Thailand

Thailand-Japan Technology Transfer Project

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On-site Survey: April and July, 2009[1]

## 1. Project Profile and Japanese ODA Loan


Project Site

Discussing project effects with instructors who received Ph.D. in Japan

### 1.1 Background

Since the 1970s, Thailand has achieved the rapid industrialization and thus high economic growth rates every year. However, a shortage for highly-educated human resources in science and engineering fields has been continuously pointed out: despite a demand for engineers to cope with the advancement of the level of technologies in the production sector and a need to strengthen research and development (R&D) capabilities for increased competitiveness and sustainable economic development, quantitative and qualitative enhancement of university instructors and improvement of education facilities lagged behind.

Faculty of Science, Chulalongkorn University

Chulalongkorn University is the oldest national university with the highest academic standard. In response to the above-mentioned situation, this project aimed to enhance education and research activities of Faculty of Science and Faculty of Engineering in terms of both “soft” and “hard” aspects.

### 1.2 Objective

To upgrade science and technology (S&T) education and research and development (R&D) activities of Faculty of Science and Faculty of Engineering of Chulalongkorn University in the capital Bangkok by improving academic standard of instructors as well as educational and

[1] The first site visit was made for a week in April 2009, and the second visit was made for three weeks in June-July 2009. The beneficiary survey was carried out during these periods, too. In July 2009, at the last stage of the second visit, a feedback seminar on the tentative evaluation results was held for project-related people and organizations.

research facilities, thereby contributing to the industrial development of Thailand.

1.3 Borrower / Executing Agency:

The Government of the Kingdom of Thailand / Chulalongkorn University

1.4 Outline of Loan Agreement

| | |
|---|---|
| Loan Amount / Disbursed Amount | 7,308 Million Yen / 6,444 Million Yen |
| Date of Exchange of Notes / Date of Loan Agreement | September 1995 / September 1995 |
| Terms and Conditions<br>- Interest Rate<br>- Repayment Period<br>(Grace Period)<br>- Procurement | <br>2.7% p.a. (2.3% p.a. for Consulting Services)<br>25 Years<br>(7 Years)<br>General Untied |
| Final Disbursement Date | October 2006 |
| Main Contractors (over 1 billion JPY) | - |
| Consulting Services (over 100 million JPY) | Japan Indonesia Science and Technology Forum (Japan). Linesman Limited (UK), Design 103 Limited (Thailand), Pacific Consultants International (Japan). |
| Feasibility Study | None |

## 2. Results of Evaluation (Rating: A)

2.1 Relevance (Rating: a)

This project has been highly relevant to Vietnam's national policies and development needs at the time of both the appraisal and the ex-post evaluation.

2.1.1 Consistency with Development Policies

First, regarding national development plans of Thailand, the 7th National Economic Development Plan (1992-1996) holds human resource development through enhancing S&T education and strengthening of R&D capacity as a priority policy program. The 10th National Economic Development Plan (2007-2011) after the project completion holds "restructuring of production in order to improve productivity and add value through innovation, knowledge creation" as the third objective out of seven, and promotes higher education and research activities in S&T. Since the currency crisis in 1997, the government has continuously held its policy of structural reform from low-waged labor-intensive industries to highly value-added industries.

Second, in relation to its higher education and S&T programs, the Thai government before the project planned and implemented programs such as those to increase the number of university students in science and engineering and to improve the quality of S&T education. After the project, similarly, the Second Higher Education Long-term Plan (2008-2022)

implements programs such as university reform[2], training of instructors, and promotion of partnership among universities for the purpose of strengthening competitiveness of the county. The objective of this project is in line with those program objectives. On the other hand, the National Science and Technology Strategic Plan (2004-2013) places in its center the development of Research Clusters (or science networks) to strengthen the innovation system of Thailand and to build partnership among education and research institutions, industries and governments in technology development. The priority industries for Research Clusters include food, automobiles, software, microchips, textiles, tourism, health and bio, many of which overlap with the academic fields that were supported by this project.

2.1.2 Consistency with Development Needs

Table 1 is a summary of higher education indicators of Thailand. It indicates the increase in the number of students in terms of both total and in science and engineering faculties, thus implying a need for an enhancement of education. The ratio of instructors with PhD has not yet reached the government target of 30% as of 2007, though the average among the 24 top-ranked former national universities was 36% in the same year.

Table 1: Higher Education Indicators of Thailand

| | 1997 | 2007 |
|---|---|---|
| Number of students (Public) | 749,522 | 1,765,409 |
| Number of students (Private) | n.a. | 283,588 |
| Ratio of new entrants to S&T faculties | 15% | 22.8% |
| Ratio of instructors with PhD | n.a. | 25% |

Source: Commission on Higher Education

Regarding the research aspect, the R&D budget of the government (including R&D budget for universities and research institutes) was 18 billion Baht or 0.24% of GDP. This percentage is low compared to other countries such as Japan (3.17%) and Malaysia (0.63%). The number of researchers per 1,000 populations is also low at 0.57, compared to Japan (7.02) and Malaysia (0.7). Those figures have stayed low since the early 2000s.

Therefore, it could be said that S&T higher education and R&D of Thailand still need improvement, and thus relevance is seen in the objective of this project, which is to upgrade S&T education and researches.

At the same time, however, the approach of this project to be based in a single top-class university does not fully serve the majority of needs of the industrial sector: the industrial sector needs supply of large numbers of engineers (undergraduate degree holders) and skilled technicians (graduates from technical colleges) from higher education institutions. On the other hand, the demand for researchers (graduate degree holders) is limited due to the R&D sections of industries are relatively small[3].

The university development plan of Chulalongkorn University shows an different aspect: despite being established as an education university, Chulalongkorn University is under transition to a world-class research university. This transition process involves promotion of researches based on Research Clusters as interdisciplinary research areas, where education is the secondary objective.

2.2 Efficiency (Rating: a)

Both project period and costs were almost as planned, therefore, efficiency of the project is high.

2.2.1 Outputs

The outputs of this project could be divided in the software development components (i.e., human exchange), the hardware development components (facility development) and the

[2] The Thai government has promoted the educational reform since the new Education Act became effective in 1999. As a part of the reform, the incorporation of national universities is ongoing for individual universities. The act of incorporation of Chulalongkorn University passed the parliament in December 2007. As of the year 2008, there are 78 public universities (including 11 autonomous universities) and 68 private universities and colleges.

[3] Based on the analysis in a study by JICA (March 2009).

consulting services. Notably, this project planned and implemented those components in close coordination with each other. It was found that the major part of the planned outputs was mostly produced, while the degree of achievement is different by component. The Japanese ODA loan was used for all components except the In-house Joint Research Fund and the S&T Transfer Program.

(1) Software Development Components

The software development consisted of the following four components.

(i) Fellowship for Chulalongkorn instructors to Japan.

This component included the degree program and non-degree (short-term) program. As Table 2 shows, a total of 36 instructors received PhD in Japan through the degree program, compared to the planned 47 persons[4]. As for the non-degree program, the actual number of instructors sent to Japan was 198, which was nearly five times more than the planned number. However, the average duration of stay in Japan was shortened to 2 months, which was less than a half of the original plan[5]. The actual number of Japanese host universities/ research institutions was 11 for the degree program and 78 for the non-degree program, compared to one (University of Tokyo) in the original plan[6].

Chulalongkorn instructor who received PhD with his advisors and colleagues (photo provided by the advisor of the host university)

(ii) Dispatch of visiting scholars from Japanese universities.

The number of the visits was 562, which was more than double as many as planned, but the average duration of stay in Thailand was shortened to less than a fourth of the plan to 0.5 months[7]. A total of 11,640 students and instructors of Chulalongkorn University received advices and lectures from the visiting scholars.

(iii) In-house Joint Research Fund (Using the Thai Government budget).

This Fund, planned to ensure funding for the fellowship program returnees to continue joint researches with Japanese universities, was not realized[8].

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[4] 40 instructors were sent to Japan, out of which 3 persons withdrew and 1 person completed the coursework and returned to Thailand without obtaining the degree. According to the executing agency, the main reasons for the failures to obtain degrees are health problems and insufficient academic ability of the fellows.

A reason for the decrease in the number of instructors for the degree program was the decrease in eligible candidates due to (i) the suspension of recruitment of new instructors (civil servants) after the economic crisis in 1997, and (ii) that Chulalongkorn University introduced a condition on newly-recruited instructors to be PhD holders. Nevertheless, in response to a higher need for PhD degree than originally estimated, the PhD obtainers through the program increased.

Before sent to Japan, a six-month Japanese language training was conducted for the candidates as planned.

The academic fields of the PhD obtainers were, in order of the number of fellows, material engineering, mechanical engineering, chemical engineering, information technology, biotechnology, environmental engineering, biology and power and energy.

[5] According to the executing agency, the reasons for the increase in the number of non-degree fellows were (i) shortened duration of stays due to tight schedule of the candidates for reasons such as lack of instructors, and (ii) the consequence of more accurate estimation of the number of fellows based on Research Profiles (see *(3) Additional Output*).

[6] The host institutions in Japan were diversified as it was found that a single university could not handle all fields of study planned by fellows. It could be highly valued that the Academic Fellowship Services consultants carefully and meticulously matched fields of study and host institutions and that the Japanese host institutions well cooperated to the program. Those factors made such a large-scale dispatch smooth without big problems.

[7] According the executing agency, a reason for the shortened period of stay by Japanese visiting scholars was difficulties in longer-term visits due to factors such as the incorporation of Japanese national universities.

[8] The Fund was not realized because the executing agency could not make the budget request in a timely manner as

(iv) S&T Transfer Program (Using the Thai Government budget).
Through this program, annual university-level workshops and approximately 60 smaller seminars/ workshops were held for fellowship program returnees and visiting scholars. However, "the development of a system of technology transfer to industries" planned during the project implementation was not realized due to the delays in implementation (see *2.2.2 Project Period*).

Table 2: Fellowship from Chulalongkorn University to Japanese Universities (Plan and Actual)

| | Planned at Appraisal | | | | | Actual | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of batches | Duration (month) | From FS (persons) | From FE (persons) | Total (persons) | No. of batches | Duration (month) | From FS (persons) | From FE (persons) | Total (persons) |
| Degree Total | -- | 43.3 | 23 | 24 | 47 | -- | 49.5 | 21 (19) | 19 (17) | 40 (36) |
| Master only | 3 | 30 | 10 | 7 | 17 | 0 | 0 | 0 | 0 | 0 |
| Master+Doctor | 3 | 66 | 4 | 7 | 11 | 3 | 27.3 | 4 ( 4) | 5 ( 5) | 9 ( 9) |
| Doctor only | 3 | 42 | 9 | 10 | 19 | 8 | 44.1 | 17 (15) | 14 (12) | 31 (27) |
| Non-Degree Total | 5 | 5 | 16 | 24 | 40 | 8 | 2.3 | 134 | 64 | 198 |
| Grand Total | -- | -- | 39 | 48 | 87 | -- | -- | 82 | 156 | 238 |

Source: Chulalongkorn University

Notes: FS stands for Faculty of Science; FE stands for Faculty of Engineering.
Figures in parentheses are actual numbers of degrees awarded.
Figures under "Duration" show averages per person. On the "Master + Doctor" line, figures under "Duration" show average durations for Master's Courses only.

Table 3: Visiting Scholars from Japanese Universities to Chulalongkorn University (Plan and Actual)

| | Duration (month) | To Faculty of Science (person) | To Faculty of Engineering (person) | Total (person) |
|---|---|---|---|---|
| Planned | 2.4 | 140 | 123 | 263 |
| Actual | 0.5 | 352 | 210 | 562 |

Source: Chulalongkorn University

Notes: Figures under "Duration" show averages per person.

(2) Hardware Development Components

The hardware development consisted of the following three components.

(i) Education and research equipment (actual total purchase value: approx. 2.9 billion Yen).
The number of departments and laboratories where the equipment were installed was mostly as planned. The types and the number of items of the equipment vary following the detailed plan prepared during the project (Table 4).

(ii) S&T information network equipment (actual total purchase value: approx. 1 billion Yen).
Equipment such as terminals (personal computers), servers, printers as well as software were installed to the computer centers of both Faculties mostly as planned.

(iii) Libraries (actual total purchase value: approx. 8 million Yen).
A total of 3,930 titles of textbooks, reference books and CD-ROMs was planned, but the number of titles actually purchased was 591 (275 titles for Faculty of Science and 316 titles for Faculty of Engineering)[9].

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the project was delayed (see *2.2.2 Project Period*) and the budget years of Thailand and Japan were different. Instead, a maximum 200 thousand Baht/ two years of research grant was provided to each degree returnee, though this grant was applicable not only to the returnees through this project but to anyone who returned from foreign countries with degree.

[9] The reason for the decrease in the number of titles of books/ CDs was the prolonged processes of the changes in procurement method (because the originally-planned international competitive bidding was not an appropriate method) and procurement preparation.

Table 4: Education and Research Equipment (Plan and Actual)

| | Planned at Appraisal | | | Actual | | | |
|---|---|---|---|---|---|---|---|
| | Faculty of Science | Faculty of Engineering | Total | Faculty of Science | Faculty of Engineering | STREC[*4] | Total |
| No. of Departments[*1] | 12 | 8 | 20 | 13 | 8 | 1 | 21 |
| No. of Laboratories | 37 [*2] | 29 | 66 | 46 | 23 | 1 | 70 |
| No. of Items[*3] | 444 | 454 | 898 | 323 | 223 | 14 | 560 |

Source: Chulalongkorn University

Notes: 1) The total numbers of departments are 22 in Faculty of Science and 12 in Faculty of Engineering.
2) Including equipment to be centrally-managed.
3) Including first and second priorities.
4) Science and Technology Research Equipment Center of Chulalongkorn University (STREC).

Analysis equipment of Chemistry Department, Faculty of Science

Computer Center of Faculty of Science

Dynamometer with endoscope of Mechanical Engineering Department, Faculty of Engineering

The procurement methods of equipment and library books were largely changed from the originally-planned method (Table 5). This change was due to difficulties in applying international competitive bidding (ICB), the original method, for the procurement of equipment/ books that were various in terms of type, quantity, specification, manufacturer and price, and thus could be considered as an appropriate measure.

Table 5: Equipment Procurement Methods (Plan and Actual)

| Component | Planned at Appraisal | Actual |
|---|---|---|
| Education and research equipment | 2 ICBs with Pre-qualification | 3 ICBs with Post-qualification (out of which, 1 ICB fell through) (Total 17 contracts concluded) |
| | | 7 Direct Purchases (Total 50 contracts concluded) |
| | | 1 International Shopping * (Total 10 contracts concluded) |
| S&T information network equipment | 1 ICB with Pre-qualification | 2 ICBs with Post-qualification (Total 5 contracts concluded) |
| | | 1 Direct Purchase (Total 2 contracts concluded) |
| Libraries | 1 ICB with Pre-qualification | 1 Optional Contract (Total 1 contract concluded) |

Source: Chulalongkorn University

Note: International shopping is a procurement method based on comparing price quotations obtained from several (usually at least three) foreign and/or local suppliers to ensure competitive prices.

(3) Additional Output (Research Profiles)

In order to harmonize different components of the software development and hardware development for effective project outcomes, this project developed a set of plans of individual joint researches with Japanese universities as a basis of programming of personnel exchange and equipment purchase. These plans were called the “Research Profiles” and included research plans and descriptions of necessary project components for individual research themes. Through joint undertakings by instructors sent to Japan, Chulalongkorn University, Japanese counterpart universities and the project consultants, a total of 42 Research Profiles (21 Profiles for 11

departments of Faculty of Science and 21 Profiles for 6 departments of Faculty of Engineering) were prepared.

(4) Consulting Services

This project involved various kinds of consulting services. Although some types of services were cancelled (as shown below), the total work volume was largely increased following the development of Research Profiles, the additional output.

(i) Software Development Support Services (SDSS) (including curriculum development and development of university management improvement plans).
Total 69 person-months of SDSS were planned, but the whole services were cancelled as the legal framework following the educational reform of Thailand had not been completed and thus the project could not specify the plan in accordance with the framework.

(ii) Hardware Development Support Services (HDSS) (including selection, procurement, installation and management of equipment).
HDSS was integrated to the Overall Project Management Services.

(iii) Overall Project Management Services (OPM) (including project implementation supervision and selection of visiting scholars).
The work volume increased.

(iv) Academic Fellowship Support Services (AFS) (including selection of host universities in Japan, pre-departure training, support for immigration and accommodation).
The work volume increased.

The implementation process of this project could be characterized by several aspects such as the fact that the core activities of project implementation and management were undertaken by university instructors who are busy in education and researches, that the project involved faculties and departments that are various and independent from each other, and that many Japanese universities also participated in the process. In order for such a project to produce various outputs with high quality, a careful support to implementation while ensuring sufficient coordination among different parties is necessary. Therefore, it could be said that the contents and volume of the consulting services for this project were appropriate. This is backed by the high appreciation by the executing agency for the performance of the consultants.

2.2.2 Project Period

At the appraisal, the project period (defined as the period from the signing on the Loan Agreement to the final disbursement) was planned to be 116 months from August 1995 to March 2005. The actual period was 134 months from September 1995 to October 2006, or 116% of the planned duration. Although the simple comparison of the planned and actual numbers of months shows a slight delay, the project period is considered as mostly appropriate for the following reasons.

(i) Despite the delays in the selection of consultants and the procurement of equipment due to insufficient experience of the executing agency in project management, differences in budget years and regulations between Thailand and Japan, and relatively weak authority given to the implementing agency (the Office of Development Projects of Chulalongkorn University), the major outputs were mostly produced during the originally-planned period[10], and the delays were kept at minimum.

(ii) As this project aimed at capacity development, it is more difficult to define, compared to

[10] The outputs that were completed by the original loan expiry date (March 2005) include 30 out of 36 PhD awards (the original target was 30), 152 out of 198 participants in the non-degree fellowship program (the original target was 40), all of the three ICBs for equipment procurement, and 6 out of 9 direct purchases of equipment.

infrastructure projects, the clear end point of the project. Therefore, a strict comparison between planned and actual implementation periods is relatively less significant.

(iii) The Loan Agreement was extended not because of the delays but for realizing additional outcomes.

2.2.3 Project Cost

While the total project cost was estimated at 8,596 million Yen (out of which the Yen loan portion was 7,380 million Yen) at the appraisal, the actual total project cost was decreased to 6,879 million Yen (out of which the Yen loan portion was 6,440 million Yen) (Table 6). The main reasons for the decrease are the downward adjustment of unit costs for the fellowship program in accordance with the regulation of the Thai government, and the shortening of periods of stays by Japanese visiting scholars in Thailand. No negative effect of these changes is seen on the production of the outputs.

Table 6: Project Cost (Plan and Actual) (Unit: million Yen)

| | Planned at Appraisal | | Actual | |
|---|---|---|---|---|
| | Total | Yen Loan | Total | Yen Loan |
| Fellowship to Japan | 1,162 | 1,152 | 976 | 977 |
| Visiting Scholars from Japan | 736 | 423 | 413 | 339 |
| In-house Joint Research Fund | 82 | 0 | 0 | 0 |
| S&T Transfer Program | 58 | 0 | 4 | 0 |
| Facility Development | 3,945 | 3,945 | 3,896 | 3,838 |
| Price Escalation | 516 | 469 | 0 | 0 |
| Contingencies | 239 | 214 | 0 | 0 |
| Taxes and Duties | 167 | 0 | 0 | 0 |
| Consulting Services | 1,691 | 1,105 | 1,583 | 1,290 |
| **Total** | **8,596** | **7,308** | **6,879** | **6,444** |

Source: Chulalongkorn University

2.3 Effectiveness (Rating: a)

This project has largely achieved its objectives, and effectiveness is highly satisfactory.

The following sections show the general improvement of quantitative and qualitative indicators of education and research outcomes, respectively. These indicators indicate not only the effects of this project but also effects of other individual projects, such as joint researches with Thai- or foreign institutions, scholarships and donation of equipment. As a result of the survey to direct beneficiaries of this project (instructors, students and graduates of Faculty of Science and Faculty of Engineering) and other stakeholders (companies and Japanese universities) for the ex-post evaluation[11], it was found that the key factors of the effectiveness of

[11] The following beneficiary survey was conducted for the ex-post evaluation (see the thematic evaluation report for details):

(1) Focus group discussions. Total five focus groups were formed: (i) participants in the degree program (10 instructors); (ii) participants in the non-degree program (16 instructors); (iii) instructors of the target Faculties but not sent to Japan (15 instructors); (iv) graduate students of the target Faculties (8 students); (v) instructors of other Faculties such as Commerce and Dentistry (5 instructors) (for obtaining a third-party opinion about the project).

(2) Written questionnaire survey: (i) 92 instructors of the target Faculties (all of 36 participants in the degree program and 56 others); and (ii) 16 advisors of the degree-program participants in Japanese universities).

(3) Semi-structured interviews: (i) 28 instructors of Chulalongkorn University (4 from the project implementation team, 9 from the university and faculty management, 17 other instructors from Faculty of Science and 12 from Faculty of Engineering); (ii) 2 staff members (instructors) of the S&T Research Equipment Center (STREC); (iii) 9 graduates from the target Faculties (2 from Faculty of Science and 7 from Faculty of Engineering); (iv) 3 companies (2 Thai and 1 Japanese); (v) 3 instructors of other universities in Thailand; and (vi) instructors of Japanese host universities.

the project might be the building of collaborative relationship with Japan through close exchange of people and a large-scale facility development. The thematic evaluation report for this project describes the details of the beneficiary survey.

2.3.1 Upgrading of Education

(1) Increase in Students

The numbers of both undergraduate and graduate students of Faculty of Science and Faculty of Engineering (the target Faculties of the project) are increasing, with particular increases in the total number at Faculty of Science and in the numbers of Doctoral students at both Faculties (Table 7). Such increases are because of Chulalongkorn policies and opening of new Departments and Programs rather than as a direct effect of this project. However, it could be positively evaluated that more students benefit from the improved contents of teaching, which is an effect of this project.

Graduate students being supervised by an instructor who participated in the project

Table 7: Number of Students of Chulalongkorn University

(Unit: person. Figures in parentheses are growth rates from 1995)

| | Undergraduate | Master | Doctor | Total |
|---|---|---|---|---|
| Enrolment (2008) | | | | |
| Faculty of Science | 3,011(66%) | 1,102(89%) | 401(2,573%) | 4,514(87%) |
| Faculty of Engineering | 3,863(32%) | 1,604(39%) | 294(2,162%) | 5,761(40%) |
| Chulalongkorn Total | 23,979(48%) | 11,247(73%) | 2,199(848%) | 37,425(63%) |
| Graduation (2007) | | | | |
| Faculty of Science | 568(53%) | 276(121%) | 51(--)* | 895(80%) |
| Faculty of Engineering | 680(3%) | 46(49%) | 35(1,650%) | 1,161(21%) |
| Chulalongkorn Total | | | | 8,325(53%) |

Source: Chulalongkorn University

Note: The number of graduated students from Doctor's course of Faculty of Science was zeroin1995.

(2) Increase in Instructors with Higher Degrees

The number of instructors holding the Doctorate degree (PhD) largely increased at both Faculty of Science and Faculty of Engineering: the ratio of instructors with PhD to all instructors increased from 44% before the project and 70% after the project (Table 8). This increase is to follow the University policy to require new instructors to have PhD, but the 37 instructors[12] who received degrees from this project all stay in Chulalongkorn University and constitute PhD holders (most of the other instructors had obtained PhD in western countries or Japan)[13].

According to Chulalongkorn University, turnover is not frequent at all Faculties. In addition to the government regulation to oblige returned instructors from foreign universities to continue services[14], instructors pointed out that the attractiveness of Chulalongkorn University itself, which is in now a big transition to a world-level research university, keeps them to stay at the University.

[12] In addition to the 36 participants in the degree program, there was one instructor who received PhD through several short-term visits to Japan joining the non-degree program.

[13] Including scholarships from the Thai governments, other countries and private sponsors of Thailand and abroad.

[14] According to the government regulation, returned instructors must stay in the current universities for at least twice as long as the period of study abroad, and those who leave earlier than this must pay the government the amount three times than the cost for study abroad.

Table 8: Number of Instructors of Chulalongkorn University by Type of Degree Held

(Unit: person. Figures in parentheses are shares)

| Faculty | Before the Project (1995) | | | | After the Project (2008) | | | |
|---|---|---|---|---|---|---|---|---|
| | Bachelor | Master | Doctor | **Total** | Bachelor | Master | Doctor | **Total** |
| Science | 34(9%) | 170(47%) | 159(44%) | **363** | 19(4%) | 111(25%) | 307(70%) | **437** |
| Engineering | 40(14%) | 114(41%) | 123(44%) | **277** | 20(7%) | 71(23%) | 216(70%) | **307** |
| Medicine (for reference) | 8(10%) | 76(60%) | 42(33%) | **126** | 8(7%) | 37(31%) | 74(62%) | **119** |
| Architecture (for reference) | 7(10%) | 47(64%) | 19(26%) | **73** | 8(8%) | 59(60%) | 32(32%) | **99** |

Source: Chulalongkorn University

(3) Improvement of Coursework

According to Chulalongkorn University, coursework was improved[15] in total 53 courses of 10 Departments of Faculty of Science (out of 11 target Departments of the Faculty) and in 40 courses of 5 Departments of Faculty of Engineering (out of 8 target Departments). In addition, new courses were opened in both Faculties: a follow-up study after the completion of this project ("*the Follow-up Study 2007*", March 2007[16]) found more than 30 new courses (18 in Faculty of Science and 14 in Faculty of Engineering) could be outcomes of this project. Opinions of graduate students collected for the ex-post evaluation are also positive about coursework.

(4) University Ranking

In 2009, the THES-QS World University Rankings, a leading international ranking of universities, ranked Chulalongkorn University the 35$^{th}$ in overall ranking, the 30$^{th}$ in natural sciences and the 24$^{th}$ in technology, all among Asian universities[17]. Among world universities, Chulalongkorn University advanced from the 223$^{rd}$ to the 166$^{th}$ in overall ranking and from the 100$^{th}$ to the 86$^{th}$ in technology in 2007 and 2008, respectively.

2.3.2 Upgrading of Research

(1) Increase in Academic Publication

Following its development policy toward a research university, Chulalongkorn University has largely increased the total number of publications. The increase rates of publications from the target Faculties of this project are higher than that of the entire University (Figure 1)[18]. According to the University, many of the outputs of researches based on new methods instructors learned and using equipment purchased through this project have already publicized. However, the average numbers of publications (on international journals) per instructor are 0.42 in the entire University, 0.53 in Faculty of Science, and 0.44 in Faculty of Engineering[19]. Regarding this point, some instructors of Chulalongkorn University and Japanese host universities pointed out that the number of publications depends on individual instructors (in other words, some write several articles a year, while some do not any) and that instructors

[15] The Project Completion Report (2007) defines improvement of coursework as deepening or widening of topics handled in a course.

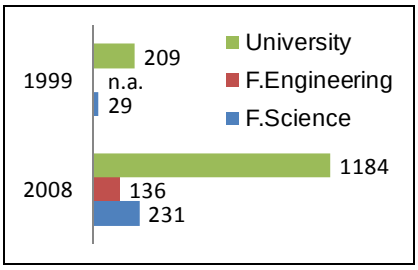
[16] "The Follow-up Study on the Thailand-Japan Technical Transfer Project", JBIC, 2007.

[17] University of Tokyo was ranked the first in the ranking of Asian universities in both natural sciences and technology. Those ranked close to Chulalongkorn University is Waseda University (the 29$^{th}$) in science and Tohoku University in technology (the 23$^{rd}$).

[18] In 2008, Faculty of Science produced 242 journal papers (of which 231 were on international journals), and Faculty of Engineering produced 176 journal papers (of which 136 were on international journals) and 230 conference papers (of which 150 were for international conferences).

[19] The average number of international journal papers per instructor is higher in some other universities than Chulalongkorn University: in 2008, it was 1.3/year in Faculty of Science of Mahidol University, known as a top-class research university, and 0.79/year in International Institute of Technology of Thamassart University.

cannot spare enough time for researches as they are busy with classes and other works.




Source: Chulalongkorn University

Figure 1: Number of Publications on International Journals

Recent figures on the number of publications produced by participants in the degree program of this project were not available. According the Follow-up Study 2007, however, 30 (86%) out of 35 instructors who had received PhD in Japan by that time produced at least one paper on international journals or conference proceedings after their return. The total numbers of journal papers produced by them are 139 by 20 instructors of Faculty of Science and 52 by 15 instructors of Faculty of Engineering. From this, the average numbers of journal papers per instructor could be calculated at 3.0 in Faculty of Science and 2.9 in Faculty of Engineering. Considering that the average time passed since their return is 3.4 years, the annual average number of journal papers per instructor could be estimated at 0.68 or larger, which is better than the faculty-wide average mentioned above[20]. Many of these publications are joint papers with Japanese researchers: up to January 2007, returnees from Japan through this project have produced 170 joint papers with Japanese researchers in Faculty of Science and 221 in Faculty of Engineering.

Therefore, it could be said that this project has generally contributed to the increase in the number of publications though there are differences among individuals.

(2) Acquisition of Research Funds

In the same way as academic publications, the amount of research funds awarded to Chulalongkorn instructors is increasing. Using the data from the Follow-up Study 2007, the amount of research funds awarded from Chulalongkorn University or other organizations to returnees from the degree program of this project can be calculated at the annual average of approximately 850,000 Baht per instructor per year[21], which is higher than faculty-level averages (320,000 Baht in Faculty of Science and 470,000 Baht in Faculty of Engineering). According to some returnees, research facilities and research outputs improved through this project have led to the acquisition of more funds. Acquisition of funds for joint researches with Japanese universities is also seen.

Thus, it can be said that this project has contributed to the acquisition of research funds, while this outcome has the same characteristic as research papers in a way that the amount largely varies among individuals.

(3) Evaluation from Inside and Outside the University

During the implementation period of this project, Chulalongkorn University and a Japanese host university conducted project evaluation several times. Those evaluations were mainly about the progress and outputs of research activities related to the project, which generally got high marks.

Besides those evaluations, many of the research plans prepared for this project (Research Profile) (see *2.2.1(3) Additional Outputs*) were designated as Centers of Excellence or Research Units, statuses given to highly significant and good research groups, and got research grants after the project. More specifically, 11 out of 21 Research Profiles of Faculty of Science were developed to 13 Research Units. In Faculty of Engineering, 4 Research Profiles out of 21 became 4 Centers of Excellence (showing higher valuation than Research Units) and 13 became

[20] The ratio of international journal papers was estimated with reference to the number of publication from Faculty of Engineering as a whole.

[21] The calculation divided 2,880,000 Baht per instructor (accumulated amount between their return to Chulalongkorn University and the time when the Study was conducted) by 3.4 years (average time passed).

13 Research Units[22].

According to Chulalongkorn University, this project brought to the University the way of conducting researches in group as shown in Centers of Excellence and Research Units. In Thailand, researchers of universities used to conduct researches individually. When this project started, members of the project management team visited universities in Japan and learned their laboratory system to conduct researches in group under one theme. They introduced the system to this project, and then to other faculties. Now, it is widespread to other major universities.

Regarding external evaluations, the Commission on Higher Education of Ministry of Education classified Chulalongkorn University as a good research university[23]. Also, the target faculties and their members related to this project received a number of awards (for example, the Department of Chemical Engineering of Faculty of Engineering received the S&E Award 2008, one of the highest awards in the field of S&T in Thailand, for its laboratory facilities and research outputs). In addition, the university rankings mentioned above show high marks not only on education but on research level of Chulalongkorn University.

2.3.3 Improvement of Academic Services

Academic services are training, consulting and testing services for other faculties of Chulalongkorn Universities and outside institutions/organizations, and constitute one of the functions of the University. The enhanced education and research capabilities through this project have also contributed to the improvement of academic services.

Table 9: Academic services from Faculty of Engineering to Industries (2007)

| | Entire Faculty (12 Departments) | Target Departments of this Project (8 Departments) |
|---|---|---|
| Training/seminar | 27 | 22 |
| Testing | 842 | 271 |
| Consulting | 47 | 22 |

Source: Chulalongkorn University

Table 8 shows some information that was available, namely, the number of academic services from Faculty of Engineering. Many of trainings and seminars are provided by the project-assisted departments. According the University, a large part of testing services is analysis of properties of materials and calibration[24].

In addition, the S&T Research Equipment Center (STREC) uses instruments including those provided by this project (10 items, such as transmission electron microscope, out of 38 items) to provide analytical and testing services to Faculties of Science and Engineering and other faculties of Chulalongkorn University as well as to outside customers. Their services are highly reputed[25]. The Food and Research Testing Laboratory established in Faculty of Science started testing services such as testing of microorganisms and residual pesticides to outside customers (food manufacturers for export, etc.), but the number of customers has not yet been many.

2.3.4 Utilization of the Project-assisted Facilities for Achievement of Project Objective.

According to Faculty of Engineering of Chulalongkorn University, 80% of the education and research equipment purchased by this project are used at the time of the ex-post evaluation. This is a good utilization rate considering opinions from Japanese universities and utilization statuses in other similar projects. In Faculty of Science, an inventory of education and research equipment purchased by the project is prepared: out of 420 items listed in the inventory, 399

[22] The total numbers of Center of Excellence (CE) and Research Units (RU) at the time of the ex-post evaluation are: 22 CE and 108 RU in the entire Chulalongkorn University; 4 CE and 37 RU in Faculty of Science; and 6 CE and 24 RU in Faculty of Engineering.

[23] The Commission said the official university accreditation system is under preparation.

[24] Many of testing services are provided by other departments than those assisted by this project. According to the University, most of them are by Department of Civil Engineering.

[25] STREC was established in 1981 with Japanese Grant Aid. In 2009, STREC was certified according to ISO17025 (General requirements for the competence of testing and calibration laboratories). The Food and Research Testing Laboratory of Faculty of Engineering is also preparing to obtain ISO17025.

items (95%), a very large number, are recorded as being used[26].

It was observed that most of the 12 laboratories in Faculty of Science, Faculty of Engineering and STREC utilized the project equipment together with equipment purchased using their own funds or donated[27]. Five laboratories said they use all equipment procured through this project. Frequency of use varies depending on purposes of the equipment or field of study[28]. The purposes of use of equipment are reported to be education, research and academic services, thus it can be said that the equipment are used for the purpose of this project.

As for information network equipment, it was reported that all of them are utilized except some servers and terminals that have already been replaced.

The reasons pointed out for non-utilization of some equipment at the time of the evaluation include (i) researches that require the concerned equipment have not yet been conducted (but planned in future), (ii) generally, equipment are not shared with other departments and faculties, (iii) spare parts are no more produced, and (iv) repairs of broken equipment take time. See also *2.5 Sustainability*.

Although the utilization status of books and CD-ROMs procured by this project for libraries was not identified, a good use is inferred from the information that 800 persons use the Faculty of Engineering Library per day and the observation of students viewing a project-procured database upon the evaluator's visit to the Library.

S&T Research Equipment Center (STREC)

Engineering Library

2.3.5 Satisfaction of Beneficiaries

At the time of the ex-post evaluation, a satisfaction survey (questionnaire survey) was conducted for instructors of Faculties of Science and Engineering, and it was found out that 82% of total 92 respondents answered that they are either very much satisfied or satisfied with both the implementation process and the outcomes of the project.

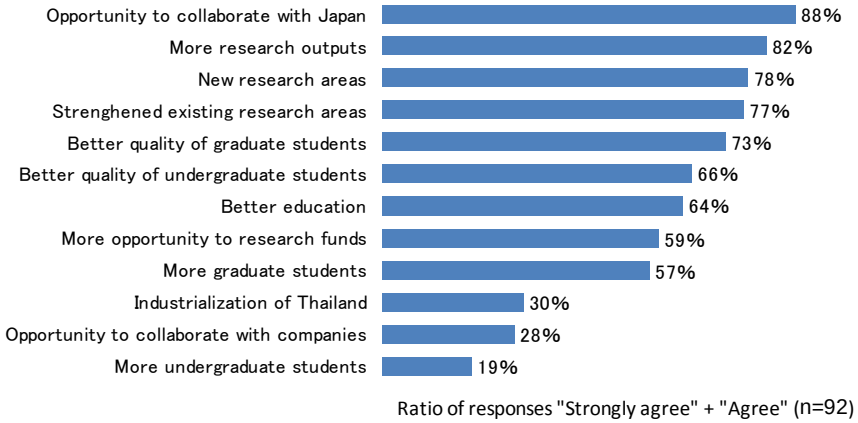
Answers about individual outcomes[29] show a high satisfaction with the creation of opportunities to collaborate with Japan. At the same time, satisfactions with the increase in the number of students and the project impact such as the promotion of industrialization of Thailand and the creation of opportunities to collaborate with industries. The low satisfaction with the number of students could be explained by the idea that the number of students is not attributed to this project. As for industrialization and collaboration with industries, the satisfactions are low possibly because the spread of the project impact from Chulalongkorn University to industries are expected in future as described in *2.4 Impact*, the next section.

[26] Among the listed equipment valued at 1 million Baht (approx. 3 million Yen), only 2 items are recorded as not being used.

[27] The utilization rate of the project equipment at each laboratory visited varies in the range of 20-80% in terms of both values and the number of items.

[28] The hours of use vary among equipment. For example, a gas chromatograph of Faculty of Engineering is always used graduate students by rotation. Also, the weekly usages of analytical instruments installed at STREC are 8-28 hours, and there is a two month or longer waiting list for electron microscopes. While less frequency of use does not mean less necessity of the equipment, there is an opinion that use of inactive equipment by other department, faculties and researchers should be promoted.

[29] Questions about individual outcomes were set with reference to the opinions raised during the focus group discussions with beneficiaries conducted before the questionnaire survey.




Source: Beneficiary survey

Figure 2: Satisfaction of instructors with individual points

2.4 Impact

With regard to the overall goal of this project, namely, the contribution to industrial development of Thailand, it was observed at the time of the ex-post evaluation that the technology transfer to industries through supply of human resources (i.e., production of graduates) and provision of academic services, while the transfer of new knowledge and technologies (i.e., commercialization of products and services based on R&D outputs) is now at the stage where the environment for promote it has been developed and the achievement in future is expected[30].

2.4.1 Contribution to Promotion of Industrial Development in Thailand

(1) Supply of Human Resources in Science and Technology

As shown in Table 1 of *2.1 Relevance* and Table 7 in *2.3 Effectiveness*, respectively, the number of S&T students is increasing in both the entire country and Chulalongkorn University. Most of graduates from the target faculties of Chulalongkorn University got jobs at private companies[31]. During interviews with some of those graduates, they commented that the basic knowledge and techniques they learned from the University are useful for their current jobs (at production section or R&D section). Also, the human resources manager of a Japanese machinery manufacturer in Thailand gave high marks on the performance of Chulalongkorn graduates working there.


Graduates from Master's and Doctor's programs working in R&D section of a big chemical company of Thailand

[30] In this ex-post evaluation, the evaluator assumed the two paths through which the project impact may have been brought to industries: (i) supply of human resources (through graduates from the target faculties getting jobs in companies); and (ii) direct technology transfer by instructors of the target faculties. The latter type of technology transfer was further divided into the contribution to promotion of R&D through provision of academic services and the contribution to commercialization of products and services through provision of new knowledge and technologies.

[31] According to the data received from Faculty of Engineering, 70-80% of graduates from undergraduate programs got jobs in private sector, around 20% went on to graduate school, and a very few entered government service. In case of graduates from Master's and Doctor's programs, around 80% went to private sector, around 10% to government service, and little cases to become instructors of Chulalongkorn University and other universities.

(2) Direct Technology Transfer from Chulalongkorn University to Industries

This project expected the two-staged technology transfer: from Japanese universities to Chulalongkorn Universities at the first stage and from Chulalongkorn University to Thai industries at the second stage. The first stage was expected as the direct outcome of this project, and the expectation was met as described in *2.3 Effectiveness*. As for the second stage, the improvement of academic services by Faculties of Science and Engineering and thus the contribution to R&D activities of companies were observed. However, evidence to show concrete outcomes of R&D brought by this project, such as the number of patents and the conclusion of licensing agreements with companies, could not be clearly found[32]. Several informants pointed out the following reasons:

(i) In Thailand, the scale of R&D especially in advanced technologies is still small (see also *2.1 Relevance*).
(ii) Generally, it takes long time to have fruits of research outputs. In particular, as Chulalongkorn University (as a research university) focuses on basic research, a long-term perspective is needed to assess the outcomes of researches (comments from Chulalongkorn instructors and Japanese researchers).
(iii) Compared to Japan, there are fewer cases of joint researches with other researchers and universes except some fields (such as particle technology and automotive engineering) (comments from Chulalongkorn instructors and Japanese researchers). As academic societies are not active in many fields, collaboration with other institutions and companies is made mainly using personal connections of instructors (comments from Thai and Japanese researchers).

The on-going university management plan aims to promote research activities and thus to contribute to society by forming "Research Clusters", interdisciplinary research fields beyond departments and faculties[33]. Considering this together with such factors that the first-stage technology transfer has been done and that cases of collaboration with companies have been accumulated, it could be said that the environment necessary for the second-stage technology transfer to industries, thus outcomes in coming years are expected.

2.4.2 Creation of Collaborative Relationship with Japanese Researchers

As already mentioned, the biggest benefit of this project raised by Chulalongkorn instructors is the creation of relationships with Japanese universities. Many of the instructors who participated in the fellowship program of this project had had no contacts with Japanese researchers. However, as a consequence of exchanges through this project, they started new exchanges (such as re-visits to the laboratories in Japan, sending their students to Japan for study, inviting Japanese instructors, holding joint seminars, etc,) as well as new joint researches. There are several cases in which participants in this project receive Japanese S&T grants to conduct R&D or provide academic services to Japanese companies in Thailand.

At the same time, it is natural to see cases where there is no more contact. It might take long

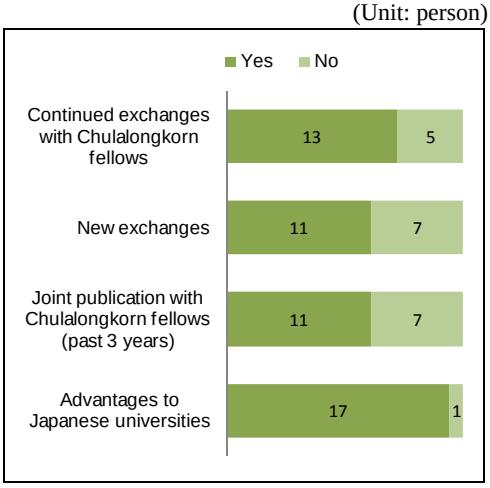
[32] The number of patent applications and the number of licensing agreements with companies have been increasing in the university as a whole, and several to more than 10 cases are with Faculty of Science and Faculty of Engineering after the project. According to Chulalongkorn University, however, none of those cases are deeply related to this project. The Intellectual Property Institute of Chulalongkorn University, the window for patent application and agreements with companies, collaboration with companies does not always lead to the conclusion of formal agreements through the Institute except those in the fields such as medicine and pharmaceutics. The reasons explained include that researches have not yet reached to the level where new knowledge and technologies are developed and intellectual properties become an issue (comments from Chulalongkorn instructors and companies), and the conclusion of formal agreement is bothersome (comments from Chulalongkorn instructors).

[33] Chulalongkorn University is planning large-scale investments for this. One of them is called the second phase of this project (but to be financed by a Thai organization), and plans to develop facilities to promote business-academia collaboration.

time even for the on-going active contacts to yield results that could contribute to society. Nevertheless, good relationships are generally well-maintained and developing even several years after the project completion, and thus future impact could be expected.

Japanese host universities also pointed out that the participation in this project benefited the Japanese side as well: according to the questionnaire survey to instructors who supervised Chulalongkorn instructors for degree, almost all of the respondents (16 in writing and 2 through interviews) said that the participation was advantageous to themselves. Advantages include the start of exchange with Thai researchers, Japanese students who acquired an international way of thinking, and the continuation of their researches by Chulalongkorn instructors who joined the research groups, which increased research outputs from the university in Japan.

(Unit: person)




Source: Beneficiary survey

Figure 3: Questionnaire answers from Japanese instructors about continuing communications and exchanges with participants in this project

2.4.3 Effects on Other Universities in Thailand

There observed some spill-over effects of Chulalongkorn instructors who participated in this project being dispatched to other universities and the education and research facilities being utilized by them. For example, instructors of Department of Chemical Engineering (established in 2004), Faculty of Engineering, Silpakorn University located in the outskirt of Bangkok, are all graduates from Department of Chemical Engineering, Faculty of Engineering, of Chulalongkorn University. There are some cases in which those instructors receive advises from their ex-supervisors at Chulalongkorn University and use some analytical instruments of it for their education and research activities. In 2008, this department produced the first graduates, and all of the eight instructors produced more than one research papers (13 papers in total) on international journals.

In case of Thai-Nichi Institute of Technology, established in Bangkok City in 2007 with support from Japanese companies, Chulalongkorn instructors and one Japanese ex-supervisor of a Degree Program participant teach students there (the latter was dispatched by JICA). Graduates from this Institute are expected play important roles in Japanese companies.

2.4.3 Environmental Impact

Environmental impacts of the laboratory facilities developed by this project could be all handled according to the standard disposal procedures of Chulalongkorn University. According to the University, both Faculty of Science and Faculty of Engineering observe the environmental consideration guidelines set by the University, and no particular environmental problems are seen.

2.5 Sustainability (Rating: b)

Though some problems have been observed in terms of operation and maintenance of the project-developed education and research equipment till the long-term impact (technology transfer to industries in particular) emerges, sustainability of this project is moderate.

2.5.1 Executing Agency

2.5.1.1 Operation and Maintenance System

The operation and maintenance (O&M) organization of this project is Chulalongkorn University. The responsibility in O&M of the facilities and equipment developed by this project,

including the securing of O&M budget, lies with users of respective facility/equipment (see below), and there is no single organization throughout the University to take care of this matter.

(i) Education and research equipment: O&M by respective department or laboratory
(ii) Information network equipment: O&M by the Computer Center of each faculty
(iii) Library books: O&M by library of each faculty

At the time of the appraisal, it was planned that Chulalongkorn University make an equipment O&M plan during the project implementation. In response, the project consultants prepared a plan to utilize STREC as the university-wide O&M unit for education and research equipment. However, this plan was not brought to realization due to such factors as the strongly decentralized organizational structure among university, faculties and departments and difficulties in repairing highly sophisticated equipment within STREC.

Besides the O&M of facilities and equipment, the continuity of researches is a key to sustainability. The organization called UNISERCH (to assist instructors in applying for research projects) at research affairs offices of the university and each faculty provide support services to individual instructors who want to apply for projects.

Such a structure is a typical O&M system with no big problems seen. However, as described later, there could be a room for further improvement for improving the O&M status.

#### 2.5.1.2 Technical Capacity

Although the situation varies among laboratories, main users of laboratory equipment are students and/or technicians employed by the faculty, and instructors themselves do not frequently operate them in many cases. No particular problems are seen in many laboratories, where the use of the equipment that require high skills for operation is limited to trained personnel, while some laboratories express concerns about the capabilities of their technicians. Some laboratory staff interviewed said that the status of technicians has not been well-established and turnover is high.

According to the Japanese researchers who were providing technical guidance to the Food and Testing Research Laboratory of Faculty of Science at the time of the ex-post evaluation, the installation and operation of the equipment are properly done following the manuals, though pre- and post- treatment of samples is less satisfactory. The guidance was being provided on voluntary basis by a Japanese non-profit organization specialized in laboratory equipment and analysis. This organization also donates some small laboratory tools such as flask stands to the laboratories.

No problem is seen in technical capacity for O&M of information and network equipment: in both Faculties of Science and Engineering, the Computer Centers employ qualified personnel (engineers and technicians) from outside and train them when needed.

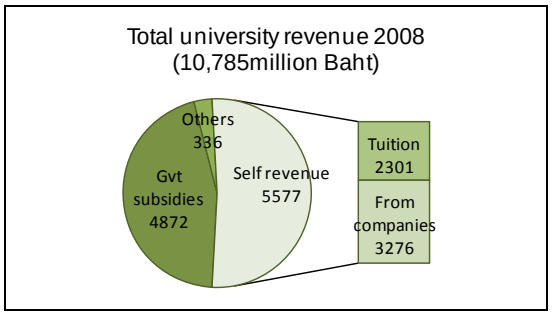
#### 2.5.1.3 Financial Status

No particular problem is seen in the financial status of Chulalongkorn University. Figure 4 shows the university budget for year 2008. The self-revenue resources account for more than half of the university budget, and its share is increasing.

The allocation of the government budget portion is decided on request basis from each department, and the allocation of the budget from the self-revenue resources is decided based on actual performance of each faculty and department. The O&M budget for laboratory equipment is funded from the university budget (self-revenue portion), revenues from academic services and research projects, donation and other resources, though the extent of fulfillment of the required amount varies depending on department, field of research, or personal connection between the instructor and outside funding resources. Some laboratories interviewed commented that their O&M budget is not sufficient[34].

[34] Among the twelve laboratories visited at the time of the on-site survey for the ex-post evaluation, four laboratories

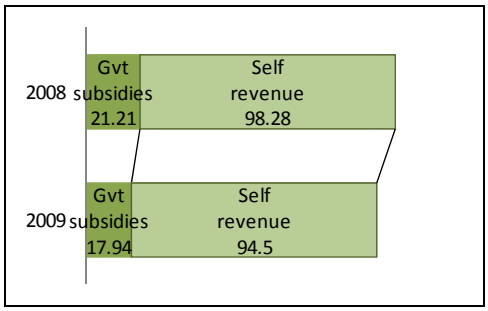
(Unit: million Baht)




Source: Chulalongkorn University

Figure 4: University budget

(Unit: million Baht)

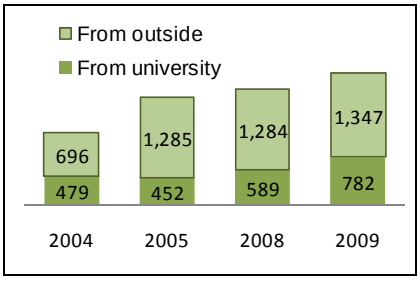



Source: Chulalongkorn University

Figure 5: O&M budget of Faculty of Engineering

The amount of the research grants earned are consistently increasing, both at the university level and at each of Faculties of Science and Engineering (Figures 6 and 7. See also *2.3.2 (2) Acquisition of Research Funds*).

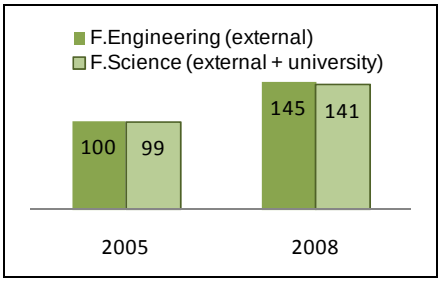
(Unit: million Baht)




Source: Chulalongkorn University

Figure 6: Research grants earned

(Unit: million Baht)




Source: Chulalongkorn University

Figure 7: Research grants to Faculty of Science and Faculty of Engineering

2.5.2 Operation and Maintenance Status

At the time of the ex-post evaluation, it was observed that the condition of the project facilities and equipment is generally good except a few cases where sensitive analytical instruments were sent abroad for repair. In seven laboratories out of twelve laboratories visited, the instructors expressed their concerns on the possibility of maintenance and repair in years to come and of replacement in further future. They provided some reasons for their concerns such as the fast obsolescence of advanced equipment, high cost for updating software, and some manufacturers stop providing even paid services after the expiration of the guarantee period (normally five years). On the other hand, a common tendency was observed among the laboratories that answered there is no problem in O&M status: all of them seemed to have close relations with companies, which again suggests the importance of personal connection of instructors in O&M of equipment.

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said there is no problem in O&M budget for equipment, and another four laboratories did not provide any answer. The rest four laboratories provided some figures on O&M cost: the annual O&M expenses for all equipment of their laboratories accounted for 0.75%-3% of the purchase price of the project equipment (i.e., those procured by this project only), which could not be sufficient.

## 3. Conclusion, Lessons Learned and Recommendations

### 3.1 Conclusion

In light of the above, this project is evaluated to be highly satisfactory.

### 3.2 Lessons Learned

(1) Coordination between equipment procurement and human resource development

A unique feature of this project is that it effectively combined human resource development ("soft" aspect) and facility development ("hard" aspect). Unlike some precedent similar projects, there was no case where unneeded but expensive equipment were procured. This was possible largely due to the planning and implementation of both "soft" and "hard" components based on specific research plans (Research Profiles), which other project could learn. The thematic evaluation report on the same project proposes more detailed lessons on the combination of different components and their effects.

(2) Scheduling with consideration of characteristics of university as an organization

In Thailand, instructors play the substantial role in managing universities. However, they are too busy with education and research activities to perform office work promptly. Even assistance by project consultants in project management could not remove all of their duties because there are many internal procedures to university that must be done by instructors themselves (e.g., those related to selection and dispatch of fellows for study abroad and equipment purchase). Therefore, it might be necessary to list up all such internal procedures in advance and make the schedule accordingly.

Also, in a project that assists several departments (like this project), the independent nature of department might cause prolonged process of preparing and coordinating the list of fellows to study abroad and of equipment among the concerned departments. When scheduling, this factor should be considered, too.

(3) Consideration of various methods for procurement of equipment

The procurement of laboratory equipment in accordance with specific research plans might increase the need for tailor-made equipment, which might make a big package deal through ICB difficult. Therefore, considering various procurement methods including direct purchase and international shopping, as was done in this project, from the planning stage could possibly enhance efficiency of implementation.

(4) Keeping human resources who received technology transfer in the organization

In this project, all instructors who participated in the fellowship program for degree stay in the university. This is attributed to several factors such as the government policy (i.e., penalties for early leavers) and attractiveness of the university itself (i.e., high sense of belonging to the university due to self-pride of being an instructor of the top-ranked university or expectation for potentials for future).

### 3.3 Recommendations

#### 3.3.1 Recommendations for Chulalongkorn University

(1) Utilization of unused equipment and practice of effective and sustainable O&M

It is recommended that the departments/ centers that have unused equipment start utilization of them according to the near-future plan informed at the time of laboratory visits.

Also, each faculty/ department is recommended to prepare and implement an equipment O&M plan systematically. In doing so, the O&M plans of STREC (ISO accredited), the Food and Testing Research Laboratory (on the way of ISO accreditation) and the one proposed by the consultants during the project implementation could be good references.

There is a possibility that some equipment will not be able to receive support services in a

few years, when the maintenance contract is expired. The University as well as each faculty/department is suggested to identify such periods to consider the necessity of replacement in future (including budgetary measures).

In order to enhance efficiency of use of expensive equipment and thus the outputs of researches, Chulalongkorn University is recommended to consider mutual interfaculty or inter-department access to laboratory equipment. This direction would be in line with the promotion of Research Clusters currently undertaken by the University[35]. In case where the main users of equipment are technicians, provision of training and incentives necessary for enhancing their operation skills and for keeping human resources is also suggested.

(2) Enhancement of technology transfer to industries

In order to pursue the technology transfer to industries that is on the half way, Chulalongkorn University is recommended to continue the promotion of the on-going university management plan (for contribution to society through promotion of R&D).

In doing so, it could be considered that there are some cases in which instructors informally collaborate with companies to avoid long procedures and overheads accompanying the conclusion of formal agreements: the increase in formal agreements in a way that faculties and departments could easily handle and that are advantageous to faculties and departments in terms of protection of intellectual property rights.

As the continuation of researches is essential for technology transfer to industries, it is expected that the University, faculties and departments work on to promote acquisition of research funds as well as joint researches and exchanges of instructors with universities abroad using opportunities inside and outside the University.

Also, it is desired that the University, faculties and departments enhance effectiveness of technology transfer by joining researches with other universities in Thailand. As one of the interviewed instructors pointed out, a key factor in past successful cases is to identify advantages of joint researches to both Chulalongkorn and partner universities.

3.3.2 Recommendations for JICA

(1) Follow-up on O&M of equipment

It is proposed that JICA plan and implement a technical assistance about the use of research equipment in a way that is similar to the one recently carried out by Japanese instructors and researchers (NPO) for some laboratories. The target laboratories might be limited as the equipment is well-utilized by skilled personnel in majorities of laboratories. However, a detailed study of the current status of equipment and training following the study would be possible by dispatch of a short-term expert or a senior volunteer. Currently, the training by the above-mentioned NPO is open not only to staff of the concerned laboratory but to staff of other laboratories in charge of the same types of work. The technical assistance could also extend to other institutions outside the University so that the activities could lead to the direct technology transfer to society.

(2) Project formulation to promote application of research outputs for the benefit of society

The technology transfer project to industries (“the second phase of this project”) that Chulalongkorn University is preparing could be a means to achieve the overall goal of this project. Although details of that new project were not available, JICA could support such efforts of the University in some way such as short-term invitation of instructors to Japan, dispatch of Japanese researchers to Thailand, which were proven effective in this project, as well as assistance in the development of a system of inter-disciplinary researches (including

[35] It should be noted that specification of some equipment must have been tailored to specific research themes. Therefore, in order to identify equipment that could be shared with others, it is proposed to first prepare an inventory of equipment and share it with other faculties and departments. The evaluator checked that Faculty of Science and STREC have already made such inventories. They could be useful for identifying the expiration date of support services and the period till replacement.

inter-faculty and inter-department joint researches and sharing of equipment), and assistance in the preparation of inventories of research equipment.

**Comparison of Original and Actual Scope**

| Item | Planned | Actual |
|---|---|---|
| (1) Outputs<br>1) Fellowship program | Degree 47 instructors<br>Non-degree 40 instructors | 36 instructors<br>198 instructors |
| 2) Japanese visiting scholars | 263 instructors | 562 instructors |
| 3) In-house joint research fund | Establishment of the fund | Not established |
| 4) S&T technology transfer | Lectures and seminars | Mostly as planned |
| 5) Facility development | Education and research equipment, information network equipment and library development | Mostly as planned<br>Additional outputs: Research Profiles |
| 6) Consulting services | Software Development Support Services (SDSS): 69MM, Hardware Development Support Services (HDSS) and Overall Project Management Services (OPM): 396MM, Academic Fellowship Support Services (AFS): 90MM | SDSS: Cancelled,<br>HDSS and OPM: 653MM,<br>AFS: 240MM |
| (2) Project Period | August 1995 – March 2005 | September 1995 – October 2006 |
| (3) Project Cost<br>Foreign currency<br>Local currency<br><br>Total<br>ODA loan portion<br>Exchange rate | <br>7,380 million Yen<br>1,288 million Yen<br>(356 million Baht)<br>8,596 million Yen<br>7,380 million Yen<br>1 Baht=3.62 Yen<br>(as of May 1995) | <br>6,444 million Yen<br>44 million Yen<br>(1,380 million Baht)<br>6,879 million Yen<br>6,444 million Yen<br>1 Baht=3.14 Yen<br>(as of October 2006) |