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Exploring the Interplay Between FLOSS Adoption and Organizational Innovation

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Abstract:

Growing research on Free/Libre Open Source Software (FLOSS) has addressed a variety of questions focusing on aspects ranging from open source development processes and developer motivation, to economic and policy-making implications. Nevertheless, a few authors have examined the adoption of FLOSS and its impact on organizational change and innovation. Adoption studies represent a particularly promising area for information system researchers to investigate the relationship between the specific properties of FLOSS and the processes of implementation and use. The goal of this article is to contribute to this field of research by discussing a former multi-targeted research agenda and by defining an empirically grounded framework for studying FLOSS adoption, drawing on the outcomes of an exploratory multiple case study involving sixteen Italian public administrations.

Keywords: FLOSS adoption, organizational innovation, multiple case study, public sector

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I. INTRODUCTION

Free/Libre Open Source Software is increasingly disseminated, both across individual user's computers and organizations' infrastructures (servers and desktops). FLOSS is a multifaceted domain as it involves very different products (a server operating system, a desktop productivity tool, or even a large enterprise application), which are produced by very diverse sources (individuals, communities of volunteers, small and large software houses) and are distributed under various licensing agreements.

Compared to proprietary software, FLOSS may introduce some interesting peculiarities all along its lifecycle, from the choice of some individuals to develop new software, to the decision of a large organizations to use software distributed under an open license. Moreover, FLOSS introduces both social themes (i.e., the roles of both the community of developers and of the users), and economic and policy-making issues (i.e., estimates of real cost and license management).

Growing research on FLOSS has addressed a variety of questions focusing on aspects ranging from open source development processes [Feller, 2001; Scacchi et al., 2006] and developer motivation [Hann et al., 2004] to economic and policy-making implications [Méndez-Durón, 2009]. Because the new domain was so large and diversified, at least two research agendas were proposed in order to investigate it: Feller and Fitzgerald's [2000] proposal was more focused on development processes, while Niederman et al. [2006a and 2006b] faced a wider scope drawing a more detailed agenda.

However, few authors have examined the adoption of FLOSS and its impact on organizational change and innovation. For example, by querying the academic journals listed in the Business Source Premier database with the following keywords in the "author-supplied abstract" field: "open source" AND "adoption," "open source" AND "implementation," "open source" AND "development," "open source" AND "business," and "open source" AND "innovation," the following results were displayed: 38, 106, 382, 104, and 85 respectively, from a total of 1.119 papers in which the term "open source" is in the abstract (search performed on 27 November 2010). This suggests a prevalence of contributions focused on the level of open source communities and devoted to their economic, developmental and strategic aspects. In their case study on FLOSS implementation in a large Irish hospital, Fitzgerald and Kenny [2003] claimed that was very little research on the deployment of OSS systems within organizations.

FLOSS has several relationships with both the social and the technical aspects of an organization and even seems to have some influence on the structure of an organization. The diversity of the emerging constructs, in terms of analysis level and facets variety, defines a complex scenario with which to deal. In such a context, this study takes the wide scope framework proposed by Niederman et al. [2006a and 2006b] as a reference model.

We have identified the public sector as a major growth area for FLOSS and have focused our examination of its adoption in this area. In this way we can examine in detail the degree to which the Niederman et al. framework provides structure for understanding FLOSS projects as they are adopted in practice.

Although Public Administration (PA) represents a subset of all organizational forms that can use FLOSS as an alternative to proprietary software, we have chosen this domain for the following reasons: (1) FLOSS is an important and growing component in the range of software alternatives used by government agencies; (2) public agencies typically have some additional complexity relative to privately owned organizations in terms of multiple stakeholders, limited resources, and legal regulations that would logically add constraints to selection of software and provide rigorous challenging of accepted views of software adoption; and (3) access to systems that in the private sector might be considered strategic and less likely to be available for research scrutiny. Change represents a big issue for public agencies increasingly involved in e-government projects. New approaches are emerging for the definition of strategies and for managing change in the e-government domain [Nasim and Sushil, 2010]. The relevance of FLOSS within this context is evidenced by the growing number of nations which are considering its adoption for developing governmental Information Systems [Haider and Koronios, 2008].

The term *adoption* in this article refers to the process of software operation within an organization, starting from software selection, to its installation and configuration on computers (implementation) and finally its use. FLOSS adoption may cause the development of new relationships with IT (Information Technologies) companies and

research institutions, or even affect the internal processes, depending on the typology of products/projects and on the use that organizations assign to these technologies.

An internal view of FLOSS adoption can, therefore, lead to achieving a better understanding of problems concerning organizational change and to develop new theories, which could link the social sphere and the artificial world of human artifacts [Gregor, 2006]. Thus, in the case of FLOSS, adoption studies represent a particularly promising area for research in the Information Systems (IS) field. To achieve this goal, we based our exploratory study on a framework derived from the IS evaluation research stream [Smithson and Hirschheim, 1998].

The overall objective of this empirical research is to better understand the relationship (if any) between organizational change and the new approaches to software development and delivery. In particular, we aim to investigate if, why, and how open source software can foster organizational change and innovation in Public Administrations. This will be achieved through the analysis of current adoption projects. The present article aims to contribute to this field of research by defining an empirically grounded taxonomy, which can be used to classify FLOSS adoption initiatives, and by defining a series of research propositions to be further investigated in order to better understand these phenomena. We also propose to associate a set of IS theories to these propositions in order to provide a starting point for fostering research in this area. This is to be done by means of exploratory research based on a nationwide multiple case study involving sixteen Italian PAs that have recently undertaken one or more FLOSS initiatives.

The article is structured as follows: first, a description of the context in which the initiatives are carried out by the Italian government and institutions which make use of FLOSS is introduced. Then, the theoretical framework and the research strategy are described. Third, an overview of the case analysis will be provided, by classifying each case along the five dimensions which have been identified. Finally, we discuss the findings of the research, highlighting the route for further investigation by linking a set of research propositions with theoretical assumptions.

II. THE CONTEXT OF FLOSS IN THE PUBLIC SECTOR

The expression *Open Source Software* is used as a label applied to very different products in different contexts: a utility, an operating system, an individual productivity software, an application package, or even a development tool. It includes both small products for individuals, and larger ones for companies. Each product, which can remain in its initial version or can mature into improved versions, may be released by an individual developer, a community of volunteers, a small software house, a multinational company, and also by the organization that requested its development.

The unifying characteristic in such a broad variety is that the source code of all these products is released to become available to anyone who wants to use or modify it. When releasing the source code, the developer can choose among several licenses, which can give more or less relevance to the safeguarding of the freedoms for the acquisition, use, distribution, and modification of the software [Niederman et al., 2006a].

The acronym FLOSS stands for Free/Libre Open Source Software, which is a really broad definition, though largely adopted today, includes all the nonproprietary software, while leaving aside the applied license. We adopt this term in the present work with this extensive meaning.

Over the past decade, governmental organizations have demonstrated an increasing interest in the open source phenomenon. In Europe a seminal study was conducted in 2002 [FLOSS, 2002]. One of the reports issued specifically addressed the theme of “Open Source Software in the Public Sector: Policy within the European Union.” In this report, the analysts started from the distinctive characteristics of a public administration with respect to private companies and have identified four major motivations for considering both policy directives toward, as well as the concrete implementation of, open source software: dependency, cost, security, and transparency.

Further studies and non-scholar contributions at the national level have enlarged the scope of the impact of FLOSS. For instance, in Italy two additional aspects emerged from the first official study on FLOSS which was commissioned by the government [Rapporto OS, 2003]. First, an expected positive impact on the market of local SMEs (Small and Medium Enterprises), providing IT services to public administrations. Second, the potential impact in simplifying public procurement processes of IT systems and removing legal and organizational obstacles to the reuse of software solutions.

In fact, the possibility to easily adopt new software tools in terms of procurement processes and implementation costs may have an impact on IT department work practices, by potentially influencing all the IT project lifecycle

phases. Moreover, the availability of a large variety of software solutions supports the innovation of both internal processes and external services, allowing the easy implementation and testing of new software solutions.

However, the scope of FLOSS initiatives is wide enough to make it unclear whether this is true and under which conditions, when considering all the possible uses of open source in public administrations. In fact, FLOSS can be adopted at different levels, starting from the implementation of system infrastructures (i.e., operating systems, database management systems, etc.) to the deployment of customized applications. It can also influence inter-organizational relationships through the setup of novel business models. Each of these situations can contribute to increase the understanding of the complex relationship between these technologies and the organizational settings within which implementation takes place. Therefore, the possibility to compare cases which are different in terms of goals and units of analysis still represents an issue in this domain.

The relevance of these topics, together with our belief in the role that information systems research can play for better understanding the FLOSS phenomenon within public administrations, gives rise to this exploratory study.

III. THE RESEARCH STRATEGY

Relationships between open source software and organizational change can be revealed by focusing on the software selection process, on the implementation of IS in the organization, and on its subsequent method of use. Therefore, taking into account the lack of research on these phases of open source software projects, we concentrated our efforts on defining a taxonomy coherent with the nature of this study. In our view, in fact, this work belongs to the first level (Analysis) of the five theory types classified by Gregor [2006], the main aim of which is to analyze and give order to a domain that is still somewhat new. In such a case, a taxonomy is worthy for aiding both the understanding of the phenomena and the interpretation of their occurrence [Gregor, 2006].

We also identified, for each category in the taxonomy, a set of research propositions which, together with the same taxonomy, should support the construction of theories of other levels among those proposed by Gregor [2006]: Explanation, Prediction, Explanation and Prediction, Design and Action.

The proposed taxonomy tries to draw up the main FLOSS project typologies, their related motivations, and implementation methods. The research propositions aim to highlight a set of relevant aspects in the field of organizational change through FLOSS.

Our general assumption is that a cross relationship links FLOSS and organizational innovation (OI). In fact, FLOSS itself can be viewed both as an innovation being adopted and as a mechanism that drives or triggers organizational change following adoption. The research strategy presented in this section aims to provide some empirical evidence to support this assumption. With this objective in mind, we must first clarify through the proposed taxonomy that FLOSS assumes several forms, depending on the actors involved, on the expected benefits and on the application scope. Second, for each FLOSS category, we show that there is a set of possible implications with their related preconditions that also deserve further analysis.

Theoretical Framework

Our interest in this article is to investigate the dynamics of FLOSS adoption in public administrations in order to understand how it can drive and trigger organizational change and innovation. On the one hand, the scope of our research question is broader than the central question of studies on IT innovation adoption/diffusion [DeLone and McLean, 2003], whose main goal is to address the question of why some organizations adopt innovations earlier and more extensively than others. On the other hand, we focus on a collection of FLOSS initiatives with specific characteristics which ask for thorough analysis. In fact, these different FLOSS initiatives can be both the cause or effect of organizational change and innovation.

Such cues led us to take, as a starting point of our research, the more detailed theoretical framework developed by Niederman et al. [2006a and 2006b]. This is a broad multilevel framework (see Table 1), based on an extensive literature review and conceived with the intention to provide IS scholars with a lens through which they can examine most of the phenomena involving open source. This framework is based on five levels of analysis: the artifact, the individual, the group/project/community, the organization, and the broader societal perspective. For each of the five levels, the authors have defined variables claiming that the most interesting research questions will involve relationships that cross such levels.

It must be noticed that the crucial construct “Artifact type” was classified by Niederman et al. [2006a] following the threefold taxonomy by Madanmohan and De [2004]: infrastructure software (operating systems, middleware,

Table 1: Open Source Variables by Level of Analysis [adapted from Niederman et al., 2006a]		
IS levels of analysis	Variables	Sample items
Artifact (A)	• Artifact type • License type • Quality of product	• Infrastructure, package, application, cross-functional application • GNU GPL, BSD, etc. • Security, reliability
Individual (B)	• Developer • User	• Salaried/unsalaried employees, volunteers • Non-developer users/ non-using developers • Motivation, job satisfaction, productivity, etc.
Group, project, community (C)	• Organization governance • Mechanics for artifact creation and exploitation	• Participation, satisfaction, conflicts • Control/trust • Development methods and tools, communication style, exploitation methods
Organization (D)	• Developer • Distributor • Users	• Economic benefit/loss • Selection methods • Dependence on outside vendor or supplier • Training and staff skills • Open source/market and hierarchy
Society (E)	• Influence on society	• Cross-national outsourcing • Privacy and security • Local economic development

database management systems), software tools (spreadsheets, word processor, etc.), and application software (packages and cross-functional software, like CRM and ERP).

The research agenda by Niederman et al. [2006a] is organized by crossing pairs of the five levels of analysis and by identifying the more interesting relationships for each pair and the related research questions. The significant relationships found by the authors occur between the six following pairs: Artifact—Individual; Artifact—Group, project, community; Artifact—Organization; Artifact—Society; Individual—Group, project, community; Group, project, community—Organization. In a second article, Niederman et al. [2006b] identify seven theories suitable to be applied in research on open source domain.

As stated by the same authors, their notable research agenda, even though wide-scoped and multifaceted, might not be exhaustive and might lack some points of observation, as well as some components. In fact, the above mentioned framework provided a starting point to which our empirical findings have both added support and some more detailed content. Thus, in addition to the main goal of the research, which is primarily to learn more about FLOSS adoption and organizational innovation, we also had the opportunity to "test" the usefulness and applicability of such literature-based framework to FLOSS adoption studies.

The character of the present research was then exploratory, and a common method for structuring the data collection phase and for performing the analysis was required from the first phases of the project. Such a method had to be generic enough to be applicable to a wide range of contexts, but also sufficiently detailed to provide effective guidance. Thus, to create order in the large and heterogeneous set of FLOSS adoptions, we decided to handle cases as if they were projects under evaluation. This choice allows us to refer to the vast body of literature on Information Systems evaluation which focuses on the methods for the assessment or appraisal of the value, worth, or usefulness of an Information System.

According with the framework proposed by Smithson and Hirschheim [1998], evaluation methods can be classified in three zones along a dimension based on their underlying assumptions. The first zone, efficiency, is characterized by fairly objective/rational assumptions regarding the nature of evaluation. Thus operational performance and quality evaluation fall in this area. In the second zone, effectiveness, evaluation is concerned with "doing the right thing" and embraces methods for cost-benefit analysis, comparison with objectives and user satisfaction studies. The third zone, understanding, recognizes that an organization typically uses a wide range of IS with different functions and includes methods for performing the evaluation within the particular organizational context. Since the understanding zone is more suitable with respect to the objectives of the present study, we referred to those methods claiming that the evaluation process should take into account both the social and technical entities that an organization is confronted with when adopting IT [Smithson and Hirschheim, 1998; Symons, 1991; Walsham, 1993]. In accordance with this view, we decided to borrow, from this body of research, the Context, Content, and Process (CCP)

evaluation method, which was originally proposed by Pettigrew [1985] and recently revised [Stockdale and Standing, 2006; Stockdale et al., 2008].

The use of the CCP method allows us to approach our overall objective, by treating the differences in terms of type and focus of the initiative (content). It also allows us to identify the unit of analysis and the rationale that lies behind the decision to implement it (context), and finally to provide evidence of cues and hints (process) for each case. In this manner, it was possible to structure the interviews by asking questions about what (content) has been investigated, by whom and why it has been implemented (context), and how the organizational change was managed (process). Table 2 summarizes the outline of the case study interviews which were to be put forward in each case to the person in charge of managing the FLOSS adoption project. Following this phase, a set of telephone interviews were carried out to clarify the research scope and objectives.

Table 2: Summary of Case Study Questions

Context (why, who)	To describe the organizational context within which the open source adoption project has been carried out in terms of: • expected tangible/intangible benefits (i.e., efficiency, reengineering, effectiveness, etc.) • methods, metrics, and parameters eventually used for carrying on the ex-ante evaluation (if any) • innovative aspects of the project • identification and description of the organizational unit and individual subjects involved in the project, together with their roles and competences both on the demand and supply side
Content (what)	To summarize the project subject by identifying: • the level of intervention (i.e., infrastructure, process, methodology, etc.) • the dimension and typology of target users (i.e., number of users, target organizational unit, role, competences, etc.) • the overall picture of the project (i.e., architecture, process, etc.)
Process (how)	To clarify how the open source software has been introduced into the project with respect to: • the project plan, in order to identify the project phase in which the decision to adopt this solution has been taken • the single activities, in order to understand the implication of this phenomenon on the people involved at different levels (i.e., users, developers, IT managers) in these projects

Methodological Approach

Several aspects motivated our choice of a case study approach over other research methods. First, evidence from known experience suggested that the boundaries between the phenomenon under investigation and the context were not clearly readable. In fact, in some cases, FLOSS represented an approach for the development of new IT artifacts, whereas, in other cases it was a characteristic of the artifact itself. Second, the investigations refer to contemporary phenomena, in depth and within their real-life context, that have no clear, single set of outcomes. Finally, some preliminary findings suggested that there are many more variables of interest than data point highlights and that multiple sources of evidence were often available.

Under this premise, and in accordance with Yin [2009, p. 9], the nature of the research question together with the focus on contemporary events justify the choice of the case study as a research method. Nevertheless, the wide spectrum of interrelated constructs and the exploratory nature of the study complicate the definition of theoretical propositions to guide data collection and analysis. Therefore, in order to avoid the situation in which evidence did not address the initial research question, we devoted substantial effort to the design phase of a multiple case study. This was with the purpose of distinguishing different categories of FLOSS adoption initiatives through which theoretical propositions can be defined and classified.

The overall research design corresponds to what is referred in the research as a *holistic multiple case* [Yin, 2009, p. 46] with the purpose of setting up the basis for carrying on further embedded multiple case studies, where the propositions of each category will be tested. In fact, the evidence from multiple cases is often considered more compelling, and the overall study is, therefore, regarded as being more robust [Herriott and Firestone, 1983]. Moreover, the results of this preliminary research will establish the basis for the development of a rich theoretical framework and for the application of rigorous replication procedures. In this way, the theoretical framework states the conditions under which a particular phenomenon is or is not likely to be found.

The Case Study Protocol

In 2003, a specific Commission was established by the Italian Ministry of Technology and Innovation in order to investigate the opportunities offered by FLOSS adoption in the public sector. The results of the analysis carried out

by a group of a dozen experts consisting of scholars, industry, and independent consultants, have been summarized in an official document which provides a FLOSS classification. It also traces a number of issues, guidelines, and recommendations addressed to public managers and politicians [Rapporto OS, 2003].

In 2003 a national program to monitor open source initiatives was established. Its aim was to collect and disseminate knowledge and best practice on open source projects, as well as fostering the possibility of reusing software modules among public administrations. Moreover, from a legislative standpoint, in 2005 new rules were introduced affecting the public procurement processes for software and IT services [CAD, 2005].

Following these initiatives, a number of workshops were organized by nonprofit associations, universities, and communities of experts. They were organized in order to provide different stakeholders, such as institutions, IT companies, SMEs, public managers, independent consultants, and scholars, the opportunity to exchange their views about the state-of-the-art, to collect suggestions for exploiting positive effects and for reducing the risks associated with FLOSS adoption.

In order to provide an answer to the general study question, we started by collecting: (1) information and documentation available on the institutional websites of centralized governmental bodies (e.g., CNIPA—National Agency for Informatics in Public Administration, Ministry of Technology and Innovation, etc.). We also collected: (2) information through direct contact with special interest groups of Italian nonprofit associations (i.e., AICA—Association of Informatics Professionals, Concreta-mente) and scholars (e.g., itAIS—Italian Association for Information Systems, etc.). By means of this set of sources, we collected a wide array of official documents useful for understanding the state-of-the-art of policies, best practice, and previous studies in the domain of FLOSS for public administrations.

The previously mentioned Rapporto OS [2003] and the portal of the CNIPA Observatory on Open Source software for Public Administrations (www.osspa.cnipa.it) provide examples of such elements. The latter represented an entry point for getting in contact with a wide range of PAs and for starting the case selection phase. Among the numerous cases of FLOSS adoption (for instance, about 170 cases are briefly presented on the CNIPA Observatory website), we have further investigated a set of sixteen initiatives which were submitted and presented by public managers during a meeting devoted to FLOSS adoption in the Public Sector. These were both more meaningful with respect to our research question and easier to access for further evidence collection. The ample diversity visible at a glance among the context and the content of these cases reinforced our choice of the protocol adopted.

We must specify that the choice of analyzing sixteen cases does not imply any attempt to pursue some form of statistical generalization. In fact, for case study research, generalizations follow the analytic mode, according to which a previously developed theory is used as a template with which to compare the empirical results of the case study [Yin, 2009, p. 38]. Following this preliminary analysis, we organized a first round of telephone interviews with a key person from each organization. This was in order to clarify the objectives of our study and to collect further data according to a predefined schema that had been sent to them and will be presented in the next section.

Finally, the results of the analysis have been discussed with politicians, public managers, researchers, independent consultants, and project managers from private IT companies in the context of a public workshop followed by ten focused meetings. The practical implications and policy-making recommendations emerging from this work have also been collected in a report published under the Creative Commons license [OSPA, 2009].

IV. CASE DESCRIPTION

The preliminary analysis of data collected from the sixteen Italian public administration cases showed an evident heterogeneous nature of the cases in terms of unit of analysis, focus, and objectives, as can be seen in Table A-1 (Administrations under examination) and Table A-2 (Detailed specification of the sixteen cases analyzed) in the Appendix.

There are cases in which open source software has been used at a system level by implementing either a centralized or a distributed server infrastructure. Second, client application packages (i.e., office automation tools, specialized tools) have been introduced in public administrations with differences in terms of the number of users involved and the migration strategy applied. Third, some cases provide insight into the deployment and configuration of customized server side applications (i.e., content management systems) based on open source components. Fourth, a number of cases show the possible role of FLOSS when a business process management approach is adopted to increase the efficiency and effectiveness of internal processes through the development of new software modules based on open standards and frameworks. Finally, a set of cases provides examples of cooperation models through which FLOSS can be spread among public administrations.

In order to understand the organizational implications of FLOSS adoption we first envisaged the use the Niederman's framework together with the above mentioned artifact categories defined by Madanmohan and De [2004], namely infrastructure software, software tools, and application software. We then realized that, even though its dimensions cover a wider scope, this framework was inadequate to shed light on all the specific issues arising from our set of cases.

Hence, to correctly address the research, we concluded that a new, more focused taxonomy was needed in order to classify the phenomena under investigation and to deeply analyze the complex set of relationships among constructs belonging to different levels of analysis. In order to fulfill this need, we decided to start from the empirical data collected through our nationwide multiple-case study. In fact, within these sixteen Italian public administrations, that have recently carried out innovative projects based on FLOSS, the answers to the question "What kind of FLOSS related innovation has been adopted and/or implemented?" were varied in nature. In some cases FLOSS innovation was related to the adoption of system and/or application packages made available by a community of developers, whereas in other cases open frameworks and open standards were used to develop new modules. Also the actors involved in each case were different. In that, in some cases IT professionals are the key players, whereas in other cases it is the domain specialists or even actors external to the organizational boundaries.

Thus, following these considerations, we proceeded by mapping the sixteen cases using the above mentioned CCP framework. We decided to use the content ("what") of the adopted solution as a clustering factor, because it both involves the object of analysis (FLOSS) and presents major similarities among the projects.

Table 3 reports the so built-up map, where:

- the Content column groups the FLOSS solutions adopted
- the Context column shows the motivation of each choice
- the Process column illustrates the main actions performed
- the column Number of instances reports the number of observations for each row

Since some of the cases contain aspects related to more than one solution, we decided to separately analyze every specific aspect by referring it to the most appropriate content. For this reason, cases with multiple instances have been cited more than once, possibly in different solutions, resulting in a total number of twenty-three instances out of sixteen cases. A detailed description of each case, together with the specification of its unit of analysis, the single instances and the referred categories are provided in Table A-2 in the Appendix.

For each of the five FLOSS adoption categories introduced, it is possible to identify a set of organizational implications. These implications will be systematically introduced in the next section where the narrative on cases will clarify the links between the categories and the theoretical framework.

V. DISCUSSION OF FINDINGS

Far from being interested in the quantitative analysis of case distribution among the five groups, we claim that the presented classification represents a first attempt toward the definition of an empirically based taxonomy of FLOSS adoption initiatives. The variety in size and nature of the examined organizations, even though coming solely from the public sector, and the number of revealed instances, reinforce both the characteristics of completeness and exhaustiveness of this taxonomy [Gregor, 2006].

We decided to propose the five groups of contents already mentioned in Table 3, as the categories (dimensions) of the new taxonomy. Then, by analyzing the relationships, we observed that four out of five levels of analysis used by Niederman et al. [2006a] were applicable to our set of cases. The only exception is the Artifact dimension that appears too generic to represent the whole range of solutions. In fact, a number of constructs and items are intuitively interlinked with FLOSS at individual, team/group/community, organization, and society level.

In order to identify the relevant relationships for each category, we started once again from the map based on the CCP method, by adopting the following strategy:

- Each item in the Context column is an objective to be achieved which is relevant at a certain level of analysis (i.e., cost savings is relevant for the organization, incentives to the SMEs for the society).
- Each item in the Process column determines a class of actors involved in that action.

Table 3: Map of the Cases Through the CCP Framework			
Content *(what)*	Context *(why)*	Process *(how)*	Number of instances
Software infrastructure updating	• Nonfunctional aspects: performance, security and reliability • Cost savings	• Increasing technical skills of IT staff for software inspection and service management • Deploying grid sw solutions	3
Client application packages substitution	• Cost savings • Immediate availability • Interoperability • Management of software licenses	• Migration strategy • Training employees on the use of sw packages • Developing internal IT skills for sw maintenance	4
Server side applications adoption	• Cost savings • Immediate availability • Easier sw maintainability • Security • Independence from the sw vendor	• Developing internal IT skills for sw configuration • Participation of young professionals to innovative projects	2
Software development through open frameworks	• Dissemination and reuse of domain specific processes, frameworks, and methodologies • Fostering process innovation beyond the organizational and the national boundaries (BPM approach) • Flexibility and modularity allowing the development of sw tailored to domain specific practices and the reuse of processes • Reliability of scientific results obtained through mathematical models and simulation	• Teamwork and inter-organizational cooperation among domain experts and IT professionals • Definition and composition of new processes starting from practices instead of sw properties and existing domain specific standards • Reuse is not limited to sw modules but it involves also processes and methodologies • IT governance and alignment to organizational goals	10
Support to other PAs by means of open licenses or communities	• Incentives to the development of SMEs providing services to public administrations	• Assigning public funds to selected projects • Centralising the requirement analysis, design and development phase of sw projects • Creation of a community with members from public administrations, private SMEs and research centers	4

The resulting, interesting relationships for each category appear eventually by crossing each level with every actor reported in the same row. The emerging network of relationships derived from the empirical data encompasses multiple levels with respect to the dimensions of the Niederman et al. [2006a] framework. The outcome of such definition and classification process is summarized in the taxonomy showed in Table 4.

The above-mentioned relationships can be better explained and formulated by referring to organizational and Information System theories, as also suggested by Niederman et al. in their second paper [2006b]. To support further research, in the following sections we present a set of research propositions, drawn upon the empirical evidence from our cases. For each category of initiatives, we refer to the corresponding FLOSS adoption cases listed in Table A-2. A couple of propositions for each category are made, in order to introduce the interaction between organizational innovation and FLOSS in terms of drivers (why), actors involved (who), and process aspects (how).

We are conscious that some form of organizational change may come from the adoption of any type of software. Nevertheless, we want to investigate whether the nature of change may be different in case of FLOSS adoption. Thus, we discuss each proposition by referring to specific forms of organizational change which may be linked to FLOSS adoption. Detailing all the possible changes is outside the scope of the study, but may also represent a set of questions for future researchers.

Table 4: Taxonomy of FLOSS Adoption Initiatives in the Public Sector		
ID	Category	Cross level relationships
A	Software infrastructure updating	• Organization—Group
B	Client application packages substitution	• Organization—Group • Organization—Individual • Team/group/community—Individual
C	Server side applications adoption	• Organization—Team/group/community • Team/group/community—Individual
D	Sw development through open frameworks	• Organization—Team/group/community • Society—Organization • Organization—Individual
E	Support to other PAs by means of open licenses or communities	• Organization—Group • Society—Organization

Finally, we suggest a set of possible theories for explaining the phenomena under investigation. More specifically, the ultimate objective is to discover whether or not FLOSS has a specific role in fostering organizational change and innovation, or whether it has an interplay with them. The aim of a suggested theory is consequently that of providing guidance to plan and to manage further research, through the identification of elements to be considered, of the model of relationships among them, and the support of methodological hints.

We deliberately limit our discussion to a couple of propositions and some theories for each category, even if we know that they are far from being exhaustive. Our objective here is to demonstrate the richness and the variety of aspects involved in FLOSS adoption.

Another relevant aspect we consider in the subsequent discussion is that organizational innovation is either triggered or driven by FLOSS adoption while pursuing the above mentioned objectives (see Table 3). In fact, for each category of the taxonomy, FLOSS can either drive organizational change or it can be the outcome of some form of organizational innovation. In fact, in some of the observed cases FLOSS adoption has triggered new organizational practices at different levels (i.e., individual, group, community, organization, and society), whereas in some other cases the FLOSS adoption itself has been driven by innovative practices within the organizational contexts. The resulting dualism in the relationship between FLOSS adoption and organizational change calls for specific analysis. For evidencing the two possible directions of this relationship, we have selected for each category of the taxonomy as many propositions. Each proposition is derived from a subset of our cases and serves as a guide for discussing our findings.

By adopting this approach our aim is to contribute in the direction of new theoretical developments and to provide hints and suggestions for the management in charge of starting and governing organizational change through FLOSS adoption projects. Further research contributions, based either on these or other cases in similar contexts, will serve to this aim. This would help in the construction of theories belonging to other levels among those proposed by Gregor [2006], being that the present work is mainly referable to the first one (Analysis).

Software Infrastructure Updating (A)

From the analysis of empirical data in this category, it seems that nonfunctional aspects such as high performance, security and reliability represent the main drivers for implementing open source solutions at software infrastructure level (i.e., operating systems, network management software, database management systems, etc.). This confirms the conventional wisdom about the advantages of having an increasing number of open source solutions available, together with large communities of programmers and IT companies supporting their development and maintenance. The same reasons can also make their deployment preferable for running critical infrastructures based on innovative architectures (i.e., grid computing) as it emerges from the case of the Bank of Italy.

The elements emerging from the empirical settings suggest two propositions (among other possible ones), which should be further investigated (see Table 5).

Client Application Packages Substitution (B)

At the user level in the analyzed cases, experience of application package implementation are motivated by the immediate availability of the software solution and by the expected advantages in terms of cost savings, especially when a large number of users are involved (Bolzano Province). The recent versions of open source office automation suites offer users similar functionalities to commercial solutions and ensure a certain degree of

Table 5: Propositions for Category A	
A1:	*FLOSS solutions at infrastructure level drive the innovation of IT management practices toward forms of open collaboration*
Evidence	Cost savings related to software licenses allow PAs to invest their resources for updating the hardware infrastructure with enlarged storage and processing capabilities (Calabria Region) and for building disaster recovery sites (Bank of Italy). Evidence from the analysis of the Calabria Region case confirm that, when deployed at infrastructure level, FLOSS contributes to change the security management processes through a larger involvement of IT staff and a more collaborative approach among team members.
Suggested theories	This proposition may be explored by following the technology-organization-environment framework [Tornatzky and Fleischer, 1990], which considers some organizational aspects (like size, human resources, management), as well as internal technology and processes and the state-of-the-art of available technology. The technological innovation of an organization is influenced by every cited factor, which can represent a constraint or a trigger for innovation.
A2:	*IT staff innovative practices result in FLOSS adoption at the infrastructure level*
Evidence	The Bank of Italy case shows that contexts where new learning processes are activated involving IT staff members, by improving their capabilities in software inspection and service management, result in FLOSS adoption at the infrastructure level.
Suggested theories	This proposition can find explanation in the absorptive capacity theory [Cohen and Levinthal, 1990] whose main assumption is that innovation depends on prior related knowledge. In this case prior related knowledge of an open source community contributed to developing the capabilities of managing the IT infrastructure.

interoperability with other systems. However, for all the cases we encountered, an accurate Total Cost of Ownership (TCO) analysis which takes into consideration the migration costs (i.e., training, assistance, etc.) cannot ensure on its own the success of the migration process. In fact, the migration strategy definition (i.e., big bang, incremental, parallel), should take into account the socio-technical nature of the organization where aspects such as skills, culture, and employee motivation can determine the failure of a migration projects (Municipality of Calimera).

The suggested propositions for this category, see Table 6, take into account two specific pieces of evidence from the analysis.

Server Side Applications Adoption (C)

This category of cases refers to the implementation of open source application packages on the server side. Content management systems, workflows management systems, portals, groupware, CSCW, etc. are examples of applications that are chosen by IT departments of large PAs as well as by very small establishments (i.e., the Municipality of Calimera). Among the expected benefits, there are cost savings, an easy procurement process and also the support of large communities of users and developers ensuring software maintainability and security. At the same time, the adoption of the server side application is a way to import into an organization routines and processes already set by other organizations. The propositions drawn are showed in Table 7.

Software Development Through Open Frameworks (D)

Cases in this category offer the richest number of clues in respect to our research goals. In fact, by choosing to develop software using open frameworks, some public administrations demonstrate paying more attention to the dissemination and reuse of domain specific processes and methodologies than to limiting the re-use to the software package itself. In this way, their aim is to foster process innovation beyond both the organizational and the national boundaries and through the adoption of a business process management approach. Open source solutions have become the enabler of this innovation process by means of their flexibility and modularity characteristics.

The choice of Retecamere to adopt open source standards for the implementation of the integrated information and communication platform has allowed a bottom up approach in which local chambers of commerce can easily contribute, for instance by requesting the implementation of new functionalities. The case of the Bank of Italy, also shows that in certain contexts which are characterized by intensive problem solving tasks, the use of open source software for carrying out simulations and other experiments, can improve the reliability of scientific results.

The propositions, coming out the evidence in this category, are discussed in Table 8.

Table 6: Propositions for Category B	
B1:	*FLOSS client packages adoption has an impact on the organizational compliance*
Evidence	The case of Municipality of Naples shows that the correct management of software licenses (compliance) has been achieved through the large deployment of Open Office suites. Compliance issues are particularly relevant in a context characterized by a large number of clients and users. In fact, an assessment performed before the Open Office deployment demonstrated that the software in use on several clients was not covered by authorized licenses. However, the effects of FLOSS adoption are not trivial. In fact, as the Bolzano Province case has demonstrated, appropriate strategies should be put in place in order to govern the migration process and to get the software accepted by the users.
Suggested theories	The exploration of this proposition can start from the resource dependency theory [Tillquist et al., 2002], which states that an organization always seeks to decrease its dependence on other organizations, due to the resources that are decisive for it. At the same time, another theoretical contribution to explain the proposition comes from the large stream of IS success [DeLone and McLean, 2003]. In fact constructs such as performance expectancy, effort expectancy, social influence, and facilitating conditions are direct determinants of usage intention and behavior [Venkatesh et. al., 2003], while gender, age, and experience moderate this impact. Moreover, by analyzing the impact of FLOSS on factors such as voluntariness, relative advantage, compatibility, image, ease of use, result demonstrability, visibility, and trialability [Moore and Benbasat, 1991], it is also possible to understand the dynamics related to the diffusion of innovation at a firm level. A deeper understanding of the phenomenon summarized by the proposition has a direct impact on the development of effective migration strategies to which cognitive theories can also contribute [Sweller, 1988]
B2:	*The empowerment of specialized users encourages the choice of FLOSS tools*
Evidence	Another hint arising from cases of client package implementations refers to the Bank of Italy. Here, specialized employees, working in the analysis and research department on economics and financial metrics, have adopted open source packages for supporting their daily activities. In this case, FLOSS adoption comes from the direct choice of the specialized users who prefer to use open source for performing both common tasks (i.e., text editing) and highly specialized tasks (i.e., routines and functions to be integrated in simulation tools). The membership of these users to largest communities of practices (i.e., statisticians) makes them aware of the advantages in using FLOSS tools in terms of transparency and reliability of computational results.
Suggested theories	A possible theoretical perspective to ground proposition B2, results from the computer self-efficacy theory. This refers to the individuals' judgment of their capabilities to use computers in diverse situations [Marakas et al., 1998]

Support to Other PAs by Means of Open Licenses or Communities (E)

Finally, the cases of initiatives in the public sector for fostering the diffusion of open source provide insights into both the rationales for this choice and the mechanisms for implementing it. This makes PAs independent from a single software vendor, by allowing them to take advantage of local communities of developers supporting the open source project. Indeed, by spreading FLOSS adoption across the public sector, the politicians aim to stimulate the development of local Small and Medium Enterprises (SMEs) instead of contributing to the profits of foreign IT companies through the price of software licences. The first assumption here is about the relationship between FLOSS adoption in the public sector and the spreading of new forms of networked organizations.

The emerging propositions are presented in Table 9.

Outlines

Many pieces of empirical evidence arise from the analysis of this rich collection of cases. In fact several research suggestions may be derived according to the characteristics, the expected benefits and the actors involved in each type (category) of FLOSS adoption. We have chosen to present only two propositions, among the many possible, for each category of FLOSS adoption initiative, in order to show the dual role of FLOSS in its interplay with organizational innovation.

In Table 10 we summarize our propositions, evidencing the following elements which are potentially useful for conducting further investigations in this domain:

- Direction of the interplay between FLOSS and OI
- Levels of analysis to be considered

Table 7: Propositions for Category C	
C1:	*The re-use of open source server side applications allows the diffusion of good practices among organizations while preserving contextual elements*
Evidence	The possibility to adapt the internal processes to those embedded in software packages provides a further example of organizational innovation. Despite application packages in general are often thought to in some way "embed" best practices, FLOSS applications can be more easily adapted to the specific needs of an organizational context. This is the case of the editorial processes for publishing content on the http://www.FiscoOggi.it portal of the National Tax Agency which have been adapted to the Drupal features. When Drupal was selected as new content manager for the institutional website, its embedded routines changed the internal workflows while preserving their contextual properties. Further investigation on this aspect could benefit from the empirical analysis performed on specific open source projects, such as PloneGov (http://www.plonegov.org/), with their respective communities of users and developers.
Suggested theories	The institutional theory [Powell and Dimaggio, 1991] can provide a good point of view to investigate this proposition. This theory claims that institutions in terms of processes, structures, schemas, rules, norms, and routines are continuously (re)produced also by the means of mimetic forms of isomorphism. The adoption of open frameworks makes it easier transfer practices among organizations.
C2:	*The development of IT skills for software selection and configuration results in a greater chance to adopt FLOSS solutions*
Evidence	In the Municipality of Calimera (LE) the administrative office takes advantage of increased IT competences for performing a feasibility study on the renewal of server side applications which resulted in the opportunity of implementing open source applications (i.e., Zarafa, Funambol, Simple GroupWare, eGroupWare).
Suggested theories	Theoretical contributions to this proposition come from the theory of dynamic capabilities [Teece et al., 1997], which emphasizes the role of the "ability to integrate, build, and reconfigure internal and external competencies" in order to reach advanced innovation. In this case, the developed competencies promote the organizational capacity to acquire, assimilate, transform, and exploit new processes.

Regarding the former, it refers to the direction of the relationship between FLOSS adoption and some sort of organizational change, either planned or promoted. Choosing FLOSS may either have a role of precondition for organizational innovation, or it can be the outcome. However any possible causality in every proposition has to be proven by further research.

As for the Levels of analysis, they refer to the actors most involved in each proposition. They are coherent with those presented in the taxonomy of FLOSS adoption initiatives (Table 4), but not necessarily exhaustive.

VI. CONCLUSIONS

This article presents the results of an exploratory research performed on sixteen FLOSS adoption initiatives promoted by Italian public administrations, in order to achieve a better understanding of the relationship between FLOSS adoption and organizational innovation. The topic of organizational implications of FLOSS adoption does not find an appropriate coverage in IS literature. Using CCP as a method for structuring empirical evidence and taking into account the research agenda by Niederman et al. [2006a and 2006b] we built a new framework to analyse FLOSS adoption. This new framework includes a taxonomy and a set of propositions based on IS and organizational theories.

In fact, we argue that the Niederman et al. [2006a] framework presents some limitations when applied to the study of FLOSS adoption projects. A possible explanation can be related to the fact that such framework is based on a literature review on the FLOSS topic, where studies are more focused on other issues such as motivational, strategic, organizational, and economic aspects of open source communities.

It should be kept in mind that all data gathered in this project pertained to organizations in the public sector. The robustness of the enhanced proposed framework represented by specific propositions can be tested by gathering data in other organizational settings. Findings similar to ours would support the degree to which organizations have some universal responses to introduction of innovation, at least in the information technology arena. Different findings from those presented in this article can be expected to highlight differences in public and private sector approaches to innovation in general or software assimilation in particular.

Table 8: Propositions for Category D	
D1:	*The community approach embedded in FLOSS fosters knowledge sharing among domain experts*
Evidence	The Department for Archaeological Finds of the Valle d'Aosta region, with the aim of innovating the finds management process, promoted a project involving another six Italian and European Monuments Departments, in this way fostering the collaboration among multiple competencies. The development using FLOSS of a new IS in the virgin context of archaeological finds management, carried with it the community concept, which was adopted by experts of different domains/organizations. They then asked for a platform for continuous knowledge sharing between them and future new users.
Suggested theories	This proposition can be explored by using the organizational knowledge creation theory [Nonaka, 1994], which states that in an organization tacit and explicit knowledge is crossed by internal flows and interchanges, with four interaction forms: socialization, combination, internalization, and externalization. A valuable further step could be that of recalling the concept of "ba" [Nonaka and Konno, 1998], a specific space where knowledge creation processes may take place. This perspective has already been adopted by some scholars just in a study on the Valle d'Aosta region case [Braccini and Federici, 2010].
D2:	*Teamwork and inter-organizational cooperation among domain experts and IT staff encourages the development of open frameworks*
Evidence	In very specialized domains, commercial software packages do not effectively support the existing practices within the PAs and across their organizational boundaries. For example, archaeologists from Valle d'Aosta Region and analysts from the Bank of Italy and ISTAT have demonstrated the advantages of collaborating with IT professionals in order to develop software which is tailored to their specific domain practices. In all these cases, FLOSS adoption choices emerge from contexts where IT skills are deliberately mixed with domain specific competences.
Suggested theories	This proposition suggests looking at open frameworks such as social systems emerging from the interaction of groups. In this case, the adaptive structuration theory [De Sanctis et al., 1994], which was also proposed by Niederman et al. in their research agenda [2006b], underlines the links among decision outcomes (efficiency, quality, consensus, commitment), new social structures (rules, resources) with the structure of advanced information technology (structural features, spirit), and other sources of structure (task, organizational environment), within the group's internal system.

In greater detail, both the categories and the relationships exposed in the taxonomy do not seem to be so influenced by the public nature of the organizations studied. For this reason, the taxonomy could also be suitable for other organizations. Similar considerations can be made with regard to the propositions of the categories from A to D, because the aspects they refer to are more concerned with organizational practices (i.e., user empowerment, competence enhancement, use of teams, etc.), than with the organization's goals or its way of finding resources. Vice versa, regarding the propositions related to category E, they are definitively PA specific, as they concern some of the targets of public policy.

We also claim that the contents of this article are both helpful to practitioners and to research communities.

Practitioners are in this case the decision makers in the field of organization and/or information systems, as well as politicians. The former can get hints about how to:

- Consider FLOSS in a proper setting
- Interpret FLOSS not only in terms of cost reduction
- Put in the same frame FLOSS adoption and organizational change

Politicians can have support for considering FLOSS not only as a technical internal choice, but also as a means to reach some of the main goals of a public administration, like the development of the national economy, promotion of collaboration among research structures and firms, and so on.

On the other hand, the complex nature of FLOSS adoption together with its relationship with organizational change and innovation hide a variety of aspects to be further investigated by researchers. Our research has confirmed that the relationship between FLOSS and organizational change and innovation is a complex phenomenon. For instance, FLOSS adoption can be associated with the effects of organizational changes on the IT governance processes, or in other circumstances it can drive or trigger innovation by linking to external capabilities.

Table 9: Propositions for Category E	
E1:	*FLOSS adoption in PAs can foster the collaboration among SMEs and other players on a local basis*
Evidence	This objective can be achieved either by assigning public funds to selected projects and by evaluating final adoption results (Umbria Region case) or by centralizing the requirement analysis, design and development phases of software projects and then, creating a community with members from public administrations, private SMEs, and research centers (Retecamere case).
Suggested theories	In accordance with the resource dependency theory [Tillquist et al., 2002], actors lacking in essential resources will seek to establish relationships with others in order to obtain the resources needed. Also, organizations attempt to alter their dependent relationships by minimizing their own dependence or by increasing the dependence of other organizations on them. From this perspective, organizations are viewed as coalitions, altering their structure and patterns of behaviour to acquire and maintain needed external resources. By adopting this point of view, FLOSS can be seen as an external resource that minimizes the PAs dependence on other organizations by increasing the number of possible service providers available.
E2:	*The collaboration of PAs, SMEs and research centers has a positive impact on the diffusion of FLOSS related services in the national context*
Evidence	This proposition is related to the relationship between these new forms of collaborations and the economic growth of local markets through FLOSS initiatives. The case of Umbria Region shows interesting examples of small projects in which local authorities and SMEs collaborate to reach a common objective by adopting open source solutions.
Suggested theories	In addition to this interpretation of new inter-organizational relationships which are enacted by FLOSS adoption, the stakeholder theory [Donaldson and Preston, 1995] and transaction cost theory [Williamson, 1981], as also recalled in the research agenda by Niederman et al. [2006b], may contribute to explaining how new governance structures, outsourcing, and inter-organizational coordination and collaboration may result in FLOSS based services. Under such a perspective, a useful contribution is also provided by Watson et al. [2008], with their research on the business models put in place by software companies devoted to open source.

Table 10: Propositions and Theories to Promote Research in Each Category

ID	Category	Proposition	Direction	Levels of analysis
A	Software infrastructure	A1 FLOSS solutions at infrastructure level drive the innovation of IT management practices toward forms of open collaboration	FLOSS → OI	Organization/ Group
		A2 IT staff innovative practices result in FLOSS adoption at the infrastructure level	OI → FLOSS	Group/ Organization
B	Client application packages	B1 FLOSS client packages have an impact on the employees' work-practices	FLOSS → OI	Individual/ Organization
		B2 The empowerment of specialized users encourages the choice of FLOSS tools	OI → FLOSS	Individual/ Organization
C	Server side applications	C1 The re-use of open source server side applications allows the diffusion of good practices among organizations while preserving contextual elements	FLOSS → OI	Organization
		C2 The development of IT skills for software selection and configuration results in a greater chance to adopt FLOSS solutions	OI → FLOSS	Team/ Organization
D	Software development through open frameworks	D1 The community approach embedded in FLOSS fosters knowledge sharing among domain experts	FLOSS → OI	Organization/ Group
		D2 Teamwork and inter-organizational cooperation among domain experts and IT staff encourages the development of open frameworks	OI → FLOSS	Team/ Organization
E	Cooperation models	E1 FLOSS adoption in PAs can foster the collaboration among SMEs and other players on a local basis	FLOSS → OI	Organization
		E2 The collaboration of PAs, SMEs and research centres has a positive impact on the diffusion of FLOSS related services in the national context	OI → FLOSS	Organization/ Society

Researchers could then benefit from the results of the analysis performed on twenty-three instances of FLOSS adoption out of sixteen cases, of the classification provided through the taxonomy, and of the suggested

propositions. All these contents, individually or together, constitute a rich platform on which further research could be based.

We finally have to recall the limitations of our study, which first of all deals only with cases from the public sector, as already stated, the empirical outcomes are, therefore, not guaranteed to be able to be generalized. Furthermore, the research has a national scope, even though such limitation may be less relevant because of the number of the public entities observed, and their high diversity in terms of level, type and size.

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1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
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APPENDIX A: DETAILED CASES DESCRIPTION

Table A-1: Administrations Under Examination

PA name	Type of organizational entity	Cases ID
Bank of Italy	Central bank of the Republic of Italy Large-size organization with multiple local branches	1
Calabria Region	Local Public Administration Large-size organization	2
Valle d'Aosta Region	Local Public Administration Large-size organization	3
University of L'Aquila	Public University Medium-size organization	4
National Tax Agency	Central Public Administration Large-size organization	5
Municipality of Lucca	Local Public Administration Medium-size organization	6
ASL 2 Turin	Local Healthcare Public Agency Medium-size organization	7
Piemonte Region Province of Turin Municipality of Turin	Local Public Administrations Large-size organizations	8
ISTAT	National Institute for Statistics Large-size organization	9 - 10
Sicily Region Sardinia Region Campania Region Ministry of Cultural Heritage	Local Public Administrations Large-size organizations Central Public Administration Large-size organization	11
Retecamere scrl	Central quality and innovation agency of the Italian Chambers of Commerce network	12
Bolzano Province	Local Public Administration Medium-size organization	13
Municipality of Napoli	Local Public Administration Large-size organization	14
Municipality of Calimera	Local Public Administration Small-size organization	15
Umbria Region	Local Public Administration Large-size organization	16

Table A-2: Detailed Specification of the Sixteen Cases Analyzed

ID	Unit of analysis	FLOSS adoption	Category
1	Bank of Italy—Organizational unit in charge of: analysis and research on economics and financial metrics (i.e., €-coin, GDP, etc.) management of equities and bond archives	Distributed server infrastructure for statistic and econometric applications (high performance computing) based on LDAP, MySQL, PostgresSQL, Apache, mod_php/perl/python, Tomcat	A
		Open source packages such as Emacs, TEX/LATEX, phpScheduleIt, Mediawiki, Open Journal System, Wordpress, etc. Open source SW components (i.e. functions, routines) for specialized commercial applications such as statistical and simulation tools (i.e., Matlab)	B
		Use of general purpose open source programming language (Python) for the development of specialized applications	D

Table A-2: Detailed Specification of the Sixteen Cases Analyzed - Continued			
ID	Unit of analysis	FLOSS adoption	Category
2	Calabria Region—Organizational unit in charge of the management of IT systems supporting: Internal processes such as HR, Workflow, accounting, etc. E-government services	Saving about 400k€ for mainframe system software licenses Updated mainframe hardware solution with Linux based operating system	A
3	Valle d'Aosta Region—Department for Archaeological Finds	Process re-engineering for the lifecycle management of archaeological finds, starting from practices and methodologies analyzed by a group of archaeologists cooperating at European level (seven partner organizations) Development of a web based application (ArcheoTRAC) based on open source components and modules	D
4	University of L'Aquila—HR office	Process re-engineering for the management of annual contracts for external lecturers. Development of a workflow engine based on open source standards and components	D
5	National Tax Agency—IT office	FiscoOggi.it portal based on Drupal	C
6	Municipality of Lucca—IT office, Demographic office, Tax office	Three-tier application platform for the workflow management of internal processes (J2EE, Hibernate, Jboss Enterprise Middleware System, Linux Slakware, PostgreSQL)	D
7	Piemonte Region—ASL 2 Turin (Health Agency)	Platform for supporting the management of in-house medical assistance based on the P4A—PHP For Applications framework	D
8	Piemonte Region, Province and Municipality of Turin	Open source document management system and BPM support platform (Electronic Record Management System)	D
		Business model based on public–private cooperation through the creation of a community for supporting the development and maintenance of the SW solution	E
9	ISTAT (National Institute for Statistics)	Development of an open source toolkit (based on Java and R) for supporting the record linkage between multiple data sources.	D
		Use of the European Union Public License for distributing the SW solution	E
10	ISTAT (National Institute for Statistics)	Development and implementation of standards and guidelines for a more efficient transmission and dissemination of statistics, including both data and metadata	D
11	Sicily, Sardinia and Campania Region and Ministry of Cultural Heritage—public fund investments offices	Open source SW for supporting the management of public fund investments lifecycle	D
12	Italian Chambers of Commerce—Central quality and innovation office (Retecamere scrl)	Integrated platform for the management of internal (within the Chambers of Commerce) and external (with local companies) information and communication. The platform is based on open source standards (php, Ajax, MySQL) and allows the automatic collection of relevant information with respect to the user (company) needs	D
		Retecamere will create a community for supporting the development and maintenance of the SW solution that will be distributed under the GPL license	E

Table A-2: Detailed Specification of the Sixteen Cases Analyzed - Continued			
ID	Unit of analysis	FLOSS adoption	Category
13	Bolzano Province—administrative offices	Experimental migration to OpenOffice for 16 users (duration: 14 weeks) Complete parallel migration to OpenOffice v2.0 (more than 2000 users)	B
14	Municipality of Napoli—administrative offices	About 800k€ of cost savings over 2000 licenses (operative system and office automation suite) Training for open source teachers Training for IT administrators	B
15	Municipality of Calimera (LE)—administrative offices	Migration to Mozilla Firefox, Thunderbird and OpenOffice (30 users) with about 30k€ of cost savings	B
		Feasibility study for the implementation of an open source application server (i.e., Zarafa, Funambol, Simple GroupWare, eGroupWare)	C
		Replacement of a Windows server with Linux, Apache and MySQL	A
16	Umbria Region—Open Source Competence Centre	Public funds (100k€ in 2007, 235k€ in 2008, 200k€ in 2009) for supporting small projects (about 15k€)	E

ABOUT THE AUTHORS

Paolo Spagnoletti received his Ph.D. in Information Systems from LUISS Guido Carli University of Rome, Italy, in 2008. He is currently assistant professor of Business Information Systems at LUISS University where he is also co-director of the Master in e-business Management and Consulting. Since 2011 he coordinates research activities of CeRSI "Alessandro D'Atri", the Research Centre for Information Systems of LUISS. He is interested in the strategic and organizational research on the management and impacts of IT based innovations. Within this area he is interested in investigating whether, when, and how organizations can benefit from IT innovations. He has performed several studies on IT adoption, IT value, information security, and e-services in both public and private sectors.

Tommaso Federici is adjunct professor of Information Systems Management and Organization Theory at the University of Tuscia, in Viterbo, Italy. He has also taught at other universities (University "La Sapienza" and LUISS G.Carli University, in Rome, Italy) and Schools of management. As author or co-author, he published papers, articles, and books (a list of them is available at www.tommasofederici.it). He is fascinated by the innovation process, particularly when a new IT artifact is introduced for the first time into a class of organizations. This is a frontier territory to be understood according to multiple perspectives and by following a multidisciplinary approach. Beside FLOSS and e-procurement, both regarded as boosters to foster organizational change in the public sector, other recent research domains are the innovation in the archaeological sector, and the ERP introduction in the SMEs segment.

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