A Study on the Motivation Factors of the Open Source Software Developers with Special Reference to the "Region"

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Abstract. This study focuses on the motivation factors driving open source software developers in Japan. After summarizing the current research trends and economic theories, the authors introduce the results of questionnaire surveys conducted in Japan in 2009, and then discuss the process in which an "Gift Economy" is embedded into "Exchange Economy". The study further analyzes "Regionality" of motivation factors of developers by dividing the survey respondents into metropolitan and other areas.

1 Introduction

The development style of open source software is a process in which software code is developed on the Internet-based open network with the participation of a number of developers, software engineers and corporations. The developed software including the source code is released to the public, and can be freely modified, improved and re-distributed. Originally open source software was developed in this kind of community-based participation style without being directly linked with business. However, a new phenomenon can be seen in which the development of open source software is embedded in the production process of private corporations. These private corporations attempt to maintain the motivation on the part of software engineers in the open source community, and then absorb the outcome of their effort and labor (working hours) over the border of corporate organizations.

This study firstly summarizes the current research trends and economic theories behind the motivation factors of open source software developers. Secondly the authors introduce the result of questionnaire surveys conducted in Japan to investigate the motivation factors of open source software developers in Japan. Thirdly, the authors take special notice of the geographical (regional) aspects of open source software developers. The regional factors or "regionality" in this sense imply that the geographical aspects may affect the software developers and their motivation, such as the place or region where they live and the reason why they live and work there. The authors divide the questionnaire respondents into metropolitan areas and

others, and then analyze how these regional factors affect and influence the motivation of open source software developers.

2 Research Trend in Motivation of Open Source Development

2.1 Open Source Software Development and Community "Organization"

With regard to the development style of open source software, Raymond (1999) advocates the "Bazaar" development style – a number of engineers, researchers, and corporations participate voluntarily in the development over the border of enterprises and organizations. The "organization" which incorporates these open source software engineers is often called "Community". Raymond applies "bazaar" as a metaphor for the market on one side, however, from another angle, it can be said that the community is an "organization" consisting of software engineers and developers connected via the Internet.

From this organizational perspective, von Hippel (2002) insists that the participation in the open source development is completely "competitive" and that the Community is fully open not only for the corporate suppliers but also for software users. On the other hand, Garcia & Steinmueller (2003) criticize the "horizontal organization" referred to by von Hippel, and analyze the hierarchical organization in open source software development by dividing core committers to the users as a form of "division of labor". Berdou (2007) applies this organizational structure as a preface, and then clarifies the features of the organization – all the parties of core committers as well as users and volunteers, maintaining motivations by themselves, form an organization and are integrated into the Community.

2.2 Development Motivation and "Gift" Concept

On the motivation of developers participating in the Community – the organization with hierarchical structure, Raymond (1999) refers to the concept of "gift".

Zeitlyn (2003), on the other hand, claims that the open source development community should not be treated figuratively in the context of neoclassical market economy. According to Zeitlyn's view, the open source development community is physically dependent on the Internet-based public domain, however, can be regarded as a society in which "gift" exchanges exist as an important principle over the economic domain, likewise the primitive society in the ancient era. In this society, when someone provides something, and another receives; there is an enforcement of action "give back". From these viewpoints, the open source development community is the small world where the gift economy is established.

In contrast to the gift concept where the provision of developed code is considered as a gift to the community, Weber (2000) claims that software development is dependent on the human capability where the principle of resource scarcity is applicable, criticizing the gift concept that this view is based on the increasing returns by improvement and enhancement of information processing

technologies such as internet bandwidth and hardware disc advancement. Weber also asserts that the developers' motivation is influenced by self-display of scarce capability and ones' "artistry". Weber's standpoint is also common in what is based on the gift economy.

2. 3 Cost-Benefit Analysis of Development Motivation

In contrast to the gift concept, Lerner & Tirole (2000) illustrate the development motivation that there exists a "tacit contract" – by taking part in the open source development, in such a way that such merits as future job opportunities, establishment of a startup company (business-based open source development), procurement of startup entrepreneur benefit by IPO, can be secured. Lerner & Tirole criticized the gift concept by insisting that "engaging in an open source development project is beneficial to the developers and profitable in business environment". Based upon this assumption, Lerner & Tirole (2002) conducted qualitative surveys regarding the open source developers' motivation and future careers in the open source development project such as Apache, Perl, Linux, and Sendmail. Lerner & Tirole describe the fact that these programmers (developers) are successful in business in their future careers. Consequently, Lerner & Tirole concluded that there exists a "tacit contract" through which the developers can gain future benefit – future job opportunities, open source related business startup, and acquisition of startup entrepreneur benefit by IPO, and that these assumed benefits can become the accompanying motivation behind early development work.

In addition, Lakhani and von Hippel (2003) analyzed the behavior of Apache developers in response to the inquiries from users. They describe that the developers may lose their exclusive value (software knowledge) by responding to inquiries, however, they may also acquire a reputation by providing knowledgeable advice in the Internet website as a public space. Lekhani & von Hippel concluded that there is a tendency that developers take this action for acquiring reputation as a strategic opportunity for themselves.

2.4 From "Gift" to "Cost-Benefit"

As we have discussed in previous sections, the primary motivation factors of open source software developers can certainly be explained as "gift" or "intellectual interest". On the other hand, we are in the supportive position that the cost-benefit features of open source development motivation will be enhanced with the expansion of open source software utilization in the enterprise fields, independent of the open source developers' motivation.

From the viewpoint of the enterprises intending to introduce open source software, the greatest reason is often cost reduction. The cost-reduction of these enterprises (or governmental organizations) may lead to the shrinking of the market in information

service industries; therefore it is necessary for these IT industries to cultivate new market to maintain and expand their business. In this competitive market of cost-reduction and necessity of new business development, the IT industries and suppliers need to incorporate outside resources into enterprise fields. These are the software development outcomes by open source software developers which inevitably create a "gift economy" embedded into the "exchange economy". The open source software has been developed in the forms such as "participation", "gift" and "artistry", not directly linked with business behavior. However, now that open source software development is incorporated into the production process of private enterprises, it is required to maintain the motivation of open source development community and also to contribute to the cost reduction in the business fields.

According to the above-mentioned study by Lekhani & von Hippel (2003) on the time contribution of open source software developers, developers recruited by private enterprises provide "more than 2 working-day time expenses a week", and the volunteer contributors spend "more than 1 working-day time expense a week" in free and open source development projects.

As has been explained about the research trend in the U.S. and Europe, the motivation of developers will make a shift from "gift" to "cost-benefit", or the degree of primary objectives will be shifted gradually from "gift" to "cost-benefit" along with incorporation of open source into the business fields. We have been referring to open source projects primarily based on existing researches in the U.S. and Europe. In Japan, the open source development has been in progress following the western world, and it is required for Japanese researchers to investigate motivation factors of developers and time allocation for open source development.

3 Open Source Software Developers' Motivation and Time Allocation

3.1 Open Source Software Developers' Motivation

In order to make an investigation on the open source developers' motivation and time allocation in a more empirical manner, the authors conducted questionnaire survey for the "Open Source Conference" held in Tokyo (February 2009), Oita (March 2009), and Shimane (May 2009). The Open Source Conference (http://www.ospn.jp) is the initiative of open source software developers and corporations and the place for new technology presentations and information exchanges. This initiative is headed by a private enterprise Begi.net Inc. (http://www.begi.net). The questionnaire includes items such as how respondents are related to open source software and motivation for their usage. As for software developers in particular, the questionnaire includes items such as how long in time the respondents are involved in the development of open source software, the number of projects being involved, the place of activities where the respondents develop open source software, and the motivation factors.

The number of total responses was 169; however, it became 80 when they were limited to those developers who are involved in development of open source software (language, operating system, database, etc.) or utilizing the open source software for system development, inside or outside of the business workplace. We assume that these 80 respondents are "open source software developers", who are involved in the open source software projects either in development itself or utilizing it in development. With regard to the question item asking the motivation factors for being involved in the open source development, the items such as "intellectual interest and fun" and "to share knowledge and skill" are overwhelmingly the largest (See Fig. 1).

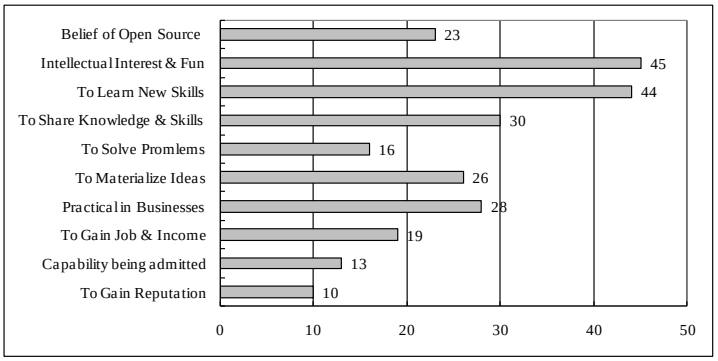

Fig.1. The Developers' Motivation to Participate in the Open Source Development (n=80, multiple responses)

In addition, the degree of satisfaction with each motivation factor was questioned (See Fig.2).

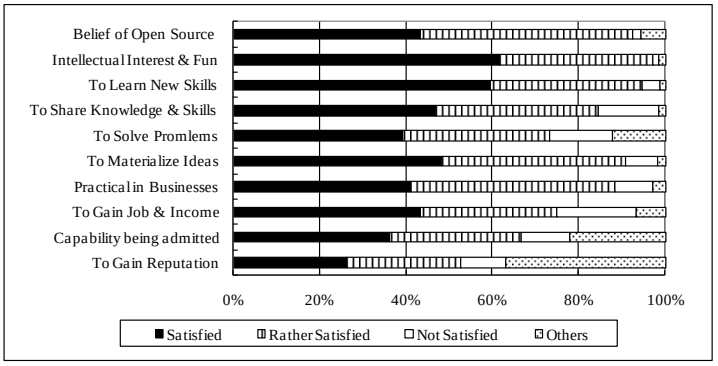

Fig.2. The Degree of Satisfaction with the Motivation Factors in Open Source Development (n=80, multiple responses)

3.2 Distribution of Developers' Time Allocation for Open Source Development

Secondly, the survey asked the developers how much time is being allocated for open source software development. In questionnaire items, the activity time in a day (100% total) was divided into "the time length of engagement in development of non open source software in working hours", "the time length of engagement in development of open source software in working hours", and "the time length of engagement in development of open source software off working hours". The time length of engagement in development of open source in working hours was 33.2% (See Fig.3), and the time length of engagement in development of open source software both in and off working hours in a day was 48.1% on average (See Fig.4).

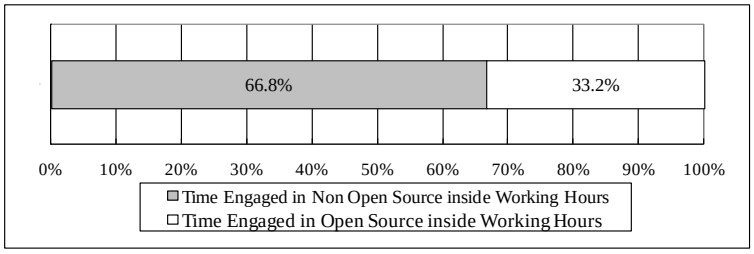

Fig.3. The Time Length of Engagement in Development of Open Source Software In Working Hours (n=80)

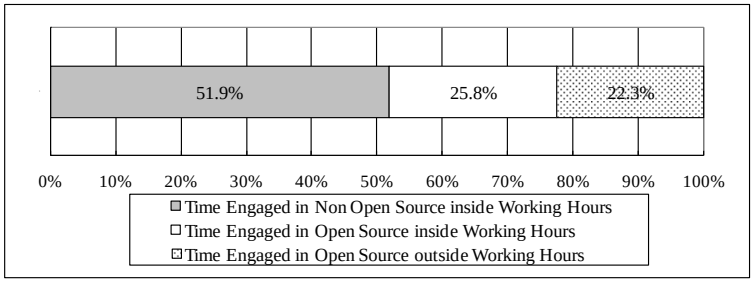

Fig.4. The Time Length of Engagement in Development of Open Source Software in a Day (n=80)

4 Comparative Analysis of Motivation Factors between Metropolitan Areas and Others

4.1 Distribution of Developers' Time Allocation for Open Source Development

Japan is populated densely in large cities, particularly the metropolitan area around Tokyo. In this study, we regard Tokyo and surrounding prefectures of Chiba, Saitama, and Kanagawa as "metropolitan (urban)", and other areas as "regional (local)" for convenience's sake. We divided the respondents' place of work by this definition and conducted a comparative analysis between metropolitan and regional areas. Behind this analysis, we set the research question: Do the motivation factors of developers differ between metropolitan areas and regional areas? If so, what would cause the difference in motivation factors and satisfaction?

The responses from the metropolitan areas were counted as 48: Tokyo 36, Kanagawa 6, Chiba 4, and Saitama 2 in detail. Those from regional areas were counted as 32. Since the conferences, in which the results of the questionnaire were used, were held in Oita and Shimane, those numbers are rather large for Oita 10 and Shimane 7; however, other respondents were scattered across the nation – Fukuoka 4, Ibaraki 3, Shizuoka 2 and others 1 (Akita, Tochigi, Fukui, Aichi, Osaka, Nagasaki).

Fig.5 illustrates the time length of engagement in development of open source software in working hours (n=48), and Fig. 6, the time length of engagement in a day, respectively (n=48)

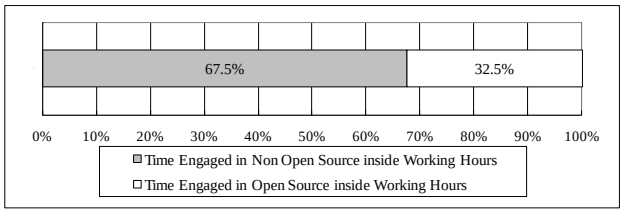

Fig.5. Metropolitan: The Time Length of Engagement in Development of Open Source Software in Working Hours (n=48)

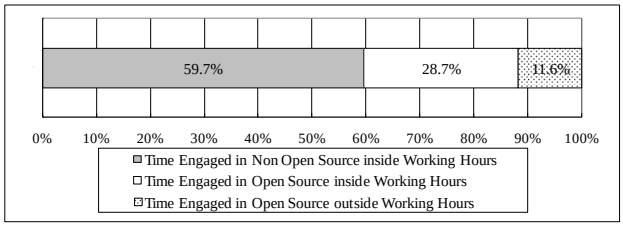

Fig.6. Metropolitan: The Time Length of Engagement in Development of Open Source Software in a Day (n=80)

Further, Fig.7 shows the time length of engagement in development of open source software in working hours (n=32), and Fig. 8 the time length in a day (n=32).

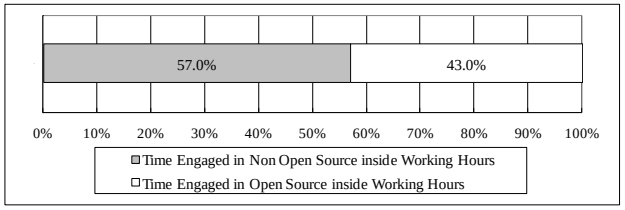

Fig.7. Region: The Time Length of Engagement in Development of Open Source Software In Working Hours (n=32)

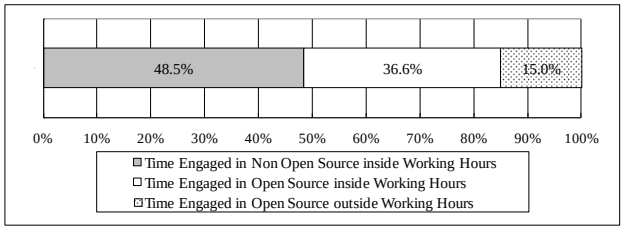

Fig.8. Region: The Time Length of Engagement in Development of Open Source Software in a Day (n=32)

With regard to the time length of engagement in development of open source software in working hours, the time share is greater in the regional areas (43.0%) than the metropolitan areas (32.5%). The time share length of engagement in development of open source in a day is also greater in the regional areas (15.0%) than the metropolitan areas (11.6%).

4.2 Degree of Satisfaction with the Development-Motivation Factors

In order to make deeper investigation into the motivation factors for open source development as to what kind of factors influence the developers' satisfaction, the authors applied the principal component analysis by SPSS with Varimax Rotation. As for the developers in total (n=80), three components (factors) are derived from the analysis (See Table 1).

Table. 1 Developers Total: Satisfaction with Development-Motivation Factors (n=80)

	Question Items	Factor 1 OSS Fundamental	Factor 2 Direct Benefit & Reputation	Factor 3 OSS Praticality
1	Belief of Open Source	0.481	0.366	0.456
2	Intellectual Interest & Fun	0.845	0.017	0.076
3	To Learn New Skills	0.783	-0.423	0.176
4	To Share Knowledge & Skills	0.852	0.102	0.236
5	To Solve Promlems	-0.053	0.447	0.801
6	To Materialize Ideas	0.322	-0.259	0.815
7	Practical in Businesses	0.525	0.046	0.556
8	To Gain Job & Income	0.436	0.657	-0.119
9	Capability being admitted	-0.002	0.879	0.081
10	To Gain Reputation	-0.200	0.765	0.150
	Contribution Ratio (%)	28.958	23.837	19.587
	Cumulative Contribution Ratio (%)	28.958	52.796	72.383

The factor 1 represents fundamental aspects of development of open source software such as "intellectual interest & fun", "to learn new skills", and "to share knowledge & skills", which we accordingly labeled "OSS Fundamental". The factor 2 explains the aspects of direct benefit from utilization such as "to gain job & income", "capability for being admitted", and "to gain reputation", which we labeled "Direct Benefit & Reputation". Lastly, the factor 3 was labeled as "OSS Practicality" which incorporates the practical aspects of open source software such as "to solve problems" and "to materialize ideas".

The contribution ratios for respective factors are 28.958% (Factor 1), 23.837% (Factor 2), and 19.587% (Factor 3). The cumulative (sum of the three) contribution ratio is calculated as 72.383%.

The following two tables indicate the results of principal component analysis applied to the degree of satisfaction with development-motivation factors in the metropolitan areas (See Table 2), and in the regional areas (See Table 3).

Table.2 Metropolitan: Satisfaction with Development-Motivation Factors (n=48)

	Question Items	Factor 1 OSS Fundamental	Factor 2 Practicality & Direct Benefit	Factor 3 Income
1	Belief of Open Source	0.595	0.458	0.277
2	Intellectual Interest & Fun	0.897	0.150	0.193
3	To Learn New Skills	0.911	-0.232	-0.025
4	To Share Knowledge & Skills	0.897	0.150	0.193
5	To Solve Promlems	0.159	0.892	-0.203
6	To Materialize Ideas	0.509	0.544	0.305
7	Practical in Businesses	0.686	0.164	0.579
8	To Gain Job & Income	0.255	-0.170	0.793
9	Capability being admitted	0.069	0.854	-0.079
10	To Gain Reputation	-0.423	0.708	0.460
	Contribution Ratio (%)	37.969	26.865	14.679
	Cumulative Contribution Ratio (%)	37.969	64.834	79.514

Table.3 Region: Satisfaction with Development-Motivation Factors (n=32)

	Question Items	Factor 1 Direct Benefit & Reputation	Factor 2 OSS Praticality	Factor 3 OSS Fundamental
1	Belief of Open Source	0.334	0.565	0.302
2	Intellectual Interest & Fun	0.116	-0.021	0.822
3	To Learn New Skills	-0.427	0.084	0.826
4	To Share Knowledge & Skills	0.189	0.401	0.720
5	To Solve Promlems	0.314	0.898	-0.147
6	To Materialize Ideas	-0.504	0.662	0.365
7	Practical in Businesses	-0.047	0.750	0.127
8	To Gain Job & Income	0.806	0.267	0.093
9	Capability being admitted	0.929	-0.009	-0.063
10	To Gain Reputation	0.852	0.051	0.022
	Contribution Ratio (%)	29.378	23.685	21.527
	Cumulative Contribution Ratio (%)	29.378	53.063	74.591

In the metropolitan areas, three components (factors) have been derived – Factor 1: OSS Fundamental, Factor 2: Practicality & Direct Benefit, and Factor 3: Income. The displayed results have almost the same tendency as the developers total, except for the fact that the items in the OSS Practicality (such as “to solve problems” and “practical in businesses”) are classed as factors with higher contributions. It is interesting that the “to gain job & income” has been classified as an independent component although the contribution ratio is lower than others.

On the other hand, the first factors derived in the regional comparison are the items relating to direct benefit (such as job & income), admittance, and reputation. The items relating to the practical and fundamental aspects of open source were classified into the factors with relatively lower contribution. In advancing analyses, the authors supposed that the components related to employment, income and reputation would be of greater importance in the metropolitan area. However, the results indicate the opposite.

5 Discussion

5.1 Open Source Development Embedded into Market Economy

Open source software has been developed by the first-class programmers across the border of nations and corporations. It should not be forgotten that this “development” has been done over the time frame of official working hours, days and nights. It is true that some portion of primary objectives and motivations can be explained by “gift” or “intellectual interest”, but if these motivations are fulfilled by private corporations, developers would probably devote their non-official working time more into open source software development.

The development of open source software is making progress in Japan, following the U.S. and Europe. As mentioned earlier, even though the motivations of Japanese developers are also “gift” or “intellectual interest” to some extent, it is an inevitable fact that more time are dedicated to development in reality, even after these

motivations are fulfilled. We can observe that there are cost-benefit aspects in development of open source software, with developers pursuing the future employment and income opportunities through involvement in open source projects.

Among the outcomes of development time (equivalent to sales or revenue), "the time length of engagement in development off working hours" might not be the one counted by the corporations directly as a form of salary or benefit packages. However, corporations developing commercial software "socially" count the development outcome of open source software. This ultimately involves a process in which the "gift economy" through open source development is embedded into market-based exchange economy.

5.2 Implication from "Regionality"

This study conducted the questionnaire survey of open source developers in Japan in order to investigate what motivation factors affect them and to what degree their experience coincides with the proposed motivation factors. We have drawn a number of interesting findings from the results of questionnaire survey and the principal component analysis to compare the motivation factors between metropolitan and regional areas.

Firstly, regarding the satisfaction with development-motivation factors, while the OSS fundamentals such as "intellectual interest" and "to share knowledge & skills" have relatively greater importance for the satisfaction of developers in metropolitan areas, the result of the regional comparison indicates that the factors relating to direct benefit (job & income) and reputation are of relatively greater importance for satisfaction in other areas. We have to consider the essential difference between metropolitan and regional areas, such as working hours (including overtime), commuting time, wage structure, etc. However, even if these facts are taken into account, the fact is that the research results imply open source developers resident in the regional areas are gaining relatively higher satisfaction with job, income and reputation than those in the metropolitan areas. This implication is of significant importance from industrial policy perspectives for those regions, and by local governments that promote information-technology industries for economic development and regional prosperity.

Another notable research finding is that the length of engagement in open source development in working hours is larger in regional areas than in metropolitan areas. It can be assumed that the regional areas have more relaxed working environment or available leisure time than the metropolitan areas. Even though open source development is embedded into market economy in both metropolitan and regional areas, it is implied from the research results that open source development contributions by developers resident in the regional areas have been more deeply understood or evaluated by community and industry, and consequently, the developers gain satisfaction in employment, income and reputation.

This study and the research sources are based on the specific conference called "Open Source Conference" in Japan, therefore the results related to motivation

factors and satisfaction influencers may vary when the targeted conference or research object groups are different. It is necessary for researchers to undertake continuous analysis on this subject and accumulate more data both quantitatively and qualitatively. However, the research perspectives proposed by this study, such as "the process in which open source software development is embedded into the market economy", "satisfaction with motivation factors", and "comparison between metropolitan and regional areas" provide a significant research base for further studies and policy implications for those region and local governments across the world, which pursue economic development through promotion of information-technology related industries.

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