Economic Efficiency of Free and Open Source Software in the Public Sector: the example of Chile

Matthias Sax

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List of Abbreviations

APDIP	Asia-Pacific Development Information Programme
BSD	Berkeley Software Design
CEO	Chief Executive Officer
CEPAL	Comisión Económica para Amérca Latina y el Caribe (see ECLAC)
CETI	Centro de Estudios de Tecnologias de la Información de la Universidad Católica, Chile
CIO	Chief Information Officer
CSS	Closed Source Software
ECLAC	Economic Commission for Latin America and the Caribbean (United Nations Regional commission)
EU	European Union
FOSS	Free and Open Source Software
FSF	Free Software Foundation
GDP	Gross Domestic Product
GNU	Gnu's Not Unix
GPL	General Public License
GVC	Governmental Value Creation
HR	Human Resources
ICT	Information and Communication Technology
IOSN	International Open Source Network
IT	Information Technology
ITI	Instituto Nacional de Tecnologia da Informa, Brazil
ITU	International Telecommunications Union
IDC	International Data Corporation
LGPL	GNU Lesser General Public License
MPL	Mozilla Public License
MS	Microsoft
OS	Operating System
OSI	Open Source Initiative
OSS	Open Source Software (also Free Software or Software libre, or FOSS)
PC	Personal Computer
TBO	Total Benefit of Ownership
TCO	Total Cost of Ownership
UNO	United Nations Organization
UNDP	United Nations Development Programme
WIPO	World Intellectual Property Organization (Agency of the UNO)

Summary

This paper reviews the advantages and disadvantages of free and open source software (FOSS) in the public sector. It is based on a survey conducted in late 2004 with the informatics community of the government of Chile, which represents the key IT decision-makers in the Chilean public sector. The survey identified criteria that affect successful deployment and usage of FOSS. The balanced scorecard was used as a basic approach for identifying the strategic IT priorities and objectives of Chilean public institutions. In addition to the survey, respondents were interviewed to make out possible positive and negative effects on the strategic objectives due to the use of FOSS. The results show that also FOSS is still backward in terms of functionality and user friendliness in comparison with closed source software, it offers various strategic advantages like higher security and transparency which are very important especially in the public sector. Due to these advantages, FOSS can compensate or even outperform still existing disadvantages. It has to be annotated that these disadvantages are often only a matter of time, until motivated members of the worldwide FOSS community eliminate them. When interviewing the IT specialists of the public sector in Chile, a very enthusiastic, open-minded and also motivated attitude towards the application of free and open source software could be perceived. However, in the majority of cases there is not enough time or resources to concentrate on doing feasibility investigations for FOSS in the institutions. Some further conclusions include that software piracy is serious jeopardy for the further development of FOSS, especially in developing countries. Due to "lock-in" effects, it can be that end-users even do not get the possibility to discover FOSS or even take the chance to join FOSS projects. It is also very important that governments manifest their opinion related to the current FOSS debate. The role of software patents needs to be demystified and advantages and disadvantages related to transparency, lock-in, public property and innovation need to be discussed objectively. The public sector of an information society needs to take position and formulate clear statements regards eventual trade-offs for the future. This publication is a contribution to this process in Latin America and the Caribbean, based on the call for research made in Goal 8 of the Regional Action Plan for the Information Society, eLAC2007 (http://www.ecalc.org/SocInfo/eLAC).

I. Introduction

This article evaluates the main factors, which are influencing the economic value of free and open source software (FOSS) in the public sector of developing countries. As a concrete case, the governmental domain of the country of Chile is chosen. To achieve a general view on the entire sector, especially strategic objectives are taken into consideration for an economic efficiency evaluation.

Due to the fact that most software adhering to the concept of open source is free of charge, it presents a chance for developing countries which do not have the resources for state-of-the-art software to benefit in latest progressions in this area. In order to analyze whether potential advantages for the public sector will also be reflected in practical use and consequently have a positive impact on the economic efficiency of FOSS, a balanced scorecard for the IT in the public sector was developed, based on the interviews with 62 IT specialists in the public sector of Chile. The results are presented in this paper, after the potential advantages of the FOSS in the public sector are discussed.

A recent prominent example of taking software set up on the Linux operating system into consideration is the case of Munich's administration in Germany. In this case, the public authorities of Munich decided to migrate their 14,000 PCs from Microsoft's Windows to Linux. A feasibility study of this case showed that a migration would be more costly than keeping the old constellation. Nevertheless, the city council decided to invest the expected amount of 35.7 million dollars to migrate the systems of the entire municipality. By observing the feasibility study arranged by Unilog Consulting more closely, a positive impact on the economic efficiency in the long run can be seen, particularly due to the achievement of strategic objectives. The net present value for keeping Windows XP was 31,303,370 €, while a FOSS solution produced a net present value of 33,762,122 €. On the other hand, the FOSS alternative achieved 5,962 points in qualitative-strategic criteria, while it were only 5,293 points with Windows. As a consequence, the costs per qualitative-strategic criterion were lower for the FOSS solution.

For this reason and since this study wants to examine the economic efficiency of FOSS in the public sector from a general view, the emphasis of this study will be on strategic aspects.

II. Free and Open Source Software

Free and / or open source software represents an alternative model for developing, licensing and doing business with software programs. There are two major definitions of FOSS, one by the Free Software Foundation (FSF) and the other one by the Open Source Initiative (OSI).

The FSF uses the expression “free software” not to refer to its price, but to several “freedom rights” of the user to do things with the software. According to FSF it gives the user the following rights:

- The freedom to run the program for any purpose.
- The freedom to study how the program works and adapt it to its needs. Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbor.
- The freedom to improve the program and release improvements to the public, so that the whole community benefits. Access to the code is a precondition for this.

The FSF definition is more restricted and very much against patents and the limitations of copyright laws, because these negatively affect the four user rights listed above.

The official definition of “open source software" by the OSI is very close to the one of free software. The difference is that OSI accepts some license forms which are looser and wouldn’t be accepted by the FSF. The concept of the OSI is focused more on practical advantages. It places value on technological issues and aspects for effective software development. Due to its historical origin, it is more business-friendly and less influenced by moral values than the FSF.

The FSF is more political, seeing non-free software as a social problem and free software as the solution for them, while for the Open Source Initiative, non-free software is a suboptimal solution.

Both organizations have come up with varying software licenses which support their goals. In the following, the two definitions will be summarized under the term “free and open source software” (FOSS).

2.1. Potential Benefits of FOSS

Depending on the points of view, there are several aspects in favor on the application of FOSS. In the following, the potential benefits for companies and organizations, developers and governments will be presented.

2.1.1. Companies and Organizations

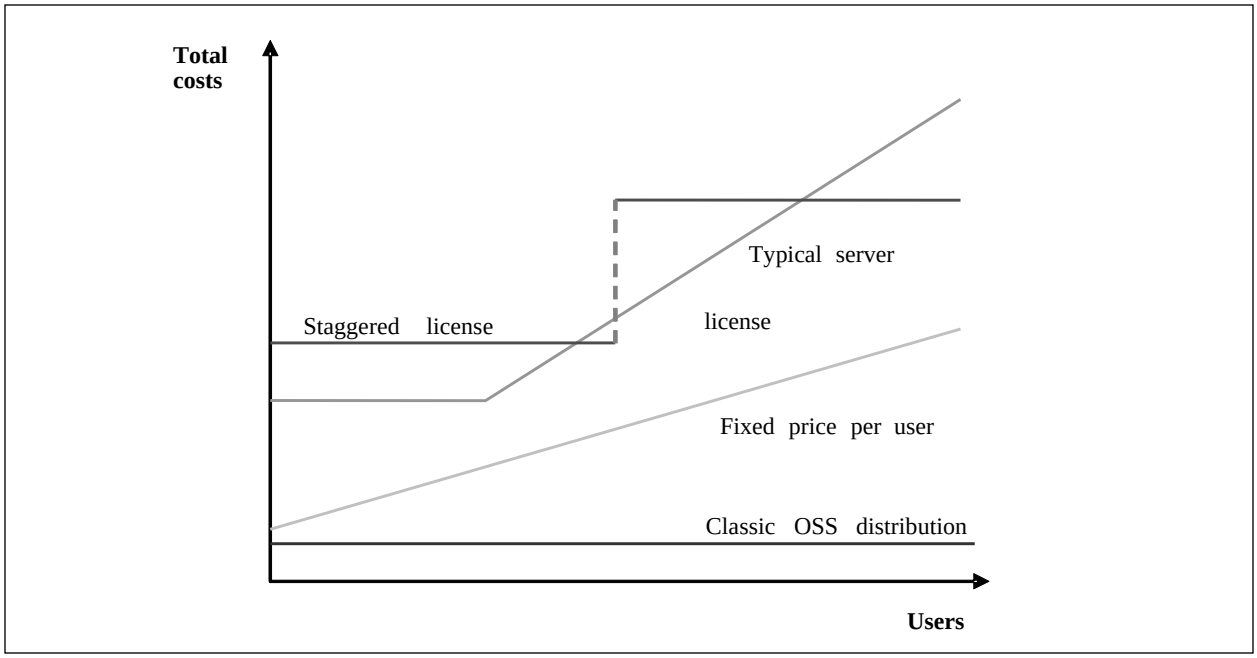
A survey published by Berlecon Research [Wich2004] brought the following reasons for companies to change to FOSS:

- Security / better access protection
- Low license fees, better price to performance ratio, installation and integration cost savings, training cost savings, operation and administration cost savings
- Higher performance, higher stability, better functionality
- Open and/or modifiable source code, higher number of potential applications, integration in acquired product
- IT service provider recommendations

Especially the low license fee is an aspect for cost savings in companies and organizations. Figure 1 taken from [Wich2004] illustrates the costs for software depending on the different license models.[1] The bigger the gap between the "Classic OSS-distribution" and the other license model, the higher the cost savings with FOSS. Overall, the figure shows that the more users have to work with the software (hence, the larger an organization is), the higher are the possible cost savings to be achieved.

[1] This work does not go into detail of the different commercial licenses, as it is not necessary to establish understanding for the possible cost saving with FOSS.

FIGURE 1
COSTS DEPENDING ON LICENSE MODELS



Source: Prepared by the author.

2.1.2. Developers

For the group of developers, there are some different advantages that also explain its popularity in this community. [GhKr2002] mention the following advantages for developers:

- There are no existing entry barriers for developers, as FOSS is a public good.
- FOSS is an excellent training system for programmers at no cost.
- It is mostly "the source of de facto standards" for protocols or systems, whether because of historical origin or those developed today.

It also sees the license models of FOSS as a major advantage since it typically gives the user the right to use, modify and redistribute the program and so also has the possibility for "value added" programming, which, due to the lack of documentation, does not exist in the case of commercial software.

The basic principles of developers for this information sharing are described in the following.

The Hackers Ethic

A "Hacker", a word that originated in the computer labs of the MIT (Massachusetts Institute of Technology), is a person who "defines themselves as an expert or enthusiast or expert of any kind" (This term should not be confounded with the meaning that the media spread in the last decades: criminals using computers. These are also known as "crackers".) [Chan2005]. Most hackers subscribe to the hacker ethic in the sense that information-sharing is a positive good and that it is an ethical duty to share their information and expertise with others by working on free software and to make it possible for others to get access to information and computational resources wherever possible. Because of these attitudes, "information sharing is such a powerful force in hacker communities, hackers actively help and encourage each

other to develop skills. This is one instance in which the ethic takes a more proactive and perfectionist approach, both creating an environment in which hackers develop their skills fully" [Chan2005].

This shows the advantage for a society to develop for FOSS or even only using it. For Stallmann, "a user of software is not less important than an author's employer. In other words, their interests and needs have equal weight, when we decide which course of action is best" [Stal1992]. His free software philosophy "operates on the harm principle, suggesting that placing any artificial restriction on the sharing of information causes a social harm that is never justified and that must therefore be avoided". The three harms according to Stallmann are:

- Because of natural restrictions, whether natural or artificial origin, fewer people can use the program.
- Users can not fix or adapt the program.
- It is not possible for users to learn from the program or base new work on it.

From this Stallmann developed the rules for the "freedom rights" for software mentioned in this chapter. Hence, this philosophy is an example of the hacker's social ethic. It guarantees that the hacker can retain his full and productive relatedness to the product and provides "the experience of being an active and fully autonomous person" when entering voluntarily in their work. This voluntariness is guaranteed through the work which must meet some challenges and must "be able to be judged how well the challenge was made" [Chan2005].

2.1.3. Governments

Especially for governments, FOSS provides a lot of possible advantages. FOSS implies less public dependence on soft- and hardware providers, reduces the chances of running into a dead-end of the development trajectory of the software, and can avoid the probability of a vendor lock-in [GhKr2002].

Furthermore, governments often see a possibility to create local jobs. In particular in the range of services and training, FOSS demands more investments, which mostly can only be satisfied on site.

In addition, FOSS also has the advantage that public sector units are able to translate needed software into the local language quite easily.

Finally FOSS fulfils the criteria of transparency software should fulfill when applied in governmental use.

2.2. Potential Shortcomings of FOSS

Besides these numerous advantages, FOSS also brings a number of potential disadvantages. As shown below, legal aspects of FOSS involve a risk of copyright infringements. This point is worsened by shifting all risk for intellectual property infringement to the licensee, which otherwise is a burden for the licenser. This can be discriminating for FOSS, especially as there are several companies with strategies of litigation against FOSS. Nevertheless, until today there have been "no successful cases brought against FOSS projects for infringing on proprietary code, despite the high profile of the SCO case against IBM. Similarly, all actions against proprietary companies for illegal use of FOSS code have been matters of compliance. Almost all have been settled out of court, and settlements have been a matter of the companies either coming into compliance or stopping the use of the FOSS code" [Byfi2005]. Yet, there are several companies offering insurances or legal securities for such cases.

Beyond this, free and open source licenses often do not contain any warranties of quality or suitability for a specific purpose. Due peer reviews in development process by members of the worldwide community, the quality of FOSS projects is often high. This derives because of [Raym2004a]. Of course, there are also “many small, unsuccessful projects” or established projects suffering problems of quality [Mich2006]. With companies developing commercial software, this could be negotiated, for example with a requirement specification [Giera2004].

Due to the historical development of software products in the worldwide FOSS community, projects tend to be technical highly developed, but lack good documentation. [Herr2003] did a small survey on the quality of introductory documentation of the top 20 of FOSS projects on Sourceforge.net. By examining the documentation of the front-runners, you would expect a lot of information about the product, but only half of the tested web sites running on Sourceforge.net answered the simple question of what a tool is meant to do.

[WoSa2004] claim, that there is also still a lack of basic applications for daily use or small companies and that existing FOSS often does not show uniformity. The last aspect makes these programs not very adequate for daily use by the masses, since, for example shortcut functions, such as “copy and paste” or “drag’n’drop”, are not uniform.

A survey conducted by [Gibi2004] gives among other things the following reasons why companies and organizations are not using FOSS:

- Lack of support and services
- Lack of applications
- Lack of human resources with required knowledge
- Difficulties of administration and usage e.g. operability

2.3. Intellectual Property

The aspects of intellectual property protection are strongly influencing the development and usage of FOSS in the public and private sector. There are three ways of protecting software: copyright, patents and trade secrets.

The World Intellectual Property Organization defines patents as “an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem”. This invention must fulfill the conditions of being of practical use and showing an element of novelty and must be accepted as "patentable" under law.

In order to show an element of novelty, it is necessary to have some new attribute which is not known “in the body of existing knowledge in its technical field” and must be an inventive step which could not be easily derived by an average person.

Furthermore, its purpose has to be accepted as “patentable” by national law, since many countries do not accept scientific theories, mathematical methods, plant or animal varieties, discoveries of natural substances, commercial methods, or methods for medical treatment to be patented.

In this sense, software patents can be very dangerous for the FOSS movement. Patent holders are in a strong position to enforce their “rights”, especially because the source code of free and open source software is always available, as the definition demands, it is very easy to find parts of a program which may infringe on existing software patents. On the other hand, due to the developing model, FOSS projects

are often created by numerous different programmers (and / or held by financially weak non-profit organizations) and making it almost impossible to enforce these laws [HaHo2003].

This might be a big problem when small companies use the FOSS licensing model for their own products. Steve Ballmer, CEO of the Microsoft Corporation, uses this aspect to dissuade Asian governments from the idea of using FOSS, as he warned them in a conference in Singapore in November of 2004 that governments might get into legal conflicts.

Nevertheless, German legal opinion assures that the use of Linux in the case of the migration of the public administration of Munich assumes little legal risks for the use of the Linux kernel. But it enumerates potential risk for further applications used, especially when they are self-made and trivial patents may apply.

Finally, it has to be mentioned, that patenting is an instrument of property protection which is only possible in the United States and a number of further countries like Japan, but not in most Latin American countries like Chile for instance. In Europe, there has been a public discussion over the last years, which will be recapitulated later in this chapter. Patents give incentives to investors for spending on innovations and improving the diffusion of this new knowledge. The latter goal obliges that the details of an invention have to be published, which contrasts today's software patenting. In this case, technical details of an innovation are not disclosed or made public in any form. The question of what should and what should not be patentable is the crucial point in this issue.

Of course, patent infringement is also possible with closed source software, but very unlikely to be explored.

The third possibilities to protect software are trade secrets. These cover "the ideas underlying particular software- including the software's structure or architecture and organization, and various features, routines and processes with the software" [Byfi2005], no matter if it the particular ideas are new or not. As the name implies, FOSS can not be protected under trade secrets, as the source code is always open for examination.

[JuZi2005] discusses in their paper the difficulty between the traditional intellectual protection framework and the challenge with knowledge intensive activities like the development of FOSS. While the traditional protection motivates innovation in free markets by allowing to "finance the initial phase of the innovation process, anticipating returns in the diffusion phase, in which they expect a legal monopoly to produce and commercialize it" [JuZi2005], it shows blatant shortcomings with knowledge intensive innovations. In fact, it can be counter-productive: it is not necessary to hold a monopoly to finance such a project because with the diffusion of the Internet it is possible to share knowledge with people worldwide with very different skills and resources at no cost. Additionally, today's computer based development is much more efficient. An example of knowledge sharing besides the software development are projects like the open encyclopedia Wikipedia (http://www.wikipedia.org) where collective production mobilizes numerous different people with varying skills with the help of the Internet.

Open Source licenses have been build on basis of the rights granted by copyright. Copyright protects "the fixed and original expression of software in the form of symbols or indicia of computer code" [BoBu2004]. In order to obtain these rights, it is not necessary to follow any institutional process or publish the work. Copyright confers exclusive rights for expressive work such as software code against unauthorized copying, unauthorized distribution of copies or the adaptation of the software code. In fact, under U.S. law an unauthorized adaptation of a work or software product protected by copyright denies the author of the new work to obtain any rights. This means, that the original copyright owner inhibits all rights in adaptations.

In case of creating a work without a derivation to the original version, it "is a defense to claims of copyright infringement" [BoBu2004]. The created work can be exactly the same as the original one and not present a copyright infringement, as long as it has been created truly independent.

These findings lead to some public policy recommendations, which are elaborated in chapter 0.

The following table gives an overview of the development in the European Union over the last years. The parliament tried to introduce a patent system in 2003 which led to protests all over Europe. Florian Mueller, founder of the political campaign NoSoftwarePatents.com, documents the whole development in [Muel2006].

TABLE 1
DEVELOPMENT OF SOFTWARE PATENTS IN EUROPE

Date	Incidents
08/2003	The parliament of the EU wants to introduce a bill for software patents. Demonstrations in Brussels, a collection of more than 150.000 signatures and the support of many Open Source websites demonstrate the disagreement by Europeans. [Krem2003]
09/2004	Official adoption of the directive for software patents delayed in the European parliament, because the translation into national languages of the new members of the European Union did not make progress. Meanwhile, the antagonists of software patents encourage the political discussion. [Krem2004b]
09/2004	Linux migration in Munich stagnates because of the uncertain legal situation with software patents and its impact on their software. Media all over the Europe report about software patents and its consequences. [Krem2004a]
01/2005	61 parliamentarians from 13 countries demand a total recommencement of the directive for software patents.
07/2005	EU-Parliament rejects directive for software patents with stunning majority. [Krem2005]
01/2006	EU-Commission starts “last attempt” for the community patent [Krem2006a]
03/2006	EU-Parliament earns critics for its new approach to reorganize the European patent system via the community patent. Krem2006]
Status quo	“By rejecting the Council's common position on software patents, the European Parliament prevented the ratification of the EPO's flagrant law-bending. However, the situation is still a paradox: software patents aren't allowed under applicable law, but the EPO and some national patent offices continue to crank them out. Then, when rights-holders try to sue "infringers", many of those patents are invalidated and others are upheld. There are differences between countries, but also within countries, and sometimes even between judges in the same court. One way or another, the situation will have to be resolved one day”. [Muel2006]

Source: Prepared by the author.

2.4. FOSS in developing countries

FOSS seems to be stronger in South America than anywhere else: in Venezuela all ministries are required to create migration plans in order to follow President Chavez’ decree to switch all public administrations to FOSS in the next two years. In Argentina, the trend to change to FOSS is even more pronounced. A survey interviewing 115 companies in Argentina found out that 42% of Argentine’s companies are already using Linux, 4.5% plan to migrate all their systems to Linux and 16% plan to adopt it for new applications. The reason for this extensive development lies in the recent economic collapse in Argentina, forcing companies to make immense cost cuts and putting aside IT managers’ last remaining concerns about FOSS solutions.

In the following, Brazil's and Mexico's FOSS development are reviewed in more detail.

Brazil

In June 2003, the Brazilian Government announced a manifesto to run 80% of to-be procured systems and migrate existing Windows systems to Linux in state institutions to Linux over a time period of three years, but finally made much more prudent approach in order to keep migration costs lower. Nevertheless, it is still increasingly becoming the centre of the FOSS movement in Latin America as it has formulated "a number of programs to facilitate its spread [Byfi2005].

Mexico

In 1998 the Mexican government announced that it planned to install the free operating system Linux in 140,000 elementary- and middle-school computer labs in the country. With this decision not to purchase the proprietary solution of Microsoft with Windows 98, Office and server software it intended to save about 124 million US dollars [Kahn1998].

But three years later the project seemed to have failed, as only 20 of the 4,500 computers installed used Linux. Reasons for this failure were, on the one hand, that the poorly equipped team was overwhelmed with installing and promoting and, on the other hand, "a lack of compatible hardware, and little political support killed off the idea" [Gonz2001]. There were not enough trained people in the schools as "the government simply shipped CDs to schools without training teachers how to use the operating system or contracting programmers to administer it." [Gonz2001].

III. FOSS and Public Sector

The public sector is the part of an economy concerned with providing basic services like the police, military, public roads, public transit or education. Furthermore, it might provide public goods, which have the characteristics of being non-excludable and non-rival, such as street lights, and services which special externalities in their collective consumption, encouraging equal opportunity, such as public education. The exact composition of the public sector varies from country to country.

In the face of very difficult fiscal environments, cost reduction has become an imperative for governments across the globe. Reduced budgets were the principal reason for many institutions of the public sector around the world to examine the possibility of using FOSS. In addition, new duties and responsibilities shrink budgets of public sector units even more, as shown in interviews conducted in Germany and Chile. Besides this, security concerns, problems of interoperability and the fear of a provider lock-in with commercial software were important aspects when thinking about the FOSS alternative.

Public Mission and Usage of IT

While private corporations have the objective of profit maximization, public administration is confronted with a different and more complex system of purposes. Primarily it is engaged in common welfare. Of course, economic efficiency is a determining factor, but it is not the main objective.

On the other hand, the essential qualities of an efficient and modern public administration are efficiency, transparency, accountability and reliability [Liik2001].

According to [GhKr2002], when using information technologies, governmental organizations are required to take into consideration that "any information they hold is not owned by them, but by the citizens, who either paid for its aggregation by taxes or delivered it themselves, normally without an alternative under the rule of law". In addition, [GhKr2002] claim that governmental organizations have the following tasks:

- Guaranteeing free access to public information
- Maintaining the permanence of public data
- Assuring security of public and citizen provided data
- Achieving efficient public spending

Under these circumstances, [GhKr2002] postulate the following criteria for software usage in the public sector:

- Unlimited use of the software
- Right to reproduce and distribute an unlimited number of copies
- Right to modify the software
- Right to reproduce and distribute an unlimited number of copies of the modified software version under the same license restrictions
- Right to use and change arbitrary parts of the software for usage within other software
- Unlimited access to source code

These criteria appear similar to those of the Free Software Foundation, are obviously very difficult to fulfill and can hardly be accomplished by commercial software, but rather by individually commissioned software or FOSS. For this reason, [GhKr2002] established a hierarchy of exceptions, in which usage of proprietary software would be the last possible. Furthermore, the software should only be permitted when the public institution guarantees the archiving of data in open standards or at least parallel to the proprietary one. What aggravates the situation is the fact that governments do not have the same contractual freedom as they have to meet further requirements of public welfare, as already mentioned.

Impacts of FOSS-related Politics

According to [Rola2004], governmental policies for FOSS can lead to failures or to suffering a setback in certain areas of specific governmental modernization if the system factors involved in each implementation are not taken into consideration.

[Rola2004] gives the following advantages and disadvantages of policies pro FOSS-implementation in the public sector:

TABLE 2
SYSTEM FACTORS OF GOVERNMENTAL POLITICS

Factors	Advantages / Disadvantages
Economical	Contributes to generating companies for technical support, qualification and the development of more secure and functional applications.
	Incentive for the creation of new jobs.
	Permits use of resources in the most efficient way, always when support and qualification services are available.
	Reduces the technological dependency on big global companies.
	Stimulates creativity and productivity.
	Encourages local and regional economic activity.
Social	To abandon commercial software can affect thousands of working people who are involved in technical support, qualification and sales of these products and have spent much time of their life preparing for this technology.
	Equilibrium is not guaranteed.
	An educative change, actually dominated by commercial software, would highly limit the access of work to the actual IT workforces (which are highly specified).
Political	Can provoke unfair treatment for the established companies and therefore weaken the investments by international capital.
Technological and Scientific	In this ambit, both alternatives have enough quality and feasibility. Windows has the most advanced model of computation and continuous renewals and updates, while Linux has been adopted by universities and leading multinational companies as development platform.

Source: Prepared by the author.

Hence, any political engagement should be examined carefully before being implemented.

IV. Economic Efficiency of Information Technologies

Economic efficiency is the main purpose of economic interaction. The approach of economic efficiency can be applied as the principle of maxima or the principle of minima. While the principle of maxima implies a given input, under consideration of given restrictions, to achieve a maximum of output, the latter assumes a given output achieved with a minimum of input. Of course, there are many transitions between these two points of view, but all have in common a relationship between input and output.

Taking only quantitative aspects into consideration has the advantage of being able to secure a correct result by mathematical calculations. On the other hand, it leads to not considering value benefits which can be hardly or even impossibly expressed by monetary numbers, as for example competitive advantages. Hence, the traditional view of economic efficiency has to be extended by qualitative aspects, especially if they have strategic significance. Furthermore, investigating investments in information technologies demands a full view in order to measure effects on preliminary and downstream processes and affiliated systems. The different possible fields of applications and their moments of use should also be taken into calculation with information technology, because of their fast-changing nature.

By setting a target state which can be compared with the actual state, the evaluation of different systems and their comparison can be made possible. With this kind of method, which is also called analysis of effectiveness, a system is only economically efficient when measured aspects exceed the target values.

In order to analyze economic efficiency a general framework of critical success factors (CSF) is essential. One possible approach to identify CSF is that based on a balanced scorecard. We have used balanced scorecard to identify important perspectives for organizations and based on these perspectives and available literature we have worked out some CSF, which we have then evaluated in a survey. In the following the approach to identify the perspectives is shown and then the survey results are presented.

The Balanced Scorecard Methodology

The balanced scorecard (BSC) was developed in 1990 by Kaplan and Norton. They noticed the disadvantages of being slanted towards the perspective of financial measurement of a company's development, because corporate success also depends on non-monetary immeasurable aspects [Horv2001]. The original concept includes three additional perspectives besides the financial one:

"customers", "processes" and "learning and growth". Due to this multi-dimensional view and integrative approach, it is a model for putting strategies into practice as it takes into account reciprocal dependencies of strategic planning, strategy mediation and implementation, as well as target controlling [Sche2002].

With the help of the BSC all sectors of an organization can be focused on the strategy of a company and its development progress is measured with adequate indicators. Therefore, the strategy of the company has to be transformed in a system of objectives and indicators which then have to be distributed to the different management levels and integrated into selected processes. The objectives have to be transformed into indicators and values to be achieved. Finally, measures to accomplish these values have to be determined.

The four perspectives can be changed in particular cases. They can be redefined and extended or further perspectives can be added. In practice, a model with a maximum of five perspectives and not more than five indicators per perspective has resulted efficient by focusing on the essential issues [Basc2001].

By setting the perspectives and mapping the strategic objectives, corporate purposes can be concretized for the different sectors of an organization. Measures and indicators can clarify the strategy of a company for its employees. Hence, the BSC is also suitable as a communication tool for the employees, because it can facilitate the illustration and implementation of a strategy [Horv2001].

Balanced Scorecard for the Public Sector

The balanced scorecard cannot be transferred one-to-one from the private to the public sector, because of its differing management aspects. Diversity of interests, the priority of common welfare above financial standpoints, democratic accountability, lawfulness and checks and balances between authorities, burocratic transparency, relations of mutual recognition and democratic legitimization between citizens and public servants and a stronger emphasis on stability and security demand a different form of management as in a private enterprise.

The result is a new perspective, "economic efficiency and legality", taking into account economic and legal restrictions in order to achieve the legal or political mission [Sche2002]. The perspective "clients" is replaced by the "common welfare perspective/citizen perspective", putting emphasis on a democratic relation between both that realizes a political vision, rather than satisfying an economic demand.

Balanced Scorecard in the IT

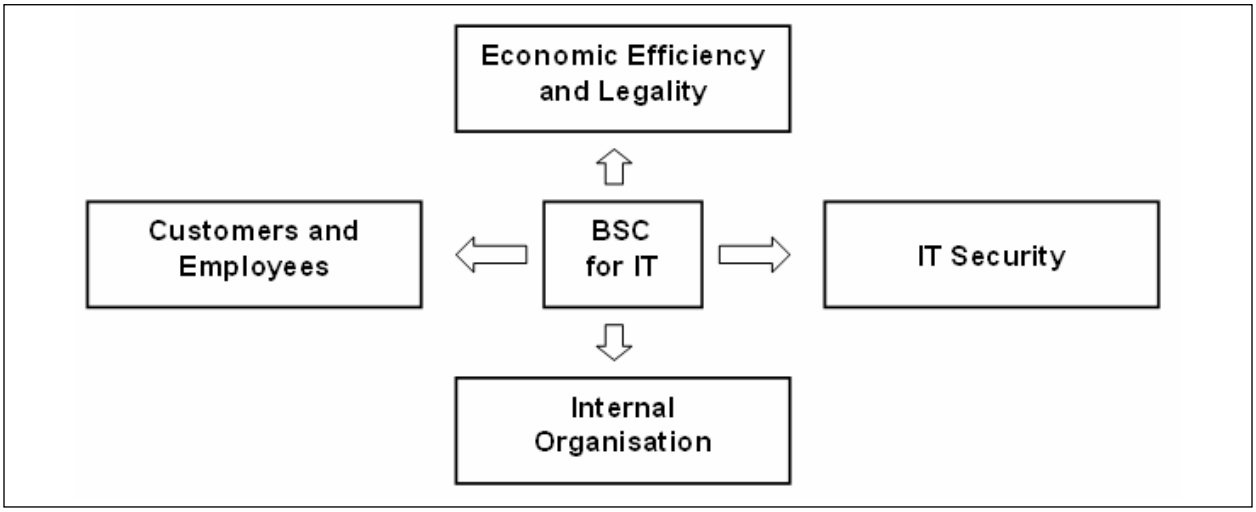
As long as IT assist public sector units to operate more efficiently, reduce processing time and increase customer satisfaction, adding value to the organization and act as a "vehicle for transformation" [Symo2004], progress in this transformation can be guided by balanced scorecard evaluations. As no IT scorecard model fits all organizations, the following approach proposes a more general scorecard in order to achieve a common basis for all the different public sector institutions.

Originally, users of the BSC establish cause and effect connections between the different objectives and define measures in the traditional three perspectives processing, learning and growth. In order to achieve the objectives in the finance perspective, the following investigation will assume financial figures as given and examine if there is a positive or negative impact from the different strategic aspects due to the use of FOSS.

A classic model for a balanced scorecard for IT, according to [Basc2001], would be set up with the following perspectives: financial, customer, process, security, learning and development. As already mentioned in the preceding chapter, financial aspects should not have so much weight in the public sector, but rather the economically efficient operation under legal circumstances.

Figure 2 shows the perspective model used in the following investigation. The perspective of economic efficiency will not be studied separately, as the impacts resulting from the other three perspectives with the use of FOSS are object of investigation.

FIGURE 2
PERSPECTIVES OF THE IT BALANCED SCORECARD FOR THE PUBLIC SECTOR



Source: Prepared by the author.

The perspectives, which are discussed in this article, are customers and employees, IT security and internal organization. Security is obviously very important for the use of information technologies, because it can have strong negative effects on the whole organization. Furthermore, it is, among other things, more important for the public sector. The perspective customers and employees should measure the consequences of FOSS usage on the institution's customers and employees, whether specialized on IT or not. There is no differentiation between customers and employees, because it is often not clear who is the customer and who is the employee for the IT departments. Strictly seen, only IT specialists are the employees and all other employees of the institution are customers of the IT department. If these customers, the employees of an institution, work more efficiently, it has also an effect on the economic efficiency of the whole organization. Furthermore, the actual customers of the institution, the citizens, are affected by IT through the non-IT employees of the institution, too. Finally, from the perspective of internal organization, the effects on the organization of IT and on the organization due to IT should be measured.

V. Survey Results

The different criteria to be evaluated by importance in the survey were set up by comparing the results of existing similar studies and due to further suggestions of IT decision-makers in the public sector. An overview of the underlying studies can be found in appendix A and an example of the online conducted survey in appendix B. The results of the survey are presented in this chapter.

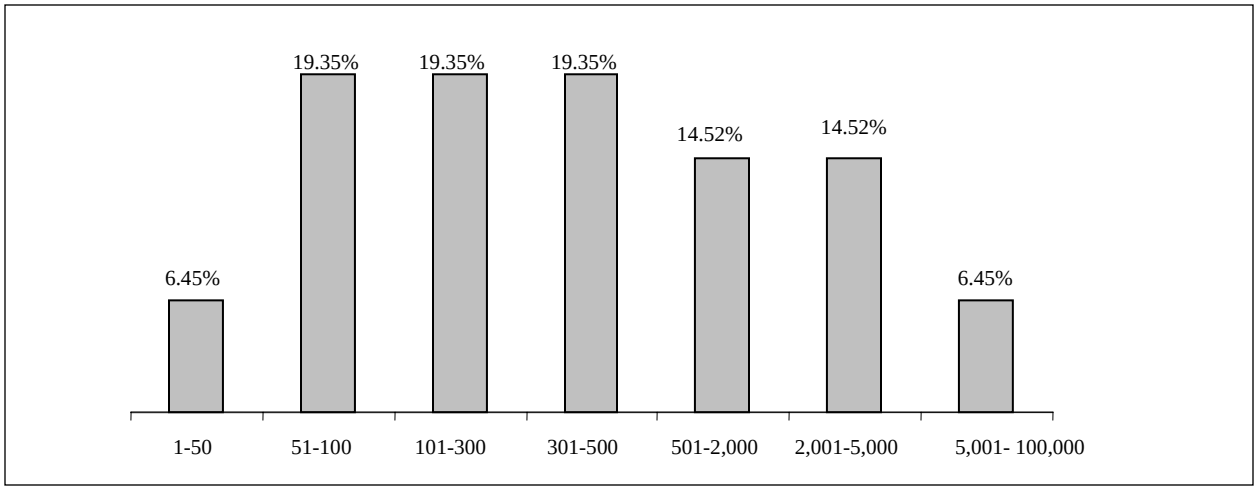
5.1. Demographic Data

The survey was conducted under the 260 IT decision-makers in the Chilean public sector. Names and contact information of these managers were provided by the Chilean government. From this universe, 62 persons filled out the questionnaire, which represents a percentage of 23.8%. Each decision-maker represents one governmental institution.

Employees

The 62 institutions represent a total of 177,668 employees, with an average of 2,866 and a median of 350 employees per institution. 1,283 of these employees are specialized in IT. About 58% of these institutions have between 51 and 500 employees, as you can see in Figure 3.

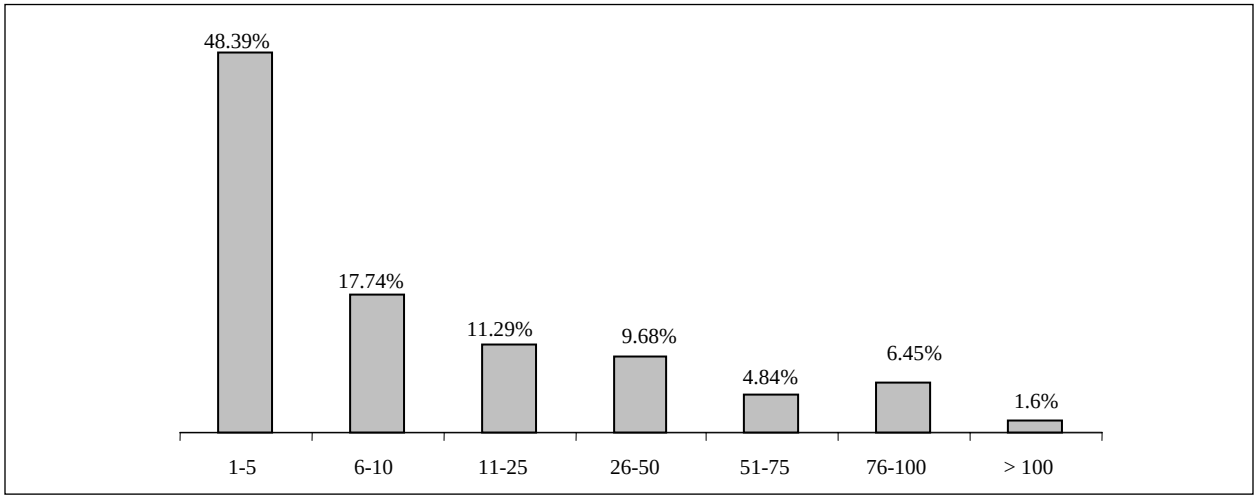
FIGURE 3
INCIDENCE OF NUMBER OF EMPLOYEES IN INSTITUTIONS



Source: Prepared by the author.

As shown in Figure 4, almost half of these institutions have only between 1 and 5 IT specialists employed, while the average of all is 21 and the median is 6 IT specialists per institution.

FIGURE 4
INCIDENCE OF NUMBER OF EMPLOYED IT SPECIALISTS



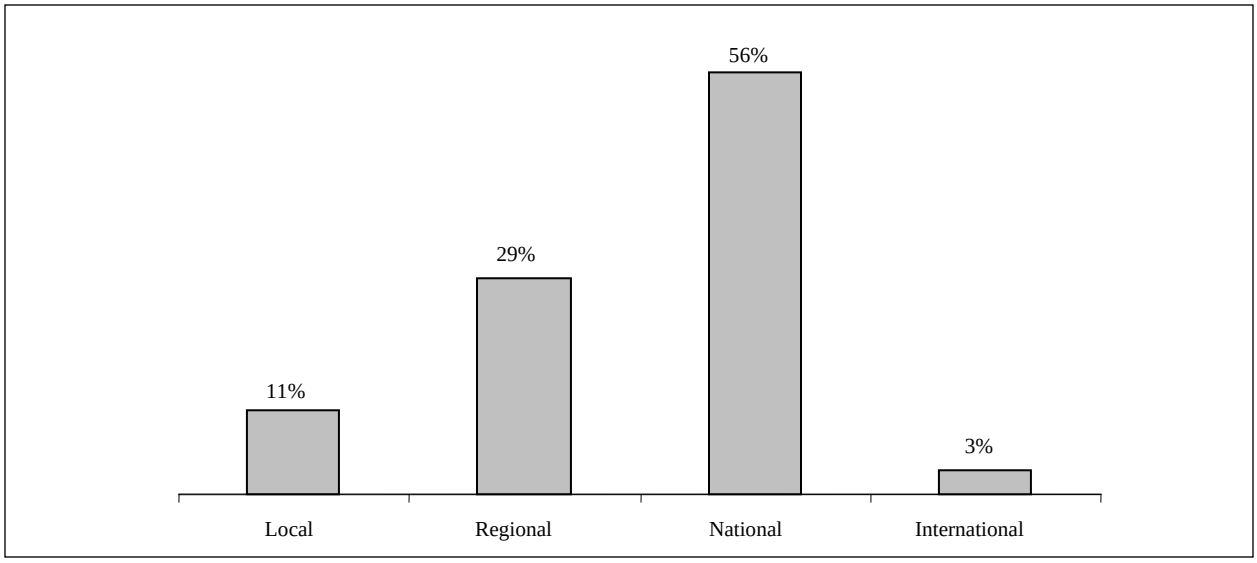
Source: Prepared by the author.

Thus, the proportion of the IT specialists to the totality is 0.7%, while the average proportion of IT specialists per institutions is 4.5%.

Orientation of Institutions

Figure 5 illustrates the orientation of the institutions. While more than the half are national institutions, like ministries, about 40% are orientated local or regional. Also, only 3.23% of institutions are orientated international, but this does not mean that the other institutions do not have international communication.

FIGURE 5
ORIENTATION OF THE INSTITUTIONS



Source: Prepared by the author.

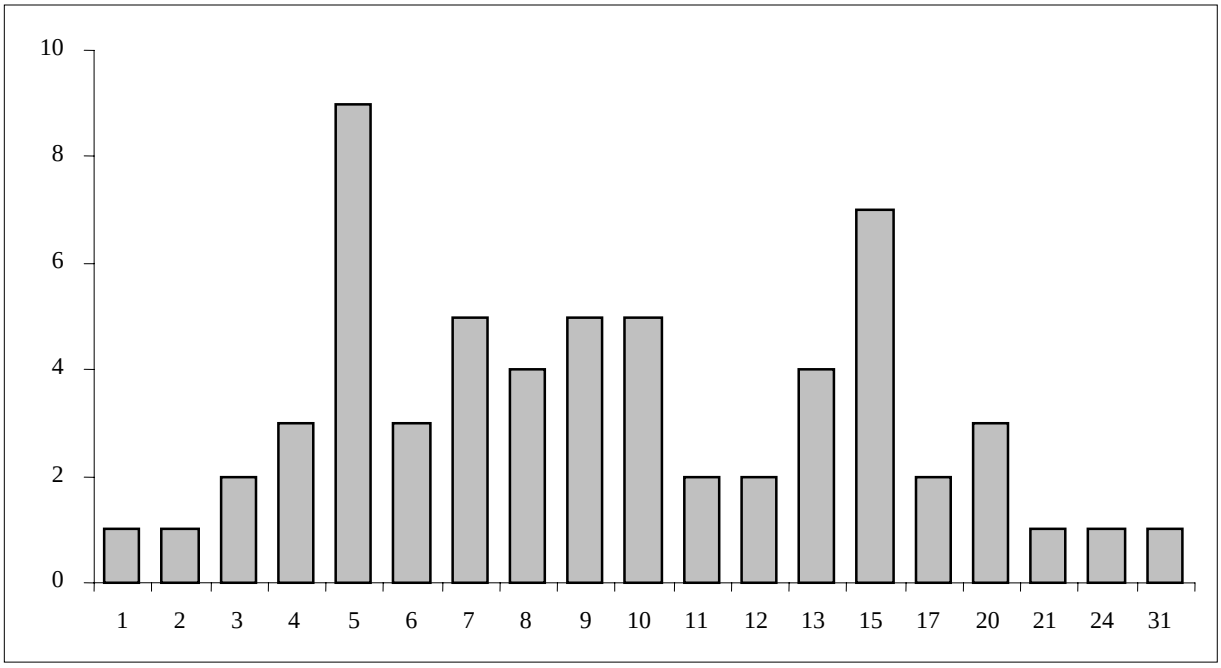
Location of Institutions

An interesting aspect might also be where the institution is located, in the metropolitan area of Santiago de Chile or not. By evaluating the names of the institutions and municipalities, the different surveyed entities could be matched with its location. The result is that almost 80% of all interviewed are located in the metropolitan area.

IT Experience in Institutions

In Figure 6 shows the distribution of IT experience in the institutions in. While the average is about ten years, there are peaks at five and fifteen years of IT usage.

FIGURE 6
YEARS OF IT EXPERIENCE IN INSTITUTION



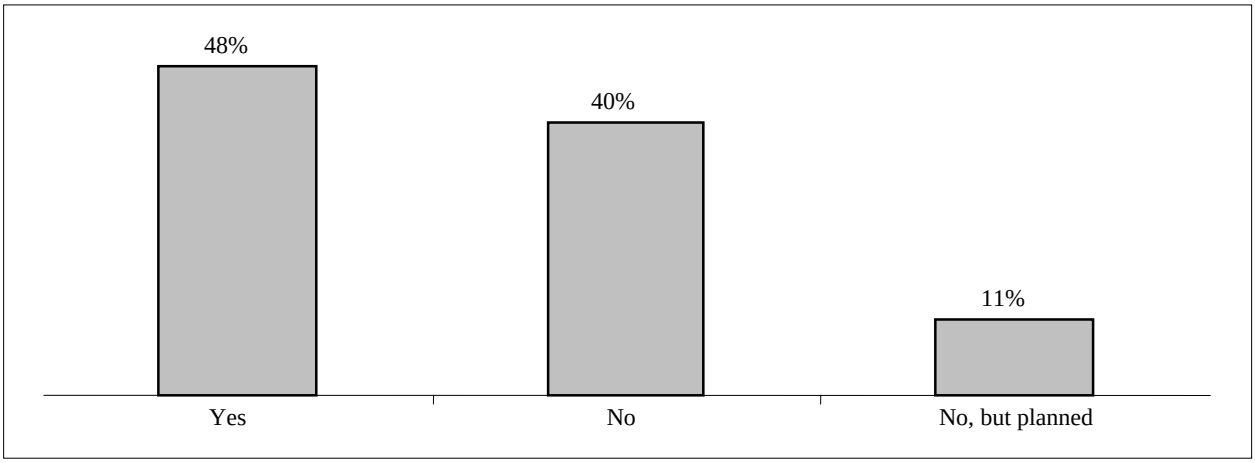
Source: Prepared by the author.

5.2. FOSS usage

More than 48% (cp. Figure 7) already have experience with FOSS and at least another 11% plan to use FOSS. Of the 11% planning to apply FOSS, the server usage leads the statistic.

Again, the names of the institutions and municipalities of the different surveyed entities were evaluated in order match them with its location. The result is that the percentage of respondents using FOSS in rural regions decreases to a value of 20%.

FIGURE 7
DOES INSTITUTION ACTUALLY USE FOSS

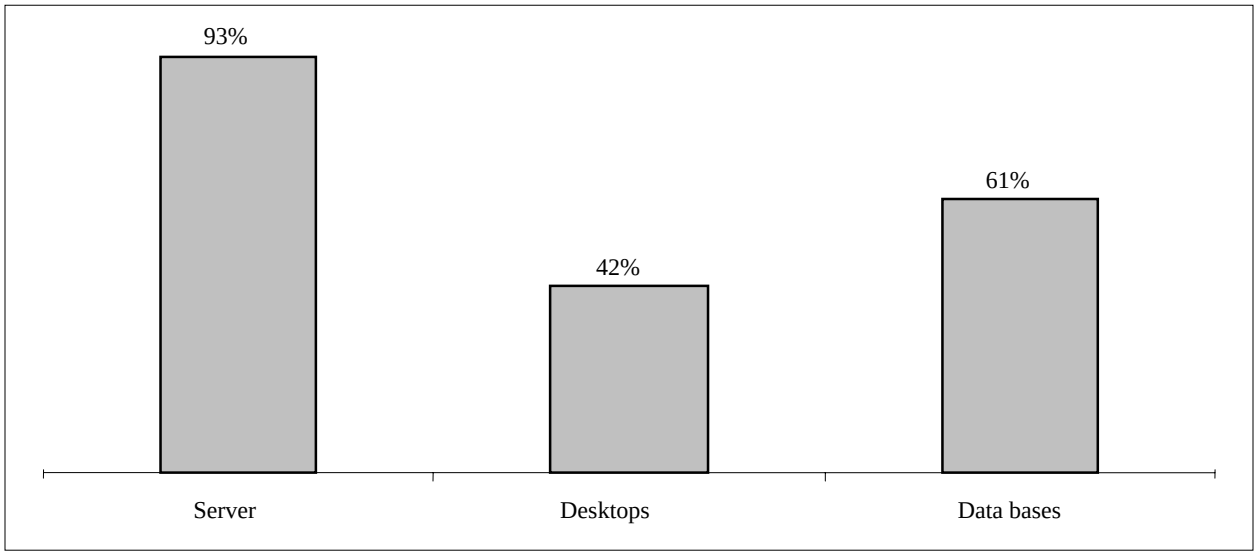


Source: Prepared by the author.

Actual FOSS Usage

As shown in Figure 8 nearly all of those applying FOSS do this with servers (93.55%) or data bases (47%). Only a minority already uses desktop applications. As the survey offered the possibility to comment the exact application of FOSS, only in two cases, the use of Linux as an operating system was reported. Furthermore, this was only on some PCs and not in the entire institution. In almost all cases, the server were used for providing e-mail and web services and / or as a firewall. The most dated Linux distribution was Red Hat. In the case of databases, MySQL was mentioned in 60% of all cases before Linux in combination with products from Oracle.

FIGURE 8
WHERE DOES INSTITUTION USE FOSS

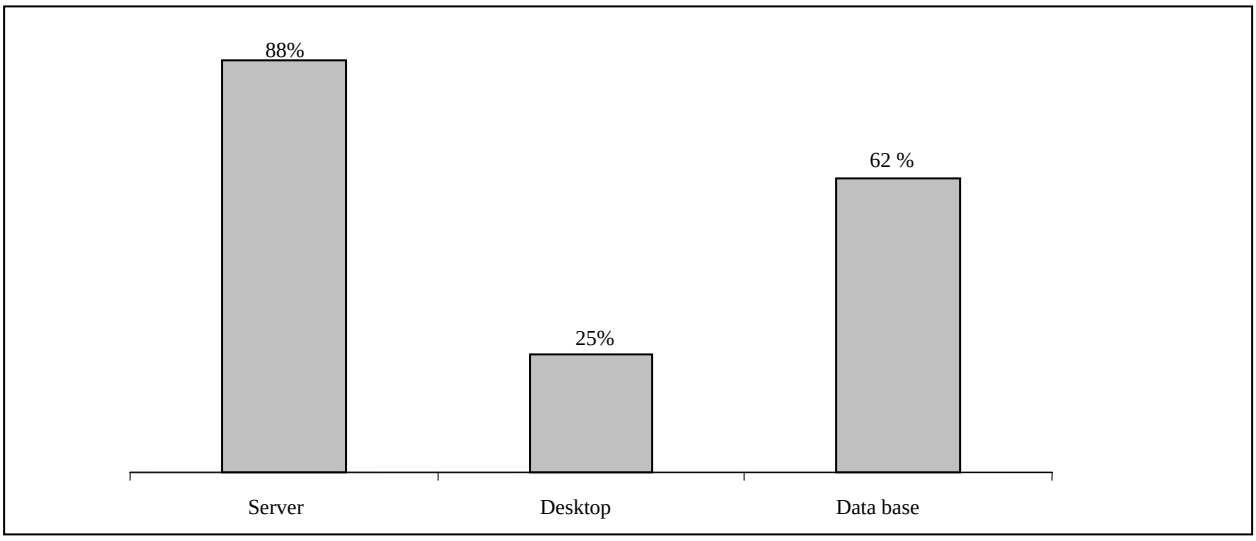


Source: Prepared by the author.

Planned FOSS Usage

Of the 11.11% planning to use FOSS in their institution most want to install it as a server (87.50%) or a data base (62.50%). Figure 9 illustrates this. In the case of planning to use FOSS on desktops, OpenOffice is taken into consideration as an alternative to MS Office.

FIGURE 9
AREA OF PLANNED FOSS USAGE



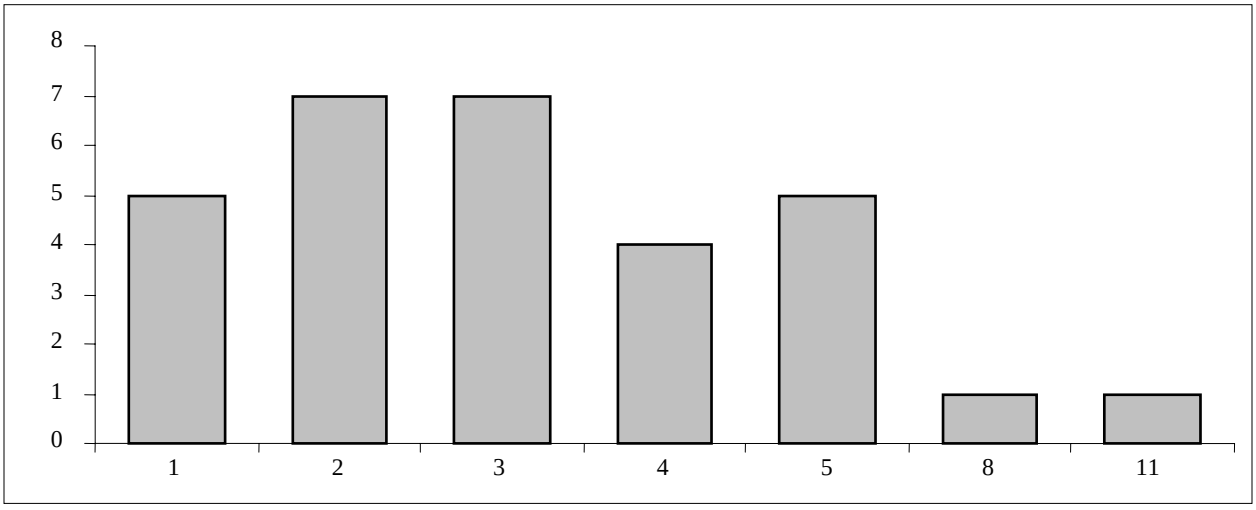
Source: Prepared by the author.

FOSS Experience

When examining the institutions' experience of FOSS in years, the distribution illustrated in

Figure 10 results. Most of the units (77%) have between two and five years of experience, while there are also two exceptions with eight and eleven years. While the peaks are at two and three years, the average is at 3.3 years of experience.

FIGURE 10
DISTRIBUTION OF FOSS EXPERIENCE IN YEARS



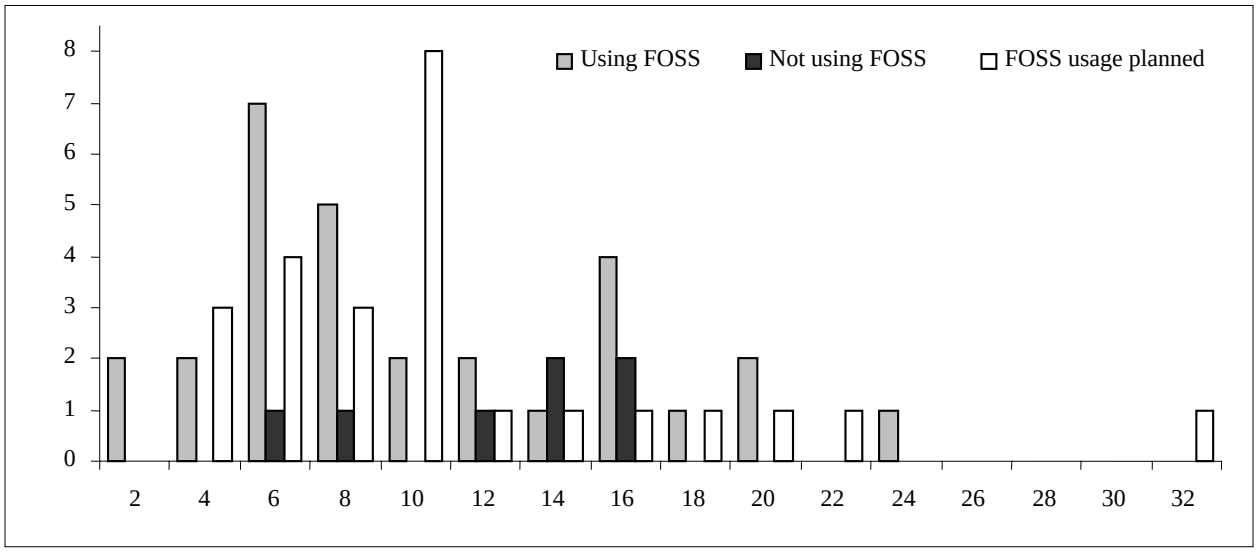
Source: Prepared by the author.

IT Experience and FOSS Usage

When examining the experience with information technologies and the usage of FOSS, it shows a tendency that institutions using FOSS have less experience then those not using FOSS or planning to use FOSS.

Figure 11 illustrates this correlation. Under institutions using FOSS there is a peak at six years and at those of planning to use FOSS at ten years. The average of experience with information technologies is 9.58 years for institutions using FOSS, 10.96 years when planning to use and 12.28 years in the case of not considering the alternative type of software.

FIGURE 11
YEARS OF EXPERIENCE WITH INFORMATION TECHNOLOGIES



Source: Prepared by the author.

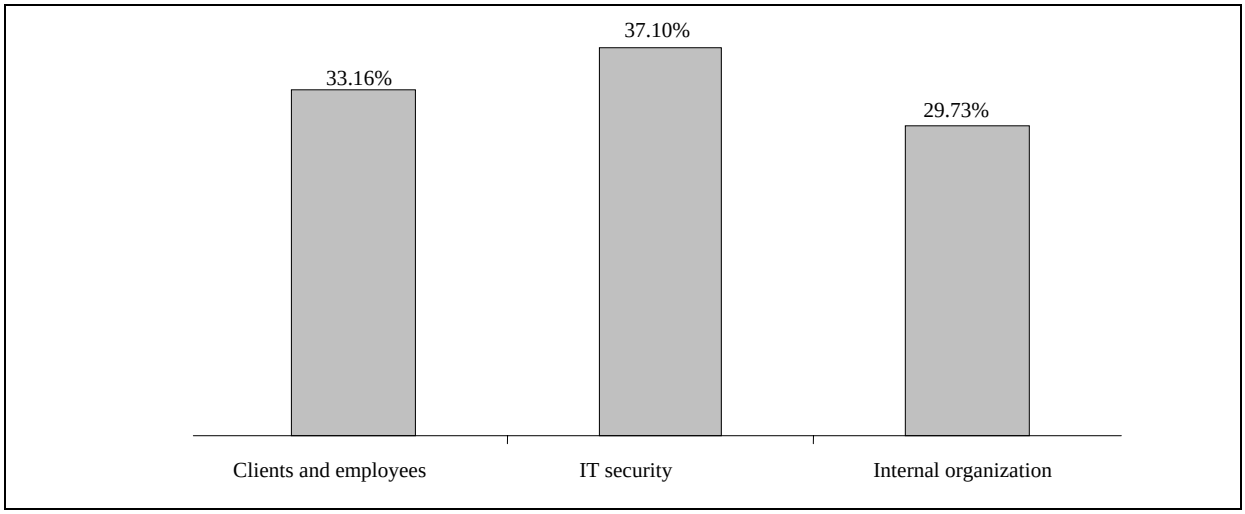
5.3. Evaluation by Importance

In the following the importance of the different criteria and the three perspectives introduced in chapter 5 will be presented in an aggregated form. When persons evaluate on a scale of importance, they only use sections representing their subjective attitude. In one case, it can be that the total scale from zero to six is used, in others, that only a part of it for example from 3 to 6 is used. In order to make these different types comparable, the used scale is always stretched to the total scale.

Importance of the Three Perspectives

According to the importance of the three perspectives, in most cases “IT security” leads the field. In the overall average it leads with 37.10%, followed by “clients and employees” with 33.16% and finished with 29.73% for the “internal or organization”. Figure 12 illustrates this result.

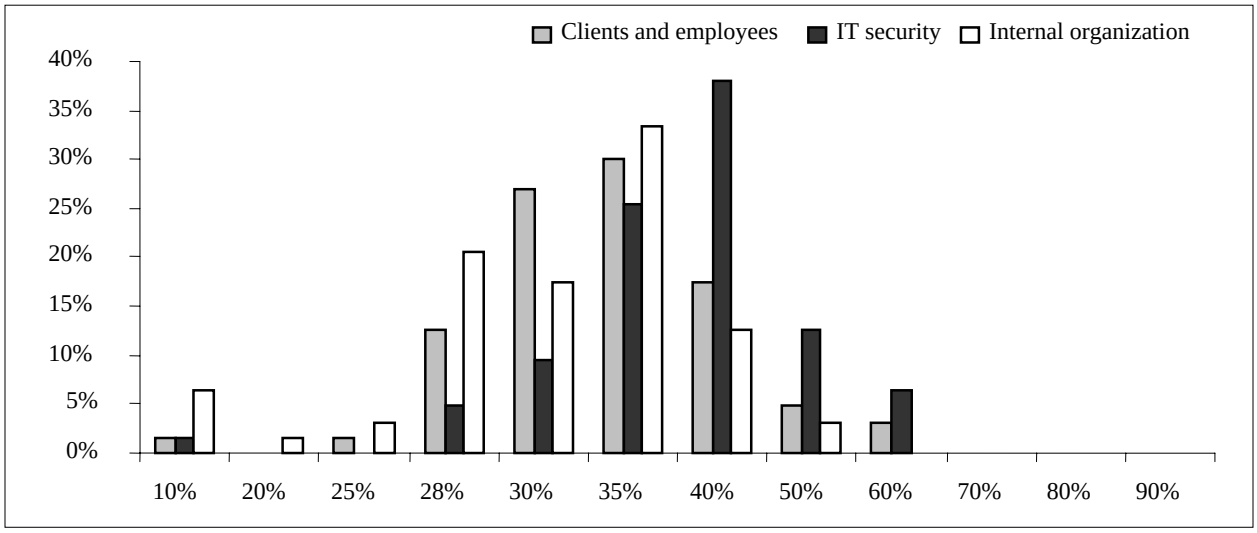
FIGURE 12
PREFERENCES FOR PERSPECTIVES



Source: Prepared by the author.

The distribution of all the preferences shown in Figure 13 underlines this fact. "IT security" is in average the most important perspective. The peak of "IT security" can be found between 40% and 50%, while the peak of the other two perspectives is situated between 35% and 40%.

FIGURE 13
DISTRIBUTION OF PREFERENCES FOR THE THREE PERSPECTIVES



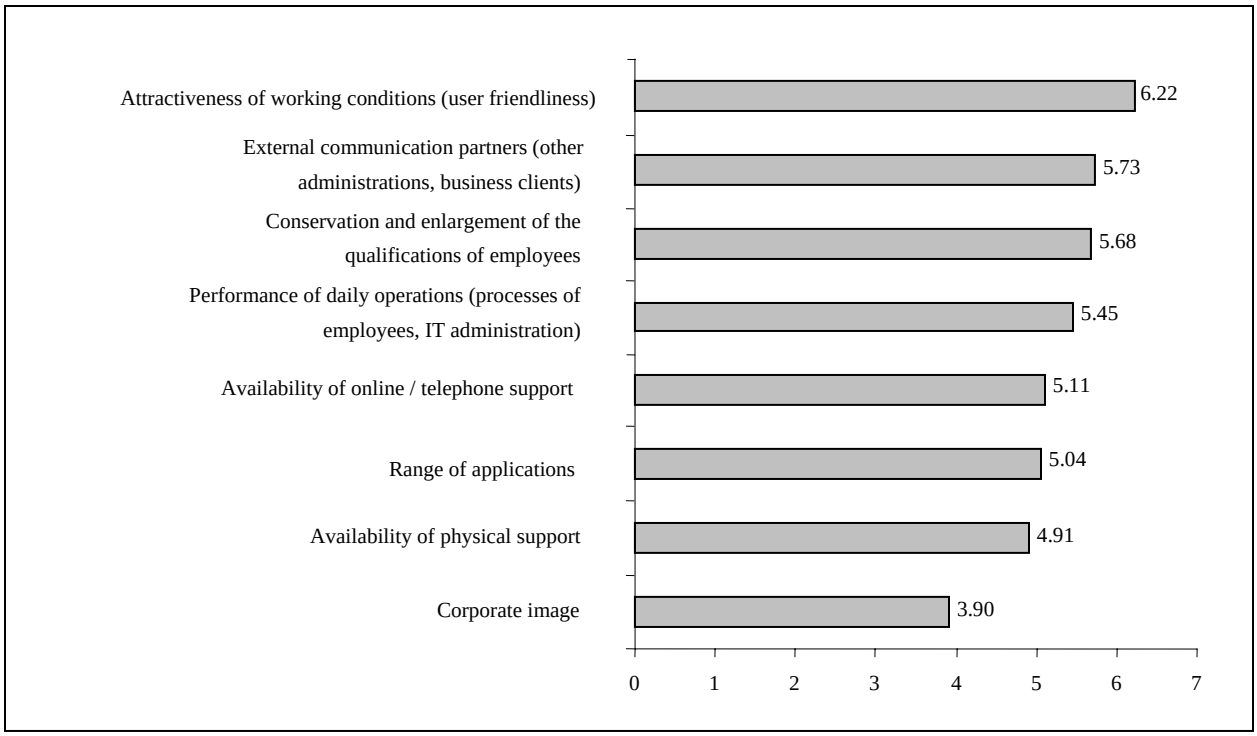
Source: Prepared by the author.

Importance of the Different Criteria

Figure 14 presents the distribution of importance for the perspective "clients and employees". As can be seen in the figure, it is remarkably more important than the following criteria (more than 0.5 points). As expected, the aspect of the corporate image received the lowest importance in this perspective.

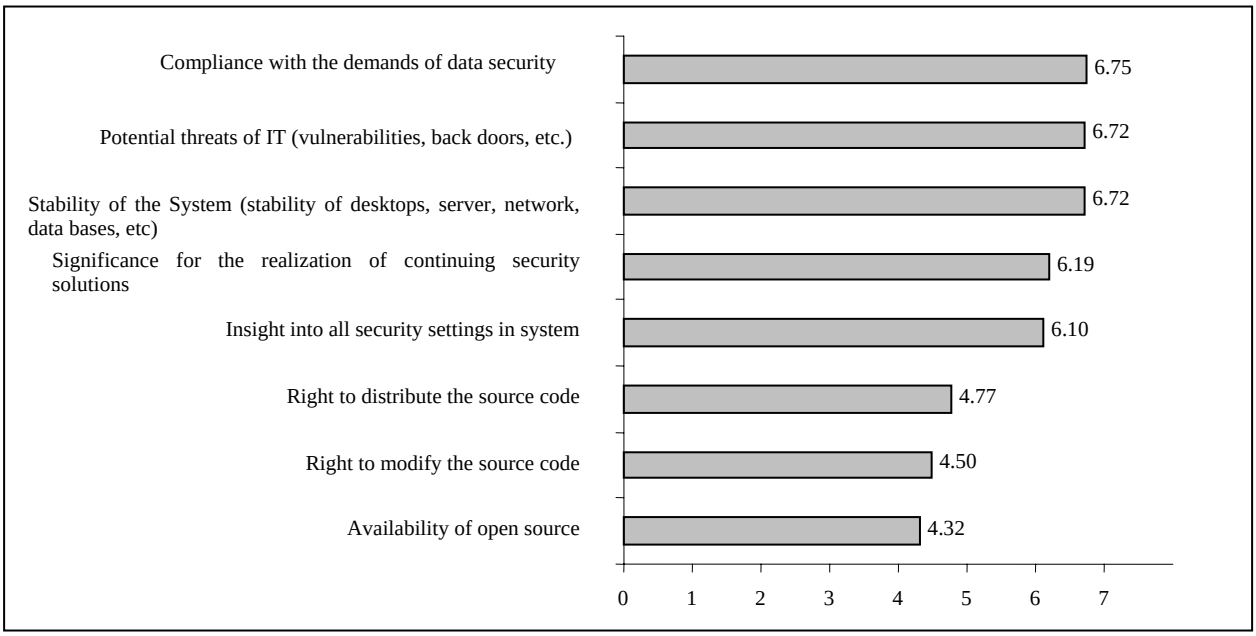
The criteria surveyed in the perspective "IT security" have received the highest values of importance in average, except those aiming at issues of open source (cp. Figure 15). This is very surprising, since among others the insight to all security settings in system could be achieved through these criteria.

FIGURE 14
IMPORTANCE OF CRITERIA FOR PERSPECTIVE "CLIENTS AND EMPLOYEES"



Source: Prepared by the author.

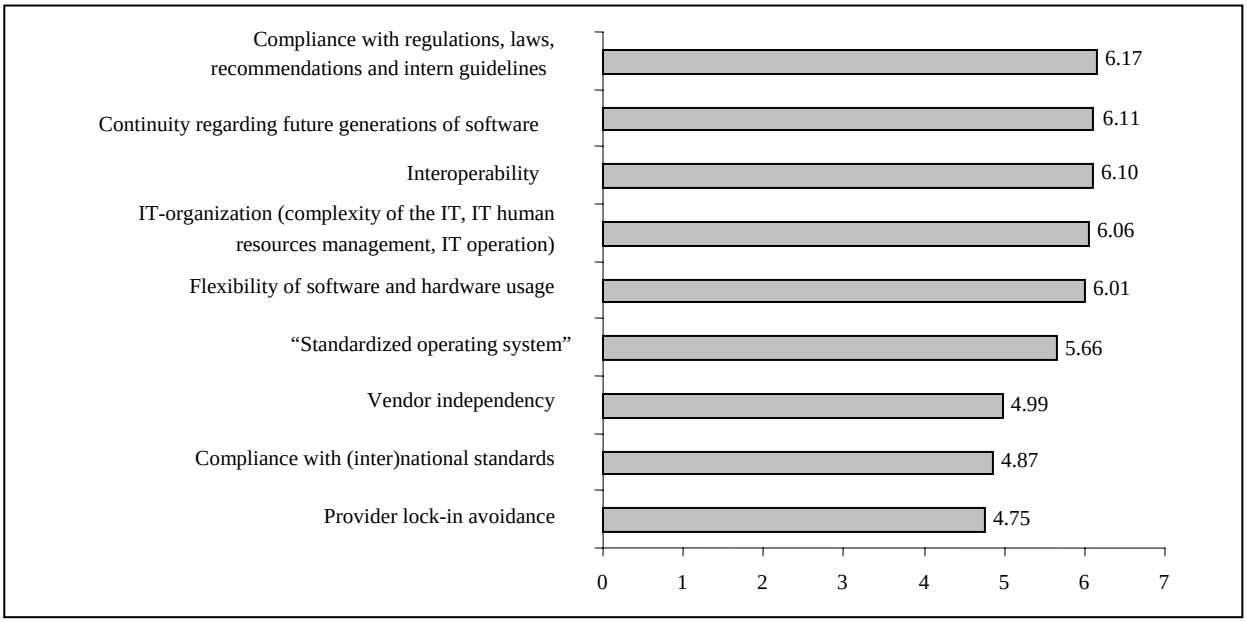
FIGURE 15
IMPORTANCE OF CRITERIA FOR PERSPECTIVE "IT SECURITY"



Source: Prepared by the author.

In Figure 16, the results of the third perspective show a rather homogenous distribution of the importance for six of the nine criteria. Vendor independency and provider lock-in avoidance are remarkable less important then the others. This is also the case for compliance with (inter)national standards, while interoperability (which has similar effects in practical use) is substantially more important.

FIGURE 16
IMPORTANCE OF CRITERIA FOR PERSPECTIVE "INTERNAL ORGANIZATION"



Source: Prepared by the author.

Differences between Institutions Dependent on FOSS Usage

In the case of clustering by usage of FOSS, 29 institutions already applying FOSS on servers, databases or desktops (group 1), 25 planning to use FOSS (group 2) and 7 not applying or planning to use FOSS (group 3) result.

Significant for these groups is that those institutions not using or planning to use FOSS put less weight on "performance of daily operations".[2] Additionally interesting is the aspect that institutions of group 3 assess less the corporate image than those of group 1 and group 2. While group 3 has only a mean of 2.6 points, group 1 and group 2 have 3.82 and 4.66 points.

TABLE

	Using FOSS	Plan to use FOSS	Not using / not planning
Quantity	29	25	7
Performance of daily operations (mean)	5.54	5.61	4.38
Corporate Image (mean)	3.82	4.66	2.6

Source: Prepared by the author.

Impacts on the Economic Efficiency due to FOSS Usage

When asking the surveyed persons already using FOSS if they had experienced any economically positive or negative impact due to the new software, two out of the 29 commented a negative impact on one aspect. In both cases, it was the need for more qualification of the IT employees and therefore a higher expense in education and support.

While about 10% did not recognize an effect on the economic efficiency until now, more than the half experienced a positive effect. This can be simply lower maintenance costs, higher uptime or more stability of used applications. Lower implementation costs were also stated very often, especially when the implementation was conducted by external consultants. In one case, the savings on the internal development of new applications due to FOSS where estimated on an 80% of previously dedicated time on this task. Of course, the most cited positive effect was savings due to no license costs. In some cases, these were so high, that the remainders were enough to create two or three new jobs.

When stated, the rest of the money was always re-invested in qualification, consulting or the upgrade of existing equipment.

[2] Mean: 4.38 in place of 5.54 for group 1 and 5.61 for group 2

VI. Impacts on Strategic Objectives

In the following chapter possible positive and negative impacts for the different surveyed aspects due to the use of FOSS in the public sector of Chile are identified. The different “hypotheses and cognitions” are derived from interviews with several participants of the survey. Some of these participants already had implemented applications based on FOSS in their institutions, or are planning to do so. Furthermore, institutions of the public sector already using FOSS in Germany have been interviewed.

The emphasis will be on the most important criteria and the influences of local factors in Chile. In addition, in order to consider the impacts on economic efficiency with FOSS, an initial situation that all institutions are using proprietary software is assumed and the changes with FOSS observed. In order to specify this, it is tested whether there is a positive or negative effect on the migration costs. As shown in chapter 6, in most cases proprietary software, in particular Microsoft products, is still the predominate type of software in use.

6.1. Attractiveness of Working Conditions

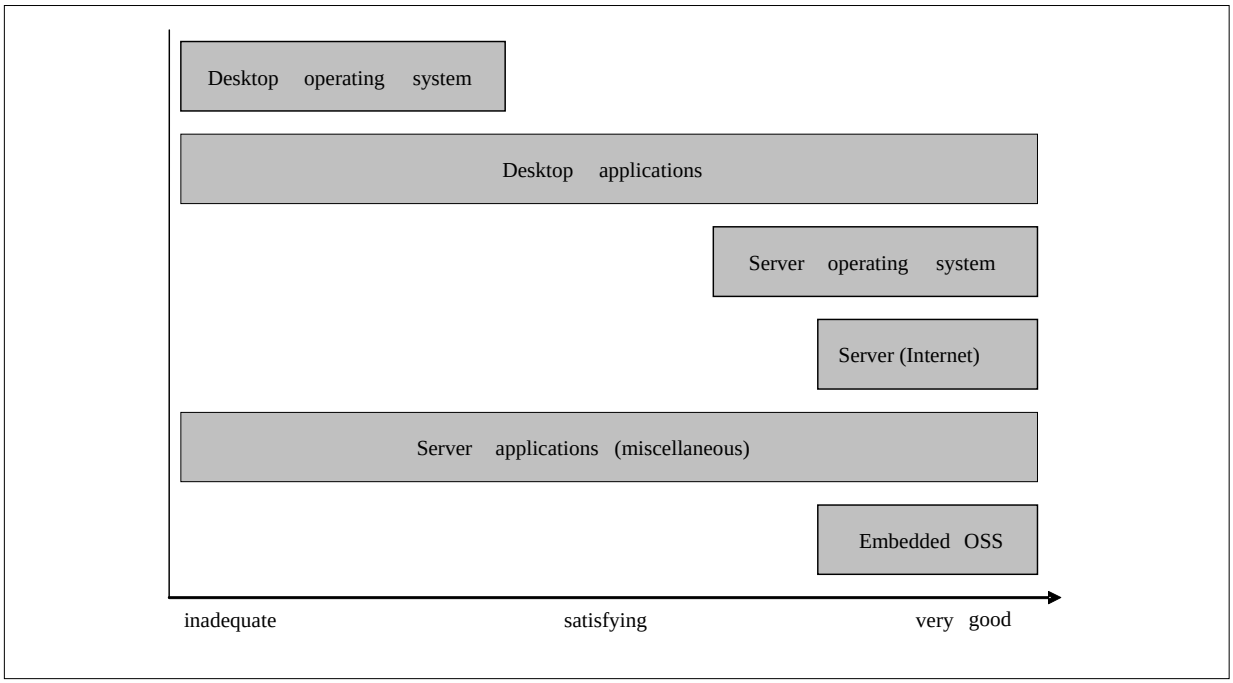
The attractiveness of working conditions with information technologies might seem one of the most difficult issues to measure as it can be easily influenced by personal attitudes, likes and dislikes.

Beside this, attractiveness can be influenced by the software itself, of course, but also by the combination with other software. One product not supporting the “drag’n’drop” functionality can be an excellent solution if used alone, but really annoying in combination with other software. It is obvious that the attractiveness of working conditions can have an influence on the performance of daily operations.

In cases of migrating a whole operating system and not only specific programs, a migration should not only be investigated in regard to standard applications used for the objectives of the institution, but also to “helpers”. These can be programs, not officially used, that help users to do tasks more easily or make daily life more attractive for them. This can be software for editing graphics (if the user normally does not edit graphics) or little games and programs to listen to music, which the user is used to have in order to relax during breaks.

Concerning FOSS, Figure 17 illustrates the maturity of the different types of free and open source software investigated by [Berl2004]. As a server operating system used to establish permanent connections with the internet, for example as firewall and internet router, FOSS is in an advanced state of development for practical use, while it is partly in inadequate shape for use as a desktop operating system.

FIGURE 17
MATURITY OF DIFFERENT TYPES OF FOSS [BERL2004]

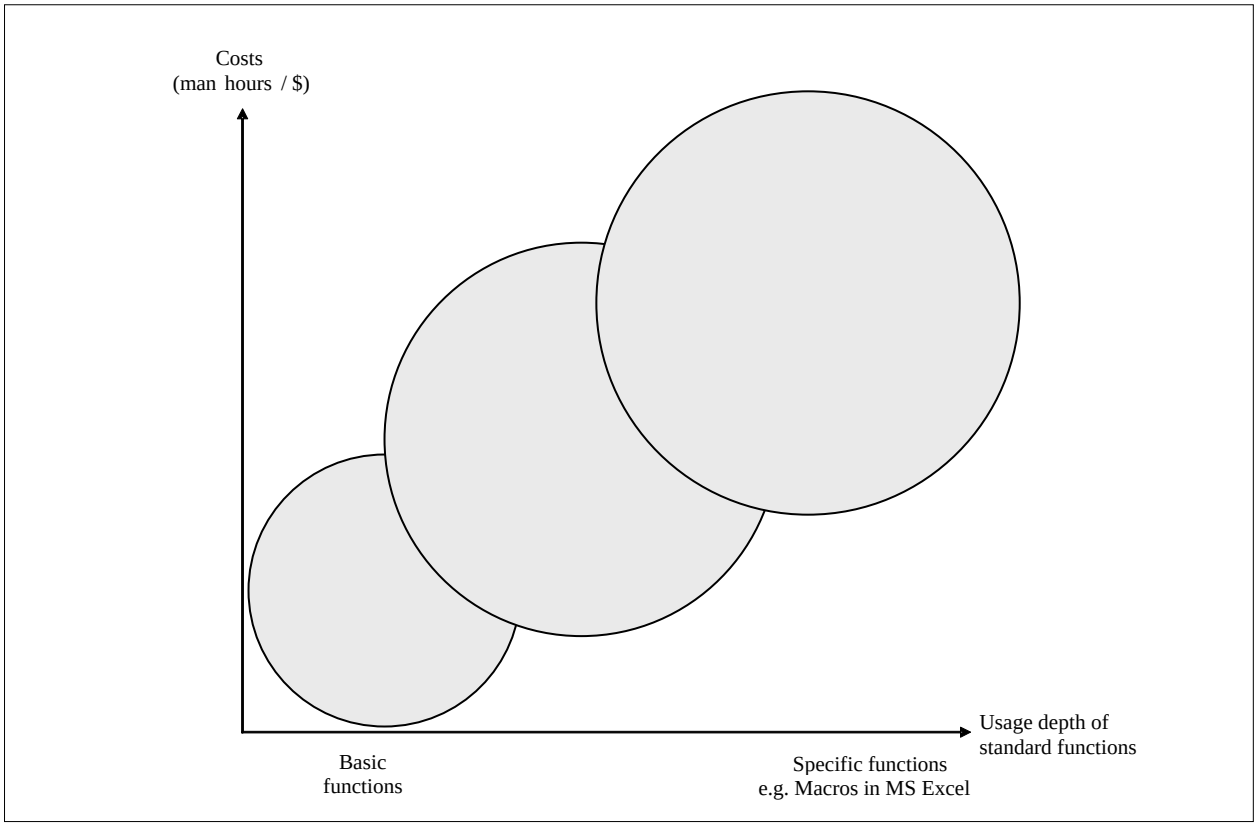


Source: Prepared by the author.

But of course, a general statement about all FOSS applications cannot be representative. As the overview of [Berl2004] shows, there is a big variety of software for desktop applications and server applications. Hence, every specific case must be examined to determine whether FOSS is appropriate or not. Often, FOSS is already on a state-of-the-art level for basic functions, but is lacking in a situation of specific employment. An example is the office suite OpenOffice. It is an appropriate replacement for most of Microsoft Office in of basic word processing, calculations and presentations, while when used to work with deeper functionality, OpenOffice cannot compete with its proprietary counterpart. One example is the macro-functionality of Microsoft's Excel which is not possible with OpenOffice's Calc.

Figure 18 shows the trend of influence on the costs of a migration. The more specifically a program is used, the more expensive the costs of evaluating, training and adapting new software can be. When an important function may not be implemented, deliberation is in order about whether to pay more for an additional programming or to accept the loss in efficiency of daily operations. As already shown in other case studies (cp. [Unil2001]), the cost of adaptation can be one of the biggest factors when migrating.

FIGURE 18
MIGRATION COSTS IN RELATION TO DEGREE OF USAGE OF STANDARD SOFTWARE



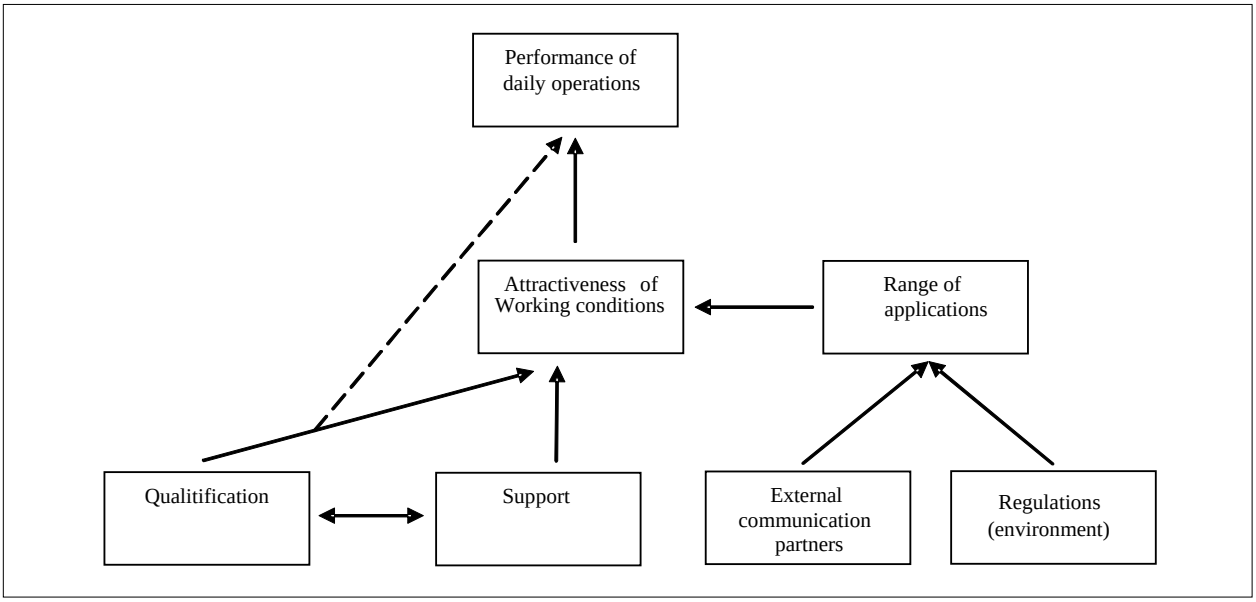
Source: Prepared by the author.

But the fact that it is "open source" gives it the tremendous advantage of profiting from the worldwide FOSS movement and from being developed continuously. An example confirming this is the case of one institution of the Chilean public sector carrying out internally a usability study of OpenOffice for institution-wide employment, who admitted that during the examination some found faults had been implemented. Of course, this can also occur by accident, but the idea behind the concept of the FOSS development process is in favor of continuous improvements.

Figure 19 reveals other influencing factors. The qualification of employees itself has got a major impact on the attractiveness of working conditions. The more familiar end-users are with the software, the more efficient and satisfying they can work with it. This also applies for the employees working in IT support with the difference that this effect might also encourage the work efficiency of the end-users who get assistance from them.

The range of applications also has an effect on the attractiveness of working conditions, because if exists a big variety of different programs, of course it is easier to replace insufficient software or to use software people are familiar with. The range of applications being applicable is dependent on two factors. First, external communication partners demanding a specific format can restrict the choice and second, of course, regulations like demands for security make it impossible to user every type of software.

FIGURE 19
CAUSE-EFFECT CORRELATIONS: FACTORS INFLUENCING AND BEING INFLUENCED BY ATTRACTIVENESS OF WORKING CONDITIONS



Source: Prepared by the author.

6.2. External Communication Partners

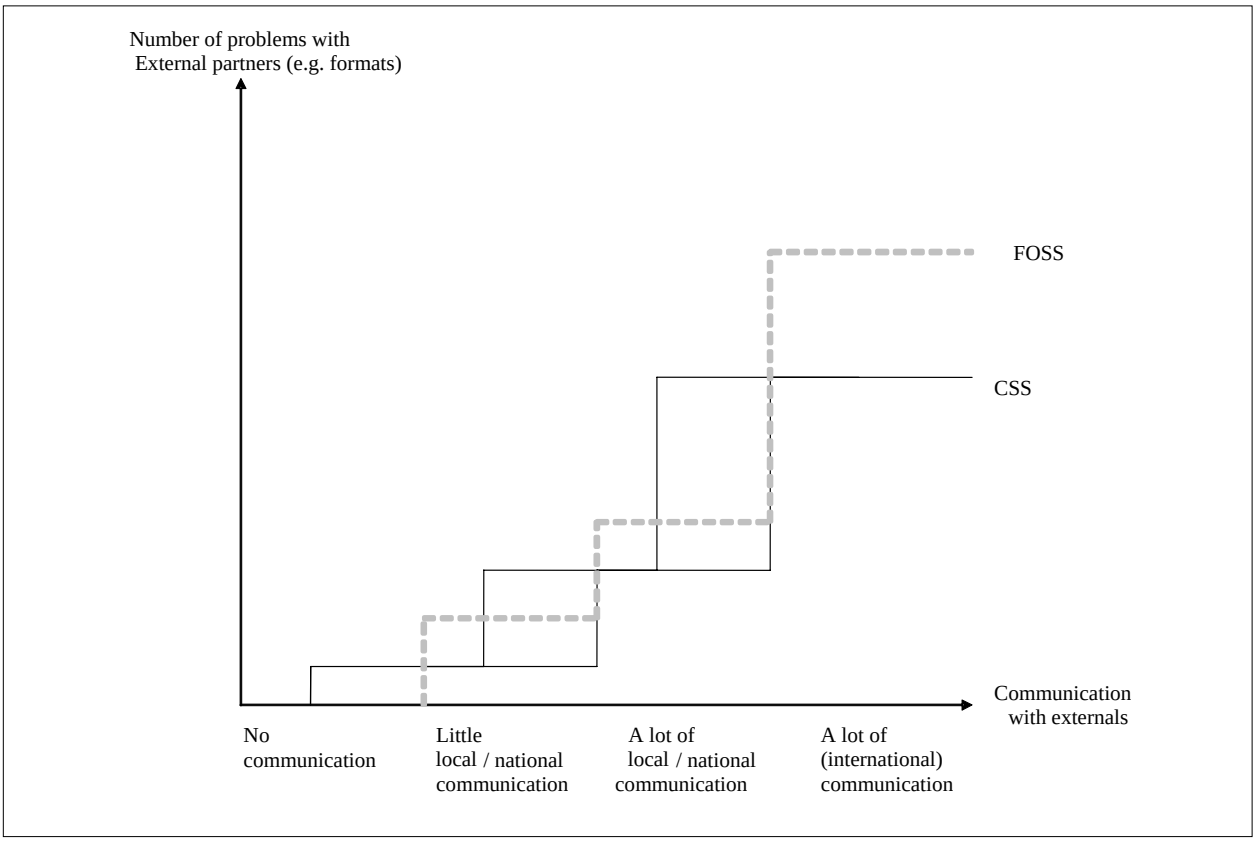
It has been shown in chapter 4 that public institutions can have relationships with other institutions, citizens and business related clients. In regard to the importance of communication with these externals, first, it has to be distinguished between institutions having a lot of communication based on proprietary standard formats and those not having this or having communication on well designed predetermined interfaces like web applications (e.g. a contact form).

It must be mentioned that the problems due to communication with interchanging documents also generate difficulties with different versions of the same proprietary product. A solution can be to fall back on formats like Adobe's PDF, which is system independent.

Assuming that problems of communication with citizens, companies and other institutions can be solved by agreeing to a common standard format, problems when interchanging internationally will hardly be solved, as this was a popular topic when talking about this issue in interviews. This problem derives from interacting with many different countries requiring different standards in IT.

Figure **20** illustrates this relationship, demonstrating a tendency for more problems through use of FOSS and an increased number with international relations.

FIGURE 20
NUMBER OF PROBLEMS IN RELATION TO AMOUNT OF COMMUNICATION



Source: Prepared by the author.

6.3. Range of Applications

The range of applications can show how many different programs for different specific objectives or also for the same task exist. This can depend on the platform used, and also on the field of usage. For example, Apple Macintosh is still popular for graphic design and desktop publishing in professional printing.

In the interviews, three main factors restricting the range of applications dependent on the operating system could be identified. First, business relations with externals based on specific proprietary software formats. Second, institutional guidelines and, finally, how specifically the software has been adapted to the needs of the particular institution.

The first aspect is characterized by the fact that it always deals with very special applications which are going to exchange formats which are not commonly used. These formats can be proprietary ones, which often make migration to FOSS very hard or even impossible. When the specifications of these formats are freely accessible, it is a format which is not supported by the worldwide community for FOSS, or the community is not able to support it when manufacturers refuse cooperation and do not publish any information for developers. This phenomenon of only supporting standard applications and hardware could also be found in cases in Germany. For example, while you do not have trouble getting a software driver for a low-cost scanner, it is very difficult or even impossible to get support for a high-end

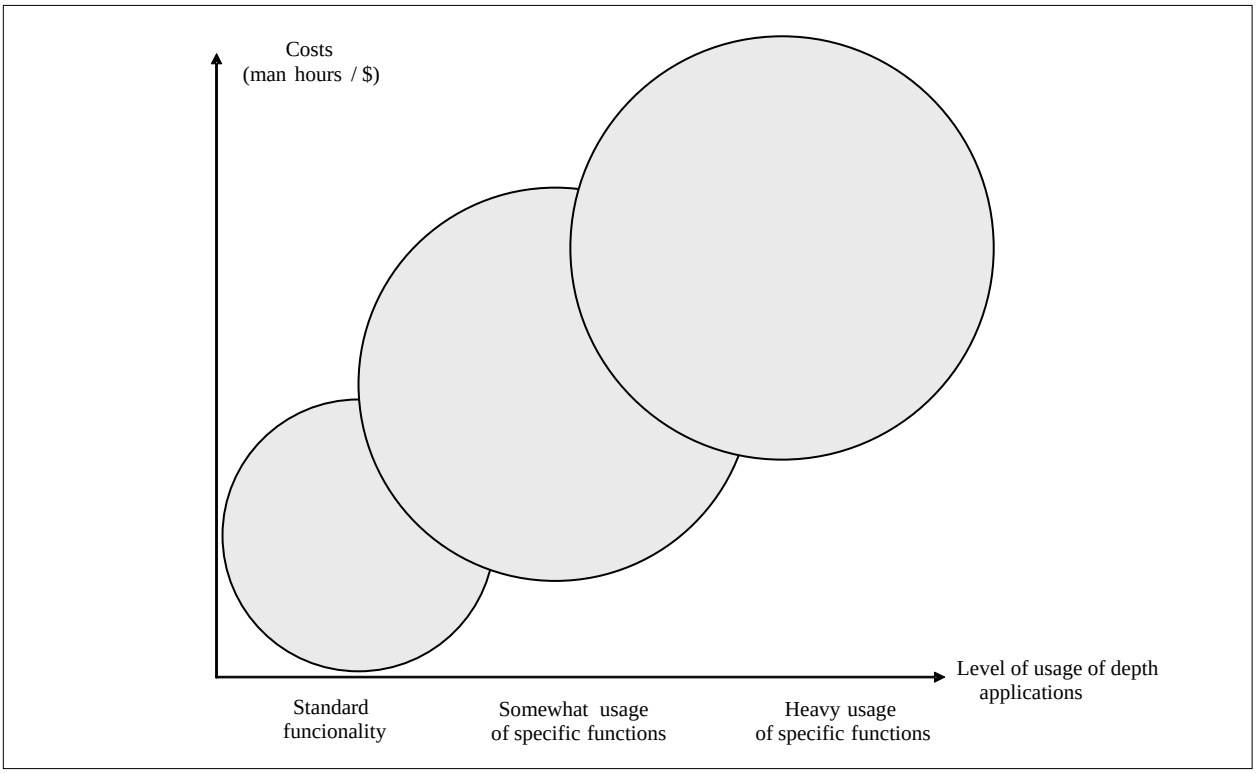
system. This is because FOSS developers just fill the gap for their personal use and, of course, high-end usage generally does not appear in home usage.

Second, there might be many undiscovered de-facto standards, due to historical development. In the interviews, some of these were discovered by accident, showing that a feasibility study of FOSS should not be concentrated on the institution itself, but, as already shown with the concept of economic efficiency profiles of Antweiler (cp. chapter 5), also in relation with its environment. Hence, deriving dependencies which were not foreseen can generate unexpected organizational problems, leading to inefficiency of daily operations. An example is an internet application used by an estimated 30% of all employees in the Chilean public sector. These are not contracted as civil servants and have to enter their time calculations in a special application supported only by Microsoft's Internet Explorer, at the time the interviews were given.

Finally, software often has been adapted to the needs of an institution. This could be standard software like Microsoft Word adapted with special scripts in order to perform existing processes faster, and external or in-house developed software. According to statements of the interviewed persons, there might be a number of further applications not compliant with all kinds of software.

According to this information, Figure 21 can be set up in order to categorize the negative effects of a migration to FOSS in relation to the specification of the different applications used. The more specific an application is, the more difficult it will be to get this application to work under an FOSS operating system and to find an alternative, respectively.

FIGURE 21
MIGRATION COSTS IN RELATION TO DEGREE OF SPECIFICATION OF APPLICATIONS



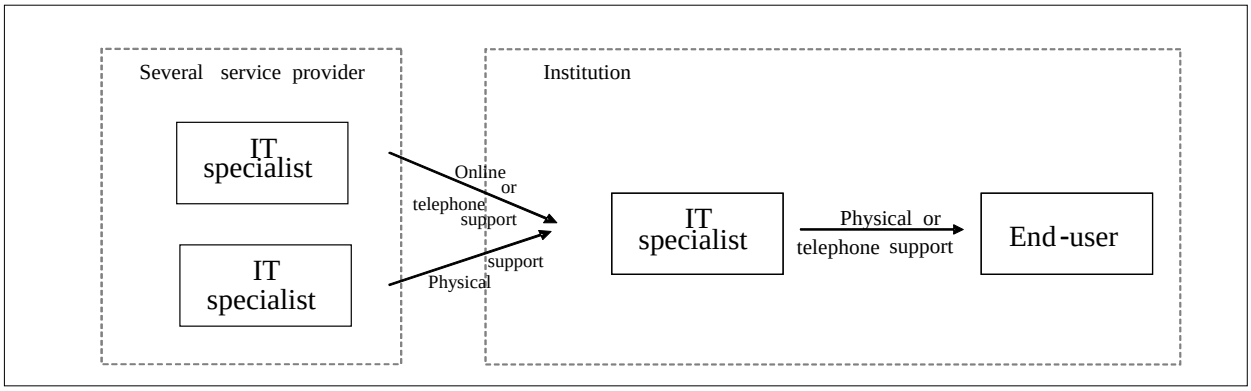
Source: Prepared by the author.

An aspect which is not reflected by Figure 21 is the possible existence of a knock-out criterion. This is a criterion which FOSS has to fulfill in any case. An example is the feasibility study arranged internally in an institution for the introduction of a new FOSS based groupware solution, which was rejected because of some functions which were absolutely necessary and the tested software could not fulfill. In the concrete case, functions for resource management were not implemented.[3]

6.4. Availability of Support

When talking about the availability of support it is distinguished between online or telephone support and on-site service. In most of the interviewed cases, the scheme shown in Figure 22 how support works in institutions could be identified.

FIGURE 22
FLOWCHART OF THE SUPPORT PROCESS



Source: Prepared by the author.

Generally, a department for information technologies exists, providing support for all end-users of the institutions. With these end-users, the support is given at work places or in the case of simple problems via telephone. It is unusual for the majority of end-users to get support directly from a software provider. This is only the case, if employees are involved who are highly specialized on a field of application in IT usage.

Whereas the IT specialists of the institutions used to deal with problems concerning software, the trend is now more to get solutions to problems via the internet. Often, these problems are also more complex. Out of the interviewed group of users, nobody could say they ever received direct support from Microsoft, either because of problems with its usage or because of programming errors of the program used. Of course, there are third party companies offering support for Microsoft products.

With FOSS, the situation is different. Principally, this is due to from the completely different business model. As already mentioned, proprietary software generates income due to licenses, while FOSS achieves these incomes through services like support or software adaptations. Furthermore, the worldwide community of FOSS is more willing to help each other and continuously improve their “own” software. Consequently, interviewed persons also said they have more possibilities and more access to online support by using FOSS.

[3] Actual FOSS solutions feature this.

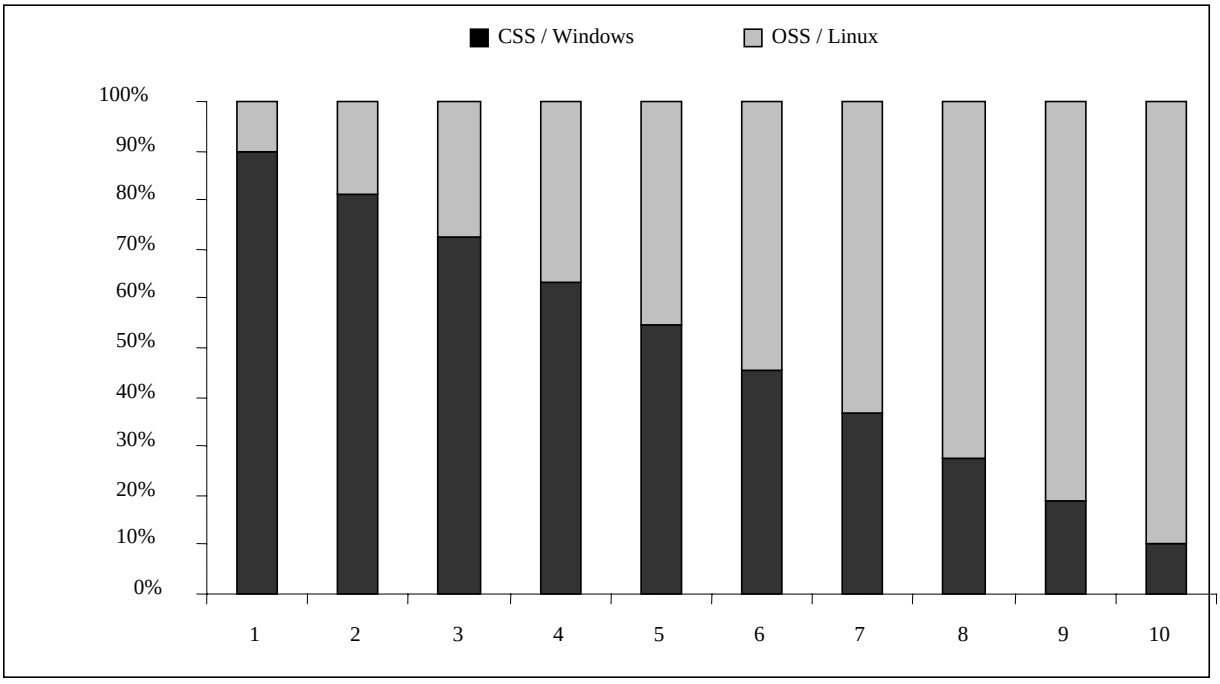
Support: Trouble Tickets

In the case of migrating an entire institution, many interviewees assumed a higher need for support because of a completely new environment of information technology which the end-users are not used to. In the case of the administration of the city Schwaebisch Hall, this assumption did not become reality.

In 1999 all computer systems of end-users were completely changed from Microsoft's Windows operating system to Linux systems. Before changing, all employees were trained in the new operating system and the new office versions. This course of instruction was held at a time, when routine employee training would have taken place, so there were no additional expenses. Of course, many templates had to be adapted to OpenOffice, but this change was used to introduce a new corporate design on all letters.

In ten months the city changed from 10% Linux and 90% Windows as operating systems to 90% Linux 10% Windows as shown in Figure 23. During this time, the number of trouble tickets[4] in the ticket request system was analyzed with the result illustrated in Figure 24, that, besides the fact that about 50% of all problems where in the area of printer usage, there were no big differences between the number of problems with proprietary software or FOSS. It must be mentioned that in Schwaebisch Hall many single user printers are used which are responsible for the majority of problems needing support. These machines more often generate the need for human interaction, the exchange of ink cartridges and toner refilling, or mechanical maintenance than centralized network printers.

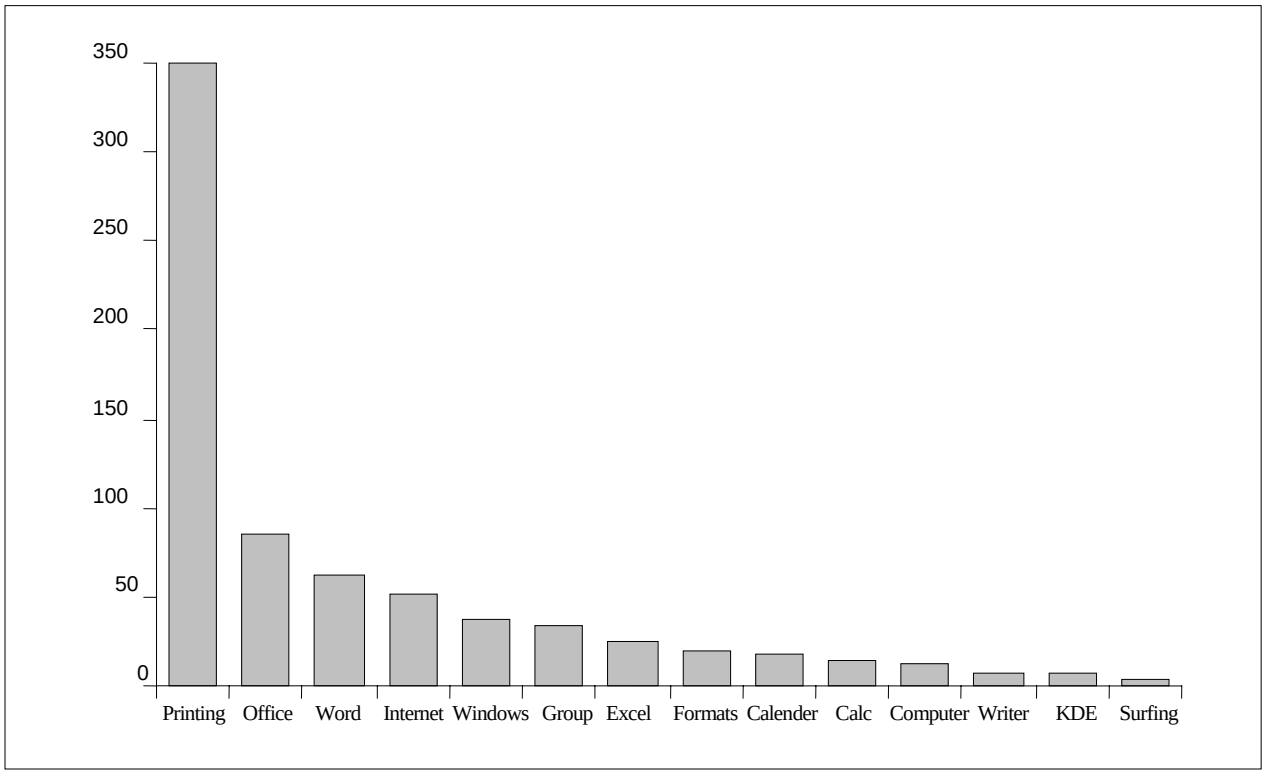
FIGURE 23
DISTRIBUTION OF CSS AND OSS IN THE INSTITUTION DURING THE 10 MONTHS OF MIGRATION



Source: Prepared by the author.

[4] Trouble tickets do not include simple problems which could be solved immediately.

FIGURE 24
STATISTIC OF TROUBLE TICKETS ("PROBLEMS") IN 10 MONTHS OF MIGRATION FROM CSS TO OSS, SUM 834



Source: Prepared by the author.

Offers of Support for FOSS

The lack of appropriate third party companies offering support and training to get IT specialists of an institution trained for FOSS was often an argument against FOSS on the part of many CIOs in the past. In Chile, this has changed noticeably in the past two or three years. Services for FOSS, especially on Linux training, are easy to get without the problem of having only few providers to choose from. Furthermore, interviewed partners told of having experienced cost savings with services with FOSS. This can be only subjective, as figures could not be quantified and compared with comparable assistance for proprietary solutions. Theoretically, it sounds realistic, because certified training for Microsoft products or those of other proprietary software producers is very expensive and for the most part it is the only way to obtain this knowledge. On the other hand, FOSS knowledge is easily achievable including additional support from the worldwide community at no charge. These savings are reflected in service prices, of course. Figure 25 shows an example for public contraction on the internet platform Chilecompra.cl.

But this aspect is valid only for the metropolitan area of Santiago de Chile and more densely populated regions. In rural regions, according to interviewed persons the situation is still difficult for FOSS. Often there are only few companies offering services for information technology and of course, due to historic development, only supporting proprietary software like Microsoft products. Hence, the calculation of use in rural regions has a strong negative impact on the economic efficiency of FOSS, because training costs increase tremendously due to expenses for accommodations and traveling, especially when air travel is necessary because of the large distances.

FIGURE 25
SCREENSHOT OF CHILECOMPRA.CL ON PUBLIC CONTRACTION FOR TRAINING ON LINUX

Source: www.chilecompra.cl

6.5. Conservation and Enlargement of the Qualifications of Employees

The conservation and enlargement of the qualifications of the employees is, on the average, the third most important criterion from the perspective of clients and employees, according to the results of the survey. With this matter, it has to be distinguished between the IT specialists and the rest of the employees. First, the impact of the latter is looked at.

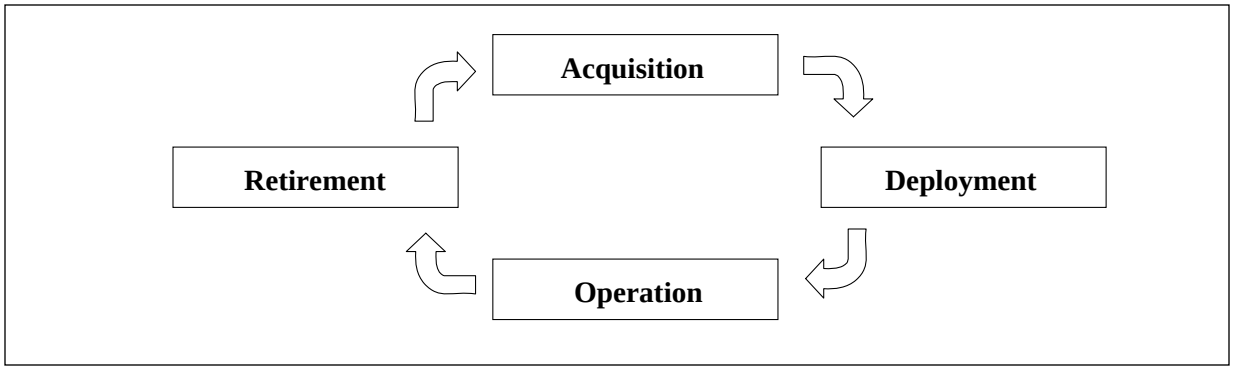
It is obvious that qualified employees work more efficiently than unqualified ones. Hence, the level or status of qualification can, but does not need to have an influence on the performance of daily operations.

Historically, the main purpose of information technologies was to replace employees, but nowadays this objective has changed to the goal of helping employees perform their daily tasks faster. [Antw1995] As shown in Figure 19, information technologies, as presented in chapter 0, should help to improve daily operations. A qualified employee can only develop all his / her capabilities, if he / she is also qualified to use the instruments of information technologies. Changing the whole environment from proprietary software to FOSS will make new qualifications necessary in order to keep the level of capability with the software used.

Although this seems to be one of the worst aspects of FOSS usage, it represents only a one-time investment, which can be softened by different factors. First of all, an attempt can be made to configure the new system and use software in a way to make it look like the old one did. This helps employees to manage the new system more easily, as features can be found where they have been found for years. Second, if possible, the date of the periodical qualifications should be at the same time as the migration in order to mitigate or eliminate additional training costs.

The IT specialists are the ones implementing, maintaining and administrating the whole IT environment. For them, it is more complicated to be "up-to-date" with their level of qualification, especially if they are supposed to change overnight to a completely new world of software. Figure 26 illustrates where the differences between the end-user and the administrator on the basis of the steps of a life cycle model are. While the end-user only has to deal with the step of operation, the administrator has to be able to handle all steps of information technology ventures. Of course, it is considerably more difficult to acquire all this knowledge.

FIGURE 26
STEPS OF LIFE CYCLE OF IT



Source: Prepared by the author.

In the case of the Chilean public sector, a strong asymmetric information distribution was observed. On one side, there are institutions already having practical experience with FOSS, on the other there are many units not using or planning to use FOSS, which have only little information about this thematic. The results of the survey in chapter 6 confirm this distribution.

While several institutions are carrying out feasibility studies, others do not have free time in their work schedule to do so or the budget to contract consultants for this. It could not be proven, but it might be the case, that different institutions are carrying out parallel internal feasibility studies on the same products. A central contact for the feasibility of software could probably help to coordinate this aspect and make this process more efficient. This issue was also proposed very often by interviewed persons. They would appreciate a better transfer of knowledge between the institutions and a directory of practical examples for orientation. Unfortunately, bad news spreads faster than good news and for this reason, the failure of the migration of the institutions of the "aduana", according to the subjective impression of the interviewees, is more widely known than good examples of FOSS usage. What makes the situation even worse is the aspect already mentioned, that in non-metropolitan regions, the availability of second-level support or formation opportunities for FOSS are very low and only possible at high cost.

Finally, peer pressure is also sometimes an argument or concluding with the statement of an interviewed person: "Which operating system would you use, when 95% of your colleagues are using Microsoft products?"

6.6. Performance of Daily Operations

As this study wants to evaluate the use of FOSS in general in the public sector in Chile, it is not the objective to analyze all specific processes. Also, as there are repetitive ones in many institutions it might be presumptuous to give a statement about the end-effect.

There were many examples in which daily operations could have been performed faster. For example, in one case, after the change from a Microsoft server to the Linux pendant, savings of up to 70% per week (about 3.5 hours) were realized in the time for dealing with the organization of the spam filter system per week. Overall, many of those interviewed report higher performance with server usage and its administration. It has to be added that almost all interviewed institutions did not have practical experience with desktop applications, at the most having evaluated several products.

But, there are also many other factors influencing the performance of daily operations, as already mentioned, like the employee's qualifications and the attractiveness of working conditions.

6.7. Potential Threats of the IT

In the Chilean government there are many young institutions or projects, which are really well equipped with information technology resources. These institutions often use state-of-the-art solutions from Microsoft in desktop and in many cases also in server application.

The longer an institution was using IT, the more often operating systems were found which were or soon will be no longer supported by Microsoft such as Windows 95 and Windows 98. In fact, one interviewed institution estimated that about 30% of desktop computers were still running on Windows 95. Data from the public sector of Peru show similar figures (cp. chapter 3).

Also, CIOs are aware that this is an upcoming potential security threat. Anyhow, it is often not possible to change this situation due to the budget cutting effect explained in chapter 4. and due to new assigned tasks in the public sector in Chile.

The older an institution is the more probable is the risk of not having the budget to change old proprietary systems. In the graphic, it is assumed in order to simplify matters that the support for Windows 95 and Windows 98 ended in 2003, and that with increasing years of existence of an operating system the number of security holes also increases, and finally that with the end of support for an operating system, the number of security holes increases remarkably faster. Of course, real data varies also in terms of type of support, like online support or bug fixes. [Sier2004]

On the other hand, institutions having experienced FOSS told about not having changed the systems configurations for years, except for security updates. For example, servers used for internet connections, firewall and proxy services used the same software over time periods of 5 to 10 years. In this time, major changes were not made. For many, the Linux system with its numerous different packages and configuration possibilities made the maintenance of a secure system often seem to be more complex, than a supplied with just one or two packages, but in fact this modularization minimizes complexity and helps concentrate on main purposes.

Of course, FOSS is not more secure than proprietary software by nature. FOSS is also developed by humans and humans make mistakes. As a consequence, as in other complex programs, FOSS also contains various mistakes and security vulnerabilities. But while with CSS the client is dependent on the cost-benefit calculation and the goodwill of the producer, FOSS is practically constantly being watched by developers and interested persons, and furthermore, active FOSS projects are enhanced and improved

all the time. In the case of the IT specialists of the Chilean public sector, this interest has lead to various discoveries of mistakes in the source code of FOSS, as the conducted interviews show.[5]

6.8. Stability of the System

The stability of the system logically is influenced by the stage of maturation as already shown in chapter 0. All interviewed institutions told about higher stability and longer uptime of their systems. It has to be taken into account that the interviewed people only had experience with server or data base systems, which has already been shown in several studies, but the aspect already mentioned in the chapter before, of constantly being watched by different groups of persons, speaks in favor of higher stability in general.

6.9. Compliance with the Demands of Data Security

On average, the aspect of compliance with the demands of data security was considered the most important in the survey. Furthermore, the strong emphasis on this from the perspective of IT security demonstrates its importance.

Surprisingly, none of the interviewed people had any specific guidelines to fulfill other than general tips, which could already be fulfilled due to existing software based encryption methods and applied precautionary behavior.

Hence, a tendency in favor of or against FOSS usage could not be identified.

6.10. Insight into all Security Settings in System

According to the demands that software being used by governments and administrations of the public sector should fulfill, the issue of insight into all security settings in systems is one of the most important aspects. As long as the authorities of governmental units do not know these, they cannot ensure that confidential data of citizens does not get into the wrong hands.

Regarding this issue, many CIOs think they have full access to them and that they know all settings, but when asked a second time if there are any control mechanisms or existing methods to prove these, many had to admit not having investigated this matter carefully. For example, it appears that it is not known exactly which kinds of communication ports software is using or what kind of security settings the software is actually handling.

Also the different aspects concerning availability of the source code have been rated on average as remarkably less important; this characteristic of software would help solve this problem, at least theoretically.[6]

[5] FOSS critics often say that the source code is not analyzed by its users. The interviews give evidence, that in serious use the opposite is true.

[6] Only because the source code is available, it does not mean, that the source code will be examined.

6.11. Interoperability

Interoperability should not only be seen as an isolated aspect of the software environment used, but also in the context of the entire Chilean public sector.

While a homogeneous FOSS environment or even a heterogeneous FOSS and CSS environment in an institution might work without any problems with interoperability, the interaction with other existing tools and solution partners can cause difficulties.

For example, if an institution migrates completely to FOSS based software, applications or web sites requiring the use of Microsoft's Internet Explorer might not be accessible.

Nowadays, it appears that due to more and more shifting of applications to web usage, this problem might be less important in the majority of cases. However, in the event of being obliged to use a closed proprietary standard, whether due to legal regulations or enforcements of the market, FOSS only can be second quality regarding interoperability.

6.12. Flexibility of the Use of Hard- and Software

Referring to the aspect of the flexibility of hard- and software, an indisputable disadvantage for FOSS can be observed for desktop usage. While FOSS has gained appropriate maturation on server usage as shown in chapter 0, it still shows deficits in desktop usage. First, regarding applications there is still a lack of standard applications (cp. chapter 0 and chapter 0) and second, a lack of support for hardware in professional usage was also reported (cp. chapter 0).

6.13. Compliance with Regulations, Laws, Recommendations and Intern Guidelines

In no case of the interviewed persons did any institution had problems fulfilling regulations, laws or any recommendations. But a distinction has to be made between institutions which often have to make changes due to modified circumstances or altering laws and those with a stable situation.

For the latter case, once a system is set up, there is no reason for advocating proprietary or FOSS solutions from the viewpoint of conforming to existing regulations.

When an institution often has to make changes, a solution based on proprietary software is not appropriate, as long as it is not fully configurable and easily adapted. Hence, in those cases, institutions normally develop solutions of their own or existing FOSS-based solutions can be used and expanded.

In some cases, interviewed partners had to implement many changes, as a general rule developers knew where to continue, whether it was their own development or FOSS.

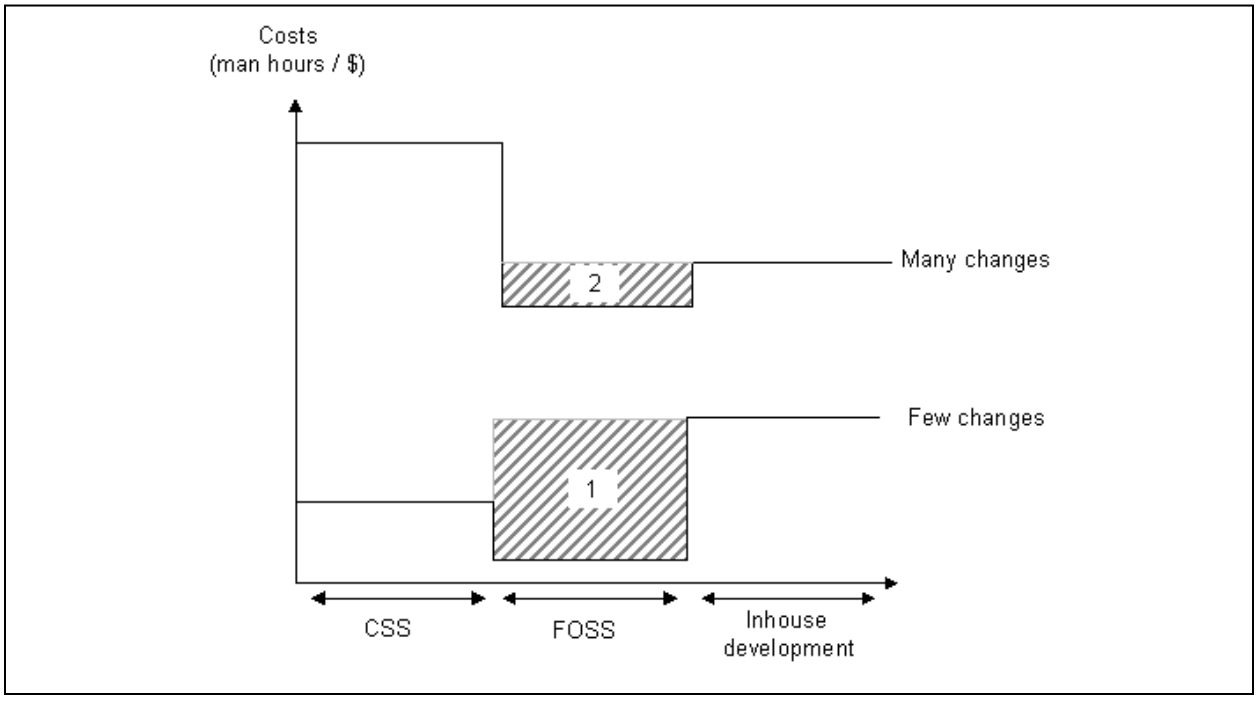
Assuming that unique commissioned software projects[7] are cheaper when created by external companies due to specialization and that after the software has been created there will be no or only few changes, area 1 in Figure 27 shows the reduction of cost in the realm of possibility due to the use of FOSS. Cost savings as a result of using FOSS can be generated by the synergy effects because of

[7] This can be a completely new development or the modification of an existing CSS based solution.

participation in existing projects and benefiting from already developed problem solutions or by releasing a project as FOSS and profiting from the involvement of external programmers who find errors and propose suggestions, whether from the world wide community or other public sector institutions. Of course, there can also be no saving, depending among other things on how adequate existing FOSS solutions are for the problem to be solved.

Under the circumstances of further continuous changes after the initial development, proprietary software or projects based on external companies become more expensive due to transaction costs. These transaction costs can occur because of further negotiations, slumps in efficiency on account of delayed delivery or, for instance, time lost in searching for a new company in the case of a provider change. When applying a FOSS project, lower savings are expected than in the first case, because as software gets more and more specific with the changes and therefore less interesting for the FOSS community and other institutions, fewer synergy effects are expected. Furthermore, with proceeding modifications the probability of regenerating the entire FOSS project increases, stashing away slowly the synergy effects achieved with FOSS. Area 2 in Figure 27 states this possible effect, in tendency smaller than area 1 of the first case.

FIGURE 27
DEVELOPMENT OF COSTS FOR SOFTWARE IN RELATION TO THE NUMBER OF (LEGAL) CHANGES



Source: Prepared by the author.

6.14. IT Organization

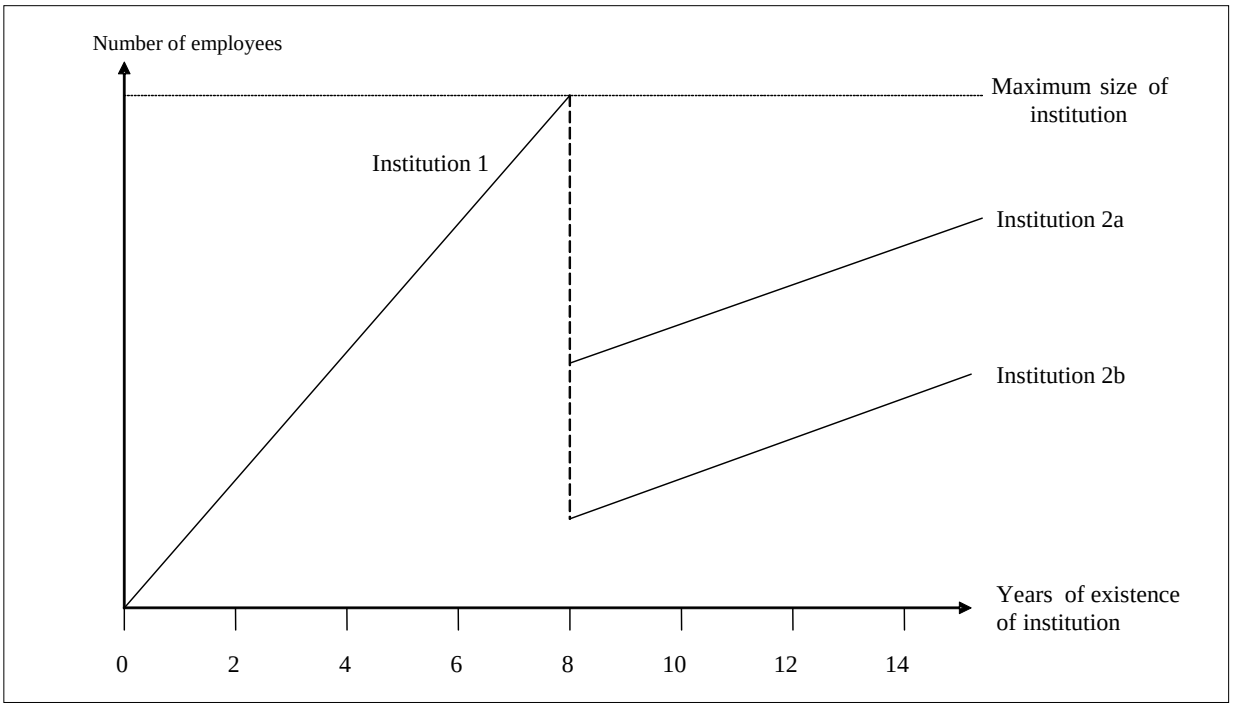
In short term, a change from proprietary systems to a FOSS pendant brings tremendous disadvantages. A migration generally would be slow and not overnight, bringing more complexity into the organization of the information technologies and distribution of the qualifications of the IT specialists.

On the other hand, the formal contraction process in the public sector (at least in Chile) is much more complicated and tedious than in private companies. FOSS can probably be beneficial here; not only

in saving license costs, but also that the procurement process is eliminated. In one case, an associate had to wait about one week for a product to be ordered, decelerating the efficiency, of course.

Another aspect concerning the IT organization is the process of migrating to another operating system. All those interviewed agreed that the bigger an institutions gets and the longer it uses information technology, the more complicated and complex a migration would be. Remarkably, the size of the Chilean public sector institutions is limited to a maximum number of employees. When it reaches this size, the institution is subdivided into two new units. Figure 28 shows an example of a case where an institution reaches this size after eight years of continuous growth. Institution 1 gets split up into institution 2a and 2b.

FIGURE 28
EXAMPLE FOR SPLIT OF AN CHILEAN PUBLIC SECTOR UNIT



Source: Prepared by the author.

Set in relation to the aspect that the bigger an institution gets the more difficult a migration would be and in respect to the increased potentiality of vulnerabilities due to the use of operating systems not supported any more as shown in chapter 0, the following statement results: The longer an institution exists, the more necessary and the more costly a migration would be.

6.15. Continuity Regarding Future Generations of Software

In May 2003, “members of various parties voted for a shift of the IT infrastructure of the municipality of the German city Munich towards Open Source software.

The basis for this decision is a compulsory and forthcoming shift to a new operating system. The support for Munich’s current operating system - Microsoft NT 4.0 – ended when Microsoft decided to discontinue the support for this operating system. Consequently, there is no guarantee that new software applications and new hardware will work under the “old” operating system.” [IDAB2004]

This statement probably expresses the situation which can be avoided with FOSS far better than establishing a framework of arguments for its advantages, such as the worldwide FOSS community, the number of various providers of Linux distributions or the possibility to take over the project and develop it oneself in case of a termination of the provider's business.

6.16. Overview

TABLE 3
OVERVIEW OF THE DIFFERENT ASPECTS AND THEIR CHARACTERISTICS

Aspect	Characteristics
Attractiveness of working conditions	can have an influence on the performance of daily operations different maturity for different types of FOSS attractiveness of working conditions influences and is influenced by several other factors
External communication partners	problems expected with FOSS; solution might be in falling back on open standards or define national standards aspect seen as problematic when interacting internationally
Range of applications	Factors restricting the range of possible applications: business relations with externals based on specific software, institutional guidelines adaptation of software to institutional needs
Availability of support	more possibilities to get support from non-official sources easier to solve complex problems support from third party companies available for FOSS; problematic in rural regions
Conservation and enlargement of the qualifications of employees	negative effects due to the change from an existing environment based on proprietary software can be softened by setting the date of migration the same as the periodical qualifications and configure the FOSS system similar to the old one
Performance of daily operations	better performances only known for server usage
Potential Threats of the IT	the older an institution is, the more probable is the risk of not having the budget to change / update the old and getting vulnerable proprietary system modularization of FOSS minimizes complexity and vulnerability possibility to find / change possible vulnerabilities in FOSS
Stability of the system	higher stability expected with FOSS due to its nature (code constantly being watched by different groups of persons)
Compliance with the demands of data security	a tendency in favor of or against FOSS usage could not be identified
Insight into all security settings in system	FOSS does give, at least, the option to investigate this issue profoundly
Interoperability	problems of interaction with existing proprietary software very probable when shifting to FOSS
Flexibility of the use of hard- and	sometimes lack of standard software especially for desktop usage and some kinds of software drivers
Compliance with regulations, laws, recommendations and intern guidelines	in case of often altering laws and regulations FOSS should be preferred, because of its easy adaptation
IT Organization	the bigger and older an institution gets, the more necessary a migration would be, but on the other side, the more costly and complex it would be (short-term consideration)
Continuity regarding future generations of software	can never be guaranteed with proprietary software possibility to continue the software development in-house

Source: Prepared by the author.

VII. Policy Recommendations

The following chapter gives some policy recommendations for different subject areas of FOSS.

7.1. Intellectual Property

[JuJe2005] gives three recommendations for public policy. First, they demand the acceptance of the Copyleft principles in the national juridical contexts. This can be supported by giving juridical advice and assistance as done standard intellectual property tools.

Second, the adoption and use of FOSS for reasons already mentioned in anterior chapters of this paper and last, public support or promotion of the production Open Source Software or standards. This can be achieved by "direct finance subsidies to free-software organizations or of placing developers paid on public funds to the disposal of open source projects" [JuJe2005]. Additionally, software already developed in public sector institutions can be published under GPL benefiting from the possible improvements from the Open Source community.

[Frost2005] even states "that software patents are in fact not compatible to OSS development, and thus from a policy position, should be enforced more selectively or eventually not at all". He gives the simple example that software patents "are costly to file and even more expensive to defend in court", it can hardly be afforded by individual FOSS developers, but easily by profitable software firms. These would be in the position to accumulate more software patents than individual developers would be able to do. With enforcing these patents, companies would be able to stop FOSS projects.

Another important aspect is the issue of illegal software copying or Software „piracy". It is not only a problem for companies developing proprietary software, but also for the development of a FOSS user group. Especially in underdeveloped countries the unauthorized use of software is widespread (the Business Software Alliance claims an estimated 97 per cent of the used software in Vietnam is obtained illegally). This is not surprising as software prices often reach to monthly salaries of national workers.

For the development of FOSS in such a country, this can be very "dangerous" when local authorities do not take actions against this and software companies maintain in silence. These companies might be interested in their software to be used by many people of such a country also they do not gain from license fees. The

consequence is, that these people (and due to peer-pressure and recommendations their friends in many cases, too) get used to the proprietary software which generates a kind of 'locked into': one day it is less complex and time-consuming to buy the proprietary version than to switch to FOSS. [8]

7.2. Planning Open Source Projects

When planning own projects to be licensed as a FOSS project, several determinants should be taken into mind before starting. [CoMa2003] investigated the open source projects repository SourceForge.net in order to find out in which constellation a project is most successful.

The main result of the study was, that "the less restrictive the licensing terms the larger the likelihood if reaching an advanced development status and that this effect is even stronger for newer projects". So, when the scope of the used license is narrow, the output per contributor of open source programs is significantly much higher. [LeTi2005] explains this complex set of opposing effects. By choosing a restrictive license, the opportunities of a commercial exploitation of the software are reduced, but it is more likely to attract programmers of the open source community willing to contribute to the new project. These persons are motivated by "idealistic and non-monetary rewards".

Further results of the study of [CoMa2003] relating to the success of FOSS projects were, that the ones which geared towards sophisticated users, as for example system administrators, have greater chances to succeed in terms of making progress in the development stage. Additionally, the determinants of projects' development stage change with the age of the project. These are for example licensing terms or software audience.

The consequence for governmental FOSS projects is to choose a restrictive license in order to attract many contributors. The commercial exploitation of the software to be developed normally is not an aim of governmental interaction.

7.3. Effectiveness in FOSS teams

[StGo2005] provides a framework of the main tenets of the FOSS ideology and suggesting which tenets may be grouped to form relevant sets of values and beliefs that tend to coincide in teams. Some shared ideological components have a positive impact on team effectiveness by enhancing trust and communication quality, while some have negative effects by either reducing input to the team or by reducing task completion

A very important point is, when organizations are interacting with members of the FOSS community or with the FOSS community in general, that they are more likely to be successful, when they are perceived as understanding and sympathetic to their beliefs, values und norms.

When starting a FOSS project, it should not be one of the most important aims to attract many developers. [StGo2005] describes that many developers may not guarantee the succeeding of a project as team size does not have "a significant effect on either effort or task completion". Furthermore, it is very important to set up rules for building consensus. Project administrator may investigate ways to mitigate negative effects on this process by instituting policies "to limit the amount of time spent on it".

[8] This would mean, to install new software, convert all existent data in many cases and train on the new software.

VIII. Conclusion

The objective of this study was to evaluate the economic efficiency of free and open source software in the public sector in Chile. Economic efficiency calculations are normally valid only for concrete cases and very difficult to be used for a general statement. For this reason, a strategic viewpoint was taken into consideration. This approach is supported by the fact that strategic aspects get more and more important in the usage of information technologies as seen for example in the case of the administration of Munich (cp. [Unil2001]).

Concluding it has to be mentioned, that also FOSS is still backward in terms of functionality and user friendliness in comparison with closed source software, it offers various strategic advantages like higher security and transparency which are especially in the public sector very important. Due to these advantages, it can compensate or even outperform still existing disadvantages. It has to be annotated that these disadvantages are often only a matter of time, until motivated members of the worldwide FOSS community eliminate them.

When interviewing the IT specialists of the public sector in Chile, a very enthusiastic, open-minded and also motivated attitude towards the application of free and open source software could be perceived. However, in the majority of cases there is not enough time or resources to concentrate on doing feasibility investigations for FOSS in the institutions. An initial step to solve this problem can be to provide more information transparency of the actual situation and development status of free and Economic Efficiency of Free and Open Source Software in the Public Sector open source software and present existing successful projects. In another step, feasibility studies should be centrally coordinated in order to save resources and work more efficient. Tested software projects should not only be evaluated by functionality, but also in relation to the fulfillment of strategic objectives in the public sector. A central contact point for the issues of information technologies could bundle all the information flows related with the issue of migration and release guidelines as an orientation. The result could be a generally higher economic efficiency of information technologies in the public sector of Chile. An example for this proceeding is given by the German “Ministry of the Interior” with releasing a “handbook for migrations” for IT usage, which will now be released again in an updated version with more than 500 pages and also in English, as the first version has been accessed more than a 100,000 times since its publication in 2003. [Bund2005]

Finally, some further recommendations have to be recapitulated: First, it has to be stressed, that software “piracy” is serious jeopardy for the further development of FOSS, especially in developing countries. Due to “lock-in” effects, it can be that end-users even do not get the possibility to get to know the free and open software or even take the chance to join FOSS projects. A clear policy against “piracy” should be the consequence.

These “lock-in” effects can also arise when proprietary software producers establish undisclosed (quasi-) standards. Hence, where there is no technical documentation, there is no chance for open source developers to create complement software. Therefore, it is necessary that an institution which is independent from any companies sets national / internationals standards for software.

Ultimately, it is very important, that governments manifest their opinion related to software patents. As already demonstrated, it has to be recognized that software patents can not only slow down the innovation of software developments, but also pose a thread against companies applying FOSS solutions. These and similar facts need to be discussed and the public sector of an information society needs to take position and formulate clear statements regards eventual trade-offs.

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