# Why Do Developers Adopt Open Source Software? Past, Present and Future

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Abstract. Free/Libre Open Source Software has evolved dramatically in the last twenty years and many open source products are now considered similar, or even better than proprietary counterparts. Given the evolution of software – both concerning its development and its usage – it is likely that the motivations for adopting an open source rather than a proprietary product have changed over time. The goal of this work is to identify the current motivations for adopting open source software, and compare them with the motivations that held in the past. We conducted a set of interviews among software practitioners, asking them to rank motivations for the adoption of open source software, and we compared these new results with the motivations elicited in previous surveys published in 2010 and 2013. The results show that motivations have actually changed over time.

Keywords: Open source software · Free software · Adoption motivations

1 Introduction

Free and Libre Open Source Software (FLOSS) is nowadays integrated in several commercial software products. Companies commonly use FLOSS libraries and products as components, or customize FLOSS for delivering new services.

In the last ten years, several researchers have proposed FLOSS adoption models or investigated the motivations that lead to the adoption of FLOSS instead of other types of software [3, 4, 6, 8, 10, 11]. The goal of this work is to take a snapshot of the current motivations that lead companies to integrate FLOSS in their products, and to support FLOSS producers in understanding which factors their users commonly look into when they are selecting software components. We replicated the surveys published by Del Bianco et al. in 2010 [1] and Taibi in 2013 [2] by interviewing FLOSS adopters in the October 2015–December 2016 period. We interviewed 64 practitioners, to understand the actual trend of motivations that drive FLOSS adoption. Results show that motivations have changed over time and nowadays developers do not care mostly about quality, ethic and economic issues, as they did in the past, but are more interested in modifiability and professional support.

The paper is structured as follows. Section 2 describes the related work and the background of this study. Section 3 presents the new survey. In Sect. 4, we illustrate and discuss the results. Section 5 discusses the threats to validity of this work and Sect. 6 draws some conclusions and outlines future work.

2 Related Work

Previous research on the adoption of FLOSS has mainly focused on adoption models, which suggested that potential adopters take into account economic factors, license, development process, product quality, while some other work highlighted economic motivations, such as the total cost of ownership (TCO) and the return on investment (ROI) [4, 10], or technological reasons [1, 5]. Qualification and Selection of Open Source Software (QSOS) [4], Business Readiness Rating (BRR) [11], and OpenBQR [3] also consider customer related factors, such as to what degree a product satisfies customer requirements. Some evaluation models, such as the Model of Open Source Software Trustworthiness (MOSST) [7], are based on the evaluation of a set of factors, weighted according to their importance, and aim at predicting the trustworthiness of a specific FLOSS product and the likelihood of its adoption. Instead, other models are usually considered by potential users when they select a new FLOSS product [5, 9]. A few studies empirically investigated the motivations considered during the adoption of FLOSS by different organization [1, 2, 6, 8, 9, 14, 15]. In 2005, Glynn et al. highlighted personal interest and relative advantage as important factors [14].

In 2009, Del Bianco et al. provided an evidence-based models for the evaluating OSS trustworthiness based on objective measures of OSS [19, 21–23]. They collected 100 questionnaires, containing 722 product evaluations [8]. In 2007–2009, Del Bianco et al. [1] ran a survey collecting motivations for adopting FLOSS from 151 participants. Product reliability and the degree to which a FLOSS product satisfies functional requirements turned out to be the most important adoption drivers. In 2012, Del Bianco et al., while investigating marketing and communication strategies of three FLOSS producers, highlighted that personal opinion and the product websites play an important role in FLOSS adoption [6]. In 2011 Basilico [26] and Lavazza [25] proposed an OSS evaluation model to recommend OSS providers the information they should publish on their portals, based on the information required by OSS identified in [1]. The same information has been used to support developers in generating the OSS testing documentation [27], and to certify the testing process [19, 28].

In 2013, Li et al. [9] conducted a survey among 294 FLOSS adopters and 212 non-adopters in Asia, identifying as main motivations personal interest, regulations & political influence, accomplishment and experiencing stimulation emerged as relevant factors. In 2013, Taibi [2] replicated the study [1] by interviewing 38 participants. He identified 22 adoption motivations, fourteen of which had already been found in [1]. The ease of customization and ethical motivations, not included in [1], were considered the most important drivers for the adoption of FLOSS. In 2015, Yamakami [15] proposed a set of OSS migration strategies identifying cost, coordination, and development process as main adoption drivers.

In 2017, Wasserman et al. [18] presented the OSSpal model, as the successor to the BRR model [11]. OSSpal is a generic FLOSS adoption model, which aims to be applicable to any kind of user. In OSSpal, the evaluation accounts for functionality (how well the software meets the user's requirements), operations (namely, security, performances, scalability, usability, configuration and ease of maintenance), support and services, documentation availability, technology attributes (software architecture, modularity, flexibility, portability, extensibility, integration easiness, completeness, faultiness), development process. The aforementioned characteristics have been proposed as elements of a guideline for FLOSS evaluation based on the authors' experience, not elicited empirically based on what criteria companies adopt during the adoption of open source code or products.

Sbai et al. classified the information considered by the OSS adopters, focusing on the information that can be automatically extracted from different platforms [24].

3 The Replicated Study

We carried out this study to investigate the current motivations that drive practitioners when selecting a FLOSS products to be integrated in the software they develop, and to outline motivation trends in the last 6 years by comparing current motivations with those identified by previous studies [1, 2]. We formulated our goal as:

Analyze FLOSS adoption process, *for the purpose of* understanding, *with respect to* motivations *from the point of view* of developers, custom integrators and project managers, *in the context of* development companies integrating FLOSS or extending FLOSS in their software products.

It is important to notice that we considered only motivations for the selection of FLOSS that can be integrated into existing software development processes, such as libraries, components, frameworks, or any tool including IDEs and Databases and others. Standalone products used for generic purposes, such as office suites or other tools were not considered in this work.

Based on the main goal, we defined the following research questions:

RQ1: What are the most common motivations for choosing a specific FLOSS product over proprietary software?
RQ2: How did motivations evolve over time?

We followed the guidelines proposed by Carver for reporting replications [12], and we designed the study as an exploratory, descriptive survey carried out my means of a questionnaire, as a replication of previous studies [1, 2]. The survey consists of closed questions based on the results reported in [1, 2]. The interview was designed to be carried out in person, to ease communication and get a better understanding of the answers provided.

To accurately replicate the previous works, our questionnaire had the same structure of the ones used in the previous studies, and consisted of three main sections:

- Background and Skills of Respondents. We collected the profile of the respondents: age, country and the predominant role in the company, the experience with FLOSS products, and the level of adoption in the organizational unit.
- Company Profile: We collected information about the type and size of the company and industrial sector.
- Adoption Motivations: We asked the interviewees to rank the motivations for the adoption of FLOSS software identified in [1] and [2] based on their importance, on a scale from 0 to 10, where 0 meant "totally irrelevant" and 10 meant "fundamental". We also invited the participants to add and rank new motivations.

As in the two previous surveys, the interviewees were not selected according to any specific criterion. We interviewed 64 developers and professionals. All the interviews were collected by the same interviewer, who also took care of considering synonyms so as to group similar motivations. During interviews, we did not provide a set of motivations; instead, we let the participants mention their own motivations and, if some of the motivations provided in [1] and [2] where not mentioned, we asked to rank their importance. The interviewer took note of the explanation of the motivation, to understand and clarify possible misunderstandings.

Before analyzing the collected responses, we partitioned them into homogeneous groups, based on demographic information. Ordinal data were not converted into numerical equivalents, since using a conversion from ordinal to numerical data entails the risk that subsequent analysis will give misleading results if the equidistance between the values cannot be guaranteed. Moreover, analyzing each value of the scale allows us to better identify the possible distribution of the answers. We ranked each answer based on the median of the importance reported in the interviews.

4 Results

As reported in Table 1, more than half of the interviewees were software developers. All the participants had experience in evaluating OSS, and have the power to decide if integrate a FLOSS component or adopt a FLOSS tool in the development process (IDE, Database, …).

4.1 Motivations for Adopting FLOSS (RQ1)

We collected 22 different motivations. The medians of the importance expressed by respondents are given in Table 2 and Fig. 1. Results are presented for all the interviewees (column "All Participants") and grouped by role.

Evaluations by the whole set of participants range from level 1 (least important) to level 8 (most important). For instance, Ease of Customization is ranked at level 8, so it is deemed more important than Quality and Flexibility, which are ranked at level 7.

It can be observed that there is substantial agreement between Developers and Custom Integrators, while, as could be expected, managers tend to give greater importance to economic and organizational aspects. Figure 2 shows the box plots representing the distributions of motivation importance provided by respondents. It can

Table 1. Characteristics of respondents.

Respondents' organization role	%	Company size	%
Developers	51.6	Medium-sized enterprises	53.1
Custom integrator	23.4	Large corporations	31.3
Project manager	12.5	SMEs	15.6
Project manager and developers	7.8		
Project manager and custom integrators	4.7		
Organizations' industrial sector	*%*	*Experience with FLOSS*	*%*
Hardware/software development	32.8	Less than 2 years	20.3
Security	12.5	Between 2 and 5 years	37.5
Finance	7.8	More than 5 years	42.2
Public administration	7.8		
Avionics	6.3		
Telecommunications	3.1		
Other domains	29.7		

Table 2. Importance of motivations for adopting FLOSS (medians) (RQ1).

| Motivation	All participants	Developers	Custom integrators	Project managers
Ease of customization	8	8	8	7
Community support	8	8	8	5
Professional support	7	7	8	8
Quality	7	7	6	7
Flexibility	7	7	6	5
Maturity	7	7	7	5
Reliability	7	7	7	8
Innovation	6	6	6	3
Multiplatform Development	6	6	6	4
Partnership	5	5	5	6
Competitiveness	5	4	5	6
No vendor lock-in	5	3	5	5
Ethics	4	4	4	5
Personal productivity	4	4	4	3
Economic aspects	4	4	4	6
Freedom	4	4	4	1
Free updates	3	3	3	3
Security	2	2	3	2
Customer requirements	2	2	2	3
Training	2	2	2	1
Reuse	2	2	2	3
Imposed by the company	1	1	1	1
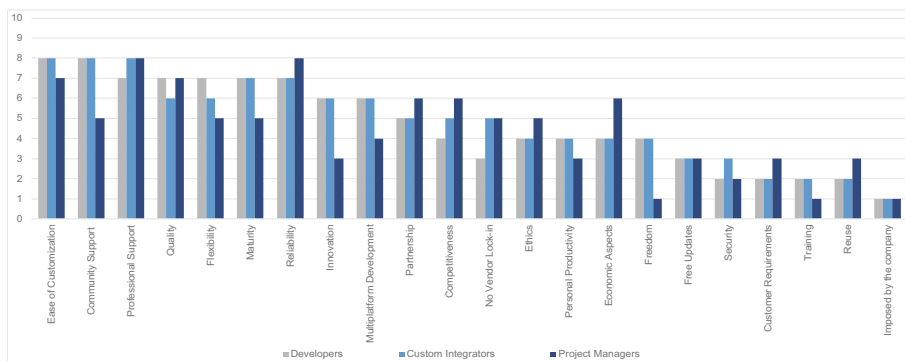
Fig. 1. Importance of motivations for adopting FLOSS in 2016 (medians) (RQ1).

be observed that there is a strong agreement among respondents on the most important motivations: for instance, the majority of the evaluations concerning Ease of Customization, Community Support, Professional Support, Quality and Flexibility were in a 2-grade range. The data in Table 2 provide the answer to our research question RQ1.

4.2 Motivations: Trend Over 6 Years (RQ2)

The results of our survey and those from previous surveys are given in Table 3. No new motivations emerged in the 2016 survey with respect to the union of those identified in the 2013 and 2010 studies. In the 2016 survey, all respondents specified the importance of all motivations previously detected, whereas in [1] and [2] respondents were free to mention and rank only the motivations they considered relevant. Hence, there are some motivations–such as Flexibility, Maturity, Ethics, etc.–that do not appear in the "2010" column, since nobody mentioned those motivations in the 2010 survey. Similarly, nobody mentioned Professional Support in the 2013 survey.

In Table 3, arrows represent changes in the importance of a motivation comparing the first survey (2010) with the last one (2016). For example, a downwards arrow shows that the importance of Reliability decreased (from 8 in 2010 to 7 in 2016). The data in Table 3 provide a first answer to our research question RQ2; however, the following observations appear useful to get a complete view of the motivations for FLOSS adoption through years.

In 2016, Developers considered Ease of Customization, and Community Support as the most important motivations, while in 2013 they considered Ethics, together with Ease of Customization, as the most important motivations; back in 2010, Customer Requirements were the main adoption driver for developers.

In 2016, Custom Integrators considered at the highest importance level also Professional Support, together with Ease of Customization and Community Support, while in 2013, Quality was considered by Custom Integrators as the most important motivation with Ease of Customization; back in 2010, Reliability was the main driver for adoption according to Custom Integrators.
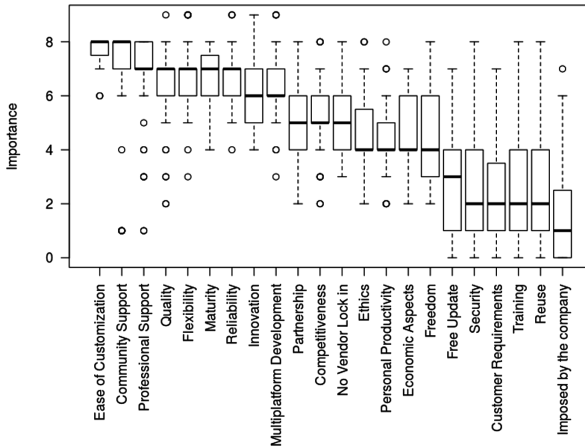
Fig. 2. Importance of motivations for adopting FLOSS in 2016: boxplots (all participants).

Table 3. Importance of motivations for adopting FLOSS (medians) (RQ1).

Motivation	All Participants			Developers			Custom Integrators			Project Managers		
	2016	2013	2010	2016	2013	2010	2016	2013	2010	2016	2013	2010
Ease of Customization	8↑	8	4	8↑	8	4	8↓	8	3	7↑	7	3
Community Support	8↑	4	6	8↓	3	5	8↑	6	6	5↓	2	6
Professional Support	7↑		5	7↑		5	8↑		5	8↑		6
Quality	7↑	6	5	7↑	6	5	6	8	6	7↑	6	6
Flexibility	7↑	2		7			6↑	2		5		
Maturity	7↑	1		7↑	1		7↑	2		5		
Reliability	7↓	1	8	7		7	7↓	1	8	8	1	8
Innovation	6↑	2		6			6↑	2		3	3	
Multiplatf. Develop.	6↓	2	4	6↑	3	4	6↑		5	4↑	2	3
Partnership	5	5		5			5↑	4		6↓	7	
Competitiveness	5↑	2		4			5↑	2		6↑	3	
No Vendor Lock-in	5↑	1	1	3↑	2	1	5↑		2	5↑	1	
Ethics	4↓	7		4↓	8		4↓	7		5↓	7	
Personal Productivity	4↓	6		4↓	7		4↓	7		3↑	1	
Economic Aspects	4↓	6	2	4↑	2	2	4	4	1	6↑	9	3
Freedom	4	4		4↓	5		4↑	3		1		
Free Updates	3↓	1	4	3↑		2	3↓		4	3↑	1	3
Security	2↓	2	5	2↓	2	4	3↓	3	5	2↓		5
Customer Reqs	2↓	1	8	2↓		8	2↓		7	3↑	1	8
Training	2↑	1	2	2		2	2↓		4	1	1	1
Reuse	2↓	1	4	2↓	2	5	2↓		5	3↑	2	4
Imposed by company	1	1	1	1	1	1	1		1	1	1	1

Finally, in 2016 Project Managers provided indications that are partly different with respect to the other roles: Professional Support and Reliability are deemed most important. In 2013, Economic Aspects were considered by Project Managers as the most important motivation, while in 2010, Reliability and Customer Requirements were their main drivers for adopting FLOSS (Fig. 3).
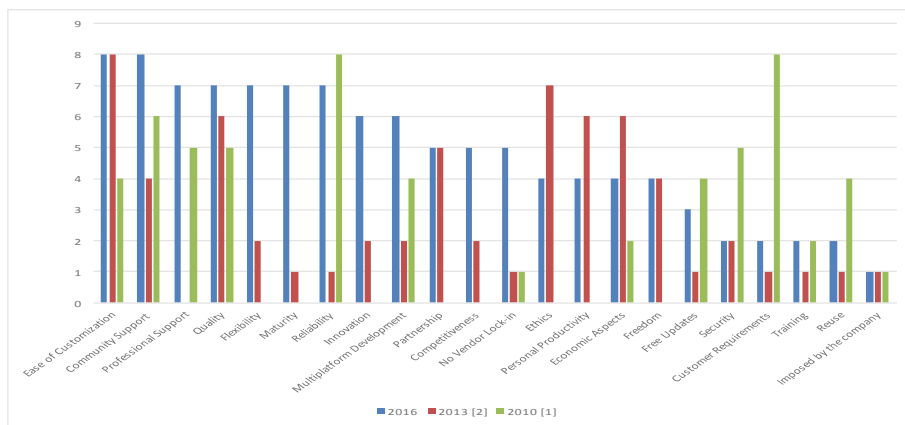
Fig. 3. Importance of motivations in 2010, 2013, and 2016 (median for all participants).

Our results confirm that – as natural and expected – Project Managers continue to focus on factors that can impact the management process of a project, while developers mainly focus on factors that affect the development phases.

As for the evolution of the motivations in the last ten years, we can see big changes from several points of views. Several motivations kept growing: for instance, the importance of Quality increased from level 5 in 2010 to 6 in 2013 to 7 in 2016. Similarly, the importance of Community Support kept growing from 2010 to 2016, resulting in one of the most important motivations in 2016. Flexibility, Maturity, Multiplatform Development, and Innovation dramatically increased their relevance in 2016 compared to 2013, not having been mentioned in 2010. Other motivations appear to have an oscillating importance: for instance, in 2010, FLOSS Reliability was among the most important adoption drivers, then its importance dropped to level 1 in 2013, and raised back at level 8 in 2016. It is very difficult to draw conclusions about these oscillating motivations.

Some motivations were constantly considered relevant: for instance, Ease of customization, Professional support, and Partnership received the same evaluation in 2013 and 2016. Some motivations' importance decreased since 2010. Other motivations, such as Training, Reuse, and Company imposition, appear definitely not relevant, having received low grades through the three surveys.

Considering role-specific evaluations, the importance of Economic aspects for managers, was very high (level 9) in 2013, but descended to level 6 in 2016, showing that the managers pay more attention to the effectiveness of the whole FLOSS-using development process, rather than to sheer costs.

4.3   Discussion

The first result of the study is that nowadays FLOSS appears to be selected by using a different approach than in 2010. The adoption drivers have changed, and economic aspects are no longer as important as in 2010 and 2013. FLOSS was initially perceived

as a free product while now it is correctly perceived as recommended by the Free Software Foundation as "free as in free speech, not as in free beer" [16]. Therefore, developers are now aware that FLOSS is not free of charge and are paying less attention to cost issues, as researchers had already predicted back in 2007 [17]. Similarly, ethical issues are no longer considered that important, probably because the ethical debate on FLOSS appears to have been settled by now.

Our interviewees preferred FLOSS since they can easily customize it, without having to deal with proprietary issues, and can provide the highest possible value to their customers. Therefore, our interviewees were highly interested in Community and Professional support, with the importance of Professional Support growing sensibly since 2010 and almost equaling Community Support. Nowadays, companies appear willing to pay for technical support from FLOSS providers – as would be the case with proprietary software – but with the freedom to access the source code and modify it. In fact, being the ease of customization a dominant motivation for adopting FLOSS, the availability of the source code is extremely important; nonetheless, having just the code is not enough: support from the community and professionals is also needed.

As expected, Quality is always considered very important by all roles, and its importance has increased over time. Other quality aspects, such as project Maturity, Reliability, and Multiplatform Development are also definitely important, thus supporting the idea that non-functional aspects of FLOSS are increasingly relevant.

Personal Productivity and potential Partnerships, which were first detected in 2013 survey, are still considered drivers of medium importance. For Personal Productivity, interviewees appear to behave as end users (as opposed to developers): they do not care for FLOSS or non-FLOSS tools, they ask for (black-box) tools and apps that help their every-day tasks. As for potential Partnerships, commercial solutions appear to be currently considered as more apt to favor the creation of business partnerships than FLOSS communities.

The results from our survey partially confirm the evaluation categories proposed by the OSSpal evaluation model [19]. OSSpal consider qualities – such as Professional and Community Support, and Ease of Customization – that ranked as important by the developers we interviewed. OSSpal also accounts for motivations considered as relevant by software end users. However, OSSpal considers several factors (such as performances and usability) that are of low importance to our interviewees, and other characteristics (such as installation and configuration easiness) never mentioned by our respondents.

5   Threats to Validity

In this section, we discuss the threats to validity and explain the adopted tactics [13].

Concerning internal validity, we identified the following issues.

Participants Selection: We selected participants with a similar background. In order to avoid any bias due to different roles, we tried to have as equal as possible frequency of roles (Developers, Custom Integrator, Managers) in the three studies. Only for Managers role we have proportionally fewer participants in the 2016 replication.

Testing: We avoided that the pre-testing (first survey) could affect the scores on the post-test, since, first we asked to the participant what they considered during the FLOSS adoption process, then, in case the answers were different from the previous surveys, we asked to express an opinion also on the motivations emerged from previous surveys.

Instrumentation: During the study we avoided changing the way data were collected and analyzed.

Design Contamination During the Different Surveys: We avoided any possible design contamination during the different surveys.

Concerning external validity, we identified the following issues.

Population Validity: The selected samples are representative enough of developers and project managers, but not enough of top management roles such as CEOs. From the results of the 2010 survey [1], we only considered the answers provided by developers and custom integrators and ignored the ones obtained from the end users.

Study Results: This survey is – at most– representative for developers using FLOSS.

Concerning reliability, in this survey, we adopted the same questionnaire used in [1] and [2]. The Questionnaire was checked by empirical studies experts.

6   Conclusions

In this paper, we investigated the motivations for the adoption of FLOSS up to 2016. In 2010, the vast majority of users was interested in getting FLOSS as-is without paying any license fee. More recent results show that ethical and economic motivations are not driving the choice of FLOSS over proprietary software: already in 2013, economic aspects and type of license were no longer considered important. New motivations, like the ease of customization, have emerged, because developers started perceiving FLOSS as means to build better products more easily.

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