitors, indicating the effect of each factor according to the metrics identified (Table I).
At the end of the implementation phase, many of the municipalities were using OpenOffice.org in their activities as their main office automation platform. The introduction of OpenOffice.org was made easier by the attitude towards change of the management, willing to release the organization from vendor lock-in, to provide more opportunities for local companies, and to reduce the cost of software licenses. This attitude was particularly evident at the initiation level. By informal interviews with the management, we discovered several roles that took a championing role towards FLOSS, and gave the starting impulse towards the process of adoption. These roles very often were in the key position to dictate the line of action in the IT department, granting in this way a stronger impulse. Slack of resources were available for the adoption process, although according to the prioritization step, these were not considered a key factor for the initiation of the whole adoption process. We also acquired knowledge from the stakeholders, that the openness of the organization for the exchange of information granted an impulse for the introduction of FLOSS. This was due to other organizations that were using different data standards. This was another impulse for the management to start the adoption process.

Other factors were considered as sort of barriers to the initiation process, like the formalization of the business processes inside the organization, or the limited interconnectedness among organizational units that could help in spreading FLOSS more rapidly. Governmental rules were not a key factor for the impulse towards the adoption process. While stakeholders in the case study believe this is a key factor for increasing the adoption of FLOSS, they agreed that in their case the impulse derived mostly from the decision taken by a management that took the leading role to embrace the change.

During the implementation phase, one of the most relevant factors in this case study has been business process reengineering. The IT management took the opportunity to integrate the new technology in their existing IT workflows so that open software libraries could be used to generate documents in open standards. Users were then forced to use the new technology to handle these documents, gaining then confidence in the new technology.

To testimony the importance of compatibility, in one single municipality, that was still handling legacy documents, the migration was cancelled, due to many interoperability problems. This is the only case that has been reported of non-adoption inside the whole organization. While the adoption was successful, technological complexity was an inhibiting factor: sampled users reported in fact not to be completely satisfied about the usability of the new software, and they did not find relative advantages in using it during their daily work. Their decision to adopt the software was mostly due to the modification of the workflows that imposed the usage of the application and the support from the top management.

In this sense, the case study shows that the management successfully overcame the negative factors at the implementation level that could potentially lead to a low users’ acceptance of the new software.

6.2 Autonome Provinz of Bozen-Bolzano (PROBZ)
As in the previous case study, the introduction of OpenOffice.org was made in parallel with the old application: we analyze positive and negative factors for the initiation and the implementation phase (Table V).
The introduction of FLOSS was unsuccessful on a large scale as it did not bring enough users to appreciate and use the new technology (Figure 5). The boxplots show the distribution of users in terms of average documents used during the period and average time dedicated to the application. We can see a limited usage, both in terms of number of users that adopted the software, and in terms of the distribution of activity. A comparison with SGV case shows that in PROBZ the final usage levels were largely inferior (\(\bar{x} = 3.26\) and \(\sigma = 1.48\) versus \(\bar{x} = 12.66\) and \(\sigma = 7.09\)).

Mostly, the initial installation of the application has been done in response to the need to interoperate with other administrations. Apart from an initial support by the management, the users were not pushed to adopt the new technology by means of further actions such as informative meetings, or training sessions.

In the initiation phase, also in this case study we found the importance of the management to start the adoption process. While in the previous case study the impulse of adoption came directly from part of the management that took a championing role, in this case study the adoption decision came from the need to interoperate with external organizations during the exchange of information. Managers interviewed on this aspect, confirmed that this was the main reason to start the whole adoption process. Also in this organization, the availability of resources for the adoption process was consistent, but not considered by managers as a discriminating factor to start the process.

Competitive pressure, governmental rules, interconnectedness of the organizational units, and formalization were sort of barriers to the initial impulse towards the initiation of the adoption process. Also in this case study, managers considered governmental rules a strong facilitator to drive the adoption process, but they recognized that in the case study this was not a factor that gave the impulse for the adoption process.

In the implementation phase, we can get the importance of three factors that were sort of inhibitors in this case study: support, organizational objectives consensus, training, and business process reengineering. The initial support given to users was reduced during the course of the migration, furthermore there was no real involvement of users about the reasons of introduction of the technology. Where this has been done results have been more encouraging (Rossi et al., 2006). Training has been performed not convincingly and targeting a limited subset of users, due to the resources needed and the limited impulse towards change of the management. Interviews with users and managers confirmed that, indeed, training is considered by both as fundamental to increase the acceptance of the technology. Especially when dealing with large number of employees, it is easier to focus on other aspects of the migration, like customization of the installation, communication to stakeholders, leaving aside training.

We must also consider that in this case study the impulse for the initial migration came from the environment – the need to be aligned with other public institutions that were pushing for the introduction of the new technology. Furthermore, the introduction of FLOSS in this case was not a complete failure: there were many indirect benefits, like a large deployment of the customized software for office automation on all clients of the public organization, an initial evaluation of the benefits of the technology, and an evaluation of the IT department about the opportunities of customization that increased their competences for future further migrations. The next section discusses in more detail the findings that can derived from Tables IV-V, and Figure 4 by comparing the results from the two case studies.
7. Discussion

When we applied our framework to two real case studies, we aimed at understanding the most relevant factors as perceived by the managers and users. We also wanted to determine the factor effect on the adoption itself, as inhibitor or facilitator. The instantiation of the framework in each case study has defined a model of adoption in the corresponding organization. The two models have been discussed in the previous sections, illustrated in Table IV-V, and compared in Figure 4. In particular, we found that the majority of the factors are equally classified as inhibitors of facilitators in the two case studies (Figure 4). This is certainly due to the similar context (same geographic region and social environment and same economic sector) the organizations share. The interpretation of the factors in the adoption process might slightly vary (e.g. “Attitude toward change”), though. The minority of the factors that are classified differently in the two organizations is the real novelty and can be associated to the success of the adoption. In particular, in SGV case study, in which the FLOSS implementation succeeded, training, organizational objective consensus, and business process re-engineering were relevant factors compared to PROBZ case study. As such, we can hypothesize that training, consensus and process re-engineering are crucial activities that drive the success of FLOSS adoption. Note that some of the factors are very specific of FLOSS adoption. For example, organizational objective consensus is a factor specifically related to the adoption of FLOSS as FLOSS is not new software, but rather innovation as a new process of distribution and access to the technology (Fitzgerald et al., 2011). Users might perceive no gain and benefit in migrating to the same type of technology. In this sense, consensus might have no relevance in other type of adoption. It is worth noticing that the top most relevant factors both in initiation and implementation phase do not affect the success of the adoption. The most critical factor that impair the success of a migration seems to be business process reengineering.

In the following, we respond to our primary research question with the findings of the previous sections.

RQ. What are relevant factors for a successful introduction of FLOSS at different phases of adoption in a public organization?

According to the perception of the management, some factors are more important than others. Specifically, managers perceive relevant three factors: governmental rules that push towards the introduction of FLOSS, the attitude towards change of the management, and the size of the public organization as larger organizations will have fewer barriers for the introduction of FLOSS (Fichman and Kemerer, 1997). The relevance of size effect can be related to the fact that size is, in fact, a proxy for other factors, like available resources for initiating an adoption process. Interesting, in this sense, is that for managers the availability of unutilized internal resources (organizational slack) is considered the least important factor for the initiation phase. This finding is opposite to the one reported in (Dedrick and West, 2004; Swanson, 1994) for which this factor cannot be underestimated. They state:

The relevance and impacts of slack resources in technology adoption has been a source of contention in the literature. While slack is argued to provide the room needed for experimentation, it is also argued that too much slack can reduce discipline and lead to investment in pet projects with limited economic value (Swanson, 1994). The interesting point in our findings is the fact that slack can take different forms (financial versus human resources) with different impacts.
The result of reduced discipline in the investment of slack resources can be peculiar to the public sector, though, as the need to invest in experimentation is not always perceived important. If we look at the findings from the users, instead, this factor is even considered a positive aspect of FLOSS adoption as resources are made available for any extra effort needed to the introduction of the technology.

Analyzing the implementation in the case studies, no governmental influence was found relevant to start the adoption process. This was not in line with the prioritization of the factors made by managers that considered the impulse of governmental directives and rules of paramount importance for the introduction of FLOSS. Our interpretation is that governmental rules are important to start the process of adoption, and the management perceives them as important in the context of public administrations. In the case studies examined, the importance de facto is more limited than expected. An explanation is that impulse is important to start the process of adoption, once such process has started, other factors become more important. This is also the main difference with organizations in the private sector: the process of initiation is more complex in the public sector due to larger external inputs that are needed to begin the whole process – mostly governmental rules. Successively, factors of impact during the implementation phases are similar to organizations that face the introduction of FLOSS: technological, and organizational issues. This results is conformant to the consideration of Hahn (2002) that a neutral government that should not impose constraints on the adoption of a certain software typology, letting the impulse come from the stakeholders, or to take into account the long term interests from the society point of view (Lee, 2006). However, managers interviewed do not agree with the view and would like a more proactive governmental impulse.

Similar to Morgan and Finnegan (2010), according to the management’s perception the compatibility of the software to be introduced is relevant, and in our case it is even considered the most important implementation factor. Furthermore, organizational factors were perceived as more important during the implementation phase rather than the initiation phase. In this sense, we found as in Morgan and Finnegan (2010) the importance of top management support during the phases of the implementation process.

The analysis of the case studies data suggests that centralization, organizational slack, size, organizational complexity, attitude towards change as the most positive factors at the initial phase in both the organizations. There is a slightly different interpretation of the factors though. The organization that also completed the implementation phase had a management more prone to changes and to championing FLOSS at the initial phase. The same organization considered the FLOSS migration an opportunity to reengineer its business processes, automating tasks when possible to allow a more transparent addition of the software inside the organization. Like in Huysmans et al. (2008), we found the importance of considering the characteristics of the organization during the implementation phase of FLOSS. This emerges by comparing the two case studies (Figure 4): both organizations operate in the context of a similar external environment, and governmental directives. The differences are largely in the internal organizational support to the implementation phase of FLOSS. In one case, there were no further actions to push the introduction of the new technology, the adoption was merely left to the own willingness of the users. This finding is consistent with the importance of a championing for the introduction of FLOSS in the public administration, according to Glynn et al. (2005): “In terms of individual factors,
the importance of support for OSS ideology and the existence of an OSS champion were rated as most important. Again, as already mentioned this factor relates well to the availability of OSS-literate personnel”. We found full confirmation of this finding in our case studies.

8. Limitations
In this article, we did not investigate the factors of impact to infer the causality in their relationships. Investigation of the causalities among factors implies building a richer framework and investigating the different hypothesis of correlation and influences between factors. We limited the analysis to the impact of the factors in the single case studies.

About construct validity, we hampered possible concerns about the selection of the outcome variable by means of the collection of evidence from multiple data sources, for example by using questionnaires and interviews, reviewing discrepancies, and contacting again participants. In cases where this was not possible, a single source of evidence was used. After the data collection from the management by means of questionnaires, the framework’s prioritization has been briefly discussed with them, together with the instantiation of the framework.

For internal validity, the fact that no causal claims among the factors were made, reduced biases in this category, in particular confounding threats, in which changes to dependent variables can be due to another variable not under investigation. Still, we are particularly subject to threats related to the instruments used for data collection and involvement of researchers in the case studies. About the instruments, we submitted the questionnaires electronically to avoid any influence of the submitters onto the answers of participants and managers. When direct observations were involved, like when determining the success of the different case studies by means of a software agent, we postponed the time-window of analysis of several months to reduce Hawthorne effect. Users knew they were monitored, but the longer time should have reduced the possible bias of changing the type of activity due to the ongoing monitoring process. Due to the qualitative nature of the research methodology, we are particularly subject to experimenter bias. We believe that sample selection bias, and procedural bias were limited. The protocol of the case studies was replicated with the aid of the IT workers of the organizations without any aim to prove or disprove the successfulness of the adoption. The usage of a multiple case study design with a theoretical replication (Yin, 2003), in which the contrasts of the different results from the case studies serve to ground and refine theory and strengthen the findings hampered this problem. The two case studies were selected among several that were performed, as such researchers had no reason to report the successfulness of a particular case study. More severe concerns are about measurement biases due to the qualitative nature of the factors’ measurement. Given the aforementioned considerations about the instruments, we additionally hampered this threat by letting each author review the material separately.

For external validity, the context of the Italian Public administration must be taken into account. The specific FLOSS used has been OpenOffice.org, and the results have to be considered under the light of this decision. Other type of software can lead to different kind of findings, although we believe that for similar typology of software the results in the case studies would have been equivalent. Results cannot be comparable in cases of software that requires more radical changes, as an operating system.
9. Conclusions
The introduction of FLOSS, although some undisputed advantages, is still problematic as FLOSS adoption reflects both the exogenous complexity of introducing a technology and the endogenous complexity of disruptive innovation.

To understand the impact of this complexity, we decided to create a framework that evaluated factors influencing FLOSS adoption to have a greater control on what determines the success of the adoption and use of a technology. We based our framework on the major frameworks of the theory of diffusion of innovation (Bradford and Florin, 2003; Dedrick and West, 2004; Rogers, 1995; Cooper and Zmud, 1990), on literature review, and management prioritization following Eisenhardt (1989) steps. We contributed to this theory identifying factors by the two phases of the adoption process, initiation and implementation, and the levels of adoption, individual, technological, organizational, and environmental (Rogers, 1995; Jones and Gallivan, 2007; Fitzgerald et al., 2011). We discussed factors in the specific case of FLOSS introduction in public administrations refining the framework to capture all the aspects relevant in our context. We submitted the list of factors to domain experts to define the priorities of the factors. The result is a mapping between phases and levels through factors prioritized and perceived by managers and/or users. The application of the framework to two real case studies produced two models of FLOSS adoption that we compared. We measured the success of an adoption phase with its completion and with the level of assimilation and use of FLOSS.

The comparison between the models allows to understand which factors can be involved in the success or failure of the adoption and which factors are in fact perceived relevant by managers and/or users. From our study, we can draw some recommendations to managers and users that aim at migrating to FLOSS:

• The cause of the success of a migration process need to be searched among factors at the implementation phase.
• Managers and users perceive benefits and shortcomings of a FLOSS migration differently.
• The failure of a migration may be better caused by organizational and individual aspects.
• The causes of failure or success might not be the ones perceived as most relevant by managers at the beginning of a migration.
• Managers should not underestimate the effect of training and users the effect of individual consensus. Furthermore, a well-defined strategy of training can avoid adverse attitude and motivate users and reaching users’ consensus to speed up migration.
• In addition, reaching consensus is a specific activity that needs to be performed in a migration to FLOSS products as it is not the product that changes rather the way the product can be manipulated and maintained.

The application of the framework to case studies by means of a contrasting result logic, provided the way to evaluate the more important factors for FLOSS adoption in public organizations, by evaluating the peculiarities of FLOSS as a disruptive technological innovation. On one side, the framework allowed to see the differences among managers' perception of the importance of factors and the relevance of factors in the
case studies. On the other side, the discrepancies among the two case studies. In the case studies, it also allowed to evaluate how a comparable initiation phase cannot be sufficient to reach the final adoption, other inhibiting factors can play their role to hinder the whole adoption process.

References


Further reading


Adoption of FLOSS in public organizations

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