Innovation in the Software Development Industry: The Effects of Open Source Software

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Abstract

This paper examines the ways in which open source software (OSS) is better for innovation in the software development industry than proprietary software. An examination of prior research and two surveys of software developers and computer science students clearly indicate that the production and availability of OSS benefits the software developer. See Appendix K for copyright and license information.

Keywords: open source, proprietary, software, innovation

Innovation in the Software Development Industry: The Effects of Open Source Software

The addition of open source software into a market is better for innovation in the software industry than proprietary software alone. By using and creating open source software (OSS) instead of or in addition to proprietary software, software developers can improve the quality and quantity of software available both to themselves and to consumers at large.

The main divide between proprietary software and OSS, other than the availability of the source code, is the price: Proprietary software frequently must be purchased, while OSS is usually provided for free. This price difference makes it easier to monetize proprietary software and is a large factor in both the popularity of proprietary software among developers and the differing effects of OSS and proprietary software on innovation.

Literature Review

Atal and Shankar (2014) compare how price competition and differences in software quality vary between two markets: one in which two proprietary software firms are competing and one in which a proprietary software firm competes against an open source software (OSS) firm. The authors utilized a statistical model to compare the two types of markets. The models compare software quality and price competition. Although OSS is often free, the authors factored in an "effort cost" when determining the price competition. The findings of the model were that a proprietary firm competing against an OSS firm may have either higher or lower profits than a proprietary firm competing against another proprietary firm, depending on the price competition from the OSS firm. The price competition depends on the effort cost of the OSS, the degree to which consumers value quality, and the degree to which the consumers of the OSS contribute to the production of the OSS. The proprietary firm had the highest profits when the price competition from the OSS firm was low, but the consumers were better-off with lower price competition. The authors also found that OSS had low value for users who valued quality in their software,

but that it may have high value for users who did not value quality (Atal & Shankar, 2014).

Howison and Bullard (2016) discuss the visibility of software used and mentioned in biology literature. The authors compiled a "balanced and representative sample" (Howison & Bullard, 2016, p. 2139) of biology literature and analyzed the content by looking for mentions of software. Once found, the mentions were coded according to a coding scheme defined by the authors. The coding scheme contained information about the mentioned software: If the mention was cited, if the mentioned software was easily identifiable and findable, if the source code was available, and if the author of the software granted permission for others to edit it. The authors found that they had access to 79% of the mentioned software, 47% was available for free, 32% allowed access to the source code, and 20% allowed users to modify the code. The authors concluded that the manner in which software was mentioned and cited in scientific literature are "varied and appear relatively ad hoc" (Howison & Bullard, 2016, p. 2151). Howison and Bullard (2016) end with a call for more research into more effective methods to properly cite software in scholarly articles.

Sacks (2015) utilizes a statistical model to examine competition between a firm that produces proprietary software and a community that produces free OSS. The author's findings are that the proprietary firm will cater to the less technologically savvy and the community will cater to those who are more technologically capable. In the presence of competition from the community, the firm targets "even less technologically savvy individuals" (Sacks, 2015, p. 268) than it would if it were facing no competition. Furthermore, the author notes that the "real price" of software has two factors: The purchase price and the opportunity cost of learning how to use it. Additionally, the author comments on how proprietary firms can benefit from "R&D spillover" from permissively licensed OSS projects (Sacks, 2015).

Widenius and Nyman (2014) discuss different business models that allow an individual or corporation to effectively profit from OSS. These business models include: "Support contracts and services", where one only supplies support for the software; "Open

core", where the core software is OSS but the peripheral software and extensions are closed source; "Business source", where the software is maintained under two licenses with a time delay between the proprietary release and the open source release; "Dual licensing", where the software is maintained under both a proprietary license and a copy-left license, so customers who cannot or chose not to comply with the terms of the copy-left license must buy the software; and "Software as a service", where the application software is open source, but the server it communicates with is closed source (Widenius & Nyman, 2014).

Xing (2014) examines the effects of both free and commercial OSS on proprietary software. The author used a statistical model to compare two different hypothetical markets: One where proprietary software only competes with free OSS and another where proprietary software competes against both free and commercial OSS. The model considered differences in usability between OSS and proprietary software, as well differences in functionality and user technical ability. The authors findings were that the introduction of commercial OSS to the market can decrease the price of proprietary software and increase social welfare without necessarily decreasing the market share of the proprietary software. A market in which proprietary software only competes against free OSS, however, may lead to higher prices and lower social welfare (Xing, 2014).

Methods

Two surveys were created using SurveyMonkey.com: One was posted on the popular programming forum /r/coding on reddit.com; The other was distributed via Slack to the employees of Xby2, a software development company in Farmington Hills, MI. Slack is an instant-messaging platform frequently used by software developers. The surveys contain the same questions, but have been kept separate to allow for comparing the data between the two sets of respondents.

Xby2 employs between 51 and 200 people ("Xby2," n.d.), and the survey is expected to reach approximately 40 people. The gender makeup of Reddit is 53% male and 47%

female. Additionally, 54% of Reddit users are American and 46% are international ("Audience and Demographics," n.d.). /r/coding was chosen over the more popular /r/programming specifically because it is less popular. As of October 17, 2016, /r/programming has 699,453 subscribers and /r/coding has 75,898. The smaller community and more strictly enforced rules in /r/coding could lead to higher quality sample data.

The survey contains six questions. The first question asks if the respondent is either a software developer or computer science student to ensure all respondents are in in the target demographic. The remaining five questions ask the respondent about how frequently they contribute to Open Source and Proprietary projects, the licenses they use (if Open Source), and the types of software they use. The licenses and types of software used were chosen to be a representation of some of the most commonly used, with an option for "Other" to account for omissions.

Results

The Reddit survey received 132 valid responses for a response rate of approximately 0.02%. The Xby2 survey received 7 valid responses for a response rate of approximately 17.5%. The Reddit survey showed that 17.2% of respondents contribute to OSS once a week or more, while 58% contribute rarely or never. The most popular OSS licenses were MIT/X11 and the GPL, tied with 58 users reporting having used them, followed by BSD with 38 users, Apache with 30 users, and WTFPL with 6. Fifty-six percent of respondents reported contributing to proprietary projects once a week or more, while 38% reported contributing rarely or never. When asked about the software they regularly use, more respondents chose OSS over proprietary software for every category except for Office Suites.

None of the respondents to the Xby2 survey reported contributing to OSS once a week or more, while 86% reported contributing rarely or never. The most popular OSS license was Apache, with 2 respondents reporting having used it followed by MIT/X11, GPL, BSD, and WTFPL with 1 respondent each. Fifty-seven percent of respondents

reported contributing to proprietary projects once a week or more, while 43% reported contributing rarely or never. When asked about the software they regularly use, more respondents chose OSS over proprietary software for Web Browsers, and more chose proprietary software over OSS for Operating Systems, Office Suites, and Text Editors. An equal number of respondents chose OSS and proprietary software for Image Editors.

For graphical representations of these results, see Appendices A-J.

Discussion

Some of the differences between the Xby2 data and the Reddit data could be accounted for by a number of factors. First, the Xby2 survey had a much smaller sample size than the Reddit survey. With only 7 responses, the Xby2 data is strongly skewed by any outliers and is not a representative sample. The larger sample size of the Reddit survey increases its resistance to outliers and brings it closer to being a representative sample of software developers. Second, Reddit likely has a more diverse socio-economic demographic than Xby2. All 7 of the respondents to the Xby2 survey are known to be employed. The respondents to the Reddit survey were using Reddit, a free website with few barriers to entry and have an unknown employment status. Therefore, it can be assumed that the average Reddit respondent is more likely to be unemployed or financially disadvantaged than an Xby2 employee and therefor is less likely to be in a position to be able to afford proprietary software when there is a workable OSS alternative. A third possibility is that Xby2 mandates the use of certain proprietary softwares that the average Reddit respondent might not otherwise use. These reasons are all indications that the Reddit data is the more accurate of the two sets for making predictions about the larger population of software developers.

Atal and Shankar (2014) and Sacks (2015) both compare a market where two proprietary firms compete with each other to one in which a proprietary firm competes with a not-for-profit OSS firm. An important difference is that while Atal and Shankar

(2014) consider an "effort cost" to producing OSS (Atal & Shankar, 2014, p. 334), Sacks (2015) instead considers a "learning cost" to using it (Sacks, 2015, p. 271). An effort cost is the cost for the developers to produce the software. Whereas a proprietary software developer would be paid for their work, and therefor incur a net gain through their labor, the OSS is free, and the developers are not paid, and therefore incur a net loss in producing the software. While this is certainly true in some cases, it fails to account for paid OSS developers or OSS developers who genuinely enjoy their work. Additionally, some OSS developers may be developing the software to directly benefit their paid career. A perfect example of this is Howison and Bullard (2016); The authors wrote and published code of their own to facilitate their research. My primary research supports the idea of an effort cost, with 55% of Reddit respondents contributing to proprietary projects at least once a week, but only 17.4% contributing to OSS projects as frequently. The cause of this gap is easily explained by the effort cost of producing OSS as well as the opportunity cost inherent to doing something for free when it could be done for pay.

The learning cost, on the other hand, is the cost for the user of the OSS to learn how to use it. My primary research does not support the idea of a learning cost being prohibitive. In fact, in the Reddit survey, OSS beat proprietary software for number of users in every category except for Office Suites. These results might be accurate for the targeted demographic of the survey, namely software developers and computer science students, but they are unlikely to translate to the larger demographic of consumers due to the fact that members of the target demographic are likely to have higher technical knowledge and lower learning costs than members of the general public. Sacks (2015) accounts for this sort of error in their model by acknowledging that any two users may have drastically different learning costs. Sacks (2015) also considers R&D spillover from OSS communities into proprietary firms, which is an advantage of their model.

That both Atal and Shankar (2014) and Sacks (2015) both only consider free OSS is significantly disadvantageous for both models. Xing (2014) on the other hand, considers

the effects of both free and for-profit OSS on proprietary software. Like Sacks (2015), Xing (2014) also considers a learning cost for the users of the OSS, but the model neither considers an effort cost nor R&D spillover.

R&D spillover, as detailed by Sacks (2015), relies on permissively licensed OSS. Permissive software licenses like the MIT, Apache, BSD, and WTFPL licenses allow OSS to be used in proprietary projects. This is in contrast to copyleft licenses like the GPL, which state that all derivative works must be licensed under a similar license. Fifty-eight percent of surveyed Reddit users reported using one or more of the mentioned permissive licenses at least once, compared to 44% who reported using the GPL. This trend towards permissive licencing could positively impact the amount of R&D spillover that occurs, thereby increasing the amount of new software being developed by companies and having a positive effect on innovation.

Another factor that affects R&D spillover other than the licensing of the OSS is the ability of the proprietary software developers to locate and identify the OSS. Howison and Bullard (2016) explain how different factors affecting the visibility of code in scientific literature, including the availability of the source code, affect scientific research. If the findings from Howison and Bullard (2016) can be generalized to more than just biology literature, one could assume that software, and more specifically OSS, suffers from a lack of visibility. If this software was made more visible to other developers, it could have a significant impact on the amount of software created.

While important for individuals and not-for-profit OSS communities, choice of software licenses is much more important for for-profit OSS companies. As explained in Widenius and Nyman (2014), many of the more effective ways to monetize OSS require the owner to be very deliberate in their choice of license. For example, “dual licensing” depends on the open source version of the code being released under the GPL or a similar copyleft license. The success of commercial OSS is important beyond the success or failure of any single company: as Xing (2014) found, commercial OSS is often of higher quality

than free OSS, and its introduction to the market lowers prices and increases social welfare.

References

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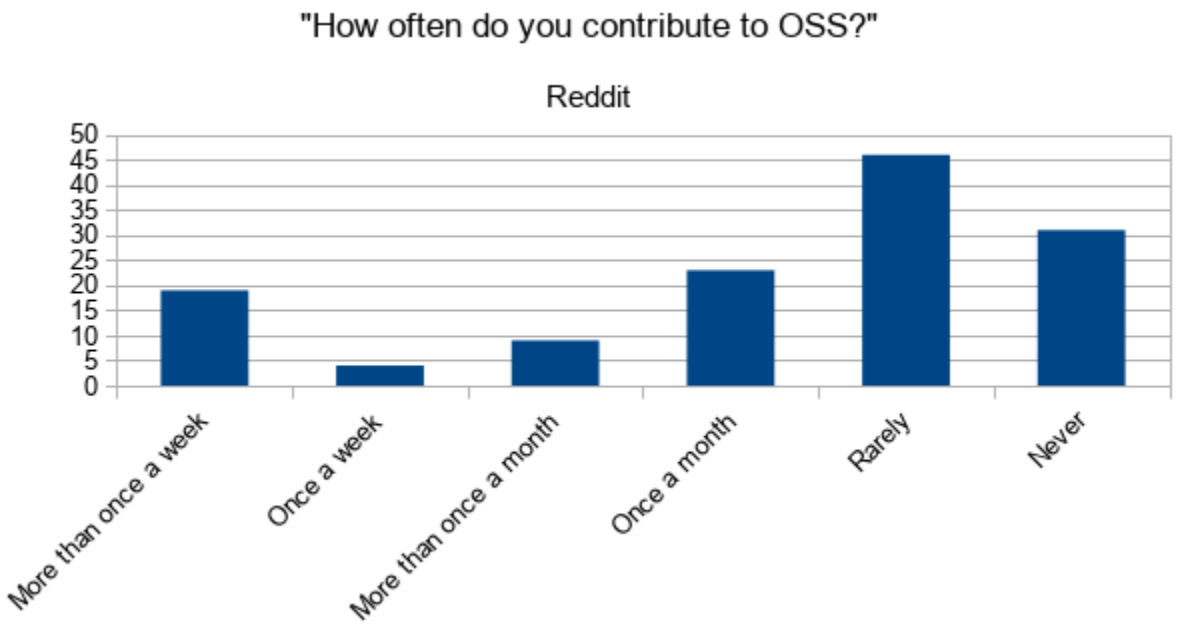
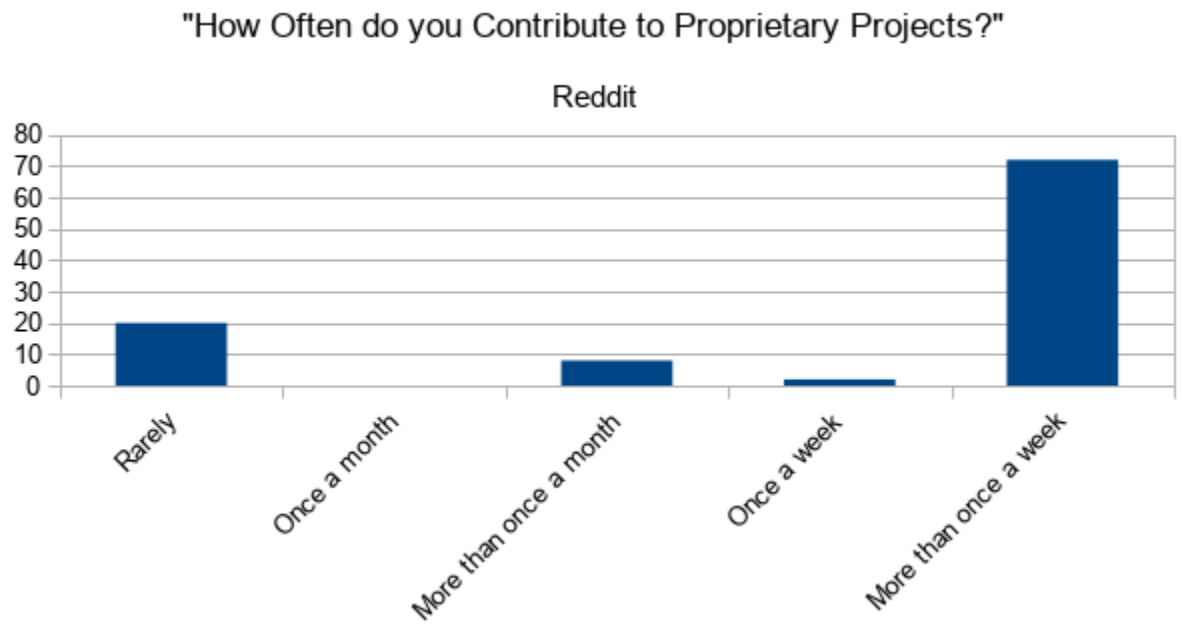
Xby2. (n.d.). *Glassdoor*. Retrieved from http://glassdoor.com

Xing, M. (2014). The impact of commercial open source software on proprietary software producers and social welfare. *Journal of Industrial Engineering and Management*, *7*(5), 1183–1196. doi:10.3926/jiem.1260

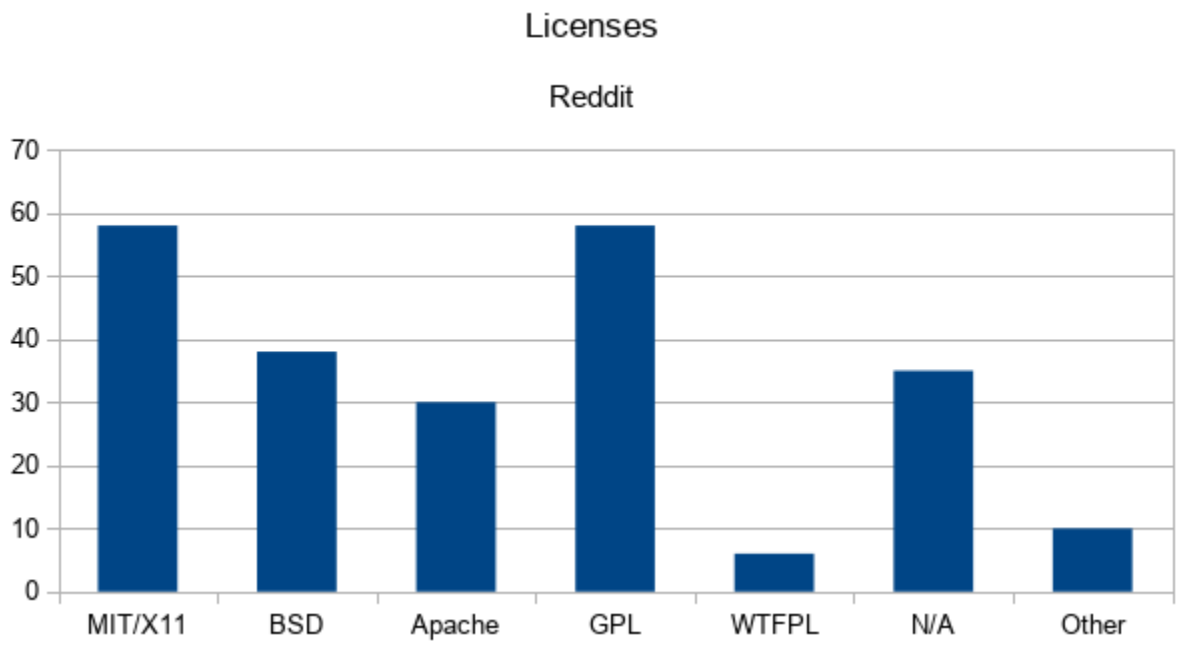
Appendix A


"How often do you contribute to OSS?"
Reddit
50
45
40
35
30
25
20
15
10
5
0
More than once a week
Once a week
More than once a month
Once a month
Rarely
Never

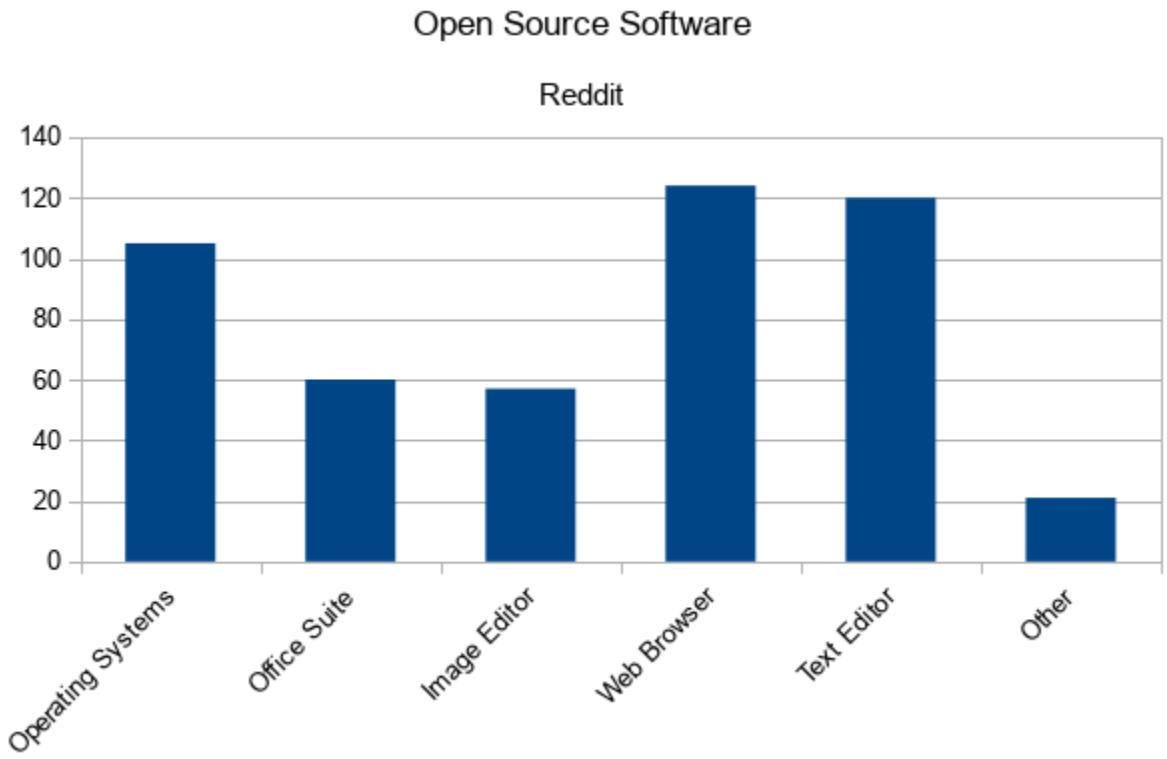
Appendix B


"How Often do you Contribute to Proprietary Projects?"
Reddit
80
70
60
50
40
30
20
10
0
Rarely
Once a month
More than once a month
Once a week
More than once a week

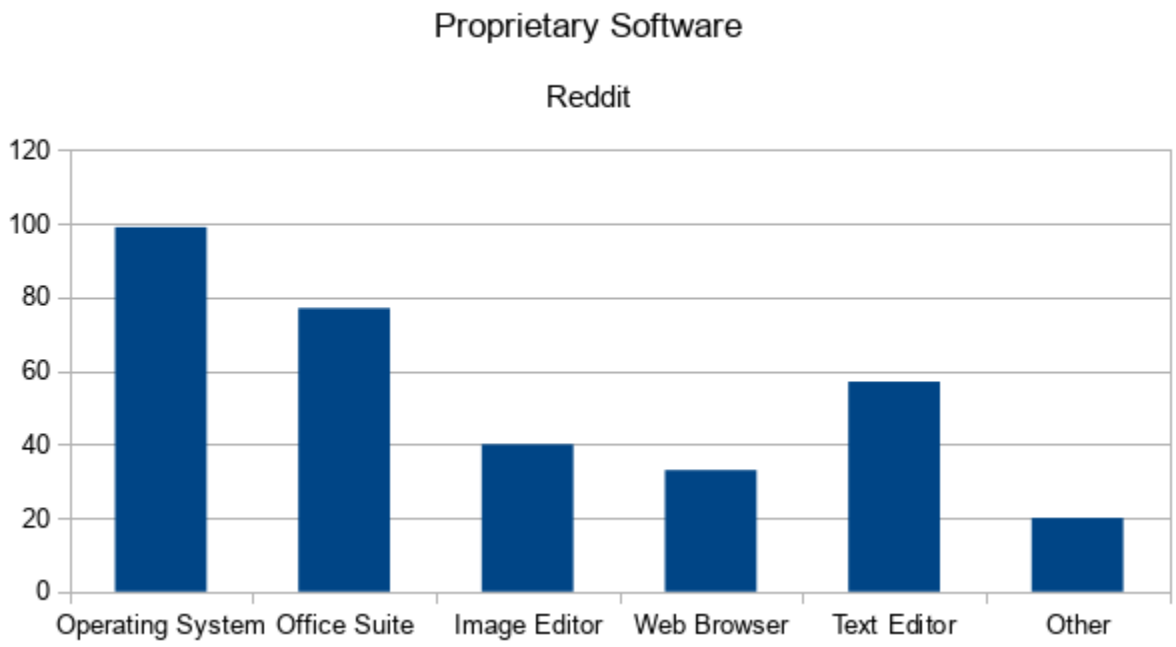
Appendix C


Licenses
Reddit
70
60
50
40
30
20
10
0
MIT/X11
BSD
Apache
GPL
WTFPL
N/A
Other

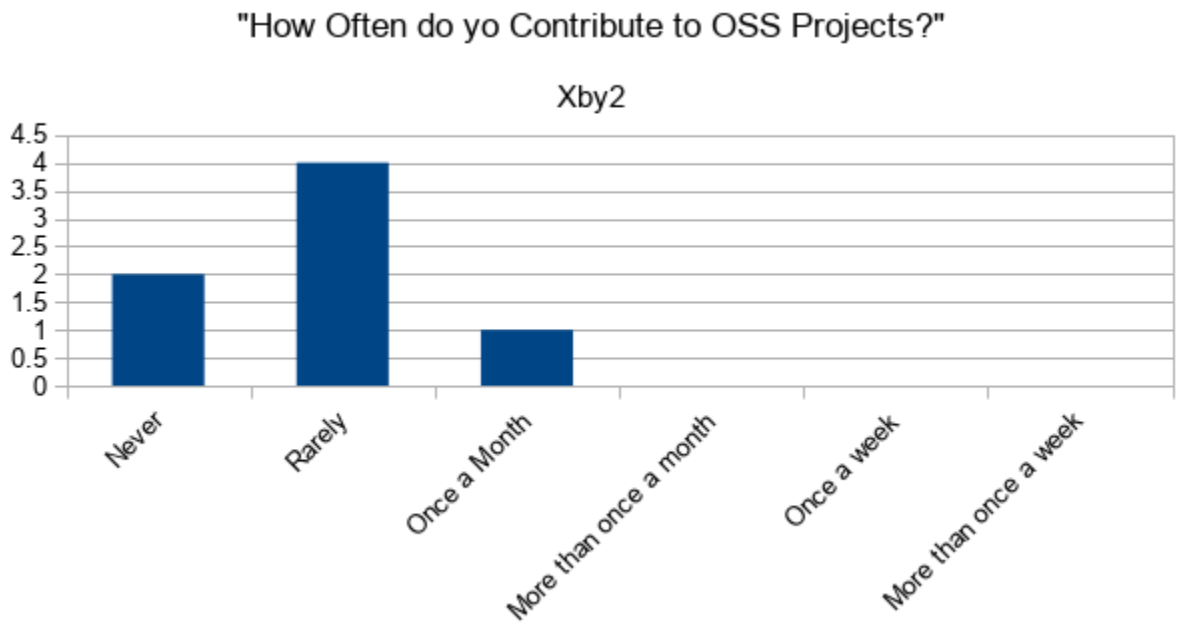
Appendix D


Open Source Software
Reddit
140
120
100
80
60
40
20
0
Operating Systems
Office Suite
Image Editor
Web Browser
Text Editor
Other

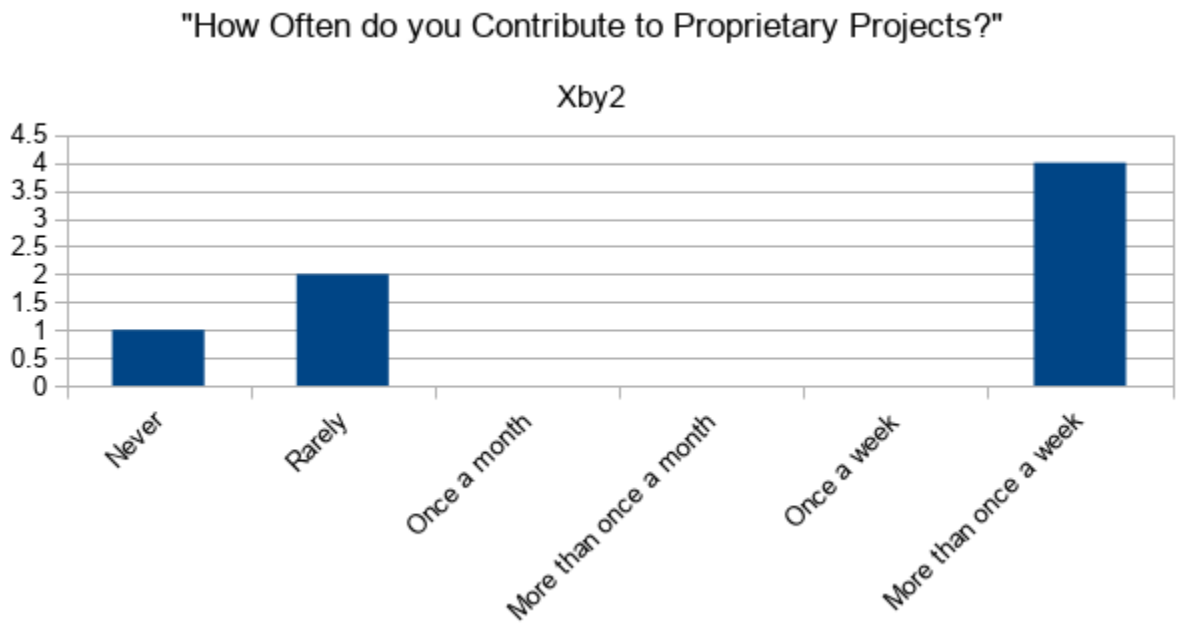
Appendix E


Proprietary Software
Reddit
120
100
80
60
40
20
0
Operating System
Office Suite
Image Editor
Web Browser
Text Editor
Other

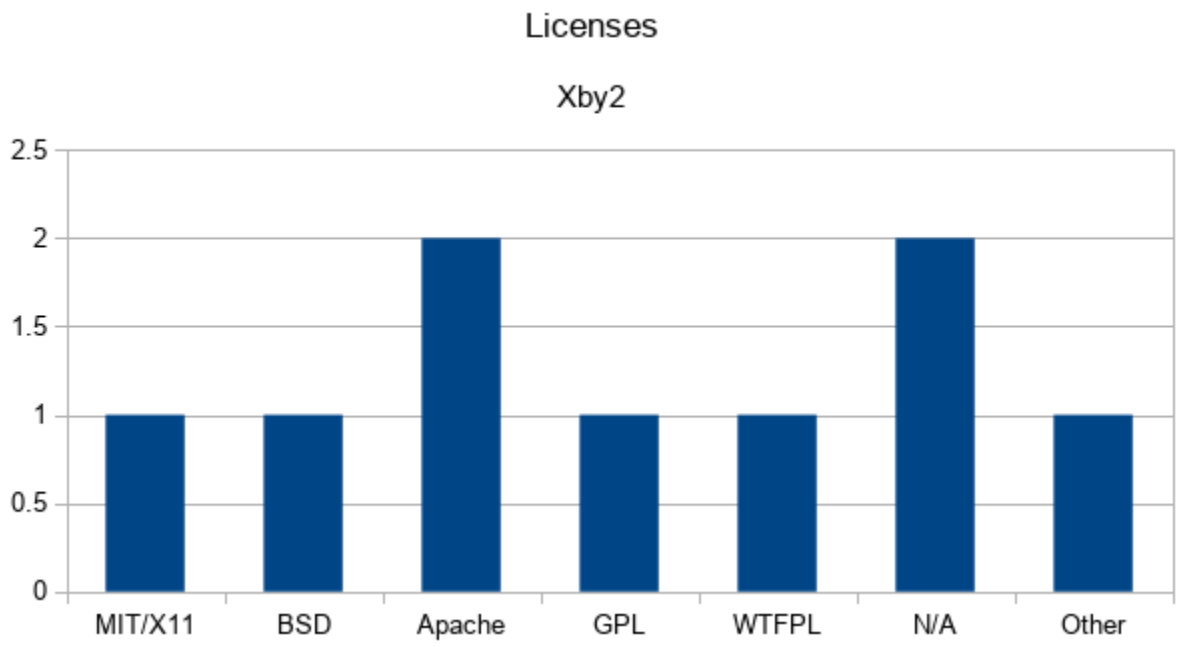
Appendix F


"How Often do yo Contribute to OSS Projects?"
Xby2
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Never
Rarely
Once a Month
More than once a month
Once a week
More than once a week

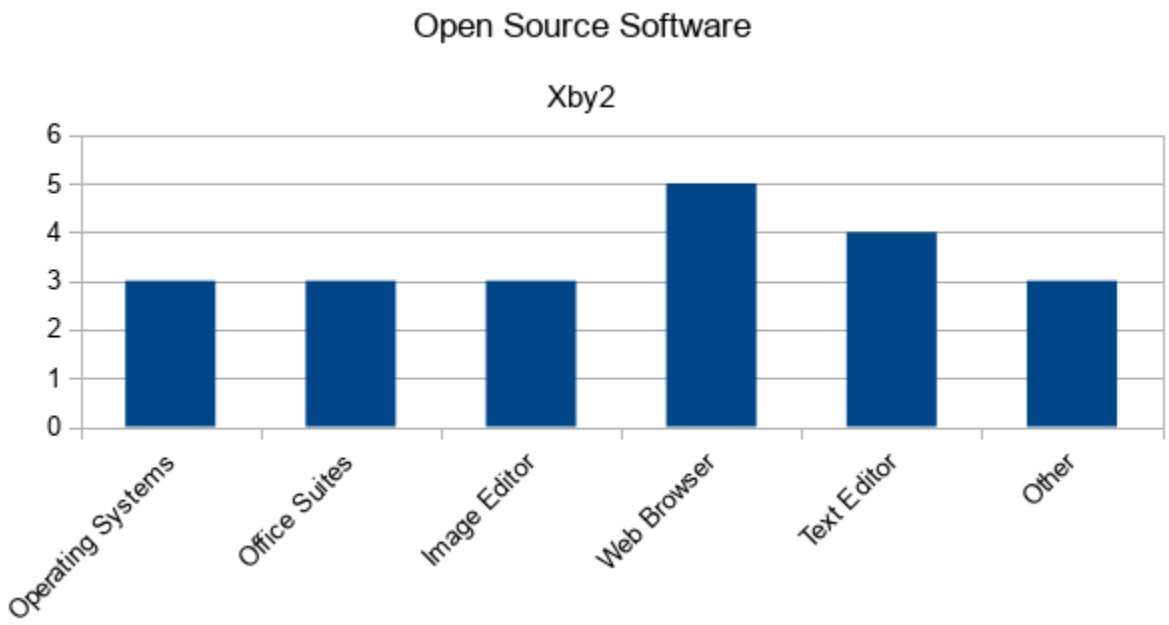
Appendix G


"How Often do you Contribute to Proprietary Projects?"
Xby2
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Never
Rarely
Once a month
More than once a month
Once a week
More than once a week

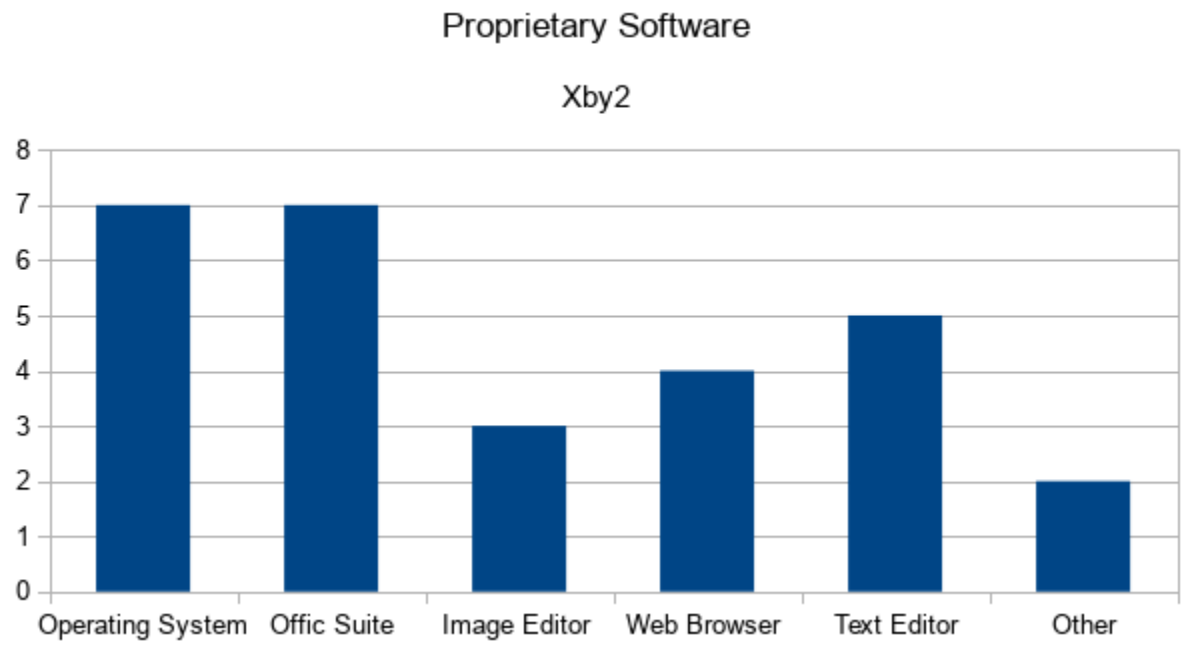
Appendix H


Licenses
Xby2
2.5
2
1.5
1
0.5
0
MIT/X11
BSD
Apache
GPL
WTFPL
N/A
Other

Appendix I


Open Source Software
Xby2
6
5
4
3
2
1
0
Operating Systems
Office Suites
Image Editor
Web Browser
Text Editor
Other

Appendix J


Proprietary Software
Xby2
8
7
6
5
4
3
2
1
0
Operating System
Offic Suite
Image Editor
Web Browser
Text Editor
Other

Appendix K

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