SURVEY ON OSS HUMAN RESOURCE DEVELOPMENT IN KOREA

2007. 1.

Korea OSS Promotion Forum WG2

Executive Summary

It was found that the 2,303 open source software (OSS) professionals are working at 171 sample enterprises, and the number of new OSS professionals employment among questionnaire respondents was 17 persons on an average. The size of future OSS professionals hiring in 2007 is expected to be 20 persons per company on an average (16.8% increase), and 24 persons in 2008 (22.6% increase), 29 persons in 2009 (19.7% increase), and 35 persons in 2010.

When the OSS professionals working for questionnaire respondents are classified by the job, software development was identified as the one that occupies the largest share. The proportion of OSS professionals deployed to software development was 37.8%, followed by SI development and design, digital contents, IT sales engineer, hardware development and design, system operation and management, communication and broadcasting service, and IT education.

On the other hand, most of questionnaire respondents newly hired experienced OSS professionals. They have hired 645 experienced OSS professionals, which was almost two times more than new recruits (324 persons). Reviewing in more details, the respondent company noticeably preferred the university or technical college graduate, and workers having 2 ~4 and 5 ~ 7 years of experience.

It was found that 7,772 OSS professionals were trained by surveyed universities and private educational institutions in 2006. When this number is classified by organization, 38 universities answered the questionnaire, and 2,036 courses in total were offered by these universities. Among them, 170 courses were related with OSS. It is estimated that 3,322 students have completed the OSS courses and graduated from these 38 universities. This estimation is based on the number of students who have completed OSS-related course, among 10,497 students who majored in IT-related subjects in those 38 respondent universities.

It was also found that 4,450 professionals were trained by 13 private educational institutions that answered the questionnaire on this occasion. However, it is only 6.7% of all IT-related trainees who graduate from 13 private educational institutions. Those institutions provide 199 IT-related courses on an average, and total number of trainees was 66,557 persons. Among them, 4,450 (6.7%) are attending the OSS course.

The proportion of OSS course provided by universities and private educational institutions, which is taken as a barometer of OSS professional supply status, was found to remain at one digit. The 38 universities that replied to the questionnaire on this occasion currently opened 2,306 IT-related courses, and 170 courses are related with OSS. It was less than 5 courses per university on an overage, and smaller than 8.3% of the entire IT-related courses. On the other hand, 13 private educational institutions that replied to the questionnaire opened 199 IT-related courses on an average, and 17 courses are related with OSS on an average. Like the case of universities, it is smaller than 10%.

Considering that the proportion of the OSS course in the research target private institute in 2004 was 26% and that of 2005 was 9.1%, the research result in 2006 is similar to the previous year. In terms of the level of OSS courses, the intermediate and advanced level occupy the larger portion in the private institutional instate,

where the beginner and intermediate occupy the larger portion in the university. It can be interpreted in such a way that private educational institutions are more sensitive to OSS demand in the market.

The survey on this occasion confirmed that there is inconsistency between demand and supply in the area of experienced professionals, rather than that of the beginner, like other IT areas, when demand and supply of the OSS professionals are taken into consideration. This unbalance was caused by the fact that the supply side trains the beginner most of the time, whereas the demand side requires the profession with at least 2 years of work experience. That is, there is discrepancy of demand and supply with regard to the human resource that has the certain level of experience.

To put it simply, there is a 2 year gap between supply and demand. That is, most of human resources trained by the educational channel are lack of required experiences and technical skills, and the supply side has the burden of hiring the beginner with sufficient experience and capability. Generally, companies have to invest time and resources in training the beginner with shorter than 2 years of experience, if they hire the inexperienced beginner.

Even though the trainee completes the OSS course at the university or the private educational institution, it takes about 6 months to 2 years on an average for the trainee to have enough skills for the field work. This research also shows that it takes about 6 months on an average for the university graduate, among OSS professionals, to perform the project independently by accommodating himself to the field work. In particular, there was the answer that it can take up to 24 months, depending on the situation. It was known that the significant amount of time is required to train the beginner developer, so that they can be assigned to the actual work. We can understand without difficulty why companies prefer professional having more than 2 years of work experiences.

As mentioned above, talented human resources required by the demand side should have experiences and technical skills but universities and private educational institutions seem to be unable to flexibly cope with this demand pattern. Disharmony occurs at this point. Two year discrepancy between demand and supply can be understood from the viewpoint that they seem to have difficulty in securing enough trainees and developing the proper lecture and training material for the OSS area, even though there is some gap between universities and private educational institutions.

The reason why the supply side feels the burden of course development and operation as well as securing enough trainees can be explained by the poor OSS related market, because the investment should be made in running the course focusing on practice in order to keep up with demand from the market that prefers experienced workforce. In short, it is fact that many employment opportunities cannot be provided to the trainee, which makes it impractical to open and run the OSS-related course that keeps pace with the specialized market HR demand.

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Overview

This survey was conducted in three areas – OSS professional utilization status, supply status, and future prospect.

For the OSS professional utilization status, companies in the IT industry was surveyed that has demand on the OSS professional. Major survey items include general company overview, human resource status, job and utilization technology area of the OSS professional, and future recruitment plan. Research on the OSS professional supply status was conducted for the representative supplier – university and private educational institutions. Information on the OSS professional training course, supply size, and difficulties was collected.

For the research, sample design of the demand group was based on the broad IT industry category proposed by the Ministry of Information and Communication, whereas the classification system of the Korea Network for Occupations and Workers prepared by the Korea Employment Information Service was applied to the supply side. When developing the questionnaire item, job and technical skill classification was applied to both demand and supply that is generally utilized by the company's work site.

1.2 Objects and Methods

1.2.1 Survey objects

A. Demand-side objects

The survey target was selected by the IT industry classification criteria.

Service type	Business type
IT Service	- Infrastructure communication service - Special category communication service - Value-added communication service. - Broadcasting service
IT Equipment	- Communication equipment - Information equipment - Broadcasting equipment - Parts
S/W and Computer-related Services	- Package software - Computer-related service - Digital contents development

The major survey area was limited to IT equipment and S/W and computer-related service areas only on which S/W professional demand is concentrated. The stratified systematic sampling method was used that collects samples from 13,311 companies in total by stratifying them into middle categories like the number of employees and revenue amount. Total 171 samples were extracted.

B. Supply-side objects

The survey target for the OSS supply source was divided into the university and the private educational institution. For the university, the department classification system of the Korea Network for Occupations and Workers (KNOW) in the Korea Employment Information Service was referred. Then, the course opening status and the course details were studied that are related with OSS, while focusing on the computer science and the information and communications engineering that play a role of the central axis in nurturing S/W professionals, among engineering departments that have high relevancy with this survey.

Large category	Sub-category	Detailed category
Engineering department	Computer science Information and communications engineering	Computer science, multimedia engineering, software engineering, information and communications engineering

The survey population was based on the university listed on the department information classification proposed by the Korea Network for Occupations and Workers, whereas the survey was conducted for the private educational institution that opened the OSS related course among specialized IT training centers throughout the country. Based on these criteria, 38 universities and 13 private educational institutions were selected.

1.2.2 Survey methods

171 companies in the information and communication industry, which have OSS professional demand, were selected for OSS demand survey. Initially, the questionnaire survey was conducted and then, the in-depth interview and the secondary document research (document study, article search, analysis of the company's web site) were performed, in order to analyze the trend of major companies.

Classification	Survey details
Generals	■ Company name, established year. ■ Major business area - S/W development - H/W development - IT service
HR status	■ Employment status and recruitment plan ■ Questionnaire composition by technology, job, and experience
OSS technology	■ Number of employees, assigned business area ■ Research on the recruited employee by technical skill, job, and experience.
Others	■ Preferences study – beginner or experienced ■ Difficulties in hiring the OSS professional

The 38 universities that opened the OSS-related course, and 13 private educational institutions and government's educational institutions were selected as the survey target for the OSS supply side. Universities were separated from educational institutions. Also, the internal training course of the company, which is a consumer, was also considered, as it was recognized as the kind of supply. Together with the questionnaire, the in-depth interview and secondary data research were used to identify the major supply trend.

Category	Survey details
Course name	▪ Number of opened S/W related courses ▪ Proportion of OSS among S/W courses
Course classification	▪ Lecture contents and status by technology, job, and experience ▪ Detailed items for technology - OS, S/W, programming ▪ Major compulsory major optional, or cultural studies (for university)
Lecturer and trainee	▪ Number of lecturers taking responsibility for OSS-related courses ▪ Number of trainees in OSS courses
Others	▪ Difficulties in opening OSS courses

To classify the job type of the OSS professional, the occupation classification system proposed by Korea Network for Occupations and Workers (KNOW, know.work.go.kr), which is managed by the Korea Employment Information Service, was referred. Emphasis was put on the IT-related job that is highly related with this survey.

Large category	Sub-category	Detailed category
Electricals/ Electronic/ Information and Communication	IT-related job	Information and communications engineer. Communication equipment engineer, communication network design and operation technician, satellite developer, system S/W engineer, application S/W engineer, computer programmer, digital image processing specialist, virtual reality specialist, voice processing specialist, education and science application S/W engineer, office application S/W engineer, database administrator, network engineer, information security specialist, web engineers, web programmer, e-commerce specialist, system administrator, system engineer, communication equipment operator, broadcasting equipment operator, system consultant, information system auditor, CRM specialist, ERP specialist, KMS specialist, technical support specialist, IT consultant, broadcasting equipment installation and repair engineer, communication equipment installation and repair engineer, communication cable installation and repair engineer, postal service clerk, postman

The classification system of the Korea Network for Occupations and Workers was applied to the survey as described below.

Job type	Classification by Korea Network for Occupations and Workers
System analysis and integration	- System administrator - System consultant - IT consultant

Web development and administration	- Web engineer - Web programmer
Network design and administration	- Network engineer
DB development and administration	- Database administrator
Programming	- Application S/W engineer - Computer programmer - Office application S/W engineer - Education and science application S/W engineer
Embedded system development	- System S/W engineer - System engineer
Security system development and administration	- Information security specialist

2. Demand-side Survey

2.1 Company overview

Total 181 companies were selected in this survey, including 71 S/W development companies, 30 IT and home appliance area companies, 33 IT service providers, 14 digital contents service providers. Among these companies, 23 companies providing more than 2 services.

Business type	No. of companies	Proportion (%)
SW development	71	41.5
IT and home appliance	30	17.5
IT service	33	19.3
Digital content service	14	8.2
Compound type	23	13.5
Total	171	100.0

<Table 1> Classification of survey target companies

2.2 Current status

2.2.1 Status of OSS professional employment

The number of dedicated OSS professionals in survey target companies was 2,303 persons, which was 16.7% of the entire employee (13,794 employees). The number of new employees who are related with OSS was 455, which was 18.5% of all new beginner employees, whereas 1,848 persons were the experienced worker (16.3% of the entire experienced workers). Experienced employees show the number smaller than new beginner employees.

Among the dedicated OSS staffs hired by companies, S/W developers and designers occupied the largest proportion (37.7%). For research and technical jobs that are not the office work, SI development/design occupied the largest proportion, followed by digital contents, IT sales engineers, H/W development/design, system operation/management, communication/broadcasting service, and IT-related education.

Many of both beginner and experienced workers were assigned to the S/W development and design. Experienced workers occupied higher proportion than beginner workers. In particular, many beginner workers were found to have been hired in digital contents, H/W development/design, and SI development/design.

Category	Entry Level	Experience	Total	Rate (%)
Research·Technical Work	1,389	6,095	7,484	54.3

Office Work	668	3,193	3,861	28.0
Production·Others	399	2,050	2,449	17.8
Total	2,456	11,338	13,794	100.0

<Table 2> Human resources of companies examined

Category	Entry Level	Experience	Total	Rate (%)
Research·Technical Work		21	21	0.9
SI Development·Design	52	193	245	10.6
SW Development·Design	148	720	868	37.7
Digital Contents	70	123	193	8.4
System Operation·Management	24	96	120	5.2
Communication·Broadcasting Service	15	54	69	3.0
HW Development·Design	64	74	138	6.0
IT Education	5	6	11	0.5
IT Sales Engineer	18	140	158	6.9
Office Work	59	421	480	20.8
Total	455	1,848	2,303	100.0

<Table 3> Human resources in OSS

2.2.2 Status of OSS professional employment by level

It was found that companies hired OSS professionals mainly for the S/W development and design area. When the total number of OSS professionals was summed from companies that clearly informed the number of new employment, 369 out 969 employees were assigned to the S/W development and design area, followed by office work, SI development/design, digital contents, system operation/management, IT sales engineer, communication/broadcasting service, H/W development and design, and IT related education.

[Unit: Number of People]

Category	Entry level				Experience			Total
	College Degree	Bachelor Degree	Master Degree	Doctoral Degree	2~4 Years	5~7 Years	8 Years or More	
SI Development·Design	5	26	5	-	28	25	15	104
SW Development·Design	35	78	21	1	87	103	44	369
Digital Contents	14	21	1	-	46	17	2	101
System Operation·Management	6	23	6	-	27	20	9	91
Communication·Broadcasting Service	-	12	3	-	13	9	3	40

HW Development ·Design	4	6	-	-	12	15	3	40
IT Education	-	1	-	-	1	4	-	6
IT Sales Engineer	2	10	1	-	17	25	4	59
Office Work	15	25	2	1	47	34	35	159
Total	81	202	39	2	278	252	115	969

<Table 4> Level of human resources in OSS

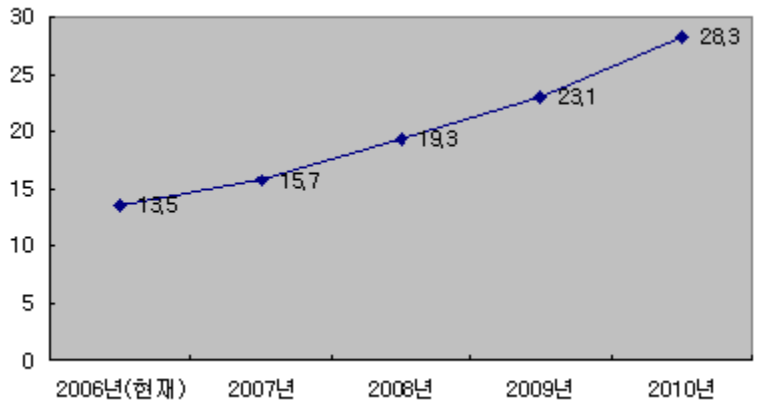
2.3 Demand Forecast

2.3.1 Employment time

Analyzing the future plan of hiring OSS professionals, 15.2% of companies answered “within 3 months,” followed by 12.6% “within 6 months,” and 15.2% “within 1 year,” and 7.3% “after 1 year.” 4.9.7% replied that they don’t have any concrete employment plan.

2.3.2 Employment volume

17 survey participant companies forecasted the proper employment volume related with OSS as 16.7 persons in 2006, 19.5 persons in 2007 (16.8% increase), 23.9 persons in 2008 (22.6% increase), 28.6 persons in 2009 (19.7% increase), and 35.1 persons in 2010 (22.7% increase).



<Figure 1> Employment Volume forecast by year (Unit: person)

2.3.3 Employment plan by job

According to the employment plan for the OSS professional in each technology among the companies whose recruitment volume was clearly announced, S/W development and programmers were the areas in which the companies had plans to employ the most people. In addition, they especially looked for the human resources in SW development and design such as Web engineers and information security engineers. IT sales engineers, consultants, project managers, system engineers, and people in digital contents and system operation and

management were also needed. The total number of people to be employed was 531. Among them, the company's preferred new recruits with bachelor's degrees and human resources with 2~4 year experience.

Category	Entry Level				Experience			Total
	College Degree	Bachelor Degree	Master Degree	Doctorial Degree	2~4 Years	5~7 Years	8 Years or More	
① SI Development·Design								
Consultant, Project Manager	2	4	4	-	7	12	5	34
System Engineer	9	6	2	-	10	4	1	32
DB Design, Administrator	1	7	2	-	11	3	1	25
Network Design, Admin.	2	4	1	-	3	1	2	13
② SW Development·Design								
SW Dev. and Programmer	4	50	18	-	54	23	2	151
Web Engineer	1	11	2	-	16	7	1	38
Info. Security Engineer	2	6	3	-	7	4	1	23
③ Digital Content	1	2	1	-	10	13	1	28
④ System Op. ·Management								
System Op. & Management	4	11	-	-	11	2	-	28
Web Master	-	2	-	-	2	1	-	5
Computer Technical Support Engineer	1	4	1	-	2	1	-	9
⑤ Comm./Broadcasting Service								
Comm. Network Dev.·Design Engineer	-	2	-	-	1	1	-	4
Communication Network Operation·Management Engineer	-	-	-	-	1	-	-	1
Comm. Network Construction Engineer	-	2	-	-	-	2	-	4
Broadcasting Engineer	-	-	-	-	-	5	-	5
⑥ HW Development·Design (Embedded)								
Platform Porting	-	-	2	-	2	6	-	10
Firmware Development	-	2	3	-	4	5	2	16
App. SW Dev.	-	3	6	-	6	9	-	24
⑦ IT Education	-	1	-	-	2	2	-	5
⑧ IT Sales								
General Sales	1	4	-	-	8	1	-	14
Sales Engineer (Pre Sales)	-	7	2	5	9	9	3	35
⑨ Office Work (Marketing/ Management)	1	1	-	3	13	7	2	27
Total	29	129	47	8	179	118	21	531

<Table 5> Recruitment Plan for Each Technology

2.3.4 Employment plan by technology category

Companies pointed out system management technology and operating systems (OS) as the essential technologies that the OSS professional must have, as well as technologies such as DBMS and programming language.

As for operating systems, 58.2% and 30.8% of the companies wanted server technology and embedded technology, respectively. 12.1% of them needed desk-top technology. As for DBMS, 50.5% and 37.4% of them wanted Oracle technology and MySQL, respectively. Few companies replied that PostgreSQL and MaxDB were needed. As for middleware, 35.2% and 18.7% of them wanted Tomcat and JBoss, respectively. As for Web•mail, 39.6%, 14.3%, and 12.1% of them wanted Apache, Sendmail, and qMail, respectively.

As for programming, the companies wanted the following languages: JAVA (46.2%), C++ (44.0%), C (31.9%), PHP (16.5%), and Python (9.9%). As for GUI, 24.2% and 18.7% of them wanted Qt and Gtk+, respectively. As for systems, the companies wanted Linux administrators (47.3%), security managers (28.6%), and network administrators (26.4%).

Category		Sub-Category	Response	Rate (%)
OS		Server	53	58.2
		Desktop	11	12.1
		Embedded	28	30.8
SW	DBMS	MySQL	34	37.4
		PostgreSQL	8	8.8
		MaxDB	8	8.8
		Oracle	46	50.5
	Middleware	Tomcat	32	35.2
		JBoss	17	18.7
	Web·Mail	Apache	36	39.6
		Sendmail	13	14.3
		qMail	11	12.1
Programming	Language	C	29	31.9
		C++	40	44.0
		JAVA	42	46.2
		PHP	15	16.5
		Python	9	9.9
		Perl	6	6.6
	GUI	Qt	22	24.2
		Gtk+	17	18.7
	System	Linux Administrator	43	47.3
		Network Administrator	24	26.4
		Security Manager	26	28.6

Pight="14.787px"al technical skills required for the OSS professional

(multiple responses)

2.3.5 OSS professional investment plan

Companies having the plan of hiring the OSS professional were found to assign the newly recruited human resource to program design and development. In addition, they also plan to utilize them to system implementation and execution, web application development, web site development and server management, and database design and development.

Category	Sub-category	Response	Rate (%)
1. System analysis and integration	• System design	28	32.6
	• System implementation and execution	33	38.4
2. Web development and system administration	• Web application development	34	39.5
	• Web site development and server administration	28	32.6
3. Network design and administration.	• Network analysis and design	14	16.3
	• Network configuration and implementation	6	7.0
	• Network management	6	7.0
4. Database development and operation	• DB analysis	13	15.1
	• DB design and development	29	33.7
	• DB administration	16	18.6
5. Programming	• Program design and development	52	60.5
	• Program evaluation and distribution	15	17.4
6. Embedded system development	• Platform porting	16	18.6
	• Firmware development	12	14.0
	• Application S/W development	21	24.4
7. Security system development and management	• Security system development	17	19.8
	• Security system operation and management	12	14.0

<Table 7> OSS professional investment plan (multiple responses)

3. Supply-side Survey

3.1 OSS Education at Universities

3.1.1 Overall situation

According to the survey, 2,036 IT-related courses were opened (54 courses per school) by 38 respondent universities. Among those courses, 170 courses were related with OSS, which is smaller than 5 courses per school, and 8.3% of the total IT-related courses.

In addition, the number of students majoring in the IT related area was 15,575 students (421 students per school), and the number of graduates who studies the IT related area was 284 students last year. The average employment ratio of the IT-related major graduate was 75.4% on an average. Among them, 3,322 graduates (32% of the entire graduate) were found to have completed the OSS related course.

The major name of the department that provides the OSS course was the department of computer science, including other names that reflect the characteristics of the department, such as department of computer, department of computer information, department of computer IT engineering, department of computer information, department of computer information engineering, department of computer information and communication engineering, and information and communications engineering. Also, other names were conspicuous that specify the detailed training course, such as department of mobile Internet, department of Internet web information system, multimedia major, and contents design major.

University	OSS-related department
Kangwon National University	Major in information and communications engineering in the department of computer science
Konkuk University	Department of computer science, department of Internet media engineering
Kyungnam University	Department of computer science
Kongbuk College of Science	Department of computer media
Kongju National University	Major in information and communications engineering in the department of computer science
Kunsan National University	Department of electronic information engineering, department of computer information
Dankook University	Major in computer science
Daegu University	Department of computer IT engineering
Daegu Health College	Administrative computer science

Daegu Polytechnic College	Department of computer information
Daejeon Health Sciences College	Department of computer information and communication
Dong Seoul College	Department of information and communication
Dong-a University	Electronic technology, department of computer science
Tongwon College	Department of computer information, department of mobile Internet
Pusan Kyungsan College	Department of Internet web information system
Sanji University	Department of computer information engineering
Seoul National University	Department of computer science, department of electronic engineering
Seoul Women's University	Computer science major, information security major, multimedia major, contents design major
Seowon University	Department of computer information and communication engineering
Sungduk College	Department of multimedia information
Songwon College	Department of computer information, information and communication, industrial design and digital electronics
Suwon Science College	Department of computer information, department of Internet information
University of Suwon	Department of computer, department of information and communications engineering, department of Internet information engineering, department of information media
Soonchunhyang University	Department of computer science, department of information and technology engineering
Soongsil University	Infocom electronic and technology system
Soongeui Women's College	unix-I, unix-II
Yang San College	Department of IT, major in computer information
Youngsan University	Department of software
Osan College	Department of computer information
Woosong University	Department of computer information
Ulsan College	Department of computer information
Uiduk University	Department of game software engineering, department of information and communications engineering
Jeonju University	Computer science
Chodang University	Department of computer science, department of information and communications engineering
Choonhae College	Department of computer information (major in hospital computing), department of health IT

Catholic Sangji College	department of computer information, department of Internet web information
Korea Polytechnic College	Department of computer science
Hankuk University of Foreign Studies	Computer science, information and communication engineering

<Table 8> OSS-related departments in each university

3.1.2 Courses in technology categories

Most OSS courses at universities were offered based on Linux. 32 universities offered OS courses. Among them, 21 universities offered server courses. As for desktop courses, 11 universities offered it, and 11 universities offered embedded courses.

As for S/W, courses were offered by the following number of universities: DBMS (28), middleware (13), and Web.mail (24). As for DBMS, 23, 11, and 2 universities offered courses about MySQL, Oracle, and PostgreSQL, respectively. As for middleware, 12 universities offered Tomcat courses. As for Web•mail, 24 and 3 universities offered Apache and Sendmail courses, respectively.

As for programming, 34, 9, and 15 universities offered language, GUI, and system courses, respectively. As for languages, courses were offered by the following number of universities: C (19), C++ (15), JAVA (19), PHP (12), and Perl (1). As for GUI, 8 and 2 universities offered Qt and Gtk+ courses, respectively. As for systems, classes were offered by the following number of universities: Linux administrator (15), network administrator (16), and security manager (7).

Category		Sub-Category	Response	Rate (%)
OS		Server	21	56.8
		Desktop	11	29.7
		Embedded	11	29.7
S/W	DBMS	MySQL	23	62.2
		PostgreSQL	2	5.4
		MaxDB	0	0
		Oracle	11	29.7
	Middleware	Tomcat	12	32.4
		JBoss	1	2.7
	Web/Mail	Apache	24	64.9
		Sendmail	3	8.1
		qMail	0	0
Programming	Language	C	19	51.4
		C++	15	40.5
		JAVA	19	51.4

		PHP	12	32.4
		Python	0	0
		Perl	1	2.7
	GUI	Qt	8	21.6
		Qtk+	2	5.4
	System	Linux Administrator	15	40.5
		Network Administrator	16	43.2
		Security Manager	7	18.9
Others			3	8.1

<Table 9> Essential technologies for the OSS professional (multiple responses)

3.1.3 Teaching staffs

OSS related courses were reviewed by professor, internal instructor, and external instructor. The number of teaching staff for OSS courses was 165 at 38 universities. That is, on average there were 4.3 teachers at each school. The number of professors with 8 years of experience or more was 60, which was the highest rate, or 36.4%. 26 professors had 5-7 years of experience (15.8%), and 15 professors had 2-4 years of experience (9.1%). 19 external instructors had 2-4 years of experience (11.5%), and 13 had 5-7 years of experience (7.9%). The number of internal instructors with 2-4 years of experience was 12 (7.3%), while 5 had 5-7 year experience (3.0%).

Category	Experienced				Total
	Less than 1 year	2~4 years	5~7 years	8 years or more	
Professor	2	15	26	60	103
Internal Instructor	-	12	5	5	22
External Instructor	-	19	13	8	40
Total	2	46	44	73	165

<Table 10> Career of teaching staffs

3.2 OSS Education at Private Educational Institution

3.2.1 Overall situation

The number of private educational institution was 13, and they opened 199 courses on an average with the average trainee of 5,120. Among these courses, those of OSS-related were 17 on an average. Every year, the private educational institution trains 4,450 persons about OSS, which are 445 persons per institution. That is, only 6.7% out of all trainees (66,557 persons in total) who attended IT-related courses offered by private educational institution have attended the OSS course.

Currently, OSS related courses provided by the private educational institute contain many Linux-related courses, such as Linux system administration, Linux network administration, Linux security, Linux troubleshooting, Linux cluster, Linux kernel internals, and Linux device driver. In addition, courses are also available for the open source database MySQL, and Java and embedding.

75% of private educational institutes answered the questionnaire that they keep the same number of OSS-related sources, whereas 25% indicates increase of the course.

3.2.2. Courses in each technology area

All of private educational institutes that answered the questionnaire said that they run the OSS lecture on the Linux platform.

10 institutions have opened the OS-related courses, which shown relatively high proportion. 90% of these institutions provide the server-related course, whereas 60% operate the embedded-related course and 40% operate the desktop-related course.

The S/W courses were opened by 7 institutions. Among them, only 54% provide the DBMS-related course, whereas only 46% provides the web/mail related source and 31% provide middleware course. Relatively many institutions (86%) provide MySQL course (open source DBMS), among institutions that offer the DBMS course. 57% of them also provide the course about Oracle DBMS. All institutions provide the Tomcat course for middleware training, and provide Apache, Sendmail, and qMail training course (by this order) as web/mail software.

The 9 institutions provide the programming course, and 69% of them provide training for the language area, and 62% of them provide the course on the system, and 38% of them provide the source on GUI. Java was the mainstream of the programming language, and some institutions opened the course on C, C++, and PHP. Security lectures occupied the largest portion in terms of the system area. Linux administrator course and the network administrator course were also opened. All institutions that opened the GUI course provide training on Qt, and 80% of them opened course for Qt.

Category		Sub-Category	Response	Rate (%)
OS		Server	9	75.0
		Desktop	4	33.3
		Embedded	6	50.0
S/W	DBMS	MySQL	6	50.0

		PostgreSQL	0	0
		MaxDB	0	0
		Oracle	4	33.3
	Middleware	Tomcat	4	33.3
		JBoss	0	0
	Web/Mail	Apache	6	50.0
		Sendmail	3	25.0
		qMail	1	8.3
Programming	Language	C	5	41.7
		C++	5	41.7
		JAVA	6	50.0
		PHP	5	41.7
		Python	0	0
		Perl	0	0
	GUI	Qt	5	41.7
		Qtk+	4	41.7
	System	Linux Administrator	6	50.0
		Network Administrator	5	41.7
		Security Manager	7	58.3

<Table 11> Classification of the open OSS course (multiple response)

3.2.3. Instructors

It was found that the average number of instructors is 71 per institution. Reviewing the work experience of the instructor, 25.6% have 5 ~ 7 year of work experience after graduated from the university, followed by 2 ~ 4 years experience and over 8 years experience after graduated from the university. It was also found that 13.9% have a Ph.D and over 8 years work experience, and the significant number of instructors has 5~7 and over 8 years work experiences with M.A degree.

Category	Experiences				Total (person)	Ratio (%)
	Less than 1 year	2~4 years	5~7 years	8 years or more		
College graduates or under	-	2	5	2	9	3.4
B.A	-	55	68	50	173	65.3
M.A	1	4	21	18	44	16.6
Ph.D	-	-	2	37	39	14.7
Total (person)	1	61	96	107	265	100.0

<Table 12> Classification of the OSS course instructors

Those institutions have 3.5 internal instructors only on an average, whereas they have 9.3 external instructors on an average, which indicates heavy dependence on the external source.

Appendix 1) Sample Education Courses at Major Public Organizations

1-1. KIPA (Information & Telecommunication HRD Center of Korea)

(Course No.1)

Category	Description	Remark
Course Title	Linux GUI Programming	
Purpose/Effect	The purpose of this course, about the program language, is for students to develop applications that operate in X Window instead of Console. Students will learn the functions of GTK+ Widzet and QT Widzet, and develop and execute the applications.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of courses Annually/Education Period	3 Times/5 Days	
Total Number of People Who Finish This Course	59	
Description	○ Introduction and Features of X Window ○ Basic Features of GTK+, Which is the Basic Toolkit of GNOME ○ Programming GTK ○ GTK+ Function ○ GNOME Widzet and Setting ○ KDE Desktop Environment ○ QT Programming ○ QT Widzet ○ QT Layout ○ Dialog ○ Event Processing ○ Event Processing ○ File, Directory Processing ○ Connection Among QT, DB, and Network	

(Course No.2)

Category	Description	Remark
Course Title	Linux Network & System Programming	
Purpose/Effect	The purpose of this course, about the advanced language, is for students to develop various programs configuring the system structure, and implement communication programs via networks through sockets and various protocols. Students will develop system operating programs and communication programs, and execute the programs.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of courses Annually/Education Period	4 Times/5 Days	
Total Number of People Who Finish This Course	78	
Description	○ Shell Programming ○ Function ○ GOB Debugging ○ System Call & Library ○ Low Level File Processing ○ Proc File System ○ Environmental Variables ○ Process ○ Thread ○ Process PIPE ○ FIFO, Semaphore ○ Share Memory ○ System V IPC ○ Socket Programming ○ Socket Protocol ○ Socket Option	

(Course No.3)

Category	Description	Remark
Course Title	Linux Kernel Internals	
Purpose/Effect	The purpose of this course is to understand the kernel/process operation type and file system structure. Students will learn the entire structure of kernel and each feature and function, and handle kernel compile, kernel tuning, file system structure, advantages, disadvantages, and system improvement.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of courses Annually/Education Period	2 Times/5 Days	
Total Number of People Who Finish This Course	49	
Description	○ Linux Kernel ○ Memory Addressing ○ Process, Thread ○ Interrupt, Exception, Queue ○ Kernel Synchronization ○ Timer ○ Scheduling Algorism ○ Memory Management ○ Process Address Space ○ POSIX API and System Call ○ Signal, Signal Handling ○ Virtual File System ○ Character Device Driver ○ Block Device Driver ○ Page Cache ○ File Access ○ Page Frame ○ File System ○ Process Communication ○ Program Execute ○ Kernel Tuning	

(Course No.4)

Category	Description	Remark
Course Title	Linux Device Driver	
Purpose/Effect	The purpose of this course is to develop the driver of the device required for the system. Students will analyze 2.4 and 2.6 kernel modules, learn how to port to kernel, build the character device driver, and port it to the system.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of Annual courses/Education Period	1 Time/5 Days	
Total Number of People Who Finish This Course	23	
Description	○ Linux Operating System ○ Device Driver ○ Linux Modules ○ Memory ○ Device Driver Initialize, Read, Write ○ Device Type ○ Kernel Timer ○ Interrupt ○ Blocking I/O ○ Queue, Bottomhalf, Tophalf ○ Proc File System ○ Memory Mapping ○ Module ○ Device Driver Application ○ Block Device Driver ○ Network Device Driver ○ System File System	

(Course No.5)

Category	Description	Remark
Course Title	Linux System Administration	
Purpose/Effect	Linux System Administration indicates the commands and management capacity required to operate Linux server. Students will learn know-how, troubleshooting skills, backup, and log analysis method required for server management, and how to implement them.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of Annual courses/Education Period	7 Times/5 Days	
Total Number of People Who Finish This Course	177	
Description	○ Features of Linux ○ Linux Server ○ Terminal and X-Window ○ Directory and Commend ○ Basic Vi Editor Method ○ Shell ○ Partition, File System ○ Linux Booting Sequence ○ Account Management and Authority ○ Processor ○ X-Window ○ Syslog ○ Daemon ○ RPM ○ Boot Loader and Grub ○ Network Installation ○ Troubleshooting ○ Kickstart ○ Kernel and Kernel Module	

(Course No.6)

Category	Description	Remark
Course Title	Linux Network & Security Administration	
Purpose/Effect	Linux Network & Security Administration indicates the network service management and server security management capability. Students will learn how to solve problems that occur during service implementation, present the methods to improve the performance, configure the security system, and optimize the system.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of Annual courses/Education Period	7 Times/5 Days	
Total Number of People Who Finish This Course	136	
Description	○ Introduction of Network ○ Network Setting ○ DNS Server ○ Web Server and Security ○ Virtual Web Server ○ FTP Server ○ NFS Server ○ SendMail ○ Postfix DHCP ○ Samba Server ○ Introduction of Security ○ Security Setting ○ Tcp_wrapper and Firewall ○ Security Tools ○ Practical Training of Network Troubleshooting ○ Backup ○ APM	

(Course No.7)

Category	Description	Remark
Course Title	Linux Cluster	
Purpose/Effect	The purpose of this course is to learn implementation methods to use Linux system as a system. Students will learn the structure of HPC and HA-LB clusters and how to implement them, test the performance through benchmarking, and perform the practical training for and implementation the configuration type for GFS and GRID clusters, which are emerging as the current trend.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of Annual courses/Education Period	4 Times/5 Days	
Total Number of People Who Finish This Course	60	
Description	○ Linux Cluster ○ Basic Hardware Structure ○ High Availability Cluster ○ LB Cluster ○ Scheduling Algorism ○ Basic Server Setting ○ HA Cluster & LB Cluster ○HA-LB Cluster Implementation through Each Scheduling Algorithm ○ HA-LB Cluster Security and Cautions ○ High Performance Cluster ○ Before HPC Cluster Construction ○ Parallel Processing SW ○ Basic HPC Implementation Setting ○ Benchmarking Tools ○ HPL ○ Commercial High Performance Cluster Construction ○ World HPC Trend Analysis	

(Course No.8)

Category	Description	Remark
Course Title	MySQL Administration	
Purpose/Effect	MySQL Administration indicates the method of managing MySQL, which is open source database. Student will learn the difference between the old version and the new version, MySQL 5.0, and construct various environments to improve the performance.	
Target	People in IT industry	
Number of People (Each Time)	25	
Number of Annual courses/Education Period	1 Time/5 Days	
Total Number of People Who Finish This Course	25	
Description	○ Features of MySQL ○ Features of Database ○ MySQL Account Management ○ MySQL Data Type ○ MySQL Command Use ○ Join Function ○ SQL Function ○ Table Control and Monitoring ○ Index ○ Query Cache ○ Tuning ○ MySQL Troubleshooting ○ InnoDB ○ Replication	

Appendix 2) Questionnaire

[For Companies]

Company Name		Department	
Respondent Name		Title	
Phone No.		Address	

1. Which business do you focus on?..... ....( )

① SW development ② IT and home appliances ③ IT service
④ Digital content service

2. Are you developing Open Source SW products or offering services in Open Source SW? .....( )

① Yes ② Under Consideration ③ No

※Open Source Software: The source cord of this SW is open to the public and provides its execution program. Thus, anyone can use, modify, and redistribute the source code.

3. If you selected Yes in Q2, which field are you involved in? .....( )

① Embedded ② OS (Distribution) ③ Package SW (Application) ④ Service

4. If you selected Under Consideration in Q2, when is the target date?....( )

① Within 3 months ② Within 6 months ③ Within 1 year ④ After 1 year

5. How many people work in your company?

Category	Entry Level	Experience	Total
Research·Technical Work			
Office Work			
Production·Others			
Total			

※ Research·Technical Work: Human resources with master's or doctorial degrees, first class engineers, computer managers or developers related to information technology and information systems, engineers, and the equivalent

※ Office Work: Human resources Involved in marketing, sales, and work at desk instead of direct development and production (Such as marketing managers)

※ Entry Level: Human resources employed from early Aug. 2005 to late Sep. 2006

6. How many people work in Open Source SW in your company?

Category	Entry Level	Experienced	Total
① Research·Technical Work			
• SI Development·Design			

• SW Dev.·Design			
• Digital Content			
• System Op.·Management			
• Comm.·Broadcasting Service			
• HW Dev.·Design			
• IT Education			
• IT Sales Engineer			
② Office Work			
Work			

※ Entry Level: Human resources employed from early Aug. 2005 to late Sep. 2006

7. Describe the career level of the people employed in Open Source SW in your company?

Category	Entry Level				Experience			Total
	College Degree	B.A	M.A	Ph.D	2~4 Years	5~7 Years	8 Years or More	
① SI Development·Design								
② SW Dev.·Design								
③ Digital Content								
④ System Op. ·Management								
⑤ Comm.·Broadcasting Service								
⑥ HW Dev.·Design								
⑦ IT Education								
⑧ IT Sales Engineer								
⑨ Office Work (Marketing/Management)								
Total								

※Entry Level: Human resources employed from early Aug. 2005 to late Sep. 2006

8. What were the recruitment requirements of your company?

Category	Very Low	Low	Normal	High	Very High
① Major Knowledge (Theory)					
② Project Performance Ability (Practical Affairs)					
③ Certificate					
④ Attitude and Characteristics					
⑤ Educational Background (Including Foreign Language)					
⑥ Others ( )					

※Frequency: Check in the target section.

9. Which route was used to employ people in Open Source SW?.....( )

① School employment center
② Private educational institution (Academy) ③ Research center
④ Open recruitment (Online·Offline) ⑤ Recommendation by neighbors
⑥ Re-education offered to existing human resources
⑦ Others (Enter:)

10. How long did it take until newly employed people with bachelor's degrees had adapted to their work?.....( )

① Before 2005: ( ) months ② 2006: ( ) months

※Criteria:

1) This question is limited to the newly employed people with bachelor's degrees. The actual adaptation period for the work is measured.

2) Through this, the level of education in universities can be measured.

3) Enter the period spent until they were able to perform projects independently.

11. Are you satisfied with their performance?

Category	Very Low	Low	Normal	High	Very High
① Major Knowledge (Theory)					
② Project Performance Ability (Practical Affairs)					
③ Creativity (Planning Ability)					
④ Communication Skill (Team Work)					
⑤ Ability to Learn New Technology					

※Frequency: Check in the target section.

12. Do you plan to employ people in Open Source SW? If so, when will you employ them?.....( )

① Within 3 months ② Within 6 months ③ Within 1 year
④ After 1 year ⑤ No plan

13. How many human resources in Open Source SW are required in your company annually?

Category	2006 (Current)	2007	2008	2009	2010
Number of People					

※Considering the growth rate of the business in Open Source SW, enter the appropriate number of human resources (TO).

14. How many people will you employ in Open Source SW for each job? (Check in the target section.)

Category	Entry Level				Experienced			Total
	College	B.A.	M.A	Ph.D	2~4 Years	5~7 Years	8 Years or More	

① SI Development·Design								
• Consultant, Project Manager								
• System Engineer								
• DB Design, Administrator								
• Network Design, Administrator								
② SW Development·Design								
• SW Development and Programmer								
• Web Engineer								
• Information Security Engineer								
③ Digital Content								
④ System Operation·Management								
• System Operation and Management								
• Web Master								
• Computer Technology Support Engineer								
⑤ Communication/Broadcasting Service								
• Communication Network Development·Design Engineer								
• Communication Network Operation·Management Engineer								
• Communication Network Construction Engineer								
• Broadcasting Engineer								
⑥ HW Development·Design (Embedded)								
• Platform Porting								
• Firmware Development								
• Application Software Development								
⑦ IT Education								
⑧ IT Sales								
• General Sales								
• Sales Engineer (Pre-Sales)								
⑨ Office Work (Marketing /Management)								
⑩ Others ( )								

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* If there is no detailed plan as indicated by sub-categories, enter the target information into the ①~⑨ sections.

15. If you plan to employ people in Open Source SW indicate in which fields will the human resources be placed?

Category	Sub-Category	Response (Check in the Target Section)
① System Analysis and Integration	• System Design	
	• System Implementation and Execution	
② Web Development and System Management	• Web Application Development	
	• Site Development and Server Management	
③ Network Design and Management	• Network Analysis and Design	
	• Network Configuration and Execution	
	• Network Management	
④ DB Development and Operation	• DB Analysis	
	• DB Design and Development	
	• DB Management	
⑤ Programming	• Program Design and Development	
	• Program Evaluation and Distribution	
⑥ Embedded System Development	• Platform Porting	
	• Firmware Development	
	• Application Software Development	
⑦ Security System Development·Management	• Security System Development	
	• Security System Operation and Management	

16. Which technology skills do you want the new recruits to have?

Category		Sub-category	Response
OS		① Server ② Desktop ③ Embedded	
SW	1) DBMS	① MySQL ② PostgreSQL ③ MaxDB ④ Oracle	
	2) Middleware	① Tomcat ② JBoss	
	3) Web·Mail	① Apache ② Sendmail ③ qMail	
Programming	1) Language	①C ②C++ ③JAVA ④PHP ⑤ eSun ⑥Perl	
	2) GUI	① Qt ② Qtk+	
	3) System	① Linux Manager ② Network ③ Security	
Others		(Enter:)	

17. If your employees need more training for their Open Source SW job, which organization will be chosen for their education? .....( )
① University ② Research center ③ Private educational institution (Academy)
④ Government educational institution
⑤ Open Source SW company (Vender) ⑥ Others ( )

※Government educational institution (e.g. Information & Telecommunication Human Resources Development Center of Korea (IHD), Small and Medium Business Administration)

[For Universities]

University Name		Department	
Respondent Name		Title	
Phone No.		Address	

1. Describe the educational status in IT related fields at your university.

Question	Answer
① Number of IT courses annually?	( )
② Number of students who major in IT related fields?	( )
③ Number of graduates students who majored in IT related fields last year?	( )
④ What was the percentage of the employment was among graduates who majored in IT fields last year?	( )%
⑤ How many Open Source SW related courses are offered among IT related courses?	( )
⑥ How many graduates completed Open Source SW related courses annually?	( )

※ Open Source Software: The source code of this SW is open to its source code to the public and provides its execution program. Anyone can use, modify, and redistribute the source code.

※ In this document, open source SW includes Linux, MySQL, PHP, Apache, etc.

2. Please, enter the names of the departments/faculties, which offer Open Source SW related classes.

Department (Faculty) name:

3. Which platform is mainly used for Open Source SW courses?.....( )

① Linux ② FreeBSD ③ NetBSD ④ OpenBSD
⑤ Others ( )

4. Which category do the Open Source SW courses belong to?

Category		Sub-category	Response
OS		① Server ② Desktop ③ Embedded	
SW	1) DBMS	① MySQL ② PostgreSQL ③ MaxDB ④ Oracle	
	2)Middleware	① Tomcat ② JBoss	
	3) Web·Mail	① Apache ② Sendmail ③ qMail	
Programming	1) Language	①C ②C++ ③JAVA ④PHP ⑤ Python ⑥Perl	
	2) GUI	① Qt ② Qtk+	
	3) System	① Linux Manager ② Network ③ Security	
Others		(Enter:)	

※Multiple responses available: Check all the corresponding items.

5. How many Open Source SW courses are offered at each level, and how many people take the courses?

Level	Number of Classes	Number of People
① Liberal arts	( )	( )
② Electives	( )	( )
③ Major electives	( )	( )
④ Major required	( )	( )
⑤ Others( )	( )	( )

6. How many people teach Open Source SW classes at your university?

Category	Experienced				Total
	Less Than 1 Year	2~4 Years	5~7 Years	8 Years or More	
① Professor					
② Internal Instructor					
③ External Instructor					
Total					

CategoryTotal

7. What percentage of projects or practical training is performed individually or by teams for each subject?

Category	Project or Practical Training
① Among IT related subjects	( )%
② Among Open Source SW related subjects	( )%

8. Do you have any problems with Open Source SW classes?....( )

① Lack of instructors ② Lack of students ③ Lack of practical training system ④ Lack of educational materials in each level

⑤ Lack of information exchange with other educational institutions
⑥ Gap between the level required by companies and that of the university
⑦ Others (Enter:)

※ Multiple responses available: Check all the corresponding items.

9. Do you have dedicated equipment for practical training in Open Source SW?.....( )

① Yes ② No

※ Equipment: Embedded testing bed, clustering system, dedicated server, laboratory, etc.

10. If you have such equipment, please specify:

Equipment :

※ Equipment: Embedded testing bed, clustering system, dedicated server, laboratory, etc.

11. Do you have industry-academy cooperation projects being performed in the Open Source SW field.....( )

① No ② Yes (If so, how many projects are there?): ( )

12. Do you have a channel that collects the requirements of companies in relation to Open Source SW?.....( )

① Yes ② No

13. If you selected Yes in Q12, which type of channel is mainly used?.....( )

① Projects with academy-industry-research institute cooperation
② Information collection through professor's internal/external activities
③ Special courses by businessmen in the field
④ Market trend information collection through media
⑤ Others: ( )

14. Are there any communities in Open Source SW?.....( )

① No
② Yes (community name: ( ), professor in charge: ( )

※Example: LUG (Linux User Group)

[For Private Educational Institutions]

Institution Name		Department	
Respondent Name		Title	
Phone No.		Address	

1. Describe the educational status of IT related fields in your institution.

Question	Answer
① How many IT courses are offered annually?	( )
② How many students taking IT courses are there?	( )
③ How many Open Source SW related courses are there among the IT related courses?	( )
④ How many students complete Open Source SW related courses annually?	( )

※ Open Source Software: The source code of this SW is open to the public and provides its execution program. Anyone can use, modify, and redistribute the source code.

※ In this document, open source SW includes Linux, MySQL, PHP, Apache, etc.

2. Please, enter the names of Open Source SW related subjects are currently offered.

Subject name (Enter all subject names if available) :

3. Is the number of Open Source SW related subjects the same as that of last year?.....( )

① Decrease ② Same ③ Increase

4. Which platform is mainly used for Open Source SW courses?.....( )

① Linux ② FreeBSD ③ NetBSD ④ OpenBSD ⑤ Others (Enter:)

※ Multiple responses available: Check all the corresponding items.

5. Which category do the Open Source SW courses belong to?

Category		Sub-category	Response
OS		① Server ② Desktop ③ Embedded	
SW	1) DBMS	① MySQL ② PostgreSQL ③ MaxDB ④ Oracle	
	2) Middleware	① Tomcat ② JBoss	
	3) Web·Mail	① Apache ② Sendmail ③ qMail	
Programming	1) Language	①C ②C++ ③JAVA ④PHP ⑤ Python ⑥Perl	
	2) GUI	① Qt ② Qtk+	

	3) System	① Linux Manager ② Network ③ Security	
Others		(Enter:)	

* Multiple responses available: Check all the corresponding items.

6. How many Open Source SW courses are there at each level, and how many people take the courses?

Level	Number of Classes	Number of People
① Beginning	( )	( )
② Intermediate	( )	( )
③ Advanced	( )	( )
④ Others ( )	( )	( )

※ Level:

* Beginning: System management and programming course

* Intermediate: Security, network, system programming course

* Advanced: Advanced developer cultivation and mid-term programming course

7. What is the number of instructors at your institution?

Question	Answer
① How many instructors for IT courses are there?	( )

8. How many instructors for Open Source SW related subjects have the following levels of experience?

Category	Experienced				Total
	Less Than 1 Year	2~4 Years	5~7 Years	8 Years or More	
① College or lower Degree					
② Bachelor Degree					
③ Master Degree					
④ Doctoral Degree					
Total					

9. How many internal/external instructors are there for Open Source SW related subjects?

① Internal instructors: ( ) ② External instructors: ( )

※ Internal instructors: Internal human resources directly employed for the courses

※ External instructors: Outsourcing human resources in each subject

10. How could you employ the instructors for Open Source SW related courses?.....( )

① Open recruitment ② Recommendation by neighbors

③ Recommendation by other educational institution ④ Outsourcing ⑤ Others (Enter:)

※ Multiple responses available: Check all the corresponding items.

11. Do you have any problems with Open Source SW classes?.....( )

① Lack of instructors ② Lack of students ③ Lack of practical training system ④ Lack of educational materials for each level ⑤ Lack of information exchange with other educational institutions ⑥ Gap between the level required by companies and that of the institution ⑦ Others (Enter:)

※Multiple responses available: Check all the corresponding items.

12. How are your Open Source SW related courses offered to people?.....( )

① Online ② Offline ③ Online·Offline together

13. Do you have dedicated equipment for practical training in Open Source SW?

Equipment type :

※ Equipment: Embedded testing bed, clustering system, dedicated server, laboratory, etc.