Utilization and Development Contribution of Open Source Software in Japanese IT Companies: An Exploratory Study of the Effect on Business Growth (2nd report based on 2014 survey)

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ABSTRACT
The usage of Open Source Software (OSS) has been extended in a wide range of business fields not only IT industries. Behind this current situation, there are tremendous inputs by the volunteer engineers in the development communities. In this series of studies, we have conducted questionnaire survey to Japanese IT companies in 2012 and 2013, and then analyzed the relation between OSS utilization and development contribution, and how these affect the business growth. Our study revealed that Japanese IT companies are rather free riders of OSS, the volume of development contributions are far less than that of utilization. From our previous studies, it was anticipated that some OSS-related factors were affecting the business growth; however, clear evidence has not been found. In autumn 2014, we conducted the questionnaire survey for the third time and this paper presents the survey results as the second report of the continued research. We constructed the simplified Logistic Model to investigate the influential factors on business growth. However, no clear evidence was found as the same as the previous study. In summary, we conclude that there are some form of relationships between OSS utilization and development contribution, but these are not the determinant factors on the business growth in the Japanese IT companies at present.

Categories and Subject Descriptors
K.6.0 [**Management of Computing and Information Systems**]: General – *Economics*

General Terms
Management

Keywords
Open Source Software, Utilization, Development Contribution, Business Growth

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1. OBJECTIVE AND METHODOLOGY
The objective of this study is to examine the present state of OSS utilization and development contribution in the Japanese IT companies, and further investigate the effect on business growth. The objective and research methodology are basically the same as our previous studies, however, it is important to explain these with formalities at the first point of the research.

We draw our research questions as follows:

1) In what level or how much degree are the Japanese IT companies utilizing OSS and making contribution to OSS communities?
2) What is the relationship between OSS utilization and contribution? Are they correlating with each other?
3) How OSS utilization and development contribution affect the business growth?

In order to obtain the data, we conducted detailed questionnaire survey to IT companies in Japan. The addressee lists were organized from the member lists of the organizations such as Open Source Consortium Japan, regional Information Industry Association in Chugoku and Fukuoka area in Japan. The survey slips were sent to 650 companies in October 2014 (requested to deliver to the management representative), and then 131 replied (response rate 20.1%). For reference information, in 2012 survey, 642 posted and then 191 replied (response rate 29.8%), 650 posted and 146 replied in 2013 survey (response rate 22.5%).

We employed the traditional postal mailing method, by which being able to send to the companies directly. Web-based survey would be easier to collect data from individuals, but it is difficult to identify the person representing the companies. In order to increase the response rate, the survey was conducted anonymously (no need to present respondents' name and company). All the questions are selective choices by Likert scale method, and then the collected data are considered as "categorical" and discrete data.

The number of questions is 25 in total as shown in Table 1 in the next page. We adopted 6 OSS development projects for question category, such as Linux, Apache HTTP Server, Database (MySQL, PostgresSQL, etc.), Ruby, Other programming language (Perl, Python, PHP, etc.), and Ruby on Rails. Application-level software (such as ERP, CMS, CRM, etc.) was excluded in our study since utilization of such application level software is becoming popular but less-popular in contribution in Japan.

Table 1: Question Items

Company profile:
- Q1. Home Prefecture
- Q2. Year of Business Establishment (7 scale)
- Q3. Main Business Field (7 categories + other)
- Q4. Capital Stock (8 scale)
- Q5. Number of Employee (9 scale)
- Q6. Number of Developers - programmers, software engineers, etc. (9 scale)
- Q7. Sales Amount (8 scale)
- Q8. Growth Rate of Sales - present term (7 scale)
- Q9. Prospect of Sales Growth Rate (7 scale)
- Q10. Growth Rate of Employee Number - present term (7 scale)
- Q11. Prospect of Employee Number's Growth Rate - subsequent term (7 scale)

Utilization of OSS - percentage of utilization (5 scale):
- Q12. Utilization of Linux
- Q13. Utilization of Apache HTTP Server
- Q14. Utilization of Database technologies (MySQL, PostgreSQL, etc.)
- Q15. Utilization of Programming Language Ruby
- Q16. Utilization of Other Programming Languages (Perl, Python, PHP, etc.)
- Q17. Utilization of Ruby on Rails

Contribution to OSS Communities - Human Resources and Direct Expenditures:
Yes/No, Amount of Human Resources (5 scale) and Direct Expenditures (4 scale)
- Q18. Contribution to Linux
- Q19. Contribution to Apache HTTP Server
- Q20. Contribution to Database technologies (MySQL, PostgreSQL, etc.)
- Q21. Contribution to Programming Language Ruby
- Q22. Contribution to Other Programming Languages (Perl, Python, PHP, etc.)
- Q23. Contribution to Ruby on Rails

Concrete outcome and effect - Degree of Agreement/Recognition (5 scale):
- Q24. OSS utilization - 10 items
- Q25. OSS contribution - 10 items

With regard to how we measure the OSS utilization, we ask the utilization ratio of OSS - how much percentage of system is used or software development is utilized by OSS in total. "100%" in Linux means that the company uses Linux for all the server operating system, and then "50-74%" in Ruby indicates that Ruby is used in the range of 50-74% software development in the company for example (the company chose to use Ruby for the project). In this company, they probably utilize (or chose to use) "Other Languages" for the rest of 25-50%.

As for the OSS development contribution, we asked contributions by human resources and contributions by direct expenditures separately. Contributions by human resources (HR) are the total amount of engineers' labor cost of the past year, invested into OSS development activities in the business hour (converted by man/month). For example, if one engineer is involved in the OSS development activities in 20% of his business hour, assuming his labor cost is USD100,000 per year, the development contribution is counted to be USD20,000. On the other hand, contribution by direct expenditure (DE) is the total amount of monetary cost to support OSS development community such as donation, sponsorship fee or membership fee. The terms of currency in the questions were originally shown in Japanese Yen, however, the terms are converted into US Dollors (100JPY = 1USD) in order that the readers can capture the volume more easily.

With regard to the business growth indicators, we simply employed the growth rate of sales and growth rate of employee number in the present and subsequent term (prospect rate). As noted previously, all the questions are to be answered among selective choices, so the respondents just circle the growth rate such as "over 20% increase", "almost flat", "10-20% decrease", etc. We assume that the business growth can be concentrated into the sales and employee number in the long run, and then asked the growth ratio in two timeframe (present and subsequent term).

2. RESULTS

2.1 Company Profiles

Figure 1 presents the establishment year of the respondent company, of which the number varies, some has more than 40 years operation year and others were rather new. Figure 2 illustrates the main business fields of the company.

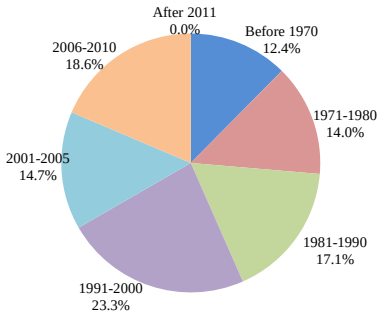

Figure 1: Year of Company Establishment

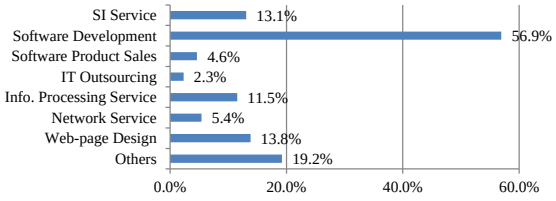

Figure 2: Main Business Fields (Multiple Answers)

The capital Stock and the number of software developers are shown in Figure 3 and 4 respectively. The capital stock less than 0.5 million USD shares more than 70%, and then the largest share of the number of developers is 10 or less. It can be said that the majority of respondent companies are small and medium sized.

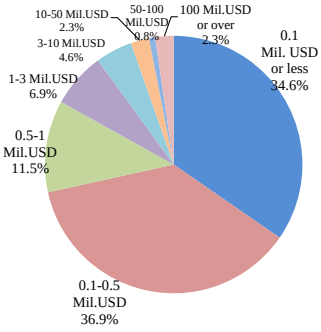

Figure 3: Capital Stock

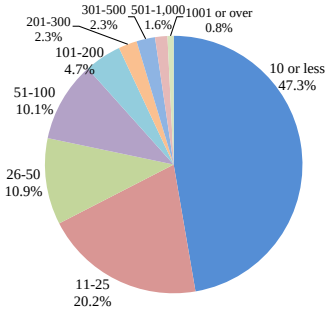

Figure 4: No. of Developers

The Table 2 shows the business growth indicators of the companies. "Almost flat" shares the largest in three indicators while 5-10% increase is largest in growth rate of sales in present.

Table 2: Business Growth Indicators

Question Item	Decrease			Almost Flat	Increase			Total
	over 20%	11-20%	5-10%		5-10%	11-20%	over 20%	
Growth Rate of Sales - Present Term	1	7	12	41	45	14	9	n= 129
	0.8%	5.4%	9.3%	31.8%	34.9%	10.9%	7.0%	100.0%
Prospect of Sales Growth Rate - Subsequent Term	1	2	11	61	44	7	2	n= 128
	0.8%	1.6%	8.6%	47.7%	34.4%	5.5%	1.6%	100.0%
Growth Rate of Employee Number - Present Term	2	3	18	72	24	5	2	n= 126
	1.6%	2.4%	14.3%	57.1%	19.0%	4.0%	1.6%	100.0%
Prospect of Employee Number's Growth Rate - Subsequesnt Term	2	0	5	76	36	5	1	n= 125
	1.6%	0.0%	4.0%	60.8%	28.8%	4.0%	0.8%	100.0%

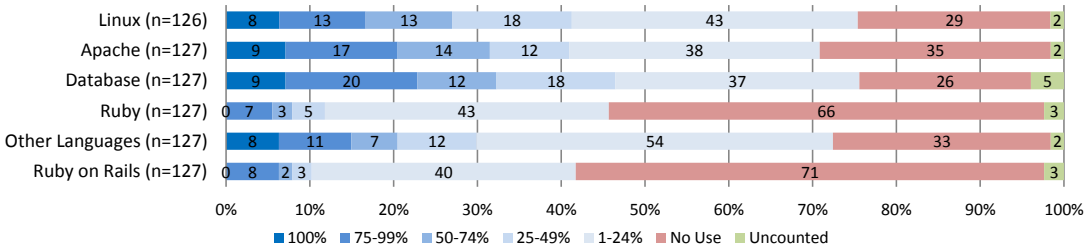

Figure 5: OSS Utilization in Japanese IT Companies

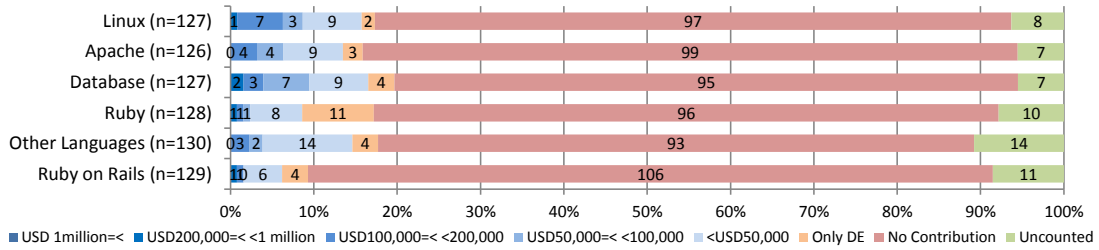

Figure 6: OSS Contribution to Communities by Human Resources in Japanese IT Companies

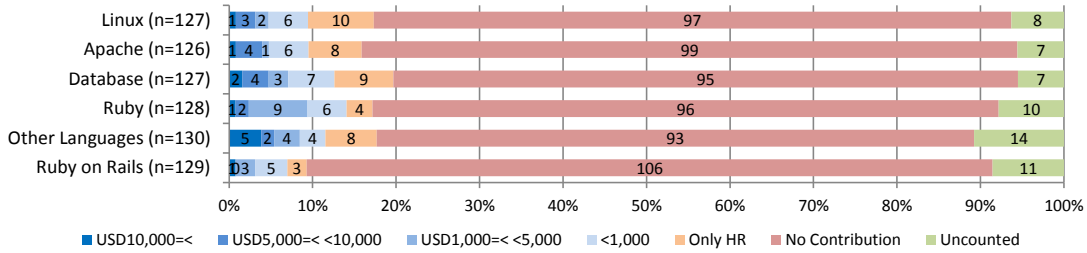

Figure 7: OSS Contribution to Communities by Direct Expenditures in Japanese IT Companies

2.2 OSS Utilization

Figure 5 above indicates how much percentage of OSS is utilized in the respondent companies. As explained previously, "Linux 100 %" mean that the company is utilizing Linux for all the operating system. As the figure indicates, Linux and Apache are utilized widely in the Japanese companies. Database and Other Languages are also utilized widely. It can be said from our sample data that approximately 70% of companies are utilizing these OSS in some portion of their systems and development in Japanese IT companies. On the other hand, utilization of Ruby and Ruby on Rails are rather lower. But we can see that more than 40% of companies are utilizing these two to some extent. The same tendency has been found as 2013 study.

2.3 OSS development Contribution

Figure 6 represents the OSS contribution by human resources (HR) and Figure 7 by direct expenditures (DE). Compared to the degree of utilization, the percentage of companies contributing to OSS communities are very low in Japan. A certain percentage responded "uncounted", so this may include the companies which have not recognized in numbers. But even taken these into account, the dominant percentage of companies (approximately 70%) do not make development contribution at all. The fact that most of Japanese IT companies use OSS without contributing to OSS development process might show that they are positioned as "free riders". Rather smaller percentage, but the survey also revealed that about 10 -15 % of IT companies do contribute to OSS development somehow in Japan. Likewise the OSS utilization, the same tendency has been observed as 2013 study.

2.4 Correlation between Development Utilization and Contribution of each OSS

In this section, we conducted the correlation analysis (by Spearman's Rank correlation coefficient) to investigate the relation between OSS utilization and development contributions are analyzed. Table 3 shows the correlation between utilization and contribution by HR, and then Table 4 shows contribution by DE respectively.

Table 3: Correlation between Utilization & HR Contribution

Utilization \ HR	Linux	Apache	Database	Ruby	Other Languages	Ruby on Rails
Linux	.264 **	.203 *	.263 **	.069	.267 **	.074
Apache	.178	.145	.204 *	-.067	.187	-.028
Database	.263 **	.192 *	.268 **	.061	.252 **	.080
Ruby	.183 *	.141	.127	.257 **	.101	.323 **
Other Languages	.297 **	.264 **	.326 **	-.042	.350 **	.069
Ruby on Rails	.079	.116	.108	.286 **	.057	.295 **

Spearman's Rank correlation Coefficient ** 1% level of significance * 5% level of significance

Table 4: Correlation between Utilization & DE Contribution

Utilization \ DE	Linux	Apache	Database	Ruby	Other Languages	Ruby on Rails
Linux	.165	.037	.090	.087	.093	.104
Apache	.138	-.020	.028	.015	.047	-.015
Database	.133	.031	.115	.155	.162	.138
Ruby	.189 *	.187 *	.263 **	.466 **	.158	.289 **
Other Languages	.202 *	.085	.099	.010	.227 *	.116
Ruby on Rails	.173 *	.115	.192 *	.447 **	.027	.257 **

Spearman's Rank correlation Coefficient ** 1% level of significance * 5% level of significance

As Table 5 shows, the significant correlations between utilization and HR are shown among Linux, Database, Ruby, Other Languages, and Ruby on Rails (except for Apache), which indicates the tendency that the companies utilizing these OSSs are contributing also by HR. In addition, with regards to utilization, Linux, Database and Other Languages are correlated with HR contribution of Linux, Apache, Database, and Other Languages, while Ruby and Ruby on Rails are rather "independent".

Regarding the DE contribution (Table 4), the correlation between utilization and contribution, Ruby, Other Languages, and Ruby on Rails are shown. However, no significant correlations are found in Linux, Apache and Database. It is interesting that utilizations of Ruby and Ruby on Rails are correlated with DE contributions of Linux, Apache (only Ruby) and Database.

In the 2013 results, the almost same tendency were shown in both HR and DE and corresponding correlations between utilization and contributions are only shown among Ruby, Other Languages, and Ruby on Rails. With these results, we concluded in 2013 study that these 3 OSSs are "objectives" for development contributions, which still need investment and contribution when utilizing them, while Linux, Apache, Database are rather generally used like proprietary software. Thereby, the findings of this 2014 survey is interesting in the points that different results are observed from HR and DE and that Linux, Database and Other Languages are linked with HR while Ruby and Ruby on Rails are linked with DE.

3. OSS and BUSINESS GROWTH

In this section, we explored the effect on business growth by OSS utilization and development contributions by correlation analysis (by Spearman's Rank correlation coefficient). The results are shown below: Correlations with utilization (Table 5), HR contributions (Table 6), and DE contributions (Table 7).

As Table 5 indicates, the correlations between all 6 OSSs and growth rate of sales (present term) are shown although significant levels differ from 1% to 5%. This result may suggest that the Japanese IT companies recognize the effect (more likely "benefit" or "expectation") of OSS utilization on the sales growth at present term. In addition, it is interesting to find that low-level OSS such as Linux and Database has significant correlation with a number of growth indicators – all 4 with Database and 3 for Linux.

Table 5: Correlation between Business Growth and Utilization

	Growth Rate of Sales		Growth Rate of Employee	
	present term	subsequent term (prospect)	present term	subsequent term (prospect)
Linux	.288 **	.218 *	.171	.200 *
Apache	.201 *	.159	.137	.107
Database	.186 *	.211 *	.196 *	.194 *
Ruby	.198 *	.191 *	.033	-.006
Other Languages	.209 *	.135	.204 *	.173
Ruby on Rails	.181 *	.130	.006	-.050

Spearman's Rank correlation Coefficient ** 1% level of significance * 5% level of significance

Table 6 below indicates the result of the correlations between business growth and HR contributions. No significant correlations are shown in terms of growth rate of sales (present term), but several significant correlations are shown for the prospect rate of growth sales in subsequent term and the prospect growth rate of employee number in the subsequent term. Significant level is lower in 5 %, but the other languages have been correlated with growth rate of employee number in both present and subsequent terms.

Table 6: Correlation between Business Growth and HR Contributions

	Growth Rate of Sales		Growth Rate of Employee	
	present term	subsequent term (prospect)	present term	subsequent term (prospect)
Linux	-.023	.205 *	.080	.060
Apache	.016	.195 *	.097	.102
Database	.075	.220 *	.151	.139
Ruby	-.001	.009	-.053	-.051
Other Languages	.063	.183	.205 *	.150
Ruby on Rails	.157	.175	.091	.054

Spearman's Rank correlation Coefficient ** 1% level of significance * 5% level of significance

Table 7 below indicates the result of the correlation between business growth and DE contributions. As a general trend, the result is different from the HR contributions. No correlation was found in the growth rate of sales in both present and subsequent terms. On the other hand, with regard to the growth rate of employee number, Ruby has significant correlation with both present and subsequent terms, and then, a strong correlation was shown with Ruby on Rails and present term. This result may show the IT companies' expectation or needs for Ruby and Ruby on Rails engineers.

Table 7: Correlation between Business Growth and DE Contributions

	Growth Rate of Sales		Growth Rate of Employee	
	present term	subsequent term (prospect)	present term	subsequent term (prospect)
Linux	.002	.056	.107	.122
Apache	-.012	.074	.081	.150
Database	-.045	.063	-.005	.070
Ruby	.089	.097	.028	.002
Other Languages	.094	.168	.224 *	.232 *
Ruby on Rails	.133	.117	.250 **	.087

Spearman's Rank correlation Coefficient ** 1% level of significance * 5% level of significance

In 2013 survey, we discussed from the results that the Japanese IT companies may recognize the positive effects of OSS utilization in present sales growth and expect contributions on future employees. However, from this 2014 survey result, different observation is needed. With OSS utilization, the tendency is almost similar to 2013 study and the company expecting the contribution on the future employee, however, the tendency is weaker and cannot be generalized and dependent on OSS.

4. LOGISTIC ANALYSIS

In this section, we conducted logistic regression analysis to explore the effect on business growth influenced by OSS utilization and development contributions. Along with our exploratory approach, we tried to find the best possible "path" to explain the OSS effect on the business growth, however, from our previous studies, no clear OSS related indicators affecting on the business growth were found. Among a number of trial models, we reached to the rather "lean" model in this 2014 study.

In process of analysis, we have faced the difficulty due to data problems – strong deviation of data. So, we constructed simplified model, changing utilization variables into dummy variables (Yes:1/No:0), integrating HR and DE contribution into 1 variable, and changing them into dummy variables (Yes:1/No:0). As for 4 business growth indicators as independent variables, we integrated 2-scale data (0, 1). To avoid multi-collinearity, Ruby on Rails variable was deleted (Ruby can be representing it), and the year of establishment was reversed into the years of operation. Descriptions of the models are shown in the next page.

Logistic Analysis

Independent Variables:	Business Growth Indicators [4] - Decrease, Flat (0) / Increase (1)
Dependent Variables:	OSS Utilization [5] - Yes (1) / No (0) OSS Contribution [5] - Yes (1) / No (0)
Control Variables:	Company Profile [3] - Scale of Capital Stock - Scale of Developers in Numbers - Years of Operation Company's Main Business Fields [6]

Table 8 represents the result of logistic analysis. The results of growth rate of sales as independent variables are NOT significant as a model (observed from Wald statistics). The results of growth rate of employee number are significant as a model both in present term (1% level) and subsequent term (5% level).

Table 8: Result of Multiple-Logistic Analysis [Model 1] Growth Rate of Sales

		Growth Rate of Sales		Growth Rate of Employee Number	
		Present Period	Subsequent Period	Present Period	Subsequent Period
OSS Utilization	Linux	1.850 *	.024	.777	.748
	Apache	.838	.418	-.692	-.921
	DB	-.554	.372	-.467	.160
	Ruby	.338	.660	-.736	-.930
	Other Languages	-.278	-.736	.944	-.318
OSS Contribution	Linux	-.208	1.761	-.581	.078
	Apache	-2.380	-1.833	-1.174	-.714
	DB	.665	.005	.675	.709
	Ruby	1.141	-.291	.577	.127
	Other Languages	.060	1.050	.540	.340
Company Profile	Scale of Capital	-.678 *	-.530 *	.012	-.497 +
	Scale of Developers	.343	.317	-.022	.535 *
	Years of Operation	.003	-.257	-.353	-.628 **
Main Business Fields	SI service	-.441	-.464	-.365	1.308 +
	Software Development	-1.148 +	-.401	.612	-.113
	Software Product	21.892	.941	2.369 +	-.642
	IT Outsourcing	-.838	.201	-19.639	-.757
	Info. Processing Service	-1.199	-.834	.628	.257
	Network Service	1.097	2.005	-18.669	.149 +
	Constant	.304 **	1.002	-.161	2.226 *
Wald Statistics		1.63	0.98	20.72 **	6.06 *
Log Likelihood		102.95	116.52	97.72	109.91
Cox-Snell R2		.310	.209	.179	.210
Nagelkerke R2		.415	.279	.262	.287

** 1%Significant (both) *5%Significant (both) + 10%Significant (both)

From the result of the significant model in the growth rate of employee number, "Software Product" in main business field is significant in 10% in present term and "Scale of Capital (10%)", "Scale of Developers (5%)", and "Years of Operation (1%)" are significant in subsequent term.

From the results of the significant models, there were found no OSS related indicators affecting business growth. Significant indicators affecting business growth were only related to "company profiles" and "main business fields".

5. CONCLUDING SUMMARY

In this study, we investigated the present state of the OSS utilization and contribution of the IT companies in Japan. Based on the questionnaire survey in 2014, we conducted correlation and logistic regression analyses to explore the OSS effects on the business growth. Confronted some technical challenges, but we have reached a number of interesting research findings which may lay some foundation for the further study in this field. Discussion related to the research questions is as follows.

Research Question 1), we found that many of Japanese IT companies are rather "free riders" in OSS utilization, without contributing to development in the OSS communities. This was also confirmed from the 2014 survey data.

Research Question 2), it was suggested that Linux, Database and Other Languages are linked with contribution by HR while Ruby and Ruby on Rails are linked with contribution by DE. In 2013 survey, Ruby, Other languages, and Ruby on Rails were forming a group of objective for contribution, while Linux, Apache, and Database were regarded as the manner of proprietary software. Our 2014 results are presenting a new trend in Japanese IT companies.

Research Question 3), the result of correlation analyses suggests that Japanese IT companies recognize positive impacts of OSS utilization on sales growth in the present term and OSS contribution on the future employee number. The trend is similar to the result of 2013 survey, however, the tendency is weaker and dependent on OSS. From simplified model, no clear determinant factors affecting business growth were found.

By the results of this study, we have not been able to reach the final goal of our research to find the determinant and influential factor(s) affecting the business growth. In summary, we conclude that there are some forms of relationships between business growth and OSS related factors of utilization and development contribution. IT companies can enjoy positive impacts on business growth by utilizing OSS and contributing to the OSS community by human resources and through direct expenditures. However, the volume of impacts is rather "subtle" at this moment in the Japanese IT companies. This result can be interpreted that there is an uncultivated opportunity for the Japanese IT companies for OSS utilization and contribution by leveraging OSS potential and linking with future business growth. Building OSS specific strategy and policy can be suggested as one of the solutions.

At last, we recognize the limitation of our research since scope and our data limits the Japanese IT companies. The present state and research findings are specific to the case of Japan. However, the research findings unveiled some features of uncultivated world of the Free /Libre Open Source Software movements.

6. ACKNOWLEDGMENTS

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