

An Empirical Investigation on the Motivations for the Adoption of Open Source Software

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Abstract— Open Source Software has evolved dramatically in the last twenty years and now many open source products are considered similar, or better, than proprietary solutions. The result is that the trustworthiness of some open source products is now very high and the motivations for adopting an open source product over a proprietary product has changed in the last ten years. For this reason, we ran a mixed research approach, composed of three empirical studies, so as to identify the motivations for the adoption of open source products. The goal is to take a snapshot of the state-of-the-art in FLOSS motivation's adoption. Results show that the economical aspects and the freedom of some type of licenses are not the main adoption drivers any more while other motivations such as the ease of customization and ethical reasons are currently considered more important.

Keywords— *Open Source Adoption; Empirical Study; Open Source Quality.*

I. INTRODUCTION

Previous research on the adoption of Free/Libre Open Source Software (FLOSS) has mainly focused on adoption models, such as MOSS [1], Open BQR [2], QSOS [3], and others based on the evaluation of a set of information usually considered by potential users when they select a new FLOSS product.

Some works highlight economic or technological reasons [4][5][6] but, to the best of our knowledge, only a few of these studies investigated the factors considered during the adoption of FLOSS by different organization[6][7]. Therefore, the goal of this study is to understand the current reasons that drive the adoption of FLOSS in IT companies, using a research approach that promises to obtain a more complete picture of the motivations for FLOSS adoption. This led to the definition of the following research question:

RQ1: What are the motivation drivers behind the choice of a specific FLOSS product over proprietary software?

In order to answer our research question, we designed a mixed research approach, composed of three empirical studies. We started with a first round of interviews to identify the high level motivations for the adoption. Then, the motivations were refined and clustered by means of a focus group with experts in FLOSS adoption. Finally, we conducted a survey to understand the importance of the motivations identified from the adopter's point of view.

Results of this work show that the motivations for the adoption of FLOSS have evolved in the last years and economical aspects and the license type are not as important

as in the past [6] while other motivations, such as the ease of customization and ethical reasons are considered more important.

The rest of this paper is organized as follows. Section II describes the related works. Section III addresses the research approach used. Section IV describes the results obtained. In Section V, we discuss results and in Section IV we present threats to validity. Finally, in Section VI we draw conclusion and future studies.

II. RELATED WORKS

In our previous work [6], we conducted a survey with 151 FLOSS stakeholders, with different roles and responsibilities, about the factors that they consider most important when assessing whether FLOSS is trustworthy. Here, we did not ask the motivations for the adoption of a FLOSS product or a proprietary one, but we asked for the factors considered to compare two FLOSS products.

We identified 37 factors, clustered in five groups: economic, license, development process, product quality, customer-oriented requirements. The product reliability and the degree to which a FLOSS product satisfies functional requirements turned out to be the most important factors for a trustworthy product, immediately followed by interoperability, availability of technical documentation, maintainability, standard compliance and mid-/long-term existence of a user community. Economic factors, such as Return on Investment (ROI) and Total Cost of Ownership (TCO), and the availability of a solid maintainer organization were far from being considered as relevant, as was widely publicized.

Yan et al [9] ran a survey with students as participants, to identify the motivations for the adoption of FLOSS in Malaysia, China, Singapore, Thailand and Vietnam, collecting 264 questionnaires for FLOSS adopters and 212 for non-adopters. They identified a set Intrinsic Motivation (to know, to accomplish, and to experience stimulation), and extrinsic motivations (identified regulation, “introjected regulation” and external regulation).

Previous works discuss some economic motivations [4][10], suggesting TCO and ROI as the most important driver for FLOSS adoption.

Other motivations can be derived by the information required by the FLOSS adoption models. These models are based on the evaluations of a set of information, weighted for their importance. Some models allow users to define the importance of some information, and to evaluate the product

they are willing to adopt. The most important methods in this category are the Open Business Readiness Rating (OpenBRR)[13], the Open Source Maturity Model (OSMM)[12], the Qualification and Selection of Open Source Software (QSOS)[3] and the Open Business Quality Rating (OpenBQR)[2] that summarizes the benefits of the previous three models. All these models, suggest to evaluate economic factors, license, development process, product quality but only QSOS and OpenBQR add customer related factors, such as the degree of which a product satisfies the customer requirement. Other evaluation models are based on a set of predefined weight for each information and allow predicting the trustworthiness or the likelihood of the adoption of a specific FLOSS product. An example is the MOSS model[1], based on the results obtained in [6].

Also in case of the evaluation models, there is an indication on the information that should be evaluated, but the motivations of the choice are not clearly identified.

Finally, a Gartner’s report [17] shows that the top three reasons for using FLOSS from manager’s point of view are the Total Cost of Ownership (TCO), the improved security and the strategic and competitive advantages.

III. THE RESEARCH APPROACH

In this section, we introduce the research approach and the study design of our work.

The goal of this work is to understand the motivations for the adoption of FLOSS software. To avoid to bias the results, based on the results available in the literature, we decided to collect the motivations from scratch by means of a first round of interviews, and then a second run of interviews to analyze qualitative and quantitative results.

This work has been composed by 3 empirical studies, as depicted in Figure 1: 1) Interviews 2) Focus group and 3) Group Interviews.

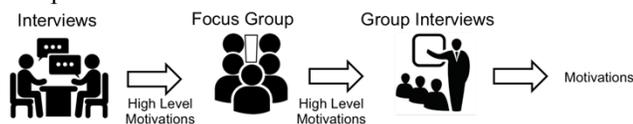


Figure 1. The Study Process

The first round of interviews has been carried out by means of a questionnaire based on open-ended questions, so as to not drive the interviewee to a predefined set of answers. Then, the focus group has been designed to cluster the answers provided by the participants in smaller sets. Finally, the survey has been conducted by means of a second questionnaire, composed by closed-answer questions, based on the motivations group identified in the focus group.

A. Interviews

The goal of this study was to identify the motivations that influence the adoption of FLOSS.

The interviews are addressed to assessing the current situation in the FLOSS adoption. The idea is to take a snapshot of the state-of-the-art in FLOSS motivation’s adoption according to developers, managers and custom

integrators. For this reason, we designed a semi-structured interview with open-ended questions.

Semi-structured interviews tend to be much more highly interactive and allow us to clarify questions for respondents and probe unexpected responses. Moreover, in order to collect a set of reliable answers, all interviews were carried out in person, by the same interviewer. We believe this is the most effective way to elicit information and establish an effective communication channel with the interviewees.

The semi-structured questionnaire was composed of three sections. After a brief first section, to profile the interviewee, and the company the interviewee belongs, we asked to list and rank the motivation for the adoption of FLOSS software, based on their importance, on a 0-to-10 scale, where 0 meant “totally irrelevant” and 10 meant “fundamental”. During the second section, the interviewer, also took note of the description of the motivation, so as to ease the clustering process to be carried out in the focus group. In the third section of the questionnaire, since we wanted to understand if the factors identified in [6] influence the adoption of FLOSS, the interviewer asked to rank the factors identified in [6], not listed as motivations during the second section of the questionnaire.

B. Focus Group

The focus group has been carried out to discuss the results of the interviews and draw qualitative conclusions on the results, summarizing and clustering the motivations. The clustering part is needed, since several users can define similar but not identical motivations.

The focus group event has been planned to last three hours. We invited five participants; four researchers with experience in FLOSS quality, adoption models and FLOSS development and the author of the paper that acted as moderator.

During the focus group we did not report the importance of each motivation to the participants, so as to avoid biased results by this value.

Before the beginning of the focus group, we provided an overview of the objectives of the study, and described how participants should discuss and act during the session. Then, we presented the motivations elicited in the survey and we wrote them on a set of post-it notes.

In order to better understand the difference among similar motivations, the moderator, who also carried out the interviews in person, reported the description of the motivation reported by the interviewees. Then, we asked the participant to organize the post-it notes on a white board using the affinity grouping technique[16].

C. Group Interviews

The final study has been designed to be executed in a group interview, with the support of a closed-ended questionnaire.

In this case, the interviewer explained each question to the participants who answered to the questions on a paper-based questionnaire.

The interviewer distributed the questionnaires to the participants before the beginning of the workshop and then,

after a short introduction of the motivation of the study, he asked to fill in the questionnaire, taking care that participants were not influenced in their answers from each other's.

We believe this method is more effective than online questionnaires, since participants have the possibility to make questions or to ask for more details.

We organized the questions in the questionnaire in two sections, according to the types of information we sought to collect:

- *Personal information, and role in relation to FLOSS*: helps to profile the interviewee and the company.
- *Motivations*: here we asked to list and rank the motivation for the adoption of FLOSS software, based on their importance, on a 0-to-10 scale, where 0 meant "totally irrelevant" and 10 meant "fundamental".

The motivations included both the motivation identified in the interviews and the missing factors identified in [6]. Moreover, to improve the readability of the questionnaire, we grouped the motivations in five groups: License, Development process, Product quality issues, Customer requirements.

IV. RESULTS

Here we report the results of the three studies, together with a short discussion and interpretation.

In order to answer to our research question, we first analyze the results of the group interviews and then we compare the results with those obtained in the first interviews after the clustering carried out in the focus group.

Finally, we compare the list of motivations with the factors highlighted in our previous survey [6].

A. Interviews

The sample of interviewees was not determined in advance. A preplanned sample would have allowed for a more controlled result analysis, but it would also have limited the possibility to add interviewees to the set in an unanticipated manner. We are fully aware that this may have somewhat influenced our results.

Here we first provide information about the sample of respondents, which can be used to better interpret the results and then, we show the collected results with a concise analysis of the responses obtained, with insights gained by statistical analysis.

TABLE I. INTERVIEWER COMPANY SIZE

Company Size	Percentage
SMEs (<250 employees)	47.5%
Medium Enterprise (250-500 employees)	17.5%
Industry (>500 employees)	35.0%

Table I contains the distribution of companies where our interviewees belong, while Table II show the percentages of the roles for four organizational roles identified in the questionnaire. Note that roles may not necessarily be mutually exclusive.

TABLE II. INTERVIEWEES ROLES

Role or title	Percentage
Manager	35%
Developer	27.5%
Custom integrator	52.5%
End user	20%

TABLE III. THE MOTIVATIONS OBTAINED FROM THE INTERVIEWS

Reason	#Answers	Frequency %
Ethic	13	34.21
Customization Easiness	9	23.68
Personal Enrichment	4	10.53
Synergy	6	15.79
Quality	6	15.79
Economic	7	18.42
Community support	5	13.16
Support	6	15.79
Flexibility	6	15.79
Free	9	23.68
Innovation	4	10.53
Documentation	3	7.89
Works better than CSS	6	15.79
Personal Productivity	3	7.89
Company decision	4	10.53
Maturity	4	10.53
Better Solution than CSS	4	10.53
Adaptability	5	13.16
Competitiveness	6	15.79
Community Enrichment	3	7.89
Avantgarde	1	2.63
Free Availability	1	2.63
Completeness	1	2.63
Customer requirement	1	2.63
Customer need	1	2.63
Economic model	2	5.26
Fast Evolution	1	2.63
Freedom	1	2.63
Internal Management	1	2.63
Independence from other SW	1	2.63
Platform Independence	2	5.26
Long-term investment	1	2.63
License Cost	2	5.26
Reduced investment for clients	1	2.63
Partnership	2	5.26
Professional Support	1	2.63
Reuse	1	2.63
Standards	1	2.63
Multiplatform development	1	2.63
Vendor lock-in	2	5.26
Training	1	2.63
Free updates	2	5.26
Higher consultancy value	1	2.63
Trustworthy	4	10.53

We interviewed a total of 38 participants. collecting 52 different motivations with an average of 4.32 motivations listed per interviewee, a minimum of 3 and a maximum of 12 motivations. After a first screening on synonyms (eg. “Ethic” and “Ethical reasons”) we reduced the total number of motivations to 33.

In Table III, we report the list of reasons together with their frequencies, ordered by #answers. Column Frequency % reports the answer’s frequency (#Answers/Total number of Answers).

The first immediate result is that, compared to our previous survey [6], several new motivations have been identified while others are not considered. Unexpectedly, most of the development factors, license issues, and quality aspects such as complexity, performance and usability are not considered as good motivations for FLOSS adoption.

However, since several motivations identified in this first round of interviews are pretty similar, the identification of similarities and difference will be analyzed after the results of the focus group.

B. Focus Group

During the focus group we discussed how to cluster similar motivations, and how to compare them to those highlighted in our previous survey [6].

The clustering, carried out with the affinity group technique, allowed to reduce the motivations to 21, on which 13 are common with the factors identified in [6] and 8 are new: ethic, personal productivity, freedom, partnership, competitiveness, innovation, flexibility, project maturity.

Table VI shows the list of motivations after the clustering process carried out, together with the results obtained in the next study. For reason of space, Table IV do not report the motivations not considered by our interviewees.

Based on the clustering results, we were also able to calculate the ranking of each motivation reported in the interviews. For reason of space, we do not report the results but we only describe the differences with the results obtained in the group interviews, in the next section.

C. Final Group Interviews

As for the interviews, the sample of interviewees was not determined in advance.

The survey has been executed during FOSDEM 2013 workshop “An Interactive Survey on marketing and communication strategies”[14]. We distributed 47 questionnaires, obtaining 21 valid questionnaires. Participants were FLOSS experts, developers and practitioners. No students or non-experienced participants were considered in the analysis of the results. Table IV contains the distribution of companies where our interviewees belong while Table V shows the percentages of the roles for four organizational roles. Note that, in this case, roles are mutually exclusive, since we asked our interviewees to answer to the questions based on the selected position.

Even if the sample was not determined in advance, the roles of our interviewees are well distributed among managers, developers and custom integrators, while no end-users filled in the questionnaire in this group.

TABLE IV. Company Size

Company Size	Percentage
SMEs (<250 employees)	33.3%
Medium Enterprise (250-500 employees)	42.8%
Industry (>500 employees)	23.9%

TABLE V. ROLE

Role or title	Percentage
Manager	9.5%
Developer	52.4%
Custom integrator	38.1%
End user	0%

A statistical analysis of the responses lets us partition the factors into importance groups, which we show in Table VI’s columns “entire dataset,” “managers”, “developers” and “customer integrators”.

As for Table III, the column “Frequency %” reports the answer’s frequency (#Answers/Total number of Answers) while column “rank” report the weighted average of ranking, using the importance of each motivation as the weight while column “[6]” shows if the motivation has an higher or lower importance than the relative factor identified in [6].

Let’s first discuss the column “entire dataset, where we identified eight importance groups, from 1 (least important) to 8 (most important). The ordered grouping indicates a statistically significant importance ranking between motivations belonging to different groups, but no such ordering within each group. For instance, the motivation “customization easiness” belongs to group 8, so it’s ranked as more important than quality and just as important as “Economic” and “Personal Productivity” which are in group 6. The number of groups depends on the portion of the population considered. For “Managers”, the statistical analysis led to nine groups while for “Developers and “Custom Integrators” to eight groups.

The motivation “customization easiness” is considered, by all groups, as the most important driver for the adoption of FLOSS. Compared to our previous survey [6], this motivation gained several positions, moving from group 4 (out of 8) to group 8.

Ethical motivations, not included in [6], seems to be very important for our interviewees while the overall product quality is at the same level of personal productivity, and economic.

Other motivations such as freedom, community support and potential partnership are relatively important (group 4) while all other motivation are definitely not relevant, lying in groups 1, 2 or 3.

TABLE VI. FINAL SET OF MOTIVATIONS (GROUP INTERVIEWS)

Reason	Entire Dataset			Managers			Developers			Custom Integrators		
	Rank	freq%	[6]	Rank	freq%	[6]	Rank	freq%	[6]	Rank	freq%	[6]
Customization Easiness	8	61.90	↑	7	0.14	↑	8	0.78	↑	8	1.00	↑
Ethic	7	66.67		7	0.29		8	0.78		7	1.00	
Quality	6	71.43	↓	6	0.43	↓	6	1.00	↓	8	0.60	↓
Personal Productivity	6	47.62		1	0.29		7	0.89		7	0.60	
Economic	6	52.38	↑	9	1.00	↑	2	0.56	↓	4	0.60	↓
Freedom	4	38.10					5	0.67		3	0.40	
Support (community)	4	42.86	↑	2	0.29	↓	3	0.89	↓	6	0.80	↑
Partnership	5	33.33		7	0.57					4	0.80	
Competitiveness	2	28.57		3	0.71					2	0.80	
Security	2	19.05	↓				2	0.33	↓	3	0.80	↓
Innovation	2	23.81		3	0.43					2	0.20	
Multiplatform devel.	2	9.52	↓	2	0.43	↓	3	0.22	↓			
Flexibility	2	23.81								2	0.60	
Imposed by the company	1	14.29	=	1	0.29	=	1	0.22	=			
Maturity	1	14.29					1	0.11		2	0.60	
Reliability	1	9.52	↓	1	0.21	↓				1	0.60	
No Vendor Lock-in	1	9.52	=	1	0.14	=	2	0.11				
Customer Requirement	1	4.76	=	1	0.14	=						
Free Updates	1	4.76	↓	1	0.29	↓						
Training	1	0.00		0	0.00							
Reuse	1	0.22	↓	0	0.00		2	0.22	↓			

When considering the different roles, few noticeable differences emerge.

As expected, managers consider Economic of higher, but developers and Custom Integrators consider its importance substantially below average. Unexpectedly, managers have a different view of Ethic and personal productivity considering both motivations of little importance compared to the other groups. Moreover, managers are not interested to freedom at all.

Custom integrators consider only a smaller set of motivations compared to the other groups, with quality, customization easiness, ethic and personal productivity as the most important motivations.

Developers' motivations are similar to the average.

Merging the result of the first set of interviews with those obtained in the group interviews, we will obtain a final dataset composed by 59 participants (38 from the one-to-one interviews and 21 from the group-interviews).

In this case, results do not change significantly, showing a similar trend as in Table VI. For reason of space, we report only the variations respect to the results presented in Table VI.

The only differences are in three motivations where Ethic move down to group 5, personal productivity moves up to group 6 and community support moves up to group 5.

We believe that this is due to the population of the interviewees, that in the interviews mainly belong to medium enterprises while in the group interviews to SMEs.

V. RESULTS DISCUSSION

The first immediate result of the study is that several development, economical and quality factors, usually considered important to evaluate a FLOSS product [6] are not considered as good motivations that drive the adoption of FLOSS.

Our interviewees prefer FLOSS since they can easily customize it, without dealing with proprietary issues and being able to provide the higher value as possible to their customers.

Ethical motivations gained a very high importance. We believe that this is due to the population of our interviewees, since we carried out the interviews during FOSDEM.

As expected, quality and economic are always considered very important while new motivations as personal productivity, Freedom, potential partnerships are also considered as adoption key drivers.

VI. THREATS TO VALIDITY

Due to the number of subjects we were able to obtain necessary power for performed statistical tests. Before performing test preconditions (normality, independence of variables, etc.) were checked to make sure that they are satisfied.

To get reliable measures questionnaires were checked by an expert on empirical studies.

Subjects have similar background and knowledge about FLOSS.

Although we ask the participant of the survey to provide individual answers, the results could be partially affected

since they were seated together in the same room. In the first two studies we employed only high skilled participants with a good experience on FLOSS while in the survey, we only analyzed the answers provided by experts. However, since we ran the survey during a FLOSS conference results could be biased in favor of FLOSS.

VII. CONCLUSION

In this work, we reported on a mixed research approach composed of three empirical studies, with the overall goal to characterize the motivations for the adoption of FLOSS products.

We first provided an overview on the existing proposal and studies investigating the motivations, including our previous survey [6] where we analyzed the factors considered by the users when they need to compare two or more FLOSS products.

Then, we conducted a first round of semi-structured interviews of 38 FLOSS users, so as to identify the high level motivations and to understand if the factors identified in [6] can also be considered motivations. Results of this first study show that most of the quality and economic factors are not driving the choice of FLOSS among proprietary software. The motivations were then clustered in groups, reducing the set to 21 motivations.

Finally, we conducted a structured group interview, based on a closed-answer questionnaire, where we asked our interviewees to rank the motivations they consider key drivers for the FLOSS adoption.

Results show that FLOSS users currently consider new motivations. Ease of customization is the most important motivator to adoption of a FLOSS product since it allows companies to better adapt the product to their customers.

Ethics is also a very important motivation. Several users consider it more ethical to adopt FLOSS instead of proprietary software.

Finally, quality, economic and personal productivity are also considered of middle importance with some variations in different groups. For instance, managers are most interested in economics, with less emphasis on ethics, as also confirmed by Gartner in [17], while customer integrators consider product quality as the most important motivation.

Although we designed both studies to minimize threats to validity, it was difficult to obtain good statistical significance for each group of users. We plan to replicate the study with a larger set of users so as to validate the results and to improve its statistical significance.

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