The Kingdom of Thailand

Data Collection Survey on the Needs for Industrial Human Resource Development in Thailand

Final Report

October 2018

Japan International Cooperation Agency (JICA)

Tekizaitekisho LLC

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Acronyms and Abbreviations

ACPE	ASEAN Chartered Professional Engineer
ADB	Asian Development Bank
ADE	Adjunct Engineer
AHRDP	The Automotive Human Resource Development Project
APEC	Asia Pacific Economic Cooperation
BOI	Board of Investment
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CMM	Coordinate Measuring Machine
CNC	Computer Numerical Control (Machine)
COE	Council of Engineers
DEPA	Digital Economy Promotion Agency
DIP	Department of Industrial Promotion
DNFE	Department of Non-Formal Education
DSD	Department of Skill Development (Ministry of Labour)
EE	Electrical Engineering
EEC	Eastern Economic Corridor
EEE	Electrical and Electronic Engineering
EIC	Economic Intelligence Center
ERP	Enterprise Resource Planning
FDI	Foreign Direct Investment
FGD	Focus Group Discussion
FTI	The Federation of Thai Industries
FY	Fiscal Year
HCDI	Human Capacity Development Institute (FTI)
HEI	Higher Education Institution
HIDA	The Overseas Human Resources and Industry Development Association
HRD	Human Resource Development
ICT	Information and Communication Technology
IEAT	Industrial Estate Authority of Thailand
ILO	International Labour Organization
JCC	Japanese Chamber of Commerce, Bangkok
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
KMITL	King Mongkut's Institute of Technology Ladkrabang
KMUTNB	King Mongkut's University of Technology North Bangkok
KMUTT	King Mongkut's University of Technology Thonburi
KOSEN	National Institute of Technology
MDES	Ministry of Digital Economy and Society
ME	Mechanical Engineering
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MICT	Ministry of Information and Communication Technology
MOE	Ministry of Education
MOL	Ministry of Labour
NESDB	The Office of the National Economic and Social Development Board
NPQF	National Professional Qualification Framework
NRCT	National Research Council of Thailand

NRU	National Research Universities
NSO	National Statistics Office
NSTDA	National Science and Technology Development Agency
O&M	Operation and Management
OEC	Office of the Education Council
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturing
OHEC	Office of the Higher Education Commission
OJT	On-the-Job Training
ONESQA	Office for National Education Standards and Quality Assessment
O-NET	Ordinary National Education Test
OVEC	Office of the Vocational Education Commission
PISA	Programme for International Student Assessment
PBL	Project Based Learning
PWC	Por Wor Chor (Vocational Certificate)
PWS	Por Wor Sor (Higher Vocational Certificate)
R&D	Research and Development
RMUT	Rajamangala University of Technology
SBTC	Science Based Technical College
SCB	Siam Commercial Bank
SD	Staff Development
SEZ	Special Economic Zone
SME	Small and Medium-sized Enterprises
S&T	Science and Technology
SIPA	Software Industry Promotion Agency
SPT	Software Park Thailand
STEM	Science, Technology, Engineering and Mathematics
STI	Science Technology and Innovation Policy Office
SUT	Suranaree University of Technology
TAI	Thai Automotive Institute
TAPMA	Thai Auto-Parts Manufacturers Association
TC	Technical College (PWS)
TCC	Thai Chamber of Commerce
TDIA	Thai Tool and Die Industry Association
TETA	Thai Electrical, Electronics and Telecommunication Industries Association
TIEN	Thailand Industrial Education Network
TLO	Technology Licensing Organization
TIEN	Thailand Industrial Education Network
TNI	Thai-Nichi Institute of Technology
TOEIC	Test of English for International Communication
TPQI	Thai Professional Qualification Institute
TVET	Technical and Vocational Education and Training
UBI	University Business Incubator
UIL	University-Industry Linkage
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
V-ChePC	Vocational Chemical Engineering Practice Colleges
WB	World Bank
WEF	World Economic Forum
WiL	Work-Integrated Learning

Summary

Background of the study and the importance of industrial Human Resources Development (HRD) in Thailand

Thailand has achieved economic development with a Gross Domestic Product (GDP) of over 6,000 US dollars per capita and its manufacturing sector plays a very important role, employing 16.2% of the national labour force and generating 28.1% of the GDP. As a result, Thailand has been categorized as an upper middle-income country. However, if Thailand continues to grow by relying on low value-added labor-intensive industry with an unemployment rate of less than one percent and a reduction of the labor force due to a declining birthrate in the near future, there will be a high risk of falling into the so-called middle-income trap. At present, the shortage of Science, Technology, Engineering and Mathematics (STEM) workforce estimated by Science Technology and Innovation Policy Office (STI) is approximately 20,000. In addition, cost competitiveness of Thailand against such neighbouring countries as Indonesia and Vietnam has been reduced significantly due to widening wage gaps. The daily minimum wage in urban areas such as Bangkok increased 1.4 times from 215 Baht in 2011 to 310 in 2017. Because of wage differences with other rival countries, labor-intensive manufacturing has been moving to countries such as Vietnam where wages are lower and Thailand has been compelled to further upgrade its industrial human resources to strengthen high value-added production in order to stay competitive.

HRD in Thailand is also vitally important for Japan as Thailand is seen as a key manufacturing base for many Japanese companies. According to a Japan External Trade Organization (JETRO) study on Japanese companies in Thailand in 2014, out of 3,731 companies active in Thailand, 51.4% (1,917) of them are engaged in manufacturing, and approximately half of them are Small and Medium-sized Enterprises (SMEs). Unlike large corporations, SMEs cannot afford HRD using their own resources, so it is important for Japanese SMEs that public higher education and vocational education institutions in Thailand produce quality technicians and engineers.

The 12thth National Economic and Social Development Plan (2017-2021) sets a goal of raising the country's current GDP per capita of 6,000 US dollars to 13,000 US dollars by 2036. The reduction of regional disparities and the strengthening of competitiveness in the international market are seen as key to achieving this goal. As key strategies, the Thai Government has promoted the development of industrial clusters. In addition, since 2017 the Thai Government has launched the area-based new economic development policy titled, "Eastern Economic Corridor Development Project" to accelerate economic growth by further developing the Eastern Seaboard into a leading economic zone in ASEAN. Both strategies target such industries as automotive, automotive parts and robotics. For both strategies, the promotion of Research and Development (R&D) and industrial HRD are critically important; therefore, special benefits are provided to the companies that invest in such activities.

Issues in Industrial Human Resource Development

One critical issue in Thailand's industrial HRD is the gap between demand and supply in both quantity and quality. Thailand has been suffering from shortage of skilled labor for the last decades and improvement of education at colleges and universities is critical to support the transition from labor-intensive industries to knowledge-intensive industries. In terms of numbers, the need for and shortage of new graduates of technical colleges and universities in Science and Technology (S&T) is estimated around 20,000 every year. The shortage has been further aggravated by the trend that the increasing number of graduates are not working in the fields that they have studied. One important reason for the shortage is the skill mismatch between what the private sector expects and the actual knowledge and skills that graduates can demonstrate. The private sector expects not only technical professional skills but other generic skills such as critical thinking,

creativity, communication and collaboration skills. Therefore, it is increasingly important for higher education and vocational education institutions to incorporate such needs into their education programs.

Educational Issues Related to Industrial Human Resource Development

Thailand has made significant improvement on access to education over the last few decades. Primary education is almost universal and secondary education enrolment has increased substantially. Yet, Thailand performs poorly in all indicators of education quality and is placed among the lowest in the ASEAN community. Therefore, the improvement of education quality remains the significantly important agenda for Thailand. Particularly, the major concerns for Thailand's industrial human resource development is a significant number of low achievers in science and mathematics at the basic education level, and another issue is the inequity in education in rural areas and socio-economically disadvantaged groups. Reducing the disparities to ensure equal access to quality education is a prerequisite to upgrade the whole nation.

Current Situation of Technical Colleges

Public technical colleges are the major provider of industry-related education. More than 140 technical colleges throughout the country offer industry-related subjects. However, Thailand's Technical Vocational Education and Training (TVET) fails to attract Thai youth as the number of students entering vocational track at higher secondary education level is gradually declining (currently less than 40%). Also, the increasing number of graduates of technical colleges do not enter the labor market but continue to study: 85% of those with vocational certificates and 30% of those with higher vocational certificates continue to study. The two major reasons are the students/parents' aspirations for higher level of education and lack of adequate skills of the graduates for the labor market. The impeding factors for technical colleges include (1) lack of accountability caused by centralized administration system and cost-per-head based budget allocation system, (2) weak monitoring and evaluation (The system is in place, yet its effectiveness is not clear.), (3) insufficient professional development of teachers to meet industrial needs for generic skills, (4) insufficient work experience and academic qualifications of teachers, (5) the need for further curriculum development (More than 80% of technical colleges develop their curriculum in collaboration with industry, yet the graduates are not utilizing their knowledge at work and they are not confident in skills needed at work.), (6) weak career guidance, (7) perception gap between policy makers and the management of technical colleges (Policy makers' main concern to upgrade the quality of TVET is not necessarily shared and prioritized by the college management.). In order to address these issues, the Thai government and the private sector have launched various programs. Such programs include the establishment of pilot model schools, introduction of work-integrated learning, competency-based standards setting and collaboration with TVET institutions in other countries.

Current Situation of Universities

In Thailand one third of public universities have the faculty of engineering, producing approximately 25,000 undergraduate students every year. Two major concerns in regards to industrial HRD at university level are the declining trend of student enrolment in S&T and the limited number of graduates in S&T fields entering the job market in their fields of study. In regards to enrolment, only one third of undergraduate students major in S&T although the government targets two-thirds. Typical students' perception is that S&T requires hard work, yet prospective jobs are not so attractive. As our survey confirmed, not so many engineering - major students do not plan to work in the manufacturing sector, and also many companies prefer not to employ new university graduates because they need to be retrained and their turn-over rate is very high.

These findings indicate that new university graduates are not equipped with the skills required by the private sector and those who enter companies also may not be able to establish themselves as an experienced engineer as they frequently change jobs. The issues for universities include (1) limited R&D capacity of universities as both public and private sectors in Thailand invest in R&D much less than other neighboring countries, (2) weak University-Industry Linkages (UILs), (3) disparities in the quality of universities and concentration of top universities in big cities and (4) lack of career education and career support to students. In order to address these issues, the Thai government has been taking initiatives in the development of an institutional framework for UILs, the mobilization of human resources for UILs and the development of work-integrated learning programs. These efforts have shown some positive outcomes and produced good practices.

Industrial HRD from the Perspective of Companies

The companies' level of satisfaction with their technical staff is also as low as about 40% according to the only survey. The team conducted in-depth interview survey to 100 companies in Thailand, identified the reasons for their dissatisfaction and interpreted them into six weaknesses of technical staff: (1) basic mathematics capability required for logical thinking and problem-solving as well as performing technical work, (2) language proficiency (English and Japanese) to effectively communicate with clients and suppliers, (3) problem-solving capability – particularly the lack of the mind-set for challenge and hands-on experience, (4) management capacity (management skill and leadership, team building), (5) basic technical knowledge and skills in high demand (e.g., mold and die and designing with 3D/CAD) and (6) discipline and aspirational/ambitious spirits. According to an online survey given to companies, many of them are required to provide retraining to their staff to deal with their weaknesses and more than 60% of them feel the cost of such training heavy burden. This is particularly so for Japanese companies because many of them prefer to send their staff to Japan for training.

Current situation of recruitment and utilization of the graduates

Approximately 60% and 30% of the companies responding to the online survey reported difficulties in recruiting R&D engineers and production engineers, respectively. Large companies have little problem recruiting new university graduates whereas it is very difficult for SMEs, particularly for those located outside Bangkok. One major problem for companies is a very high turnover rate of technical staff. Therefore, SMEs prefer to recruit only those who have work experience as technical staff. According to the online survey, the companies assigned the majority of the new recruits to production, but also assigned their employees to designing and product development, operation & maintenance and sales. This indicates that the companies expect engineers to work for production but also perform other functions such as drawing and design modifications. Most of the interviewed companies prefer to recruit graduates from the technical college located close to the company because locally recruited technical college graduates tend to stay long term with the company. Technical college graduates are mainly assigned to production and operation and maintenance. Very few Thai companies utilize technical college graduate as engineers. In the Thai companies, the career path for technical college graduates is distinct from that of university graduates and their salary scale is set accordingly. In contrast, Japanese companies are more flexible in this regard. In fact, about 60% of the Japanese companies interviewed by the survey team promote technical college graduates to positions for engineers, taking account of their capacity and performance.

Limited cooperation by companies with educational institutes

Linkage between educational institutes and the industry is weak. The mode of collaboration is primarily accepting students for internship and providing scholarships to some extent. There are some cases where a joint education program is systematically developed with industry and companies also provide scholarships. Yet, such cases are still very limited. One finding from the online survey to companies is that companies are increasingly interested in taking more active roles in industrial HRD including expanding internship program, conducting joint research and providing equipment. Some industrial organizations are actively supporting universities and technical colleges in Thailand. Particularly, the federation of Thai Industries takes initiative in curriculum development and training for technical college teachers and students in the field of automotive and automotive parts manufacturing.

Limitations for students

In Thailand, academic qualification is very much valued by companies to judge students' capability. There are different tracks for technical college and university graduates and technical college graduates are most likely employed as technicians and university graduates are employed as engineers. This significantly limits career opportunity for technical college graduates. Their opportunity to transfer to universities is also limited as very few credits can be accepted by universities. For university graduates, pursuing an engineering career has a limitation due to limited opportunity of R&D in the private sector as many companies focus on production. University graduates who join companies prefer to be transferred to other departments such as sales and administration after working for technical departments. Our survey of university students show that they perceive pursuing a career as an engineer is not favorable in terms of salary, working condition, and promotion, and less than 40% of them want to work in the manufacturing sector. These limitations are important factors that cause supply-demand gap in industrial human resources.

Qualifications as a means of HRD

Professional, occupational and vocational qualifications can be an effective instrument to improve the status of engineering occupations when the holders of the qualification standards are accepted by employers and/or users of services. There are three types of qualifications established in Thailand in the fields of engineering and industrial technology, namely, engineering qualifications of the Council of Engineers (COE) with 210,000 registered engineers in 8 fields as of 2016, vocational qualifications of the Department of Skill Development, the Ministry of Labor (DSD-MOL) conducting tests for 66 vocational skills) and occupational standards of Thailand Professional Qualification Institute (TPQI) conducting tests for 17 occupations. Engineering qualifications of COE are necessary for engineers engaged in construction and civil engineering projects. However, the engineers engaged in manufacturing and engineering students are not so interested in obtaining such official qualifications because companies do not require or value such qualifications. Regional professional qualifications such as ACPE and APEC engineers can be effective in promoting the status of engineers as such professional qualifications could facilitate their mobility across the border. However, at present, the numbers of and the demand for ACPEs and APEC engineers are still very limited. Vocational qualifications of DSD-MOL are well known but their standards need to be further improved to be fully accepted by companies. Also, wages for highly demanded jobs exceed the minimum wages; therefore, there is less incentive for company employees to obtain vocational qualifications. More companies demand their employees multi-tasking. Vocational qualifications need to accommodate such new needs. Occupational qualifications of TPQI are established in response to industry needs. Such qualifications include "Mold and Die specialist" and "Mechatronics Technicians". TPQI qualifications have been introduced only for a few years and its qualifications are not known to companies so much. TPQI qualifications can be an effective tool for technical college graduates to develop their career paths to fill in the gap with the academic qualifications needed to be an engineer.

Effective approaches for industrial human resources development in Thailand

Due to the above-mentioned weaknesses of technical staff, as mentioned earlier, many companies face the following three issues: (1) shortage of engineers who can cope with industrial advances: insufficient supply of engineers who can cope with new technical changes and demands (e.g., engineers with multi-disciplinary engineering knowledge who can manage an entire production process and contribute to productivity improvement, engineers who have basic knowledge and know-how on product design and development), (2) shortage of quality technical staff in production: insufficient supply of technicians with requisite qualities (e.g., multi-tasking technicians who can manage production, technicians who can properly maintain advanced facilities and equipment), and (3) shortage of middle level and senior engineers: those who work in the manufacturing sector do not pursue engineering careers in a company as they prefer to be transferred to non-engineering work and/or a management position.

The team identified the following approaches to effectively tackle these three issues:

For (1), Thailand needs to establish new types of technical colleges to the same level as highly competitive engineering colleges by establishing model colleges, based on the experiences of KOSEN (Colleges of Technology) in Japan that can produce practical DD and production engineers. It is also important to upgrade the capacity of incumbent engineers for innovation and career development by introducing a new graduate program specialized in manufacturing (e.g., MONOZUKURI).

For (2), a good approach is to develop a joint education program with industry, utilizing past good experiences in Thailand, and upgrade the curriculum that responds the immediate needs of industry and produce industry-ready technicians. For this purpose, the development of vocational teachers' capacity is necessary through refresher training and the improvement of teacher education.

For (3) career education and career support for students should be introduced to universities and technical colleges to make engineering study and work more attractive to and motivating for students through joint efforts made by universities/technical colleges and industry.

Resources and references In Japan

The survey team conducted interview survey to 30 Japanese universities and 13 KOSENs to study measures that could be introduced to universities and technical colleges in Thailand in order to overcome the above-mentioned weaknesses of students. Pre-entrance education, study support room/center and the assignment of class teachers to the room/center are commonly used tools to improve students' performance in mathematics and basic sciences. For the improvement of technical and generic skills, Project-Based Learning is widely used in such forms as student projects, extra-curricular activities and Internship/cooperative education. For foreign language proficiency, extensive reading, e-learning and studying abroad proves to be effective. KOSENs use dormitory life to instill work ethics and discipline. In addition, some universities and KOSENs have developed well-designed career education and career support systems for students as well as UILs systems. Many of the surveyed universities and KOSENs are positive about future cooperation with Thai counterparts. Some of them have already introduced their systems of career education and UILs in ASEAN countries including Thailand.

HRD for ICT industry

In addition to the manufacturing sector, the survey team conducted survey on the current situation about HRD for ICT industry in Thailand. For HRD for ICT industry, Ministry of Digital Economy and Society (MDES) is the key organization for policy and institutional development particularly for the socially vulnerable. Software Park Thailand (SPT) under the National Science and Technology Development Agency (NSTDA), MOST is the key implementer of ICT related programs. SPT provides high-end training courses for IT professionals, promotes quality standard of local companies, supports both local and international collaboration for new market opportunities. The demand for ICT professionals is very high as ICT technologies have drastically expanded in both public and private sectors. The number of ICT professionals working in software industry is less than 45,000 (NSO, 2015) and the number of university graduates in ICT related majors is approximately 12,000 (software market survey, 2013). The demand for computer related professionals is projected to be more than 100,000 people by 2023. The salient feature of ICT occupations in Thailand is that such occupations are almost exclusively taken up by university graduates and technical college graduates account for only 2% of the total workforce. This is because the number of students in ICT related programs in the technical colleges is only 2,600 (OVEC, 2015) and these programs are not well equipped in terms of curriculum and resources to produce ICT professionals. The main issues for universities include the difficulties to provide students with latest, practical ICT knowledge and motivate students for quality improvements under favorable environment for ICT related majors to get employment. A high drop-out rate is also a major issue for some universities due to weak mathematical ability of students and/or lost interest in ICT in the course of their study. There are several ICT related industrial bodies but they are not active in HRD. There is also one software-related society, but not very active. Some vendors provide training to students in collaboration with universities in the use of their software but the number and scope is limited. There are several types of qualifications certified by public organizations and vendors, but such qualifications are not necessarily valued by either students or companies. TPQI has introduced some qualifications in such fields as IT project management, software development, network and security system. The development of the certification system is still at a rudimental stage as the number of the certified is still very small and certification for higher levels have not been fully established.

In order to increase the pool of diverse human resources for ICT industry, such measures are effective as the introduction of ICT related courses (e.g. programming) for students in other disciplines in the national universities, the provision of career orientation and education to reduce drop-outs of students and turn-over rates of ICT professionals and curriculum development for technical colleges (e.g., programming). Currently IT related qualifications are not so valued by either companies or university students. Yet, one type of qualification worth supporting is the strengthening of network security related qualifications, given the importance of network security to the general public.

Chapter 1 Background of the Study

1.1 Background of the study

Thailand has achieved economic development with a GDP of over 6,000 US dollars per capita. As a result, Thailand has been categorized as an upper middle-income country. However, if Thailand continues to grow by relying on low value-added, labor-intensive industry with an unemployment rate of less than one percent rate and a reduction of the labor force due to a declining birthrate in the near future, there will be a high risk of falling into the so-called middle-income trap.

In order to avoid the middle-income trap and achieve a further economic leap, the Government of Thailand has been announcing new policies aimed at upgrading industry, such as research and development (R&D) projects, and the introduction of the cluster policy, which grants investment benefits to industry with the purpose of integration of knowledge-intensive industries that require advanced technology. For the industries that require advanced technology and next generation industries, the Government of Thailand classified the following six clusters as Super Clusters, which were announced by the Thailand Board of Investment in September 2015: 1. Automotive and Parts, 2: Electric Appliances, Electronics and Telecommunication Equipment, 3: Eco-Friendly Petrochemicals, 4: Digital-based industries, 5: Food Innopolis and 6: Medical Hub. In addition, the Thai Government has launched the area-based new economic development policy titled, "Eastern Economic Corridor Development Project (EEC Project)" since early 2017 by developing the Chachengsao, Chonburi and Rayong Provinces for the development of EEC.

On the other hand, it is essential to promote industrial human resource development (HRD) in addition to infrastructure development and investment in R&D, in order to demonstrate that such measures are truly effective and achieve upgrading of industry. Furthermore, 4,567 Japanese companies are doing business in Thailand[1], but they also have been facing problems to secure sufficient numbers of highly skilled engineers, management and R&D personnel. From this point of view, it is important to support focusing on industrial human resource development.

Based on the above background, in order to promote the industrial human resources that Thai industries need, the Government of Japan, the Government of Thailand and related organizations are discussing a program on practical engineering education utilizing the knowledge and experience of Japanese "Monozukuri," and considering setting up a new program, organically taking a scheme of the Japan International Cooperation Agency (JICA).

1.2 Objectives of the study

The main objectives of the study are to collect information, including data on industrial needs for HRD, analyze the issues and challenges for industrial HRD in Thailand from the perspectives of the industries and higher education institutions, identify necessary resources in Japan for proposed projects, and to study effective approaches and projects to support higher and vocational education institutions in

[1] According to the JETRO survey conducted in January 2014 to Japanese companies in Thailand (Published in June 2015)

consideration of ongoing discussion between the Japanese and Thai Governments, and propose concrete projects.

1.3 Basic approaches of the study

In order to propose effective approaches, the survey team first studied the current situations of higher and vocational institutions in Thailand, then examined the industrial needs as well as the needs of higher and vocational institutions, explored the possibilities of private investment and considered possible cooperation with the ongoing efforts made by other organizations. For example, KOSEN (National Institute of Technology in Japan) is supporting two technical colleges in Thailand to introduce the KOSEN model by improving curriculum and pedagogy. The survey team studied these efforts to create synergy effects. Third, the survey team studied good practices and lessons from Japanese universities and KOSEN in their efforts to produce practical and innovative engineers, improve their reputation and link up with industry. The institutional and social applicability of such good practices and lessons to Thai Higher Education Institutions (HEIs) and Technical and Vocational Education and Training (TVET) institutions was also studied. In identifying effective approaches and projects, the study team studied various options for approaches and assessed the extent to which each approach could help fill the gap between supply and demand in industrial human resources in Thailand. Finally, the survey team studied the financial, technical and institutional sustainability of the proposed projects so that the outcomes of such a project would be continuously produced after the project duration and would become institutionally entrenched.

1.4 Survey methodologies

1.4.1 Main targets

The main targets of the survey included both Japanese and local companies engaged in the manufacturing of automobiles and parts and electric and electronic products in Thailand, engineering universities and technical colleges in Thailand and Japanese engineering universities and KOSEN.

1.4.2 Survey methods and the scope of survey

The survey methods and the scope of survey are as follows:

	Questionnaire survey		Interview	
	Samples	Targets	Interviewees	Targets
Survey in Thailand				
Companies	138	Manufacturers mainly of automotive and auto-parts, electric and electronic products	100	Manufacturers mainly of automotive and auto-parts, electric and electronic products
Universities (departments)	122[2]	Universities that have relevant engineering fields such as Electrical and Electronic Engineering (EEE) and	20	Departments known for producing engineers for manufacturing sector and/or located close to industrial areas

[2] The total number of faculties and departments in engineering including public, national and private universities.

		Mechanical Engineering (ME) departments		
Technical colleges	84	Technical Colleges (TC) (industrial technology)	20	TCs close to superclusters and other TCs given priority by Office of Vocational Education Commission (OVEC)
University Students	266	Students in EEE and ME	33	One session of Focus Group Discussion (FGD) with bachelor and master students in EEE and ME
Technical college students	599	Students in mechanics, electrical and electronics, automotive courses	74	Three sessions of FGD with students in mechanics, electrical and electronics, automotive courses
HEI and TC graduates	-		10	In-depth interviews of reputable engineers for career path study
Survey in Japan				
Universities	-		31	Well-known universities for University-Industry Linkage (UIL), raising students' standards, Work-integrated learning (WiL) and closely linked with industry
KOSEN	-		13	KOSEN active in international cooperation, with close relationships with Thai HEIs and TCs, participated in UIL projects
Municipality	-		1	Municipal government actively supporting UIL

Prior to the questionnaire survey and interviews, announcements were made by the Japanese Chamber of Commerce, Bangkok (JCC) and The Federation of Thai Industries (FTI) asking their member companies to cooperate with the survey team. The survey team then contacted individual companies for interviews.

Relevant organizations interviewed by the survey team were as follows:
AMATA PCL, Board of Investment (BOI), Chiang Mai University, Council of Engineers (COE), Department of Skill Development, Ministry of Labour (DSD-MOL), The Federation of Thai Industries

(FTI), King Mongkut's Institute of Technology Ladkrabang (KMITL), King Mongkut's University of Technology Thonburi (KMUTT), International Labour Organization (ILO), Office of the Higher Education Commission (OHEC), Office of the Vocational Education Commission (OVEC), Rajamangala University of Technology (RMUT), Rajabhat Universities, Science Technology and Innovation Policy Office (STI), Suranaree University of Technology (SUT), Thai Automotive Institute (TAI), Thai Auto-Parts Manufacturers Association (TAPMA), Thai Chamber of Commerce (TCC), Thai Electrical, Electronics and Telecommunication Industries Association (TETA), Thai-Nichi Institute of Technology (TNI), and Thai Professional Qualification Institute (TPQI).

The list of organizations that responded to the surveys in Thailand is shown in Annex 1. In addition, the survey team conducted online surveys of 47 universities and 14 technical colleges on equipment. The list of Japanese universities and KOSEN interviewed by the survey team is shown in Annex 2.

The members of the survey team and their respective fields of study were as follows:

Team Members	Fields of study
Kaneyasu Ida	Team leader/industrial needs study
Rie Atagi	Study on higher and vocational education institutions
Ai Ishitobi	Resource study in Japan (1)
Keiji Tateyama	Resource study in Japan (2)

1.4.3 Survey Schedule

Study period: November 2016 – January 2018

- Questionnaire survey: December 2016 – February 2017
- Interviews and FGD: December 2016 – August 2018

1.4.4 Constraints and limitations

- Some companies were very cooperative, but generally it was very difficult to receive responses from companies to the questionnaire survey. It is likely that many of them found that the topic of industrial HRD was not particularly relevant to their company or they were burnt out by responding to many surveys. Another difficulty was that answering all the questions often requires both technical and administrative personnel. Therefore, many questions were unanswered, resulting in a significant reduction in the valid responses.
- The survey team tried to collect the statistics from several sources so that they would not significantly deviate from the reality. Yet, the statistics available were considerably different from agencies concerned and it was sometimes difficult for the survey team to have a clear understanding of the current situation, particularly about the supply-demand gaps in the labor market.

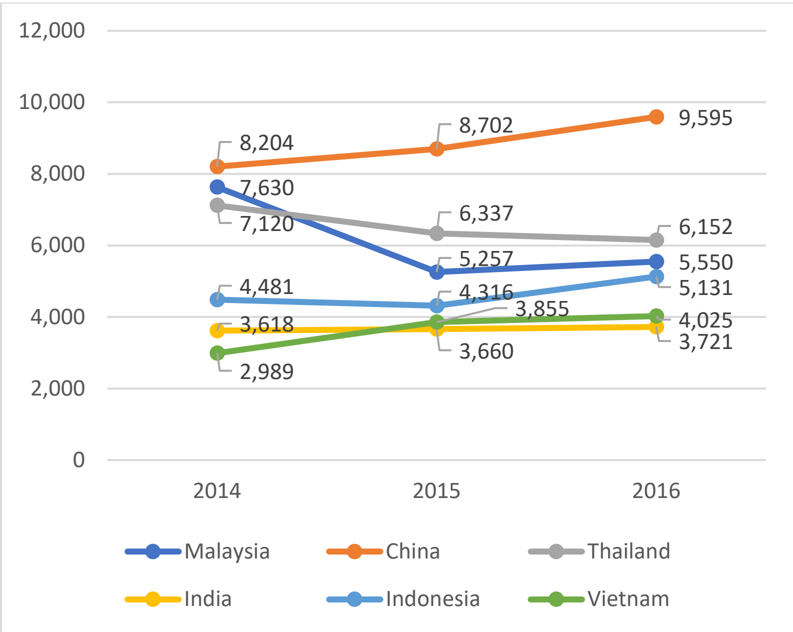
Chapter 2 Supply-demand gaps, factors causing the gaps and solutions

2.1 Importance of automotive and auto-parts, and electric and electronic industries

The manufacturing sector plays the leading role in Thailand's economic development. In 2016, the manufacturing sector contributed 28.1% of Thailand's GDP of 395 Billion US dollars and the manufacturing sector accounted for 88.7% of the total export value, which accounted for 53.4% of GDP.[3] In the manufacturing sector, the automotive and auto-parts industry and the electric and electronic product industry are particularly important. For example, these industries account for 44.0% of the country's total export value – machinery including computers (17.4%), electrical machinery and equipment (13.9%) and vehicles (12.7%).[4] In 2016, these industries also employed a large workforce. Out of the total employment of 38.87 million people, the manufacturing sector accounts for 16.2% (6.21 million people).[5] 525,000 people are employed in automotive and auto-parts industries[6] and approximately 600,000 people in electric and electronic industries.[7]

2.2 Issues for the manufacturing sector

One of the largest issues for the Thai manufacturers is the wage increase. The daily minimum wage in urban areas such as Bangkok and Samutprakan increased 1.44 times from 215 Baht in 2011 to 310 in 2017. Thailand's wage level for engineers has reached levels close to that of China and Malaysia, and the wage gap with Indonesia, India and Vietnam remains wide, as shown in the tables below.



Source: Japan External Trade Organization (JETRO)
Figure 1: Cost of employing a worker for one year (US dollars)

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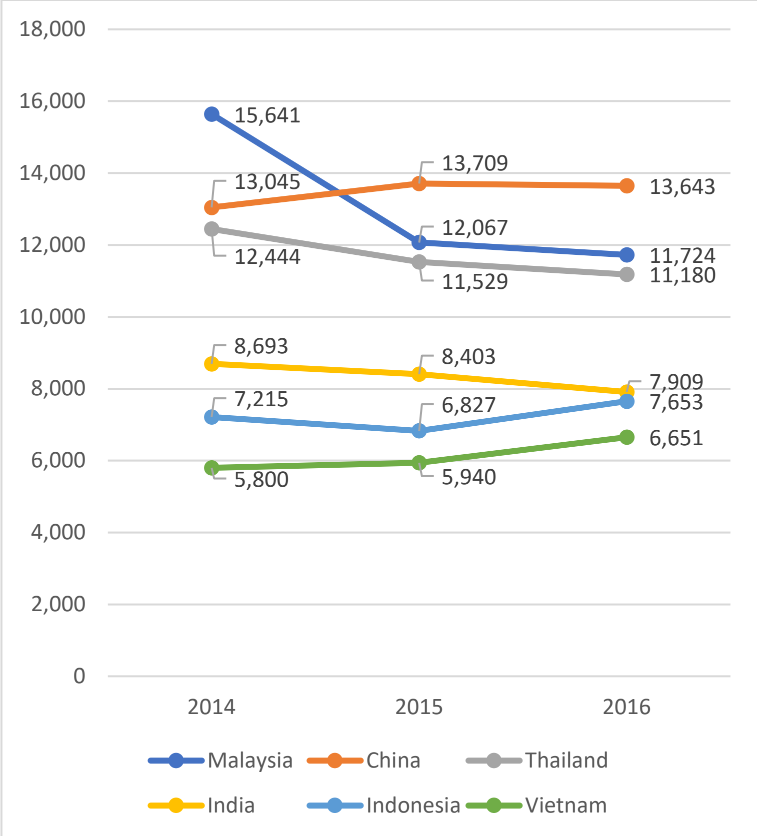
[3] Japan Center for International Finance (2016) http://www.jcif.or.jp/report/world/004.pdf *Accessed on March 10, 2017
[4] IMF (2016) *World Economic Outlook Database* (GDP based on Purchasing Power Parity). *Accessed on March 10, 2017
[5] National statistical Office of Thailand *The Labor Force Survey Whole Kingdom 2016* (http://web.nso.go.th)
[6] Thai Automotive Institute (2016) *Overview of World and Thai Automotive Industry Situation - 2nd Focus Group under Thailand Automotive Intelligence Unit Project (AIU)*
Thai Automotive Institute (2017) http://www.thaiauto.or.th/2012/th/research/research-detail.asp?rsh_id=12 - Accessed on March 10, 2017
[7] BOI (2016) *ELECTRICAL AND ELECTRONICS INDUSTRY SEES HIGH EXPORT GROWTH*
http://www.thinkasiainvestthailand.com/web/en-investment-opportunity.php?id=16 - Accessed on April 13, 2017



Source: JETRO

Figure 2: Cost of employing an engineer for one year (US dollars)

Because of the wage differences with other rival countries, labor-intensive manufacturing has been moving to countries such as Vietnam where wages are lower and Thailand has been compelled to strengthen high value-added production in order to stay competitive. In the case of the automotive and auto-parts industry, such pressure has been strongly felt lower down along the supply chain. According to Thai Auto-Parts Manufacturers Association (TAPMA) and Thai Automotive Institute (TAI) data, the number of first tier suppliers of auto-parts declined from 690 companies in 2011 to 462 in 2015 and the number of second and third tier suppliers was down from 1,700 to 1,137 during the same time period. There have been concerns in the auto-parts industry that an increasing number of companies would relocate their operations to other countries such as India and Indonesia. Thai Electrical, Electronics and Telecommunication Industries Association (TETA), the industrial organization for the electric and electronic industry, is also very concerned with the relocation of production bases to countries such as Vietnam, which has the advantage of manufacturing products with high general versatility because of its competitive labor costs. Under this circumstance, the Thai Government has actively introduced measures to upgrade its industry, which requires making improvements to industrial human resources for the manufacturing sector.

2.3 Industrial policies and industrial human resource development

2.3.1 Cluster Development Policy

The 12th[th] National Economic and Social Development Plan (2017-2021) sets a goal of raising the country's current GDP per capita of 6,000 US dollars to 13,000 US dollars by 2036. The reduction of regional disparities and the strengthening of competitiveness in the international market are seen as key to achieving this goal. As key strategies, the Thai Government has promoted the development of industrial clusters, established the Ministry of Digital Economy and Society to foster the development of digital industry and prepared the establishment of Special Economic Zones[8] (SEZ) to boost regional economies. The cluster development and EEC are especially important to escape the middle-income trap by encouraging Foreign Direct Investment (FDI) to invest in advanced technologies.

Table 1: The list of Super Clusters

	Super Cluster	Target Provinces
A	Automotive and Parts Cluster	7 Provinces (Ayutthaya, Pathum Thani, Chonburi, Rayong, Chachoengsao, Prachinburi, Nakhon Ratchasima)
B	Electrical Appliances, Electronics and Telecommunication Equipment Cluster	7 Provinces (Ayutthaya, Pathum Thani, Chonburi, Rayong, Chachoengsao, Prachinburi, Nakhon Ratchasima)
C	Eco-friendly Petrochemicals and Chemicals Cluster	2 Provinces (Chonburi and Rayong)
D	Digital-based Cluster	2 Provinces (Chiang Mai and Phuket)
E	Food Innopolis	To be announced
F	Medical Hub	To be announced

Source: BOI

In the initial stage of the cluster development, the Thai Government has targeted the super clusters and other clusters (agro-processing products, and textiles and garment clusters). The cluster development is supported by government agencies in wide-ranging aspects, including human resources and technological developments, infrastructure development and logistics system, tax incentives and non-tax incentives, financial support, and amendments of rules and regulations to facilitate investment (Incentives and benefits to investors for human resources development is shown in Chapter 4.).

In terms of the level of concentration of factories, the automotive and auto-parts cluster and electrical appliances, electronics and telecommunication equipment cluster have been more developed than any other cluster. As of 2016, the data on the number of factories by 59 industrial estates in 18 provinces show that the two provinces in Eastern Thailand, Chomburi and Rayong, targeted for the two clusters, have the largest numbers of factories. (see Table 2) Therefore, Eastern provinces could be the immediate target for industrial HRD in alignment with the cluster development policy. For the reduction of regional disparities, regional hubs and SEZs could be targeted for industrial human resource development such as Chiang Mai for the North, Songkla for the South and Nakhon Ratchasima for the Northeast.

Table 2: List of Factories Operating in Industrial Estates as of 2016

	Provinces	Region	Clusters (A – F)	The number of factories
1	Chomburi	East	A, B, C	1,879
2	Rayong	East	A, B, C	1,321
3	Samutprakarn	Central		722
4	Bangkok	Central		538

[8] Initial SEZs are as follows: (1) Tak (Thailand-Myanmar boarder area), (2) Mukdahan (Thailand-Laos boarder area), (3) Sa Kaew (Thailand-Cambodia boarder area), (4) Songkla (Thailand-Malaysia boarder area) and (6) Trat (Thailand-Cambodia boarder area)

5	Chachoengsao	Central	A, B	340
6	Ayutthaya	Central	A, B	284
7	Samutsakorn	Central		242
8	Pathum Thani	Central	A, B	200
9	Lamphun	North		92
10	Saraburi	Central		39
11	Ratchaburi	West		33
12	Songkla	South		23
13	Prachinburi	Central	A, B	8
14	Pitchit	Central		7

Source: Industrial Estate Authority of Thailand (IEAT)

2.3.2 Eastern Economic Corridor (EEC)

In addition to the cluster development policy, the Thai Government has launched the area-based new economic development policy titled, "Eastern Economic Corridor Development Project" to accelerate economic growth since early 2017 by further developing the Eastern Seaboard into a leading economic zone in ASEAN. The key strategies for EEC development include (1) the implementation of large infrastructure development projects to upgrade aviation system, sea transportation and high-speed railway system through public and private partnership, (2) attracting target industries by providing tax and non-tax incentives and (3) community development to provide quality of life and environment to international standards. For the promotion of private investments in the EEC, the Thai Government has targeted such industries as automobiles, electronic parts and robotics, bio-businesses, aviation and O&M related businesses and medical services/medicine and devices.

The Project designated Chachengsao, Chonburi and Rayong Provinces for the development of EEC that is expected to grow into a metropolitan hub for trade and investment and function as the well-developed gateway to other countries. Therefore, it is recommendable that the forthcoming Japan International Cooperation Agency (JICA)-assisted projects would also align with the Thai Government's flagship project to create synergy effects by providing advanced industrial human resources in the fields of automotive and electric/electronic industries to be developed in the three target provinces. The latest situation about human resource development in EEC is shown in Annex 16.

2.4 Importance of Japanese manufacturers in Thailand

The latest data on BOI approved projects shows that investment from Japan has been significantly greater than that of any other country. BOI approved projects include investments in public facilities and agriculture, but the vast majority comprise investment in manufacturing. It is quite important to sustain the high level of FDI in the manufacturing sector by securing a stable supply of industrial human resources.

Table 3: Foreign Direct Investment approved by BOI by country (Unit: Million Baht)

	2012		2014		2016[9]	
1	Japan	371,465	Japan	260,784	Japan	57,466
2	Netherlands	35,413	USA	84,644	Singapore	37,228
3	Hong Kong	35,084	Luxembourg	59,700	China	32,537
4	Singapore	26,321	Singapore	36,875	Netherlands	29,924
5	USA	20,470	China	31,799	Hong Kong	20,165

Source: BOI

It is valid for the Japanese Government to mobilize Official Development Assistance (ODA) for industrial HRD in Thailand. According to a JETRO study on Japanese companies in Thailand in 2014[10], out of 3,731companies active in Thailand, 51.4% (1,917/3,731) of them are engaged in manufacturing, and 50.5% (968/1,917) of them are Small and Midsized Enterprises (SMEs). Unlike large corporations, SMEs cannot afford human resource development using their own resources, so it is important to help public HEIs and TVET institutions in Thailand produce quality technicians and engineers for SMEs.

2.5 Potential areas for cooperation

According to the study[11] conducted in 2015 on the overseas operations of 895 Japanese companies, Thailand is seen as the second most attractive destination after China. 33.1% of the companies plan to expand their sales and 10.6% plan to increase production. In terms of Research and Development (R&D), few companies plan to expand their operation overseas, yet Thailand is ranked as the fifth most common destination (1.8%) for R&D and the third most common place (3.8%) for localization of products produced in Japan. It is difficult to know exactly how many Japanese companies have R&D functions in Thailand. However, the number appears to be increasing. According to the survey conducted by JCC in 2016, out of the 488 companies that responded to the survey, 53 companies responded that they have established a unit such as an R&D unit or technical center in Thailand. The main reasons for their decision include product development targeting the local or regional market, fostering the development of R&D personnel, productivity enhancement, technology transfer and data collection. Research is still limited, but three companies have established a center for basic research and five companies have set up a center for applied research in Thailand. For many Japanese companies, Thailand is a very important base for production and sales, and they increasingly see it as a base for R&D. Therefore, it is necessary to prepare an enabling environment in HEIs to respond to the increasing need for R&D personnel.

2.6 Policy of the Japanese Government towards Human Resources Development in Thailand

In 2015, the Japanese Government proposed the industrial HRD cooperation initiative, supporting industrial HRD in Asia to cover as many as 40,000 people over a period of three years at the ASEAN business investment summit. In March and June 2016, to realize this initiative, the Japanese Government, together with JICA Thailand Office, organized the Round-table Conferences on industrial HRD and discussed a joint cooperation initiative with the Thai Government as well as relevant

[9] The Thai Government changed its policies regarding benefits and incentives in 2014. The total investment in 2014 drastically increased by 60% as many companies made investments before the changes were made, then decreased in 2015 and 2016.

[10] "Nikkeikigyo shishutsu doko chousa 2014 nendo" (In Japanese) by JETRO (June 19, 2015)

[11] "2016 nendo nihonkigyo no kaigaitenkai ni kansuru ankeitochousa kextuka gaiyou" (In Japanese) by JETRO (March 2017)

stakeholders, including universities and the business sector. The proposed initiative aims at upgrading Thailand's industrial structure, responding to industrial needs, quantitative and qualitative development of industrial human resources, promoting private investment in higher education and supporting Thailand to become a hub for industrial HRD in Southeast Asia. Both sides are discussing measures to realize the proposed initiative. This survey focused on effective cooperation approaches to foster practical engineers and innovative engineers through technology-oriented education, which is one of the pillars of the proposed initiative.

2.7 Policy for Industrial Human Resource Development

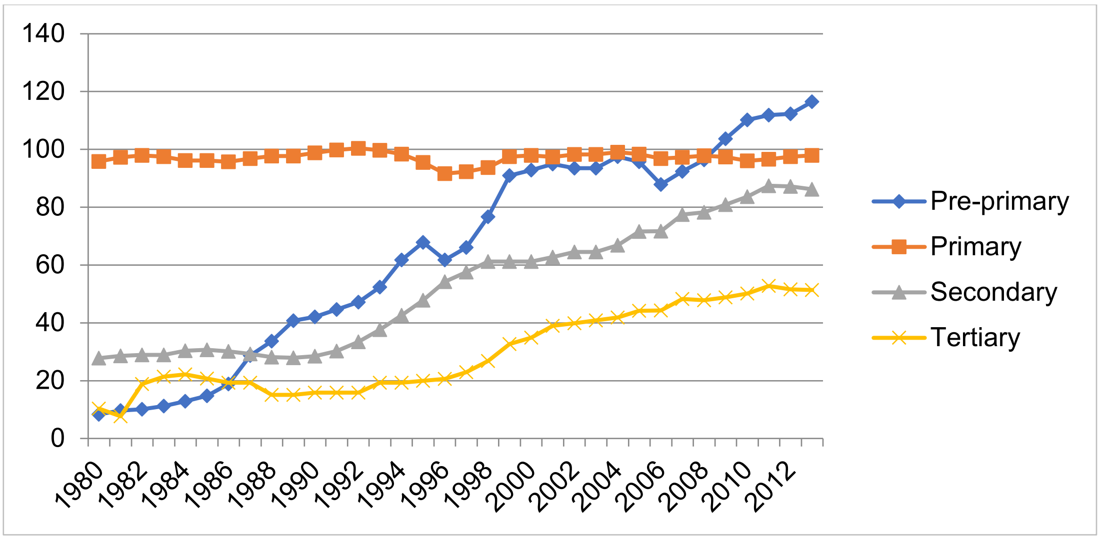
In order to achieve sustainable economic and social development, science and technology capability is considered a driving force. Numerous programs are being implemented and many of them are the efforts of collaboration with multiple agencies: At the basic education level, the Institute for the Promotion of Teaching Science and Technology (IPST) takes a lead to promote integrated approach of Science, Technology, Engineering and Mathematics (STEM) education and to nurture the talented in various programs such as Olympiad participation. Work integrated learning is strongly promoted by OHEC and implemented in various forms by each educational institutes and universities. National Science and Technology Development Agency (NSTDA) sets up institutional framework for university industry linkages such as Science Park and STI also implements a pilot program such as Talent Mobility to establish a legal framework for human resource mobility among industry, higher education and research institutes (see Annex 3).

2.8 Educational Issues Related to Industrial Human Resource Development

2.8.1. Achievement: Thailand has been successful in providing access to education

Thailand has made significant improvement on access to education over the last few decades. Primary education is almost universal and secondary education enrolment has increased substantially in accordance with the educational reform which was enacted by the 1999 National Education Act (amended in 2002). The major policies in the 2002 educational reform include: the compulsory education policy for primary and lower secondary school, and the adoption of 12 years (from primary to upper secondary schooling) free education, which was expanded to 15 years including pre-primary schooling since 2010. These policies have helped to improve access to secondary education. Thailand's gross enrollment ratio increased from 87% in 2001 to 94% in 2010 at the lower secondary level, and 60% in 2001 to 70% in 2010 at the upper secondary level. Furthermore, at the higher education level, enrolment increased from 40% in 2001 to 51% in 2013, which exceeds the expected student enrolment for Thailand's per capita income[12] (see Figure 3).

[12] Brixi, Hana Polackova. (2012) *Leading with ideas: skills for growth and equity in Thailand*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/873221468118462666/Leading-with-ideas-skills-for-growth-and-equity-in-Thailand



Source: United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics[13]

Figure 3: Gross Enrollment ratio by Level

2.8.2 Challenge: Improving the quality of education remains a challenge

While Thailand has made significant progress in access to education, quality of education remains a significant challenge. In order to develop a highly skilled and capable workforce for the future, education plays a major role and its quality is a critical factor for sustainable development. According to the World Economic Forum's Global Competitiveness Report 2016-2017[14], Thailand performs poorly in all indicators of education quality and is placed among the lowest in the ASEAN community.

Table 4: Ranking of Education Quality Indicators in Selected Asian countries

Indicators	Thailand	Indonesia	Malaysia	Philippines	Singapore
Quality of primary education	90	54	23	75	4
Quality of the education system	67	39	12	44	2
Quality of math and science education	81	53	19	79	1
Quality of management schools	77	49	25	41	4

Source: World Economic Forum (2016)

There are two major concerns over the current situation of Thai education concerning industrial human resource development. One is a significant number of low achievers in science and mathematics at the basic education level. Another issue is the inequity in education, in both opportunity and quality, which is more indirect but critical to develop the whole nation.

First, the quality of education in science and mathematics at the basic education level is a prime concern since it is the foundation to further develop students' knowledge and skills at higher levels of education

[13] United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. http://www.indexmundi.com/facts/Thailand/school-enrollment Accessed on February 20, 2017

[14] World Economic Forum (2016) *The Global Competitiveness Report 2016-2017*

for knowledge-based industries. While this report focuses on higher education levels, students' knowledge, skills and attitude have to be built from the early stage of their education.

Thai students' academic performance has not shown much improvement over the last decades, as measured by both international and national tests. At the national level, the O-NET is used to measure Thai students' achievement levels, but the results are disheartening. Thai students scored considerably low in science, mathematics and English and what is worse, the scores deteriorate as they get older, as shown in Table 5.

Table 5: O-NET Score Science, Math and English by Level

Grade	Science	Mathematics	English
6th Grade	37	42	34
9th Grade	38	25	30
12th Grade	30	20	25

Source: NIETS, 2014[15]

At the international level, Thai 15-year olds ranks considerably below the average of their OECD peers in math and science, as shown in the PISA assessment. PISA intends to measure the application of knowledge, rather than the acquisition of the knowledge of the curriculum. Overall, Thailand ranked 54th out of 70 participating countries, placing herself in the bottom quarter. Moreover, Thailand's performance has not improved over the decade. Although 2012 results showed a substantial improvement, unfortunately 2015 results deteriorated. Despite vigorous efforts by various government agencies, Thai students' performance has been relatively stagnant (see Table 6).

Table 6: Thai Students' Score in PISA: 2003 - 2015

Subject	2003	2006	2009	2012	2015
Reading	420	417	421	441	409
Mathematics	417	417	419	427	415
Science	429	421	425	444	421

Source: OECD

What more perturbing is the high percentage of low-performing students in both science and mathematics. Figure 4 and Figure 5 shows the percentage of students of each proficiency level in mathematics and science of PISA[16]. Compared to a high performing country like Japan[17], Thailand has a large proportion of students who achieve level 2 or below. PISA has established the level 2 as the threshold level that students can function in daily life and defines those who achieve level 2 or below as "low performers."[18] More than 70% of Thai 15-year old students are low performers in both mathematics and science, which is significantly higher than OECD averages of 42-45%, respectively. In particular, the highest percentage of Thai youth achieving only level 1 in mathematics is worrisome since math is considered as the basic foundation to develop skills in science and technology.

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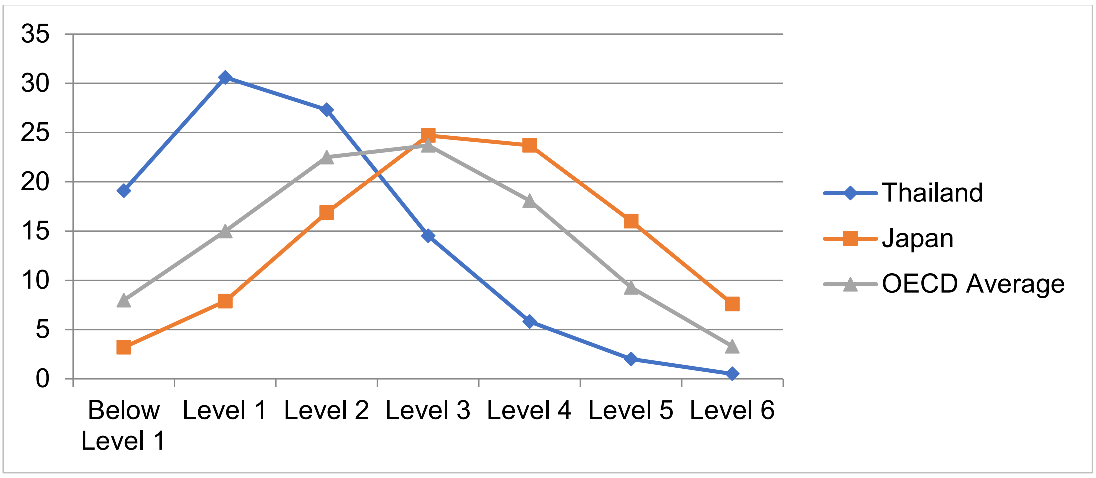
[15] NIETS (2014) *Annual report 2014***.** NIETS . http://www.niets.or.th/uploads/content_pdf/pdf_1438068312.pdf

[16] OECD (2014) *PISA2012 Results: What students know and can do: Student performance in mathematics, reading and science,* Vol.1.

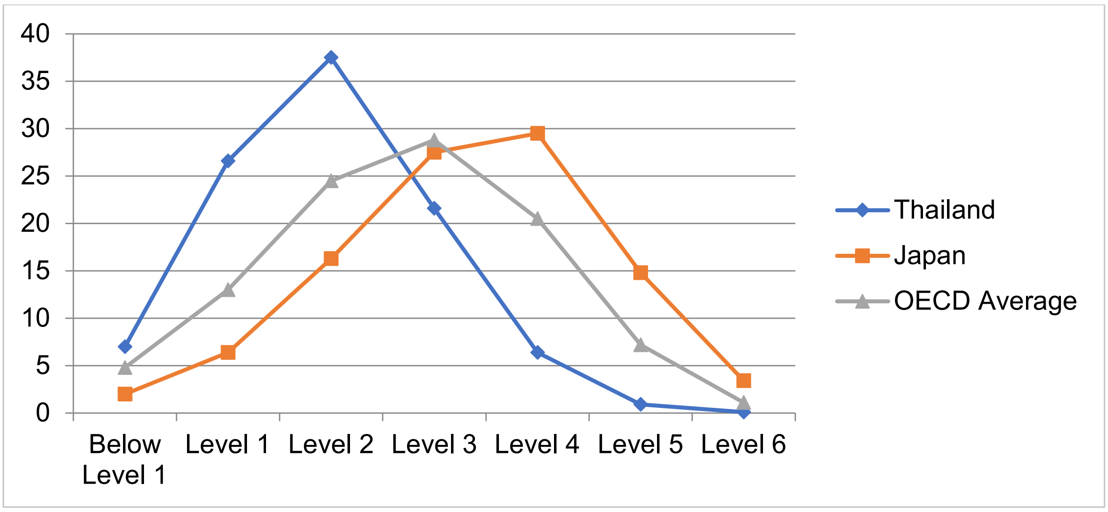
[17] ranked 7th in math and 4th in science in 2012, 5th in math and 2nd in science in 2015

[18] For example, level 2 in scientific literacy was defined as "the baseline level of scientific literacy, … which students begin to demonstrate the scientific knowledge and skills that will enable them to participate actively in life situations related to science and technology." (OECD (2013) *PISA 2012 Assessment and Analytical Framework*, p.113)



Source: OECD (2014)

Figure 4: Percentage of Each Proficiency Level in Mathematics – PISA 2012

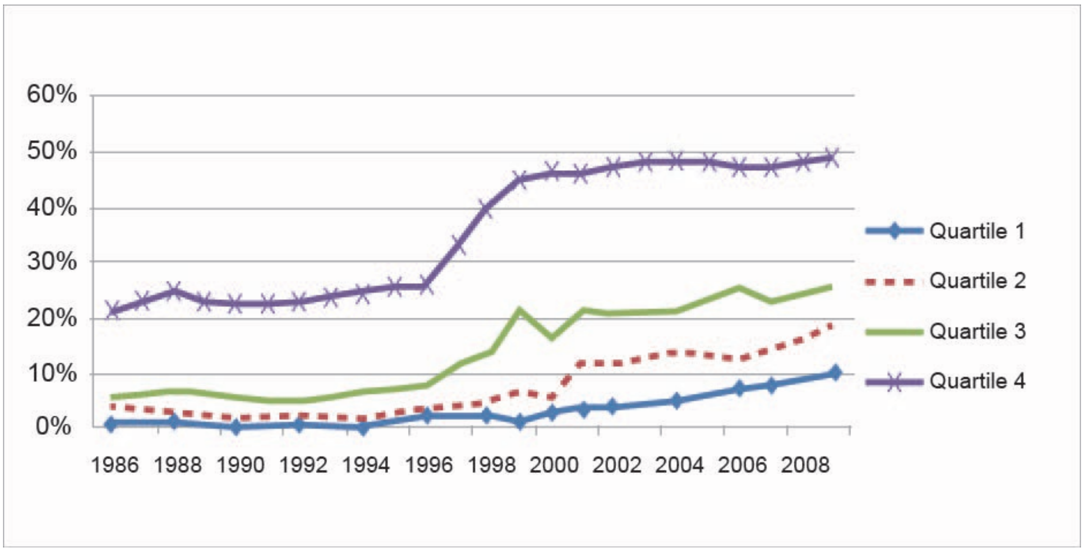


Source: OECD (2014)

Figure 5: Percentage of Each Proficiency Level in Science – PISA 2012

Thai education has promoted developing a small number of elite students to be a driving force for technological innovation, such as Mahidol Witthayanusorn School and Princess Chulabhorn's Colleges and they are achieving impressive outcomes. However, in order to maximize the economic benefits from technology, it is also important to develop a large pool of skilled workers to support them. Both top-down and bottom-up approaches are necessary and when more than half of Thai youth are in the category of low achievers, strengthening the bottom-up approach is an urgent need.

Another concern is equity in education in both opportunity and quality: Thai students' enrolment and performance vary significantly by geographical and socio-economic conditions. In terms of enrolment, while more than 90% of students in all regions study in lower secondary schools, there is a considerable gap in upper secondary school participation, ranging from 82% in Bangkok to 57% in the northeast, which is the poorest region in the country.[19] While Thailand's tertiary education enrolment exceeds the expected level for its income, the expansion of access does not mean equal opportunity for all. Figure 6 shows that the gap between the highest income quartile and lowest income quartile is evident and since 1996, the gap has widened significantly[20].



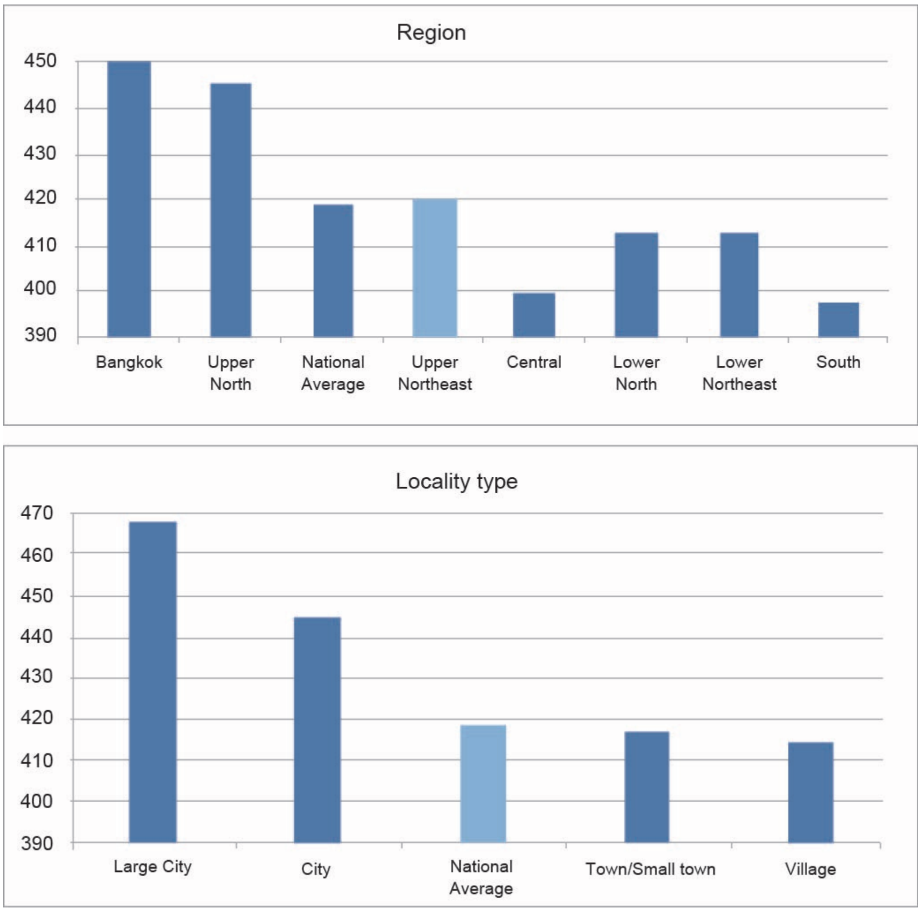
Source: OECD (2013)

Figure 6: Tertiary Enrolment Rate for 19-25-Year-Olds by Income Quartile, 1986-2008

Thai students' performance distinctively varies by region and locality type. Bangkok and the upper north region where the second largest city, Chiang Mai is located, perform much higher than the rest of the regions. The disparity between the highest score in Bangkok and the lowest score in the south region corresponds to more than one proficiency level of PISA (62 points). Students in urban areas perform much higher than those in rural area where about 10,000 small sized schools with fewer than 120 students are located. Those schools are mostly extension schools where lower-secondary schools have been added to primary schools. While extension schools contributed significantly to providing access to education, they suffer from shortages of qualified teachers and adequate teaching materials and facilities. This issue of quality of education in rural area, mainly pertaining to small schools, needs to be paid special attention to improve the equity of education.

[19] When looking at the participation in upper secondary education for the age group of 16 to 18 years old by income group, the lowest income group's participation was only about 50% in 2008, while the highest income group's participation was nearly 80%. Although the disparity has gradually decreased over the last two decades, Thailand needs to continue their efforts to close the gap.

[20] OECD (2013) *Southeast Asian Economic Outlook 2013: With Perspectives on China and India*, http://dx.doi.org/10.1787/saeo-2013-en. adopted from OECD/UNESCO (2016) , *Education in Thailand: An OECD-UNESCO Perspective,* Reviews of National Policies for Education, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264259119-en



Source: IPST 2013, adopted from OECD/UNESCO[21] (2016) p.84.

Figure 7: Mathematics performance by region and locality type – PISA 2012

Equity is a critical issue that Thailand must address. Ulrich Zachau, World Bank Southeast Asia's Director, stated that, "The single most important thing for Thailand is to improve its education and skills outside Bangkok."[22] Reducing the disparity to ensure equal access to quality education is a prerequisite to upgrade the whole nation. Developing quality education in rural and socio-economically disadvantaged areas is a challenge that Thailand needs to solve.

2.9 Issues in Industrial Human Resource Development

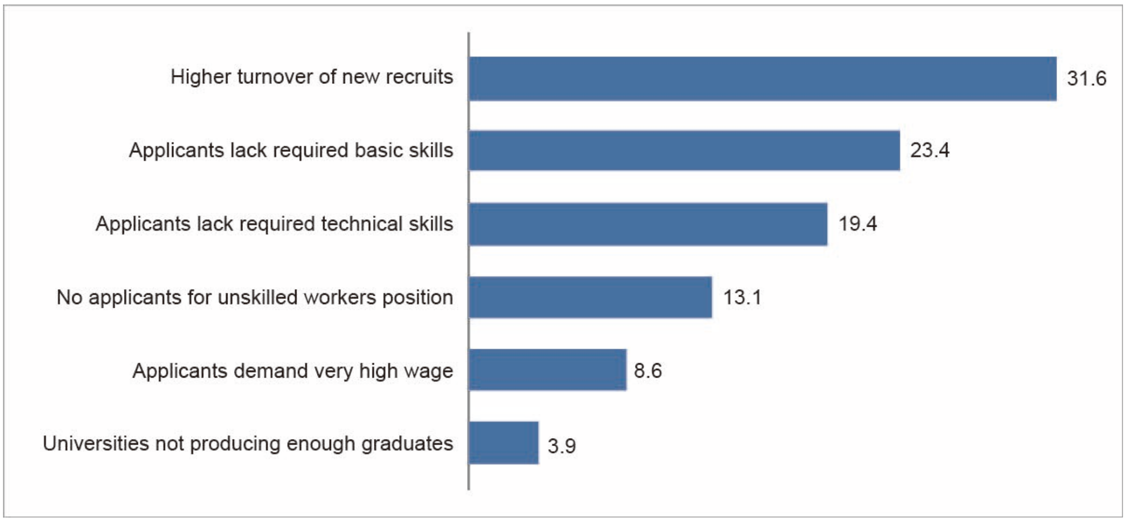
2.9.1 Prolonged Issue of Shortage of "Skilled" Workforce

Thailand has been suffering from shortage of skilled labor for the last decade. While various factors are involved in promoting business, the shortage of skilled workforce is one of major issues in Thailand. The survey under this mission confirms that high turnover rate and unsatisfactory skills of workers are still major issues.

The 2007 Productivity and Investment Climate Survey (PICS) reported that an average of 30% of firms (50% of firms in automotive parts, 34% of firms in machinery and equipment, 32% of firms in

[21] OECD/UNESCO (2016)
Ra, S., B. Chin, and A Liu. (2015) *Challenges and Opportunities for skills Development in Asia – Changing supply, demand, and mismatches* Asian Development Bank
[22] From the article in the Nation Newspaper, June 2015

electronics and electrical appliances) suffered from a shortage of skilled productions workers[23] . The top three reasons for job vacancies are high turnover of new recruits followed by the lack of required basic and technical skills of the applicants. About quarter of the firms surveyed reported lack of basic and technical skills as major reasons for vacancies (see Figure 8).



Source: Thailand PICS 2007, World Bank (2012)

Figure 8: Main Reasons of Job Vacancies

Forty percent of firms consider the shortage of skilled labor to be one of the major constraints in doing business in Thailand. Finding a skilled worker is extremely difficult since 80% of the total Thai workforce is classified as unskilled. Thailand has to spend an average of 5.2 weeks to find a skilled production worker, which is much longer than the international average of 3.8 weeks[24]. In ordnneer to compensate for this gap, nearly 80% of firms in Thailand are providing formal re-training to their employees, which is much higher compared to other countries[25].

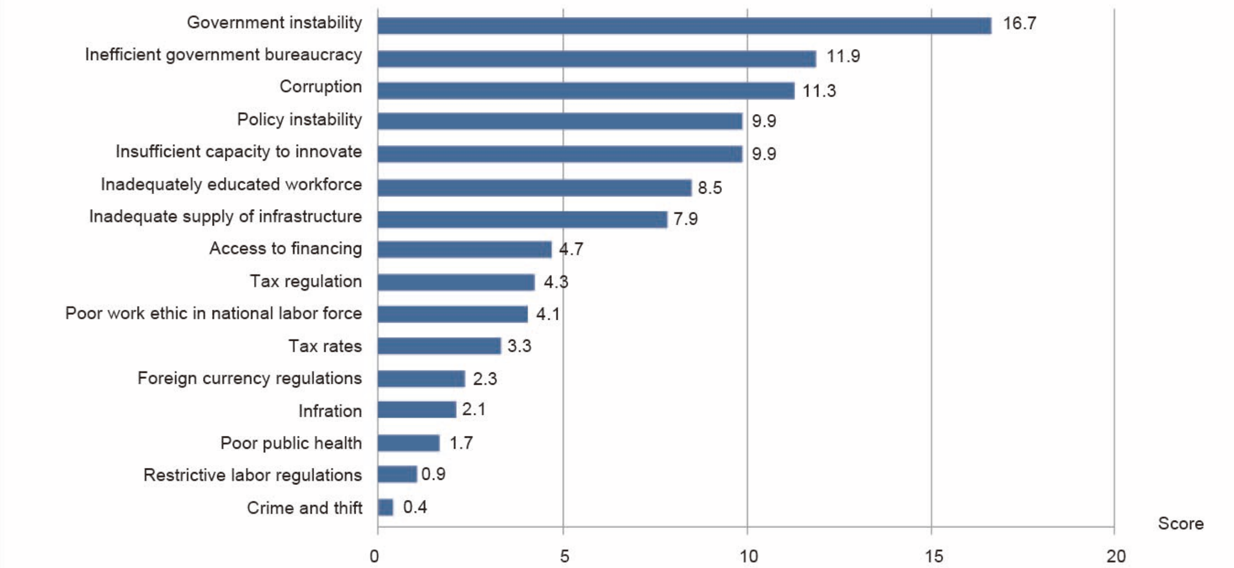
The latest report by the World Economic Forum (2016) shows that factors related to human resources including insufficient capacity to innovate, inadequately educated workforce and poor work ethic in national labor force, are considered as most problematic factors for doing business in Thailand (see Figure 9). Thailand's competitiveness ranking has been stagnant, at around 30-35th, for the last few years.

[23] World Bank (2009) *Thailand - Towards a competitive higher education system in a global economy*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/475311468335417752/Thailand-Towards-a-competitive-higher-education-system-in-a-global-economy

[24] Ibid.

[25] Brixi, Hana Polackova.

DSD under MOL provides "pre-employment" for newly-graduates. The official said 7,000-8,000 graduates receive the training per year in machinery field.



Note: From the list of factors, respondents to the World Economic Forum' s Executive Opinion Survey were asked to select the five most problematic factors for doing business in their country and to rank them between 1 (most problematic) and 5. The score corresponds to the respondents weighed according to their rankings.

Source: Adopted from World Economic Forum (2016)

Figure 9: Most problematic factors for doing business in Thailand (2016)

2.9.2 Mismatch in Quantity and Quality for Technical Colleges and Universities

The previous study conducted by the JICA Thailand Office in March 2017 has identified that a critical issue in Thailand's industrial human resource development is the gap between demand and supply in both quantity and quality[26]. Improvement of education at colleges and universities is a key factor to support the transition from labor-intensive industries to knowledge-intensive industries. However, educational institutions at both technical college and university levels are not meeting the demands of private sector in industry. In this section, common issues in Thai industrial human resources concerning both technical colleges and universities are discussed.

2.9.2.1 Demand for skilled technicians and engineers

In terms of numbers, the shortage of qualified skilled technicians and engineers is clear in the Thai labor market. Although a coherent national projection is not available and the statistics that are readily available differ greatly among the agencies concerned, the need for and shortage of graduates of technical colleges and universities is evident. For example, the demand for workforce in the science and technology area in 2023 will be 625,500, including approximately 220,000 graduates with vocational certificate and higher vocational certificate and nearly 400,000 graduates with bachelor's and higher degrees[27]. More specifically, STI has projected about 400,000 engineers and engineering technicians are needed in 2023. Among them, half of them should be bachelor's and higher degrees. Another half should be at the level of vocational and higher vocational certificates (see Table 7).

[26] Japan International Cooperation Agency (Thailand Office) (2016) *Data Collection Survey on Industrial Human Resource Development in Thailand*.
[27] STI (2016a) "*Work-Integrated learning", Presentation at the Thailand-US Roundtable on STEM Education",* by Thiti Bovornratanaraks National Science Technology and Innovation Policy Office

Table 7: Projected Industry Demand of Engineers and Engineering Technicians in 2023

Below high school	High school	Vocational certificate	High vocational certificate	Bachelor and higher	Total
7,761	4,548	54,478	140,039	199,901	406,727

Source: Estimated by STI, Thiti Bovarnratanaraks (2016)[28]

Also, MOL has projected the needs and shortage of the labor force in manufacturing industries including electric and electronics, and automobile and automobile parts engineering. The graduates of technical college and higher education level in 2025 are needed twice as much as those in 2017[29] (see Table 8).

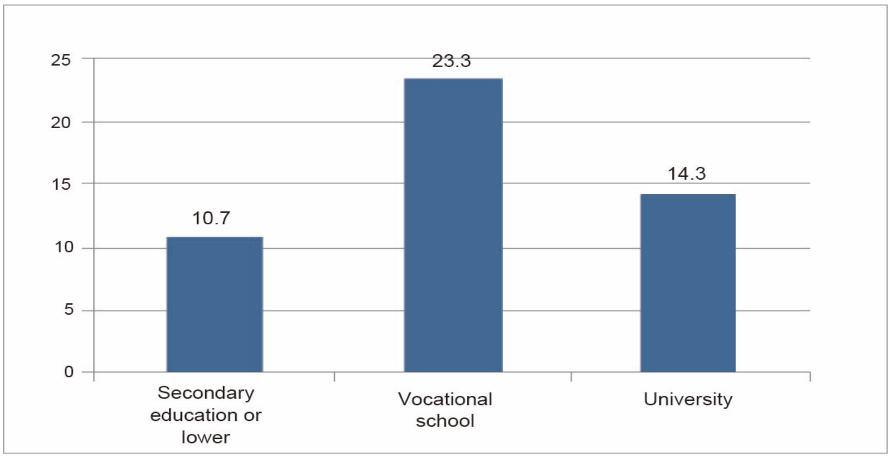
Table 8: Demand projection of labor force in manufacturing industries by academic level: 2017 and 2025

Year	2017				2025			
Fields	Voc. Cert.	Higher Voc. Cert.	Bachelor	Higher than Bachelor	Voc. Cert.	Higher Voc. Cert.	Bachelor	Higher than Bachelor
Electric and Electronics	3,165	5,197	10,941	4,399	3,093	3,356	8,604	2,318
Automobile and Automotive Parts	3,605	3,166	5,586	1,760	8,772	12,335	33,685	6,779
Other Production Industry	7,152	9,290	20,591	4,688	6,099	13,825	44,179	7,476
Sub-total	13,922	17,653	37,118	10,847	17,964	29,516	86,468	16,573
Total	79,540				150,521			

Source: MOL (2014)

While the above projection presents the greatest needs for the bachelor's level, Economic Intelligence Center (EIC) survey has identified that openings for technical college graduates are hardest to fill[30]. Twenty three percent of job vacancies for technical college graduates are not filled. Although 14% of vacancies for university graduates are not filled, the supply of university graduates is better (see Figure 10).

[28] STI (2016a)
[29] MOL (2014) *Need and Shortage of labor by skills* http://manpower.mol.go.th/pmanp_2014/index.php/main/table_view/90
[30] EIC (2015) *Insight – Bridging Thailand's Labor Gap*. SCB. *http://dx.doi.org/10.1787/9789264259119-en*



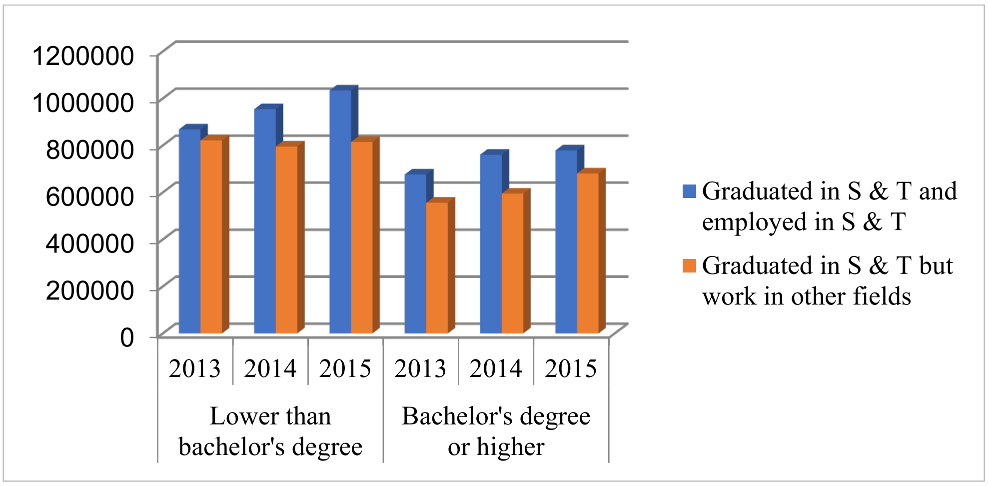
Source: EIC (2015)

Figure 10: Shortage of Workers by Education Level (% of group workers)

Thailand currently produces about 70,000 graduates in industry-related subjects at the higher vocational certificate level, and about 90,000 S&T graduates at bachelor's degree and higher than bachelor's degree levels. Among university graduates, about 25,000 graduates are from the Faculty of Engineering.

2.9.2.2 Mismatch in career path

While there is a need to increase the number of skilled technicians and engineers, the issue is not necessarily that technical colleges and universities are not producing enough graduates, but more concern lies in the trend that the graduates are not entering the labor market in their fields of study. Thailand currently has 1.8 million graduates of science and technology (S&T) fields working in S&T fields, but at the same time, 1.5 million graduates of S&T are not working in S&T fields. Figure 11 shows the current fields that graduates in S&T fields are working by the level of education (lower than bachelor's degree and bachelor's degree or higher). Those who are not working in S&T fields are nearly the same of those working in the fields at both levels.[31]



Source: National Statistical Office and STI (2016b)

Figure 11: Ratio of fields of work for S&T graduates by level

[31] For the top 10 occupations for those not working in science and technology fields, see Annex 4.

Furthermore, there is a worrisome trend that the ratio of young Thais entering the S&T labor market is decreasing. In 2010, the percentage of S&T workforce of 20-29-year-olds to the total S&T workforce was about 40% but it gradually decreased to 30% in 2015[32]. More details of quantitative analysis at the levels of technical colleges and universities will be discussed in Chapter 3.

2.9.2.3 Skills Mismatch

The issues of quantity and quality of labor are not independent, but they are interrelated. In other words, the shortage of skilled labor is not simply a shortage of numbers, but it is related to the skill quality of the applicants. While the quantitative shortage of technicians and engineers is an issue, the interviewees under this mission did not express much concern with the shortage in the numbers. Rather, they are more concerned with the quality and skill mismatch of S&T graduates. Graduates of technical colleges and universities are not meeting the expectations of the private sector. According to a survey by MOL, what the private industry sector expects for graduates of technical colleges and universities is much higher than their actual knowledge and skills acquired at school in all standards[33].

2.9.2.4 What skills are needed?

The graduates of technical colleges and universities are not meeting the expectation by the private sector, but what kind of skills and knowledge are considered weak and most needed? The survey team finds that in order to produce practical and innovative engineers, focusing only on technical professional skills is not sufficient. The survey team has summarized the skills expected by the private sector through interviews and survey as follows:

1. Technical/Professional knowledge and skills
2. Basic knowledge in mathematics and sciences (chemistry and physics)
3. Foreign language proficiency: English is a must and Japanese is an advantage
4. 21st century skills (e.g., critical thinking, creativity, communication, and collaboration)[34]
5. Work ethics and discipline (e.g. punctuality, commitment, responsibility)

All of the above skills are mentioned as important to the varying degrees by the private sector. According to the 2007 PICS survey, participating firms rated their employees' skills as poor or very poor in the basic subjects such as English, IT and mathematics at over 95%, 80% and 50% respectively. Furthermore, the survey shows that more generic abilities such as creativity, communication, and problem solving, which are considered important aspects of the 21st century skills are also poor. According to this survey, the skills in basic subjects and generic abilities are considered much more serious than technical/professional skills (see Figure 12).

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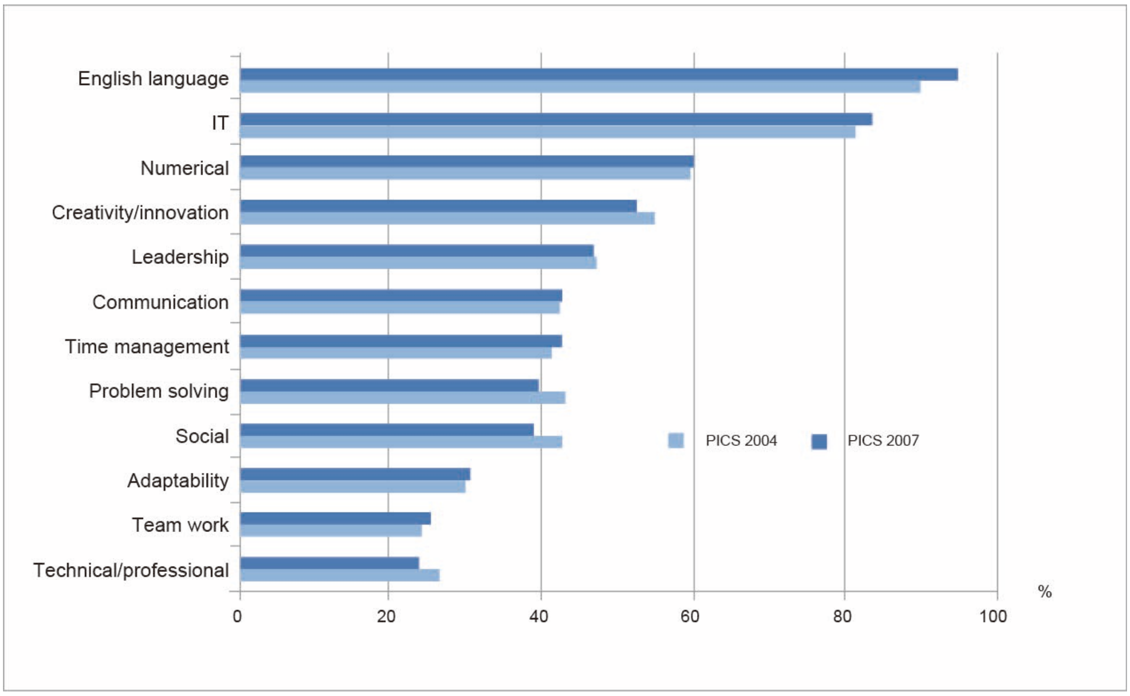
[32] STI(2016b) *Thailand Science & Technology Indicators 2015*. National Science Technology and Innovation Policy Office.

[33] MOL (2015) *Need of labor's Knowledge and Skill* National Policies for Education, OECD Publishing, Paris.

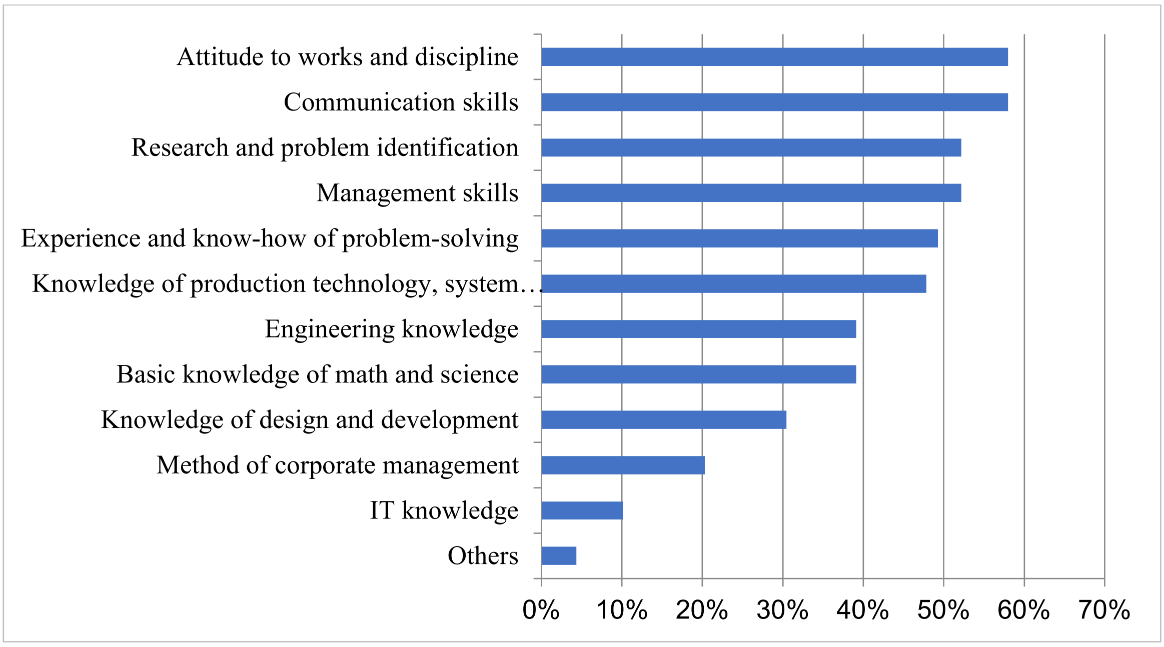
[34] ILO names this skill as "Core work skills" defining "the abilities to learn and adapt; to read, write and compute competently; to listen and communicate effectively; to think creatively; to solve problems independently; to manage oneself at work; to interact with co-workers; to work in teams or groups; to handle basic technology; and to lead effectively; as well as follow supervision." Resource: ILO (2015) *Integrating Core Work Skills into TVET Systems: Six country case studies*. ILO. The term used to describe these skills considerably by nations. For the examples of the term, see Annex 5.



Source: Thailand PICs 2004 and 2007, adopted from The World Bank (2012) p.13.

Figure 12: Percentages of firms who rate their employees' skills as poor or very poor

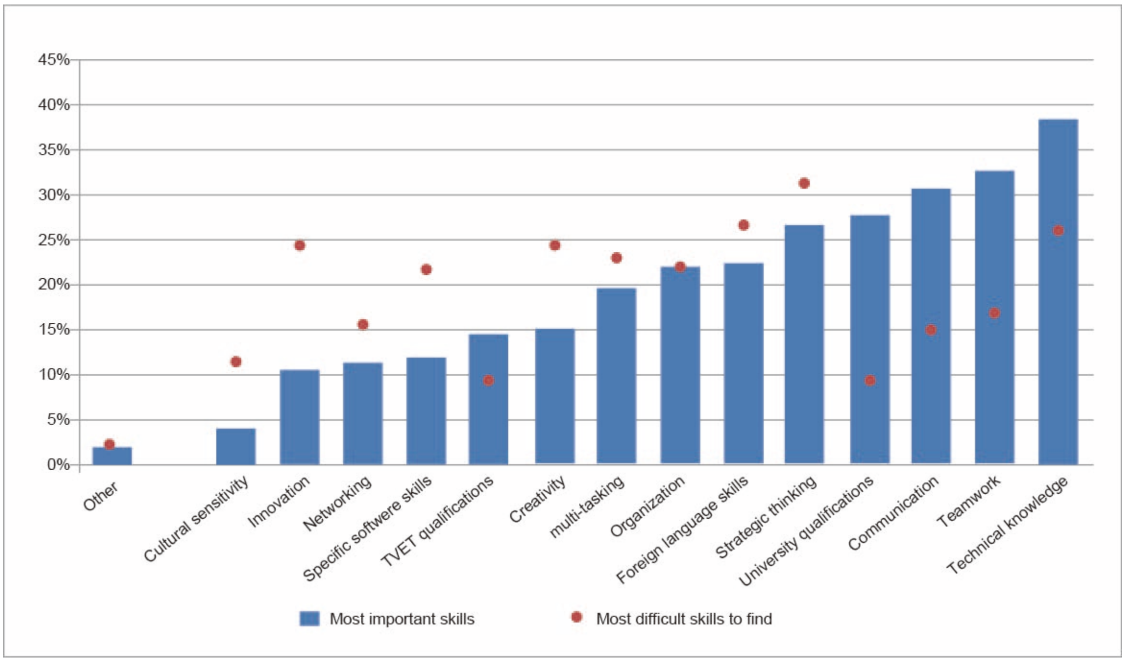
Our online company survey also confirms the above finding. When asked what skills are weak and need to be improved, more than 50% of companies have responded that communication skills, discipline and 21st century skills such as problem solving and management capability need to be improved. Weakness of these skills is perceived more serious than weakness of technical knowledge and skills (see Figure 13).



Source: Based on the results of online survey given to companies

Figure 13: Skills Need to be Improved

ILO has done a survey on enterprises in ASEAN community[35]. In this survey, technical knowledge is considered most important, 38.6% of enterprises cited as such, followed by more generic abilities such as teamwork and communication. However, interestingly enough, the skills most difficult to find are strategic thinking and problem solving, followed by foreign language skills, creativity and innovation (see Figure 14).



Source: ILO (2016)

Figure 14: Survey results on enterprises in ASEAN countries

These findings indicate that in order to produce highly skilled industrial human resources, not only technical knowledge and skills but also other skills need to be developed. Basic science and math knowledge are the foundation to further develop technical skills. 21st century skills and discipline are not easily transferred but developed through various activities and experiences. English, as a communication tool is considered highly important since globalization is an indispensable factor for Thai economy to develop. Accordingly, holistic approach of education needs to be considered. More details of skills needed by the private sector will be discussed in Chapter 4.

2.9.3 Risk Factor of Skills Mismatch

The mismatch of skills can be a high-risk factor when Thailand is trying to develop more-advanced industries. As explained in this section, the shortage of skilled workers indicates serious concern over a mismatch of skills and this gap between demand and supply will continue to widen, unless Thai educational institutions shift the focus on developing more laborers who will be able to think critically, be creative and solve problems in collaboration with others, with a solid foundation of basic subjects and advanced technical skills.

[35] ILO (2016) *ASEAN in Transformation – Perspectives of Enterprises and Students on Future Work.* Bureau for Employers' Activities (ACT/EMP), Working paper No.11. International Labour Office.

An Asian Development Bank (ADB) study (2015) reports that the economic growth in many Asian countries over the last three decades was driven by “a large supply of young workers with relatively high levels of basic education but limited levels of advanced education and skills.” This human capital, with low wages, was in alignment with production line industries and basic services. However, this model will no longer work for sustainable development. Emerging occupations (e.g., managers, highly qualified engineers and research scientists) requires advanced skills and “the need for soft skills (e.g., creativity, adaptability, and interpersonal communications) rises in more advanced firms and economies.

While Thai economy is currently making a decent progress, GDP increase was 3.2% in 2016 and expected to increase to 3.5% in 2017, the current human resource development system is not preparing graduates for success in the long term, and therefore Thailand needs to develop new models of preparing skilled workforce. In other words, Thailand is trying to climb the technological ladder and in order to achieve innovation in technology, there is a need to reorient education and training for the future workforce.

Chapter 3 Educational Institutes for Industrial Human Resource Development

This Chapter will discuss the current situation and challenges of industrial human resources development in the formal school system at upper secondary and higher education levels. More specifically, the following two groups are targeted: 1) Technical colleges administered under OVEC, and 2) State universities of technology under OHEC.

Thailand's formal schooling system is the same as Japan's 6-3-3 system: 6 years of primary school, 3 years of lower secondary school and another 3 years of upper secondary school. On entering upper secondary school, students choose either a general or vocational track. Technical colleges offer a vocational track at the upper secondary level and another two years at the higher education level. Their place in the Thai education system is shown in Annex 6.

While technical college and university have common issues in light of industrial human resource development discussed in the previous chapter, the expectations and responsibilities of technical colleges and universities are different and discussed separately. In the following sections, these key interrelated questions are discussed:

1. Why are the graduates of technical colleges and universities not entering the S&T labor market?
2. Why skills mismatch is happening?

Furthermore, this report will present the current efforts by the Thai government to address these issues. Key programs will be discussed in detail so that they can be referred to in the JICA project proposal.

Lastly, the study on equipment on both technical colleges and universities is presented. The list of equipment necessary for mechanical engineering and electric/electrical engineering for the basic level and advanced level are identified and the situation for technical colleges and universities are analyzed.

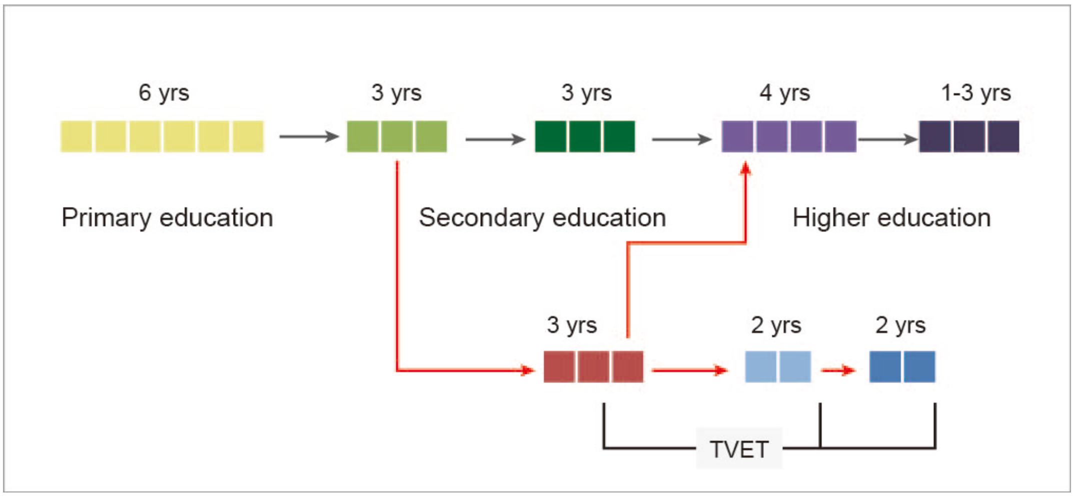
3.1. Current Situation and Challenges of Technical Colleges

In this section, the key issues of OVEC technical schools and colleges offering industry-related subjects are discussed. First, the overview of TVET is introduced. Secondly, the current situation of TVET is presented which includes the situation that TVET is not attracting Thai youth and that the graduates continue to study. Also, the two major reasons that the graduates continue to study, namely demand for higher level of education and lack of adequate skills, are discussed. Thirdly, the challenges of TVET are discussed which are: 1) lack of accountability; 2) weak monitoring and assessment system; 3) need for professional development of teachers; 4) institutional constraints of teachers; 5) curriculum development capacity; 6) weak career guidance and 7) perception gap between policy makers and directors of technical colleges. Lastly, the Thai government's efforts to tackles these issues are introduced which are categorized into the following: 1) establishment of pilot model schools; 2) work integrated learning; 3) competency-based standard setting and 4) collaboration with international agencies.

3.1.1 Overview of Technical and Vocational Education and Training (TVET)

TVET is divided into three types: formal, non-formal and informal. Under the life-long learning policy, learning in any type of education is recognized and the credits can be transferable when the standards are met. In the public sector, the key organizations responsible for TVET include: OVEC, the Office of Private Education Commission (OPEC) and the Department of Non-Formal Education (DNFE) under the Ministry of Education (MOE), the DSD under the MOL, and the Department of Industrial Promotion (DIP) under the Ministry of Industry. Other ministries provide technical training such as the Ministry of Agriculture and Agricultural Cooperatives.

This chapter will discuss the formal TVET in the school system which is administered by OVEC under the MOE. TVET in the school system is provided at three degree levels: vocational certificate (Por Wor Chor) at upper secondary level, higher vocational certificate (Por Wor Sor) at post-secondary level (two-year associate degree level) and bachelor's degree[36](see Figure 15). Traditionally, degrees were provided at only two levels, upper secondary and post-secondary, but the 2008 Vocational Education Act enabled the existing technical colleges to provide bachelor's degrees.



Source: Adopted from OVEC (2014)[37]

Figure 15: Structure of TVET System

The purpose of education at technical colleges is to produce skilled workers and technicians, and further develop practical technologists and engineers. The executive officials of OVEC and administrators of the technical colleges visited under this mission all emphasized that their specialty is "hands-on learning" and "practical training." Research is not a main focus of their institutions.

The technical and vocational school system is extensively spread throughout the nation through 426 public and 464 private technical schools and colleges. In 2015, there were about 960,000 students

[36] TVET in Thailand follows the 2013 Curriculum for the Certificate of Vocational Education (including revised version in 2014) at the lower certificate level and 2014 Curriculum for Diploma of Vocational Education at associate degree level.

[37] OVEC (2014) "*TVET in Thailand*" Presented at Dual Excellence Conference 2014, October 7, 2014, by Dr. Siripan Choomnoom, Special Expert Member of the Vocational Education Commission and Senior Advisor for the Office of the Vocational Education Commission Thailand.

studying in these programs, and two-thirds of students are enrolled in the public school system[38] (see Table 9).

Table 9: Number of Students, Teachers and Institutions of Technical Colleges

<table>
<tr><th rowspan="2">Level</th><th colspan="2">Number of Students</th><th colspan="2">Teachers</th><th colspan="2">Institutions</th></tr>
<tr><th>Public</th><th>Private</th><th>Public</th><th>Private</th><th>Public</th><th>Private</th></tr>
<tr><td>Vocational track at upper secondary</td><td>434,663</td><td>204,040</td><td rowspan="3">27,622</td><td rowspan="3">7,865</td><td rowspan="3">426</td><td rowspan="3">464</td></tr>
<tr><td>High vocational certificate at technical college</td><td>235,794</td><td>83,144</td></tr>
<tr><td>Bachelor</td><td>3,656</td><td>n/a</td></tr>
<tr><td>Total</td><td>674,113</td><td>287,184</td><td colspan="2">35,487</td><td>5% in BKK</td><td>17% in BKK</td></tr>
</table>

Source: Information Technology and Vocational manpower center, OVEC and OPEC[39]

Public technical colleges play a major role in providing industry-related education and training throughout the nation. About 70% of public technical colleges offer industry-related subjects, while 70% of private technical colleges offer business and commerce related subjects. Furthermore, public technical colleges are located in every province, with only 20 colleges in Bangkok, while about one quarter of private colleges (about 100) are located in Bangkok. According to statistics from OVEC and the OPEC, about half of the students who study in the industry-related programs, which is the largest number of students by program, followed by the students studying in commerce, tourism and agriculture (See Table 10.) The list of technical colleges is shown in Annex 7.

Table 10: Number of Student by Program

Program	Public School (2015) *1			Private School (2012) *2		Total
	Voc. Cert.	Higher Voc. Cert.	Diploma	Voc. Cert.	Higher Voc. Cert.	
Agriculture	13,449	8,189	69	40	23	21,770
IT	2,625	3,503	192	-	1,771	8,091
Home Economics	13,907	5,096	55	282	-	19,340
Fishery	520	1,129	0	-	-	1,649
Commerce	136,829	85,199	729	166,521	65,010	454,288
Art	10,009	1,728	90	3,276	475	15,578
Industry	241,457	126,124	2,292	74,823	24,817	469,513
Tourism Industry	15,588	4,762	229	7,379	1,416	29,374
Textile Industry	279	64	0	-	7	350

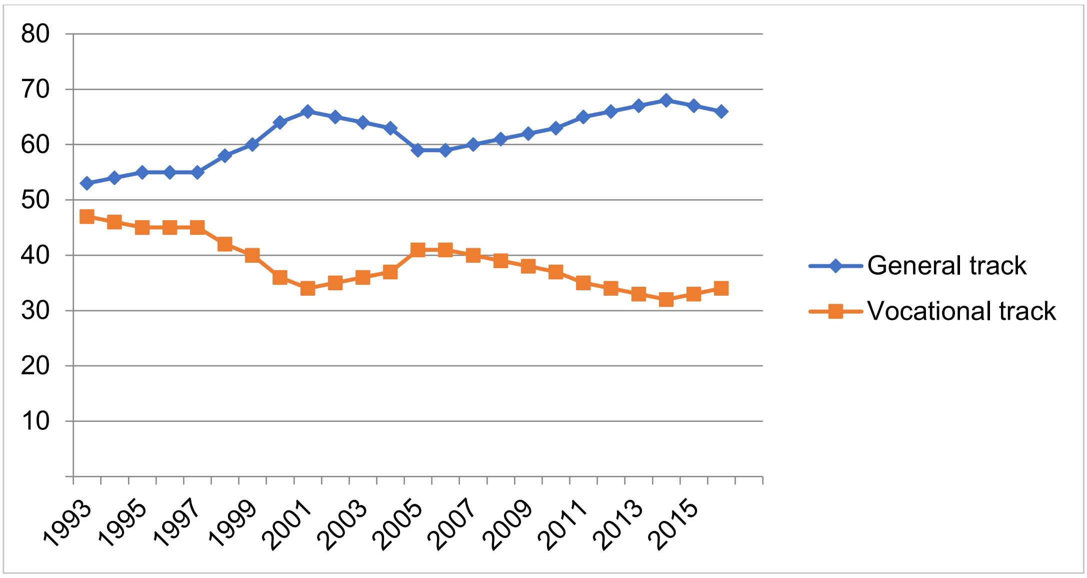
Source: *1 OVEC, Information Technology and Vocational manpower center
*2 OPEC[40]

[38] These private technical and vocational schools and colleges used to be under the OPEC, but following a Decree approved on February 12, 2016, they have come to be under OVEC.
[39] The statistics for public and private schools are from the year 2016 and 2015 respectively. Public school teachers include short-term contract teachers. Resource: OPEC (2015) "*Private Vocational Institute statistic 2015*" http://www.opec.go.th/list-name-school
[40] http://www.opec.go.th/sthiti-rongreiyn-xekchn

3.1.2 Current Situation of Technical and Vocational Education

3.1.2.1 TVET not attracting enough young students

An initial concern over shortage of quantity and quality is that Thailand's TVET is not attracting enough young students. The number of students in TVET is declining gradually. Especially, the number of those entering the vocational track at the upper secondary level has decreased over the last decade. While total enrolment in upper secondary education has increased moderately, the increase was due to the number of students in the general track. The ratio of vocational track students compared to general track students dropped from 47% in 1993 to the lowest 32% in 2014 (see Figure 16).



Source: Office of Education Council (OEC)[41]

Figure 16: Ratio of Students Enrolled in Vocational Track vs. General Track

The Thai government set the target of a ratio of 50 to 50 (general vs vocational) in 2015, but it has not been successful. There is a general demand for higher education, which is considered more prestigious and perceived by the public to provide a better future income relative to vocational education. Under the current educational reform, the Thai Government has expanded access to the universities by providing 12-year free education and upgrading various institutes to university status. While this policy has helped increase access to universities, students' and parents' preference to advance in the general track has become stronger since this will give them a higher chance to be enrolled in universities.

Furthermore, there is a negative public perception of technical and vocational education. TVET is characterized by "3Ds": dangerous, difficult and dirty.[42] Also, a series of violent conflicts among technical college students has worsened the public image of technical colleges. The vocational track is considered as a second option, after the general track. Combining an increasing demand for higher education, easier access to universities, and negative perceptions towards TVET, Thailand has not been successful in attracting the future generations to TVET.

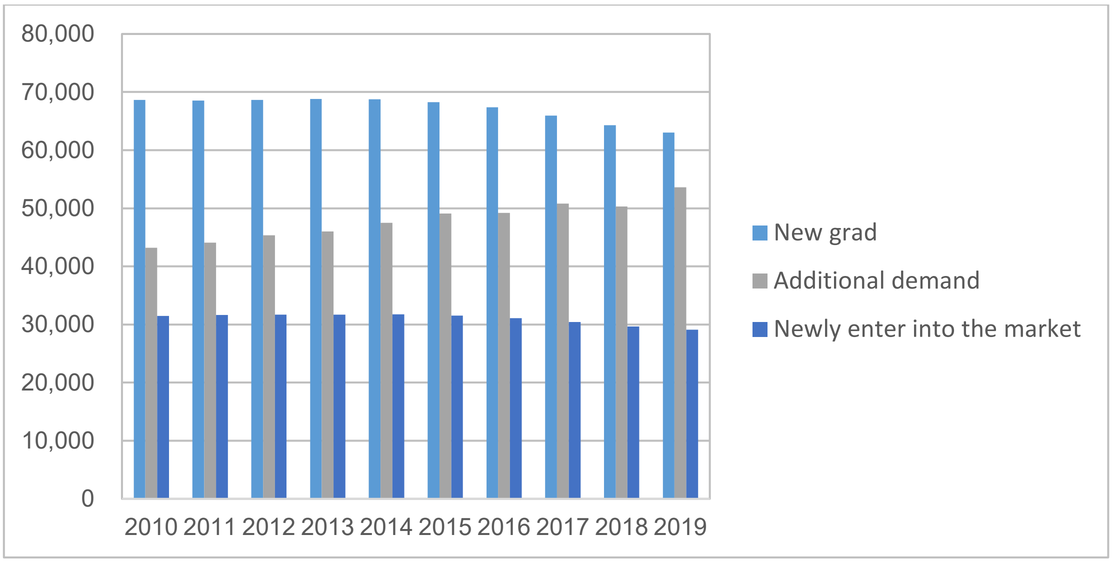
[41] OEC (2016) *Education in Thailand (Draft)*

[42] The statement is mentioned in the interviews with executive officers of OVEC and also technical school administrators.

There is, however, a notable change in this trend. There has been an increase, although subtle, in the number of students enrolled in the vocational track in 2014 to 2016. This increase may be an indication of positive outcomes of the government efforts, which will be discussed in a later section of this chapter.

3.1.2.2 Technical college graduates continue to study

The shortage of technical college graduates in the workforce is not because technical colleges are not producing enough graduates to meet the needs, but because the graduates are not entering the market in their major. While fewer students majoring in science and technology is a concern at higher education level, this is not the case for students in technical colleges. In fact, at the upper secondary level, more than half of the students major in industry-related subjects and at higher vocational certificate level, the majority of students major in industry-related subjects (see Table 10). STI's study on the demand and supply of STEM workforce shows that there will be enough graduates for this decade, at 70,000, to meet the needs of 40,000 to 50,000 STEM workforce. While it is a concern that the number of graduates of technical colleges is gradually decreasing and the demand for those graduates is increasing, the more concerning issue is that those technical college graduates are not entering the market, filling only half the positions, about 30,000, as shown in Figure 17.



Source: STI Office

Figure 17: Higher Vocational New Graduates vs. Market Demand

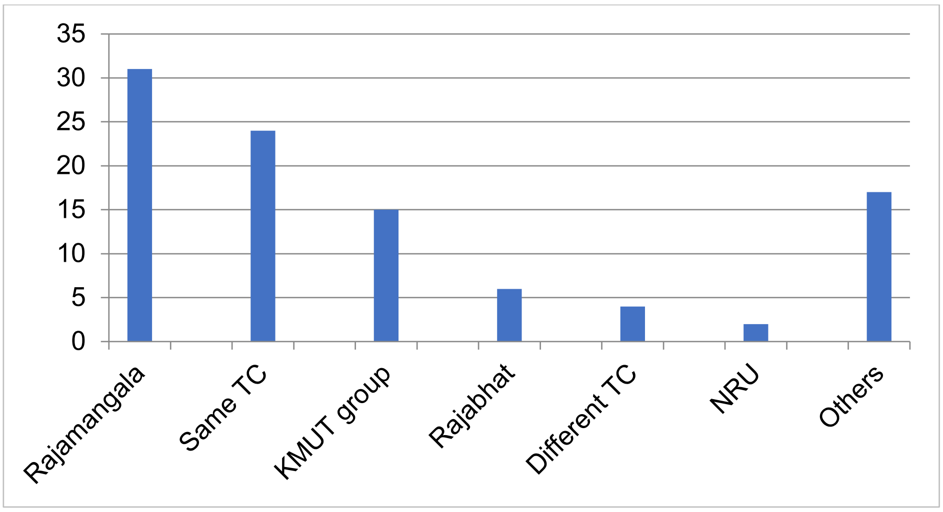
A major factor of technical college graduates not entering the market is because a substantial number of graduates continue to study at a higher level of education. Graduates of both upper and post-secondary levels can advance their study at either university or technical college and advancement rates for both graduates with vocational certificates and higher vocational certificates are high, 85% and 30% respectively, as shown in Table 11.

Table 11: Students Pathways after Graduation by Level

Level	Continuing Study	Employed	Unemployed
Vocational certificate level（PWC）	85.2%	11.3%	3.5%
Higher vocational certificate level (PWS)	29.8%	59.8%	10.4%

Source: OVEC (2012)[43]

Although TVET aims to prepare students for employment through "the acquisition of knowledge and skills for the world of work", only 10% of graduates with vocational certificates and 60% of graduates with higher vocational certificates are employed after graduation[44] (see Table 11). Vocational high schools are not considered as their formal education destination anymore and those with higher vocational certificate also continue to study.[45] This tendency is more evident at larger size schools: In the survey of the targeted schools under this mission, advancement rate of those with vocational certificates is similar (86%) but advancement rate of those with higher vocational certificates is much higher, 53%, compared to 30% of OVEC overall statistics.[46] After the 2008 Vocational Education Act, technical colleges started offering bachelor's degrees, at about 80 colleges in 2015, and graduates can advance their study at technical colleges. In our survey of the targeted schools, one quarter of the graduates with higher vocational certificates in industry-related subjects advance their study at the same colleges, following those going to Rajamangala University's group, which are former science and technology institutes under OVEC administration (see Figure 18). Most of other bachelor's degrees obtained are from private universities.



Source: Based on the team's survey results given to technical colleges

Note: Others are mostly private universities

Figure 18: Universities That Technical College Graduates Advance To (%)

[43] OVEC (2012) "*Number of employment entering labor market year 2012"* (in Thai) Information Technology and Vocational manpower center, http://techno.vec.go.th/

[44] TVET is defined by UNESCO as "those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupation in various sectors of economic life" (http://www.unesco.org/new/en/newdelhi/areas-of-action/education/technical-vocational-education-and-training-tvet/)

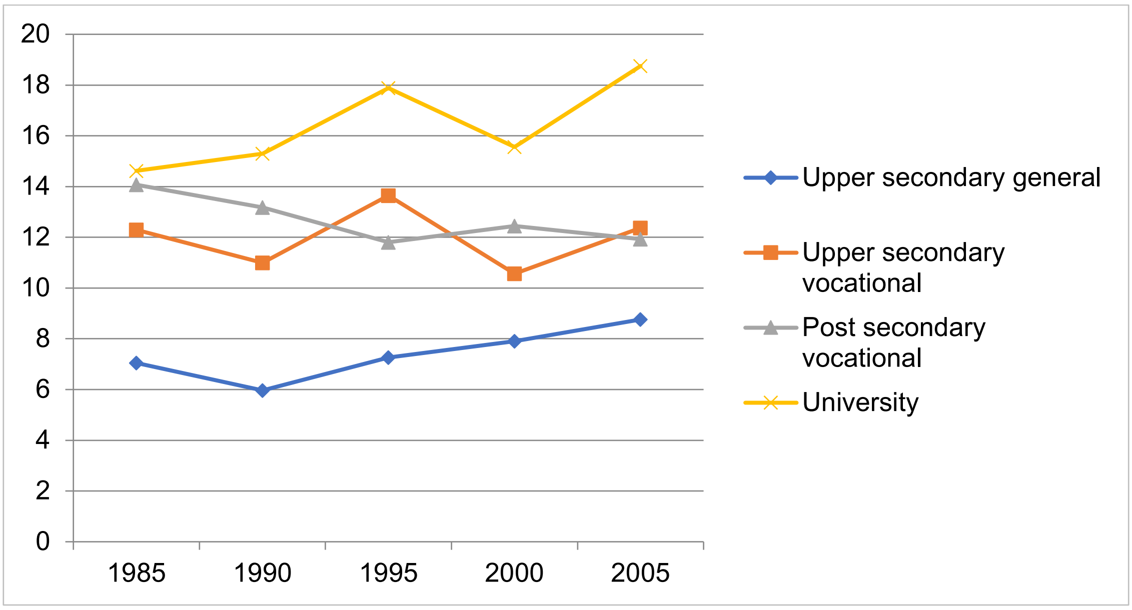
[45] According to the research conducted in 2013 by the Labor Market Research Division under the Department of Employment, MOL, approximately 8.95 and 14.16 percent of the students completing vocational certificate and diploma levels entered the labor market. The statistics do not match to those by OVEC.

[46] Among 17 colleges targeted, 12 colleges have more than 2,000 students and 4 colleges have 1,000-2,000 students.

3.1.2.3 Why do they continue to study?

The reasons of a significant portion of technical college graduates continuing to study are multiple, yet two major reasons are as follows: 1) demand by industry and students to seek for higher level of education and 2) lack of adequate skills of the graduates.

First of all, Thailand places a high value on diplomas, namely bachelor's degrees, as it is supported by a high enrolment rate in tertiary education for its income level, as mentioned in Chapter 2. In addition to the prestige it holds, having a bachelor's degree means a substantial difference in monetary aspect. The 2012 World Bank report presents the wage premium for tertiary education over secondary education is about 120% in Thailand, which is the highest level of the East Asia region and remains strong especially in manufacturing sector[47]. Private rate of return to tertiary education is still high, although the relative value is declining over the years, compared to those to upper and post-secondary vocational education (see Figure 19. Also see Senkrua, 2015[48]).



Source: Tangtipongkul, 2015[49]

Figure 19: Private Rate of Return by Level of Education (%)

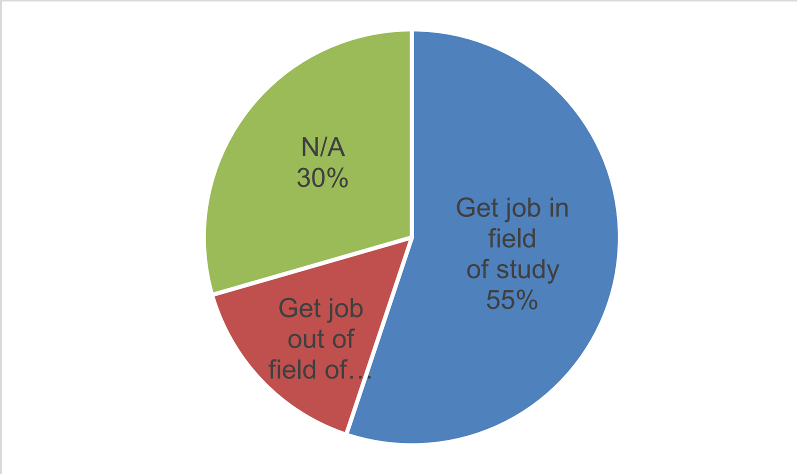
Our interviews confirm this finding. While some companies evaluate actual competencies over diploma type, many companies have an established human resource management system which differentiates technical college graduates from university graduates. They have a different salary scale and technical college graduates can often be promoted only up to the supervisor's level but not manager's level, which is reserved only for university graduates.

[47] Brixi, Hana Polackova

[48] Akkaya Senkrua (2015) *THE MISMATCH IN THAI LABOR MARKET: OVEREDUCATION*, A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy (Economics) School of Development Economics National Institute of Development Administration.

[49] Tangtipongkul, Kaewkwan (2015) "Rates of Return to Schooling in Thailand" in *Asian Development Review*, Vol. 32,No.2, pp. 38-64 C 2015 Asian Development Bank and Asian Development Bank Institute

Secondly, a reason that technical college graduates continue studies is that they are not equipped with the knowledge and skills employable by the private sector. The skills mismatch is a major issue and "the private sector demands higher levels of education to compensate for the inadequate skills of vocational graduates."[50] As shown in Table 11, 10% of technical college graduates are not employed. This is a significantly high rate when considering Thailand's overall unemployment rate is about 1%. Furthermore, among those who are employed, only half of them obtain a job in their field of study (see Figure 20).



Source: OVEC

Figure 20: Ratio of Those Working/Not working in their Field of Study Higher Vocational Certificate

Our survey of manufacturing companies finds that 38% of companies (61% of Japanese companies and 11% of Thai companies) did not employ any newly graduates of technical colleges in 2015. Interviewees under this mission explain that the companies have a policy not to employ newly graduates of technical colleges because they need to be re-trained for another two to three years and they quit easily, hence the investment cost is lost.

3.1.3 Challenges of technical and vocational education

The following section discusses the challenges of technical colleges concerning why the skills mismatch happens. In addition to poor performance of Thai youth in science and math and equity issue discussed in Chapter 2, improving TVET is one of the top priorities in the Thai education system. The 2015 UNCTAD report presents a rather critical view of the TVET system in Thailand, stating "the existing TVET system is no longer considered a major mechanism for training skilled workers and requires a major overhaul."[51] The Thai government has taken this external view seriously and responded with various policy measures: TEVT reform is one of them[52]. In this section, the challenges need to overcome in order to solve the skills mismatch are discussed based on the interviews and surveys conducted under this mission.

[50] UNCTAD (2015) *Science, Technology & Innovation Policy Review: Thailand*, United Nation. P.33
http://manpower.mol.go.th/pmanp_2014/index.php/home, https://pisathailand.ipst.ac.th/isbn-9786162028793/
[51] Ibid. P.83.
[52] Pichet Durongkaveroj (2015) *Science, Technology and Innovation Policies in Thailand: Achievements and Challenges* The 18th Annual Session of the United Nations Commission on Science and Technology for Development, May 6, 2015.

3.1.3.1 Lack of accountability

Autonomy and accountability are the key measures to improve the quality of education: Those who are in charge of educational institutes should be able to make decisions in educational administration and be accountable for the outcomes (For example, see Arcia et al (2010) and OECD (2011)[53]). However, currently, the administration of technical colleges is still very centralized: recruitment and deployment of teachers are centrally managed. Funding is based on cost-per-head subsidies, not performance based, from the central government, hence schools are incentivized by recruiting more students rather than improving the quality of education. The Thai government is promoting decentralization under the education reform, but its progress is slow.

The quality of technical colleges varies significantly. The interviewees of companies under this mission have commented that the quality of technical college graduates differs, from those who are comparable to the university graduates to those who cannot even conduct simple repair and cleaning. Their diplomas do not endorse the quality. One company mentioned that it does not even differentiate technical college graduates from high school graduates, since they do not see a difference in their skills. Currently, the quality enhancement of graduates depends on personal commitment and enthusiasm of each college director, which is difficult to sustain.

Improving the quality of education at all levels is a critical issue for the Thai education system, yet this is not a simple, easy task. The definition of quality of education can vary depending on which aspects are being considered and accordingly, the measurement of that quality aspect will change as well. Furthermore, measurement is criticized as often being subjective based on indefinable measurement such as individual perception. It is not in our scope of work to answer the questions above, but the system to hold its directors accountable for their graduates can be an effective means to ensure the quality of all technical colleges.

3.1.3.2 Weak monitoring and assessment system

The system to monitor and evaluate the quality of education needs to be strengthened. The appropriate assessment can be used for accountability. Thailand has laid out an extensive system to monitor and evaluate the quality of education, but its implementation is questionable and effectiveness is unclear. For example, all technical colleges have to conduct annual internal assessments according to eight standards. Each standard has a range of sub-standards meticulously described. Their self-assessments results are good: on average, they score themselves higher than four out on a scale from one to five. (see Table 12).

[53] Gustavo Arcia, Harry Patrinos, Emilio Porta, and Kevin Macdonald (2010), *School Autonomy and Accountability in Context: Application of Benchmarking Indicators in Selected European Countries*. The World Bank. http://siteresources.worldbank.org/EDUCATION/Resources/278200-1290520949227/7575842-1339186330807/SAA_Europe_Benchmarking_Note_Feb_7_June2012.pdf accessed on February 5, 2017.
OECD (2011) "School autonomy and accountability: Are they related to student performance?" in PISA in *FOCUS* 2011/9 (October) file:///C:/Users/atagi/Documents/JICA/Ref%20Doc/OECD%20sch%20autonomy%20and%20accountability.pdf accessed on February 5, 2017.

Table 12: Internal Assessment of Technical Colleges

Standards		Scale out of 5
Standard 1	Evaluation of students and graduates (% of students with Grade Point Average (GPA) of more than 2, % of students with V-net score, % of graduates who have jobs, etc.)	4.27
Standard 2	Evaluation of curriculum and teaching methods (quality of teacher's planning, teaching, training, etc.)	4.28
Standard 3	Evaluation of vocational education management (development of schools, management of database, development of teachers and personals etc.)	4.27
Standard 4	Evaluation of academic and vocational services (quality of academic and vocational services management)	4.28
Standard 5	Evaluation of innovation, invention, creative project and research (quality of innovation, invention, creative project and research management of teachers and students)	4.38
Standard 6	Evaluation of awareness building and promotion of Thai identity (quality of awareness management in environmental conservation and sufficient economy)	4.33
Standard 7	Evaluation of academic quality assurance (quality of internal quality assurance system etc.)	4.34
Standard 8	Evaluation of vocational training (quality of short-term vocational training, level of satisfaction of students who are trained, etc.)	4.50

Source: OVEC

For external assessment, the Office of National Education Standards and Quality Assurance (ONESQA) was established as an external agency for quality assurance under the educational reform. ONESQA has also developed extensive criteria related to quality, but its implementation methods still need to be improved. According to the evaluation of 2011-2015, almost all public technical colleges were rated excellent and good (412 out of 415 colleges) and only three schools were rated fair and not meeting the standards.

These results do not correspond to the actual situation presented by various studies and findings of this survey. Other quality indicators such as standardized test score and drop-out rate do not endorse it, either: In 2014, those students in industry-related majors scored only 42 out of 100 in general subjects and 37 on average in professional skills in V-NET[54]. The drop-out rate of technical college students is high. A survey by OVEC found that 64,773 students in vocational certificate and higher vocational certificate programs dropped out during 2009 and 2011, which was 28% of the total.[55] OVEC concluded that the reasons for dropping out are due to institutional factors such as inappropriate curriculum and lack of professionalism of teachers, in addition to those factors attributed to individual students (OVEC, 2013)[56].

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[54] NIETS (2014), *Annual report 2014*. NIETS. http://www.niets.or.th/uploads/content_pdf/pdf_1438068312.pdf

[55] The sampling of 353 schools (85% of the total of 416 schools) is used by the bureau of monitoring and evaluation under OVEC.

[56] OVEC (2013a), *Summary of implementation on vocational student dropout reduction project, fiscal year 2013*, http://www.vec.go.th/portals/30/tabid/1235/ArticleId/2224/2224.aspx

OVEC (2013b) *Analysis of Drop out, Operation manual for vocational student dropout reduction project, Bureau of monitoring and Evaluation*, Office of the Vocational Education Commission, bme.vec.go.th/portals/30/DOWNLOAD/1เล่ม.pdf

Furthermore, the monitoring and evaluation system can focus on enhancing the quality of education, rather than assuring it. For example, the ONESQA is an agency to assure the minimum quality of education, but not necessarily to enhance the excellence of education.

Also, various programs are undertaken to increase the quality of graduates by meeting the needs of industry. OVEC has implemented an internship program which almost 100% of students in industry-subject majors participate. The dual education program has been in place for almost ten years and currently 16% of students participate, and OVEC is trying to increase the number. However, these programs are not adequately monitored and evaluated. Its effectiveness is unknown and factors for improvement are unidentified.

3.1.3.3 Need for Professional Development of Teachers

Teachers are the key players for learning and the system to support their capacity building should be strengthened. According to international studies, weak capacity of teachers is a serious concern of TVET: The 2013 World Bank report points out that one of the key needs to improve TVET is capacity building of technical college teachers and the 2015 UNCTAD report concludes that the deteriorating quality of TVET is "as a result of a shortage of qualified teachers, poor teaching methods and insufficient investment."[57]

The survey team is hesitant to conclude anything about the quality of teachers since there is no tangible mechanism to monitor and assess teachers' quality in Thailand, as mentioned in the previous section.[58] In fact, the data of our extensive survey presents perplexing results. Our online survey of nearly 600 students shows very positive feedback on teachers: the overwhelming number of students, more than 90%, answer that their teachers not only show how to solve a problem, but also guide them how to identify, think and solve the problem and guide them as mentors[59] (see Table 13). However, our interviews of technical college alumni vary: Some have a positive memory of teachers, but others feel that their teaching quality was very poor. The observation of classroom teaching at some colleges under this mission shows that their teaching style is more chalk-and-talk, rather than inquiry-based: Teachers demonstrate experiment as the textbook prescribes, but they do not utilize the experiment to further develop students' thinking. These contradicting data indicates disparity in the quality of teachers.

Table 13: Students' Perception on Teachers' methods

Your teachers' teaching methods	Yes
He/she gives you a problem and explains how to solve the problem.	97%
He/she gives you an advice on how to think, identify a problem and solve it.	97%
He/she gives you an advice on how to choose your project or research topics.	91%

Furthermore, graduation rate is lowest among the levels of education: The graduation rate of vocational track students at upper secondary level is 79.4% while that of primary, lower secondary and general track at upper secondary school levels are 97.1%, 89.8% and 92.1%, respectively. Resource: OEC (2015), *Education Statistics 2015*, Office of Education Council. http://social.nesdb.go.th/SocialStat/StatSubDefault_Final.aspx?catid=4

57 UNCTAD, p.83

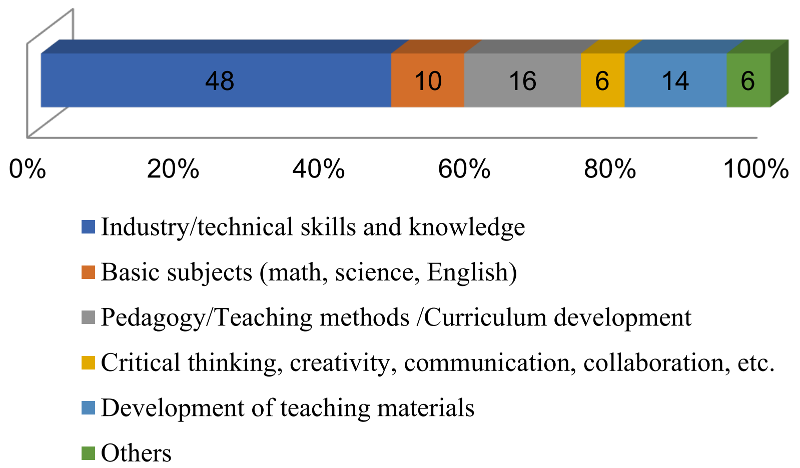
58 This is not only a case of Thailand, but also for many nations. See the discussion in OECD (2005) *"Teachers Matter: Attracting, Developing and Retaining Effective Teachers"*.

59 It is not clear if this reflects reality or students answer positively out of respect for teachers.

He/she advises you reference books or papers to deepen your understanding.	93%
He/she acts as your mentor.	95%

Source: Summarized by the survey team based on the results of online survey to technical colleges

Current teacher training focuses on technical skills and knowledge. Among the targeted colleges surveyed, the majority spends on average 50%, some colleges spend up to 70-80%, of teacher training on technical skills and knowledge. Training on teaching methods, developing curriculum and teaching materials are not considered top priorities for teacher training, with time spending ranging from 10-20% (see Figure 21). However, as mentioned in Chapter 2, technical skills are not the only skills expected for the graduates by the private sector. On the contrary, more generic skills such as critical thinking and problem solving are considered especially weak for the graduates. These skills are not transferable knowledge but can only be developed through good teaching practice and methods. More comprehensive and balanced teacher training is necessary to develop the capacity for developing these skills.



Source: Summarized by the survey team based on the results of online survey to technical colleges

Figure 21: Type of Teacher Training

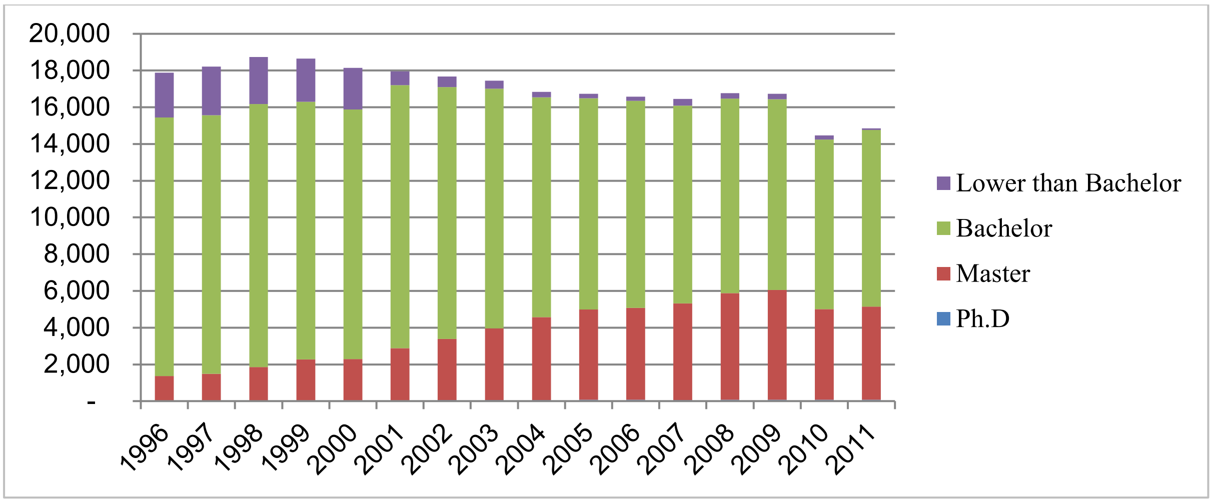
3.1.3.4 Institutional Constraints of Teachers

Other institutional constraints that prevent the quality of teachers at technical colleges include status and pay scale. Technical college cross-covers both upper secondary and higher education levels, but teachers are administered under the category of basic education and are not meant to be at the level of higher education institutes[60]. Technical college teachers' academic backgrounds are not as high as those at higher education institutes. Although their qualifications have considerably improved over the decades - the ratio of graduate degrees holders (Master's and Ph.D.) has increased from 8% in 1996 to 35% in 2011, this ratio is still much lower than those of higher education institutes, where more than 90% of faculties hold higher than bachelors' degrees[61] (see Figure 22).

[60] For example, Japanese KOSEN is considered as higher education institute and 90% of teachers hold higher than bachelor's degree (57% of Ph.D. and 32% of Master's).

[61] Currently, there are about 8,000 teachers with bachelor's degree, 7,000 with masters and 200 with Ph.D, according to OVEC.

Teachers at technical colleges are required to hold a teacher license and follow the salary scale of teachers under the teachers' civil service commission, which does not provide administrative flexibility like higher education institutes. In order to encourage professionalism in the teaching occupation, Thailand has adopted a teacher license system under the current educational reform, which requires a bachelor's degree and one year of teaching practicum, but it does not require working experience in industry for TVET teachers, unlike other countries. OVEC officials mentioned that three to five-year experience in a real industrial environment would be desirable, but newly recruited teachers do not have working experience. In our survey, 35% of technical colleges state that only less than 10% of teachers have working experience in industry. Conversely, those who have worked in industry cannot enter the teaching occupation since they usually do not have a teacher's license. OVEC is trying to solve this problem by sending the in-service teachers to industry for one month a year, but the number of participants is very limited - 700 to 1,000 teachers a year.



Source: OVEC, Information Technology and Vocational manpower center

Figure 22: Public Technical College Teachers by Level of Degree (1996-2011)

Another constraint is the government policy of downsizing the number of civil servants. This policy has resulted in off-setting the shortage of teachers by hiring short-term contractors. In 2013, there were about 25,000 teachers in the TVET system, but nearly half of them, 43% in public TVET schools, were employed on a short-term contract basis. These short-term contracted teachers do not enjoy the same welfare package as the government employed teachers and their starting salary is not necessarily equivalent to that of government employed teachers. Subsequently, those employed on a short-term basis do not have an incentive to stay in their posts, which leads to the shortage of teachers at schools. In our survey, 40% of teachers are contract-based on average, and quarter of technical colleges has less than 30% of government-employed teachers. Only half of technical colleges, 52%, responded that they have enough qualified teachers. The shortage of teachers leads to overloading teaching hours. OVEC's standard of teaching hours is 18 hours per week, but the interviewees of technical colleges state that teachers often teach as many as 30 hours per week, which risks the quality of teaching.

These institutional constraints have a negative impact on a future generation of technical college teachers. In regards to pre-service teacher training, faculty of industrial education takes a major role to produce technical subject teachers at technical colleges: Thailand Industrial Education Network (TIEN) which consists of ten faculties of industrial education, three from King Mongkut's University of Technology (KMUT) group and seven from Rajamangala University group, produces about 2,500 graduates every year (see Table 14)[62]. However, an executive of TIEN mentions that only 20-30% of the graduates have become teachers at technical colleges and among those who are newly recruited, half of them quit during the first two years of probation period. The reasons of high turnover rate are not clear, but the executive mentions that the current environment does not support them to stay: the recruitment system is centrally managed and the graduates are not ready to deal with the reality of technical colleges.

Table 14: List of industrial education related programs

University	Degree	Courses
KMUTT	Bachelor of Industrial Education	• Mechanical Engineering • Electrical Engineering • Civil Engineering • Industrial Engineering
KMUT North Bangkok (KMUTNB)	Bachelor of Industrial Education	• Mechanical Engineering • Electrical Engineering • Civil Engineering and Education • Computer Technology • Production and Industrial Engineering • Mechatronics Engineering
KMITL	Bachelor of Industrial Education	• Architecture • Interior Environment Design Education • Design Education • Engineering Education • Agricultural Education
RMUT Thanyaburi	Bachelor of Industrial Education	• Computer Engineering • Mechanical Engineering • Electrical Engineering • Civil Engineering • Electric and Telecommunication Engineering • Industrial Engineering
	Bachelor of Education	• Computer Education
RMUT Bangkok	Bachelor of Industrial Education	(1) Industrial Engineering (2) Mechanical Engineering
	Bachelor of Education	• Home Economics
RMUT Pranakorn	Bachelor of Industrial Education	• Mechanical Engineering • Electrical Engineering
RMUT Srivichai	Bachelor of Industrial Education	• Industrial Engineering • Electronic &Telecommunication Engineering • Mechatronics Engineering
RMUT Suvarnaphum	Bachelor of Industrial Education	• Mechanical Engineering • Electrical Engineering • Electronic &Telecommunication Engineering • Industrial Engineering
RMUT Isan	Bachelor of Industrial Education	• Industrial Engineering • Civil Engineering • Electrical Engineering

[62] Data surveyed by Dean Council of Education Faculties in Thailand, June 2016.

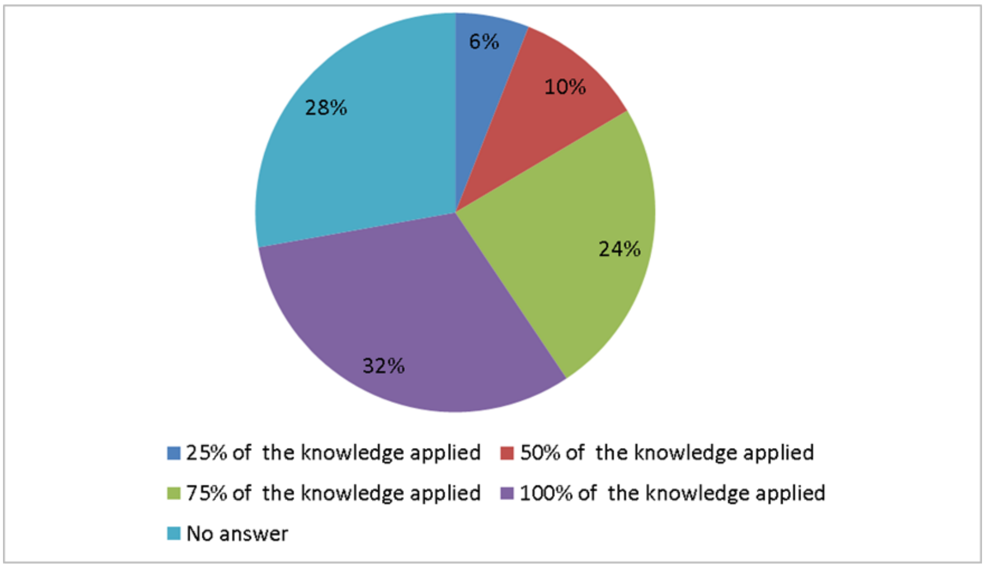
		• Electronic &Telecommunication Engineering • Welding Engineering • Computer Engineering • Mechanical Engineering
RMUT Lanna	Bachelor of Industrial Education	• Electronic &Telecommunication Engineering Education • Industrial Engineering Education • Electrical Engineering Education • Computer Engineering Education • Civil Engineering Education

Source: TIEN

In order to solve the issues, TIEN is trying to establish a set of standards for technical vocational teachers which is based on hands-on skills and industry engagement (Currently, one set of standards apply to all levels and types of teachers). Also, TIEN is developing curriculum for pre-service teachers which incorporates pedagogy in technical subjects and also divides one-year practicum at school into half at school and the other half at industry. TIEN's efforts should be coordinated with the related agencies such as OVEC and the Teachers' Council.

3.1.3.5 Curriculum Development Capacity

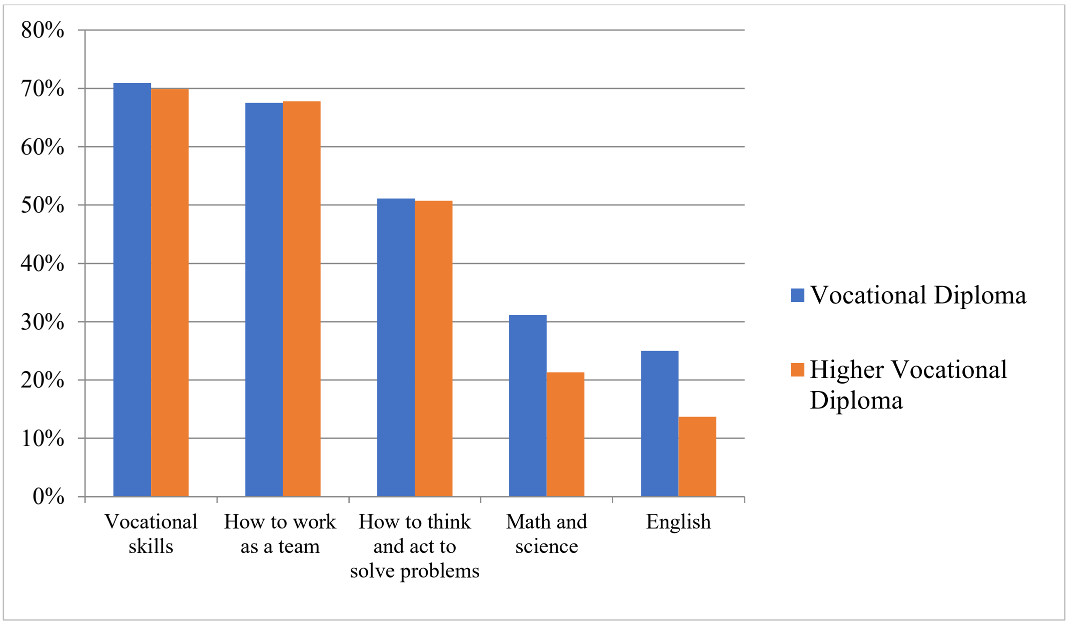
Technical colleges need to strengthen their links with industry in developing their curricula. Although our survey shows that 82% of technical colleges develop curriculum in collaboration with industry, three-quarters of them meet only once or twice a year and more in-depth collaboration is recommended. A study by OVEC shows that graduates of technical colleges do not fully utilize their knowledge at their workplace: While around half of them report that they utilize 75 to 100 % of the knowledge acquired at school, one third of them do not apply their knowledge in their workplace (see Figure 23).



Source: OVEC

Figure23: Percentage of knowledge applied in job of high vocational certificate student

While practical technical skill is the strength of technical college students, the private sector also demands other skills such as basic subject knowledge in math, science and English, and also problem-solving skills. The current curriculum prescribes about 70% to be spent on practice, and 30% on theory and a very small number of hours are allocated for basic subjects. Accordingly, the students are not confident in these areas: Our survey of students shows that about 70% of students are confident to acquire vocational skills and teamwork by the time they graduate. However, only 50% of them are confident in their problem- solving skills, 20% in science and math and 12% in English, respectively (See Figure 24). While the number of lesson hours is limited, there should be ways to improve other capabilities in addition to vocational skills.



Source: Summarized by the survey team based on the results of online survey to TC students

Figure 24: Students' level of confidence in skills

3.1.3.6 Weak Career Guidance

Reliable and appropriate information and guidance on the career path is missing in the TVET system. According to the 2012 World Bank report, "weak access to reliable information and formal support, along with a reliance on informal networks in making study and career choices are a common problem in developing countries with a proven adverse effect on the labor market" (p.26). Thailand needs to overcome this shortfall since this is one of the factors contributing to the gap between schools and industry in both quantity and quality.

Career counseling is not well placed in the system of TVET. Our interviews confirmed that there is a lack of job placement systems in schools, and an insufficient information network to promote career paths in technical fields. Thai youth needs appropriate guidance in finding jobs and also developing a vision for their career paths. According to the survey by OVEC, over 50% of those unemployed graduates of both vocational high school and technical colleges report that they need help in finding a job[63] (OVEC, 2012). OVEC's analysis of the factors to attract students into an appropriate vocational

[63] Among 89% of trackable graduates, 142 out of 271 students at upper secondary level and 365 out of 713 students of technical colleges reported that they need help.

track reports that the most effective means is to present a successful case of one of their graduates developing in their career paths, so that other students can develop a vision. Using public relations media and advice from teachers and seniors are also considered effective means to attract students to the vocational track.

3.1.3.7 Perception Gap between policy makers and directors of technical colleges

There is a significant perception gap between the central government and each individual technical college. While the policy makers and international organizations urge to upgrade the quality of TEVT, there is not much concern expressed by directors of technical colleges interviewed under this mission. They are concerned with outdated facilities, but not the quality of teaching. In regards to teachers, they state that they have enough qualified teachers and they compensate for the lack of working experience in industry by sending them to companies for training. In regards to students, the directors are more concerned about teaching them discipline rather than other skills and knowledge. They are not concerned with students obtaining a job, since they collaborate with industry through internships and the dual education system. When leadership are satisfied with the status quo and do not feel the urge to improve in the same way as policy makers, TVET reform will be very difficult.

This perception of directors is in line with some managers of small-sized auto-parts companies interviewed under this mission. Currently the Thai economy is still growing, and the managers do not feel their business is threatened at high risk. Small sized companies are happy with the current dual education system or internships since they can recruit good candidates while paying minimum wages and enjoying tax exemptions. What they expect of students are hands-on skills and more discipline such as being on time for work, being diligent at work and being responsible for completing the work.

However, policy makers feel that this is a short-term vision. The current situation may not last for a long-term and that is why policy makers are urging to overhaul TEVT. It is necessary to for directors to understand the long-term vision and close the perception gap for the national development.

3.1.4 Initiatives / Efforts by the Thai Government and the Private Sector

In order to improve the quality of TVET and its status, the Thai Government and also the private sector have been making vigorous efforts[64]. The major initiatives currently taken are summarized below.

1. Establishment of Pilot Model Schools
2. Work Integrated Learning
3. Competency-Based Standards Setting
4. Collaboration with International Agencies

These are not exclusive and are related to each other. Numerous initiatives are taken by both government and private sector at both national and international levels and some examples of each aspect are introduced in this section.

[64] OVEC has set the Ten TVET agenda for supporting TVET reform, and various programs have been implemented (See Annex 2). These three categories discussed here address the multiple agenda out of the Ten TVET agenda.

3.1.4.1 Establishment of Pilot Model Schools

In order to upgrade the social image of TVET and improve the quality of education, there are some pilot schools/colleges established to become a role model for other schools to follow. SBTC is one of them (see Box 1 for summary).

Box 1: Science-Based Technology College (SBTC)

SBTC are national vocational schools for gifted and talented students who have developed skills in innovation and technology. The teaching and learning of this project use a project-based approach. The aim of this approach is to develop these students to become technologists or innovators in the future.

The cabinet approved this program on December 18, 2007 and the Ministry of Education and the Ministry of Science Technology decided to launch the pilot program from 2008-2012. The first SBTC is Science Based Technology Vocational College (Chonburi) and they have expanded into the second phase since 2012 to the following colleges.

- Lamphun College of Agriculture and Technology (Agricultural Biotechnology)
- Suranaree Technical College (Science Based Industrial Technology)
- Singburi Vocational College (Food Technology)
- Phang-nga Technical College (Innovation in Tourism)

(Source: OVEC)

SBTC is currently offered at the upper secondary level. SBTC requires applicants in Grade 9 to have a GPA higher than 2.75, especially in science and math. They are tested through tests, short essays and interviews for competencies in science, math, and professional aptitudes. Those admitted enjoy a full scholarship, including tuition fees and living expenses. Their regular schedule is orderly, waking up at 5 am, being at school from 8 am to 4 pm, and working on a study project in the evening.

SBTC emphasize Project-Based Learning (PBL) as a method to apply knowledge for problem-solving experience. The students can consult tutors after school at an academic clinic and lecturers from nearby universities are invited to teach them. They have to complete 132 credits to graduate, in contrast to 103 credits in normal technical schools. Their cost-per-head government subsidy is high, 70,000 baht a year, compared to 6,500 baht for industry-related majors in the vocational track at the upper secondary school level.

The competition to enter is high. One school reported 43 out of 85 applicants were accepted and another school reported 80 students were accepted out of 150 students who had taken the test after they had been screened among 330 applicants.

The two SBTC colleges visited under this mission, which emphasize industry-related technology, present impressive outcomes. For both schools, all of the students advance to universities. The drop-out rate is zero, which is striking when the dropout rate of TVET colleges is about 30%. While SBTC has some challenges such as insufficient teachers specialized in science and math or PBL, lack of coordinators between SBTC and supporting universities, and insufficient PR to acknowledge the quality of their students, the principals of schools reported SBTC’s positive influence on the students in other courses. In 2015, about 200 students (about 80 at Suranaree and Chonburi in industry-related subjects) are studying at SBTC. Although the number is very limited, their successful outcomes are noteworthy.

The Vocational Chemical Engineering Practice College (V-ChePC) is another example of model school (see Box 2 for summary). V-ChePC is offered at two-year post-secondary school level, and requires the applicants the similar criteria to those of SBTC. They must have GPA, higher than 2.75, especially in science, math and English. They are tested for academic competencies, interviews and must write short essays. They all live at boarding school, enjoying full scholarships including all expenses covered. Their schedule is similar to that of SBTC and they practice a half an hour meditation in the morning and evening.

V-ChePC's teaching and learning is based on constructionism in which the students learn "how to learn" with the emphasis on using the project-based learning method in developing the students' transversal skills. V-ChePC is supported strongly by the six companies: The students have a chance for internship at the six companies, for which they get paid about 300 baht a day. Also their expenses, about 100,000 baht per head per year for the total of 80 students, are paid by the six companies. The total funding by the industry was 10 million baht a year for the initial stage of 6 years and currently stands at 8 million baht[65]. The competition is high as well: 40 out of 150 are accepted and only 30% of the students come from Rayong where the college is located and the remaining 70% come from all over Thailand.

The outcomes are impressive. No drop-out is reported, except for one with a health issue. All of the graduates acquire a job at the six companies. Their salary is rewarding: According to the principal, graduates who started at 13,000 to 18,000 baht a month salary a few years ago now earn about 60,000 baht a month at one of the six companies. UNESCO recognizes the program, saying that "measures of success are a high employment rate of graduates, several performance awards, and positive feedback from the industry." Further, UNESCO states that "this success is attributed to a combination of industry involvement and the application of constructionism in developing well-rounded graduates."[66]

These model schools are certainly benchmarking a successful case of TVET by becoming a driving force to improve the quality and changing the public image of TVET. Currently, the number of students enrolled is very small and it will be a challenge to extend the program at a national basis. For SBTC, all graduates advance to universities, which questions the purpose of TVET. V-ChePC is a great case of public private financing model, but if this model can be extended to other industrial sectors is an issue. However, these schools are noteworthy efforts by both the government and private sector.

Box 2: Vocational Chemical Engineering Practice College (V-ChePC)

V-ChePC was established in 2008 by six petrochemical companies, namely SCG Chemicals, PTT Global Chemical, UBE Group (Thailand), Dow Chemical Thailand, Star Petroleum Refinery and Thai Oil Refinery at the Map Ta Phut Technical College to prepare graduates with the qualifications, competencies and attributes required to work in the petroleum and petrochemical industry. V-ChePC is selected as a model for Thailand's specialized vocational education curriculum by the OVEC.

[65] PTIT Focus (2015) Vol.29, No.08, August.

[66] Ibid

3.1.4.2 Work Integrated Learning

Cooperation and partnership with industry are the key words to improve the quality of TVET. Various programs to improve TVET are being implemented in cooperation with the private sector such as dual education, internships, work-integrated learning, and cooperative education. In this section, dual education, internships and some model projects are introduced.

(1) Dual Education

Thailand has been implementing dual education for the last decade. The 2008 Vocational Education Act recognized dual education as one of the types of TVET. (See the summary of dual education in Box 3.) In 2015, 91,500 students were studying in the dual education system, which is about 15 % of the population in TVET, involving 10,527 companies. This ratio increased from 7% over the last few years and OVEC is trying to increase the ratio to 30%, about 130,000 students in 2016 and 154,500 students in 2017, increasing the number of companies involved to 18,000[67]. (Post Today, 2016) Currently, the private sector receives a 200% income tax deduction, and OVEC is trying to raise the ratio to 300%. In addition, twenty six public-private partnership committees have been set up in 26 industries to close the gap between demand and supply, in both quantity and quality.

Dual education is a good option for those who cannot afford the schooling fees, or more likely the opportunity cost of not working. They can continue to study while earning a small stipend and also, they have a good chance to obtain a post after completion of their study. Dual education in Thailand does not have a third party to coordinate, monitor and assure the quality, while, in Germany where the dual education model originated, the Chamber of Commerce plays a significant role as a coordinating and monitoring agency. One director of a big-size technical college interviewed mentions that dual education is beneficial only when a partnering company understands the educational purpose of dual education, otherwise students are simply considered as cheap labor. He only sends 5% of his students to dual education program. Furthermore, when the workplace is far from school, additional expenses such as transportation and accommodation occur which can limit the spending on quality improvement of the program. Also, communication between companies and schools can be limited to foster a close network and relationship to improve the effectiveness of the program. While quality assurance is still a significant challenge for dual education and its effectiveness should be examined in more details, this practical program should be supported to expand the opportunity for TVET and close the gap between schools and companies.

Box 3: Dual Education

The dual-vocational training program involves students participate in hands-on training in suitably selected companies. Educational institutions collaborate directly with public or private enterprises in drafting action plans and setting goals for students to meet. The program also enables the students to do field work while benefiting from an allowance to cover living expenses and compensation for their contributions made towards the company's income and profits as temporary employees.
(Source: OEC, 2016)

[67] Post Today, February 19, 2016. (in Thai) *Exhibition of Thai Dual Vocational Education*

(2) STI-WiL

STI-WiL is a pilot program of "school in factory" launched by STI, targeting the students at higher vocational diploma level and those at master's degree level. Students spend more than 90% of their time working in factory during daytime and site-lecturers who are either university lecturers or master students teach theory applied at work in the evening. Participating companies enjoy the tax exemption. The program started with 17 students with Michelin but the number of participating companies is increasing steadily and the program will expect 3,000 students within a couple of years. A noteworthy point of this program is that they target the disadvantaged students, while often this kind of pilot program targets elite students. The retention rate is high, only a handful of students drop out while usual turnover rate is 20-30%. STI states that the key factors of the program are the role of care-takers, not only academic and industry coordinators, but program managers who go between education institutes, industry and the government, and master students who act like "big brothers" for high school students. The program provides full room and board which is managed by residential administrators who are master students.

(3) Internships

Internships have been a widespread form of work integrated learning in TVET. Among those surveyed under this mission, all technical colleges except one have an internship program. The length of internship varies depending on the type of education (dual or normal) and also from school to school. In general, it ranges from two months to four months for normal vocational courses, and the students could receive 2-4 credits for a year. The theme of internship is decided by mutual agreement. The students have an opportunity to visit factories once or twice a year. Again, internship is considered as a good experience but its effectiveness is unknown. Monitoring and assessing the program should be developed to maximize the opportunity.

(4) Other Program: The Enjoy Science Project

Chevron is supporting "the Enjoy Science Project" which is a commitment of US $30 million for a 5-year public-private partnership to strengthen Thailand's competitiveness and innovation by improving STEM and vocational education across the country. Under this program, 6 TVET hubs will be established and 60 technical colleges will participate in the program benefitting over 100,000 TVET students, as well as teachers, principals, government officials and workers. (Kenan Institute Asia, 2015)

3.1.4.3. Competency-Based Standard Setting

Establishment of competency-based standards across education and occupation is being pursued to improve the quality of TVET. Thailand has developed the Thai Qualifications Framework for Higher Education (TQF: HEd), the Thai Qualifications Framework for Vocational Education (TQF: VEd), and the National Qualifications Framework (NQF), which were approved by the Cabinet in 2013 in order to prepare the Thai workforce to meet national and international standards of knowledge, skills and competencies and to promote the system of quality assurance. TPQI was established in 2011 under the Prime Minister's Office. TPQI is to set the competency-based standards of specific occupations. Twenty-three "industry skills" councils have been established for key economic sectors such as automotive, petrochemical and micro-electronics. Modeled after councils in the U.K. and Australia, these councils are comprised of representatives of the private sector, academic institutions and government agencies, and provide a forum to develop the competencies needed by industry.

Also, the DSD has its own standards for certain occupations. OVEC is trying to develop a curriculum to meet the standards of both agencies, so that graduates of technical schools and colleges would be automatically granted such standard certification. Currently, there are 11 colleges acting as pilot test sites for DSD and 13 colleges for TPQI, and the pilots were to be completed in 2016[68]. In the automotive sector, 19 colleges are joining with AHRDA and OVEC to roll-out a revised curriculum and facilitate engagement between the colleges and the private sector.

While the integration of the ASEAN economic community is advancing, identifying standards and competencies of occupations in the region has become an important topic of discussion. Thailand is now trying to prepare an ASEAN Qualifications Reference Framework (AQRF). AQRF is a regional common reference framework to enable comparisons of qualifications across ASEAN countries and also to promote life-long learning in the region.

Competency based curriculum in collaboration with TPQI is a good direction to assure quality of graduates. However, this effort has just started and not well known among the private sector. Our interviewees are skeptical of the value of such certificates since they may not be relevant to the business they conduct, yet they have to compensate for the cost. Currently, this effort is driven by the government, but in order for the system to work, the demand-side driven is a key word and involvement and commitment of private sector will be a challenge.

3.1.4.4 International Collaboration

International collaboration in TVET includes various activities such as student exchange, a study abroad program, teacher training, and technical assistance from overseas. While these activities are being carried out, a transfer of foreign education system models is being considered to strengthen TVET. Learning best practices from overseas and trying to meet international standards can be effective means to improve the quality of education. As mentioned before, dual education from Germany, “Career Academy” in the US and “KOSEN” in Japan are considered good models to help improve the quality of TVET (see the summary of KOSEN in Box 4).

[68] It is not clear how the standards of both agencies, DSD and TPQI, are complementing each other from the interviews under the mission. DSD has set 4 levels of standards, while TPQI has 7 levels. While DSD has developed National Skill Standards since 15 years ago covering 200 areas, a newly established TPQI covers a limited area. Their focus on skills seems to be different.

Box 4: KOSEN (National Institute of Technology)

KOSEN was established in 1962 to respond to an urgent demand from Japanese industry. KOSEN is an institute of higher education that nurtures leading future engineers through a practical 5-year program of integrated education following graduation from lower secondary school, by focusing on experimentation, demonstration, and hands-on practice.

Cultivating engineers in correspondence with the globalization of industry and higher education is a big issue for KOSEN. KOSEN is making efforts to enhance substantial activities such as English teaching, overseas internship programs, international exchange of students and staff, and technical cooperation. (Source: KOSEN)

OVEC has supported the exchange of students and teachers between KOSEN and SBTC. The initial stage of exchange was limited to individual KOSEN such as Nagano, Kumamoto, and Kisarazu, but OVEC has now signed a Minute of Understanding with KOSEN-KIKO, which is the central administer of the 51 KOSENs in Japan and plans to expand the exchanges. Three students (selected out of 10 applicants) from Suranaree SBTC are scheduled to study at a KOSEN for 4 years (including 1 year of Japanese language training) starting in 2016.

OVEC is considering a pilot program of establishing a Thailand-Japan Technical College, which would follow KOSEN standards. Since the mission of KOSEN is to foster creative practical technical engineers, the graduates of Thailand-Japan Technical College are expected to have Japanese technical standards with an understanding of Monozukuri (Innovation in Manufacturing) and Kaizen (practice of continuous improvement). Also, discipline and work ethics of the culture of Japanese industry are considered vital to learn. Furthermore, KOSEN is proud of its 100% employment rate (excluding those who continue to further studies) despite times of economic downturn. The know-how of career counseling is considered a great lesson for Thai technical colleges as well. In our survey, 72% of technical colleges consider KOSEN model is applicable to their schools.

While KOSEN model is being seriously considered for Thai technical colleges, it is very important to study the applicability in Thai context. Technical colleges in Thailand and KOSEN in Japan have very different background and it is not possible to establish a model to expect the same outcome of KOSEN. Short-term strategies for a long-term vision should be examined and close monitoring and evaluation system should be established.

3.2 Current Situation and Challenges faced by Universities

This section discusses the major issues faced by universities, especially in the science and technology fields, in regards to industrial human resource development. First, an overview of higher education is provided. Secondly, the current situation of universities is described, including the trend for less enrolment in science and technology and the failure of graduates from science and technology fields to enter the job market in their fields of study. Thirdly, the following challenges faced by universities that need to be overcome to solve the skills mismatch are discussed: 1) weak R&D capacity; 2) weak UILs; 3) disparities in the quality of universities; and 4) lack of career guidance. Lastly, the Thai government's initiatives and individual universities' efforts are introduced, namely 1) the establishment of an institutional mechanism; 2) the promotion of the mobilization of human resources and 3) the development of a work-integrated learning program.

3.2.1 Overview of Higher Education

HEIs in Thailand are administered by OHEC under the MOE. OHEC has mandates on formulating policy recommendations and higher education development plans, setting higher education standards in line with international standards, providing recommendations on a resource allocation framework for higher education development, and monitoring and evaluating the outcomes of higher education management.

There is a total of 156 institutions as of July 2015 and among them, at least 58 universities have a faculty of engineering[69]. HEIs are categorized based on their status as follows (see Table 15).

Table 15: Number of Higher Education Institutes by Status

Type of HEIs		Total Number	Number of Universities with Faculty of Engineering*
Public Universities	Autonomous University	19	14
	Public University	15	9
	Rajabhat Universities	38	5[70]
	Rajamangala Universities	9	9
Private Universities, Institutes, Colleges		75	21
TOTAL		156	58

Source: OHEC

* Not counting different campuses of the same university.

Currently, there are about 60,000 teachers and over 2 million students are involved in higher education institutions. 80% of them belong to public institutions and 40% of them are located in Bangkok.

The 2nd 15-year Long-range Plan for Higher Education (2008-2022) sets a goal of achieving a "higher quality Thai higher education system." Major expected outcomes of this plan are development of knowledge and innovation, as well as stronger linkages with industries that are critical for the country's global competitiveness and sustainable development. This plan categorizes higher education institutes into four groups to ensure that each institute can provide relevant excellence based on its nature and provide suitable human resources to best serve Thai economic development. The four groups are:

1) Research University/ Postgraduate University:
   In 2009, nine public universities were selected to become National Research Universities (NRUs) to develop strong research capabilities. These universities were Chiang Mai University, Chulalongkorn University (CU), Kasetsart University (KU), Khon Kaen University (KKU),

[69] Information as per the list of HEIs in OHEC's website http://www.mua.go.th/

[70] Rajabhat Universities, former teacher colleges, which account for half the number of public HEIs, have opened not only education-related courses, but also science and engineering courses. Most Rajabhat universities have engineering programs under their faculty of science or faculty of industrial technology. At present, at least five Rajabhat universities—Chaiyaphum, Thonburi, Mahasarakham, Udon Thani and Ubon Ratchathani—have a faculty of engineering.

KMUTT, Mahidol University (MU), Prince of Songkla University (PSU), SUT and Thammasat University (TU).

2) Science and Technology University/Specialized University/Comprehensive University:
   Main function: to transform academic knowledge into applicable knowledge to be utilized for industries for the betterment of production and economic development.
3) Four-Year University/ Liberal Arts University
   Main function: to promote community development and life-long learning.
4) Community College:
   Main function: to provide education at a level lower than a bachelor degree; focusing on agricultural development and development at the local authority level.

In this study, the focus is on the faculty of engineering at (1) Research University/Post Graduate University and (2) Science and Technology University/Specialized University/Comprehensive University, since they are closely related to the target of industrial human resource development.[71] In 2015, about 21,000 students graduated from the faculty of engineering, 38% from S&T universities and 31% from national research universities (NRUs) (see Table 16).

Table 16: Number of Graduates from Engineering Faculties in 2015

Categories	Bachelor	Masters	Doctoral	Total	%
National Research Universities (NRU)	4,873	1,595	107	6,575	31%
Other Public Universities	2,911	210	17	3,138	15%
S&T Universities, colleges, Institutes (including RMUTs)	7,696	385	46	8,127	38%
Private Universities, colleges, Institutes	3,304	129	6	3,439	16%
Total	18,784	2,319	176	21,279	100%

Source: OHEC

3.2.2 Current Situation of Universities

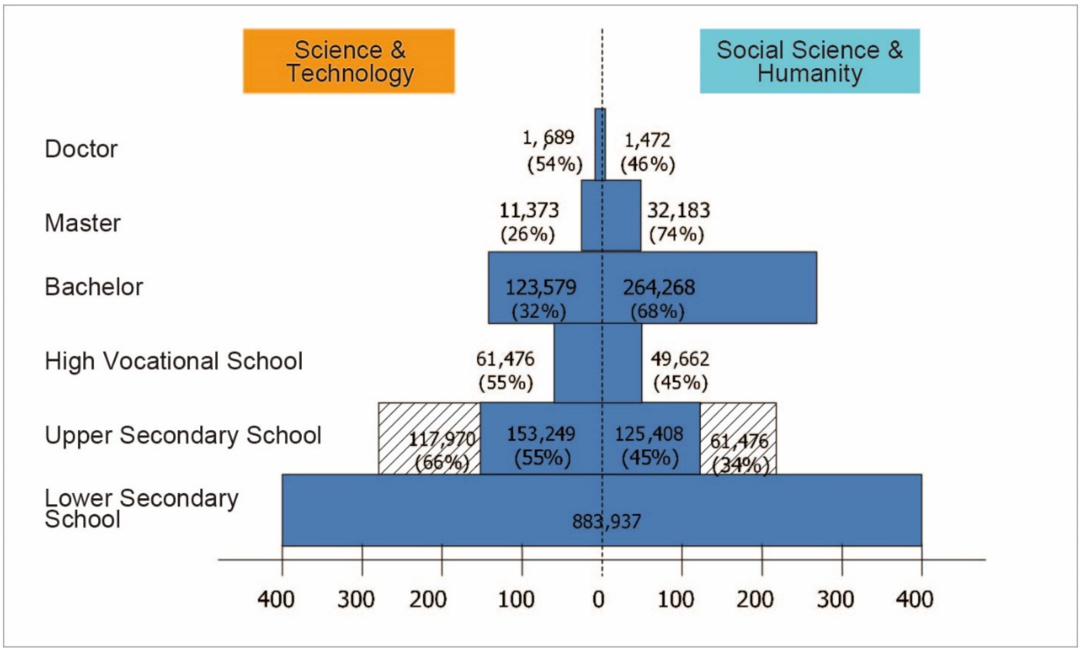
3.2.2.1 Lower enrolment in science and technology

The demand for university graduates in the engineering field is projected to increase, as mentioned in Chapter 2. In fact, the demand for university graduates is the highest among those with various levels of education by both STI and MOL projections. However, one concern is an insufficient number of students majoring in the science and technology fields. According to the STI report, only one-third of students in bachelor's degree programs major in science and technology, while the remaining two-thirds of students major in social sciences and humanities.

Our interviews find that there is a general perception that majoring in S&T means hard work and job prospects that might not be attractive enough to make up for the difficulties. While a relatively high percentage of students at the upper secondary education level, particularly in the vocational track, study

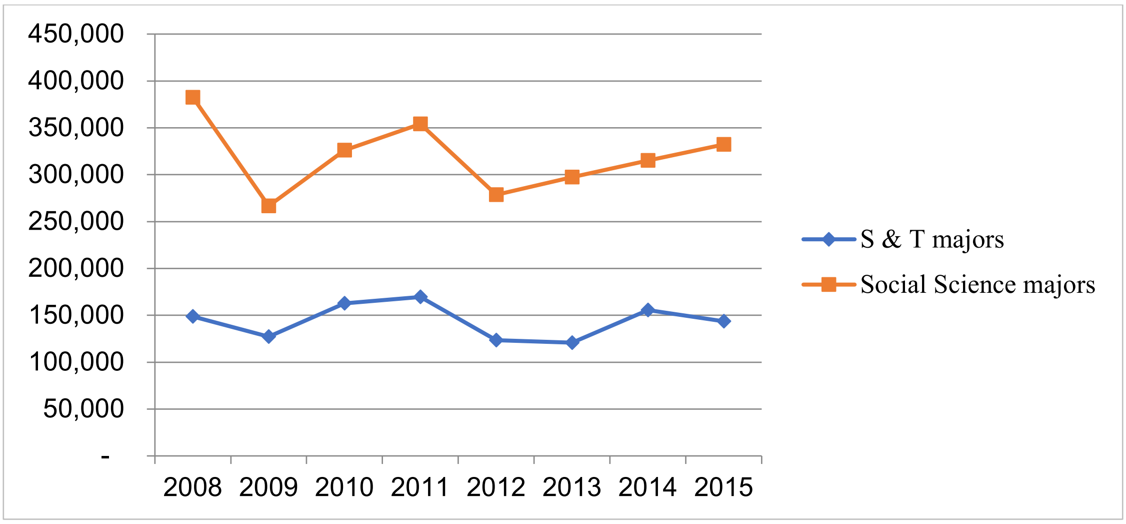
[71] Our survey has focused on the Faculty of Engineering of these universities, especially the departments related to mechanical engineering, and electric and electrical engineering.

in the science and technology fields, this trend to produce more social sciences and humanities majors at a higher education level does not meet the STI need of Thailand (see Figure 25).



Source: National Science Technology and Innovation Policy Office (2011)
Figure 25: Comparison of Enrollment in S&T vs. Social Sciences and Humanities

The 11th Higher Education Development Plan (2012-2016) promotes efforts to increase the number of students majoring in S&T fields. The target ratio of enrollment of S&T versus social sciences were set at a ratio of 40:60 in 2013, 50:50 in 2014 and 2015 and 60:40 in 2016. However, the outcome has been the same for the last decade and has not met the target, as shown in Figure 26.



Source: STI (2016b)
Figure 26: Number of Students Majoring in S&T vs. Social Science

Thailand has been successful in expanding access to higher education. By implementing various policies such as providing free 12-year education and upgrading various institutes to university status, enrolment dramatically increased over the last two decades, from 19.3% in 1997 to 51% in 2013. However, expanding access to higher education does not mean that Thailand is producing a larger S&T labor force. The number of S&T graduates and the number of engineering graduates have been gradually decreasing, as shown in Table 17.

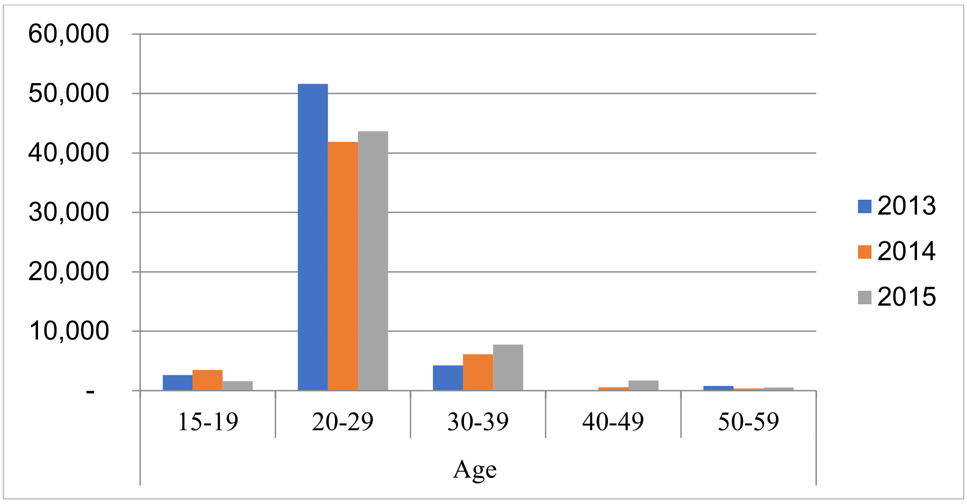
Table 17: Number of Engineering Graduates (Bachelor's degree level) 2008-2014

Year	2008	2009	2010	2011	2012	2014
Number of graduates in S&T fields	93,748	96,173	97,295	91,746	77,709	86,231
Number of graduates in engineering program	31,196	33,056	27,739	31,711	27,619	25,354

Source: STI (2016b)

3.2.2.2 Where do S&T graduates go?

S&T graduates are not entering the S&T labor market and its ratio is gradually increasing, as shown in Figure 27. According to STI statistics, only about 60% of engineering graduates work in S&T fields. So where do the rest of S&T graduates go? Continuing education is not a factor, unlike technical college graduates. Less than 10% of S&T graduates advance to higher levels of education. Although national statistics for paths taken after graduation are not available, some data presents serious concerns for the career path for S&T university graduates. The first one is the high unemployment rate. While the high unemployment rate of youth is a global concern (see ILO, 2016)[72], Thailand also faces this issue. Unemployment of S&T graduates in the age group of 20-29 is significantly higher than any other age group (see Figure 27).



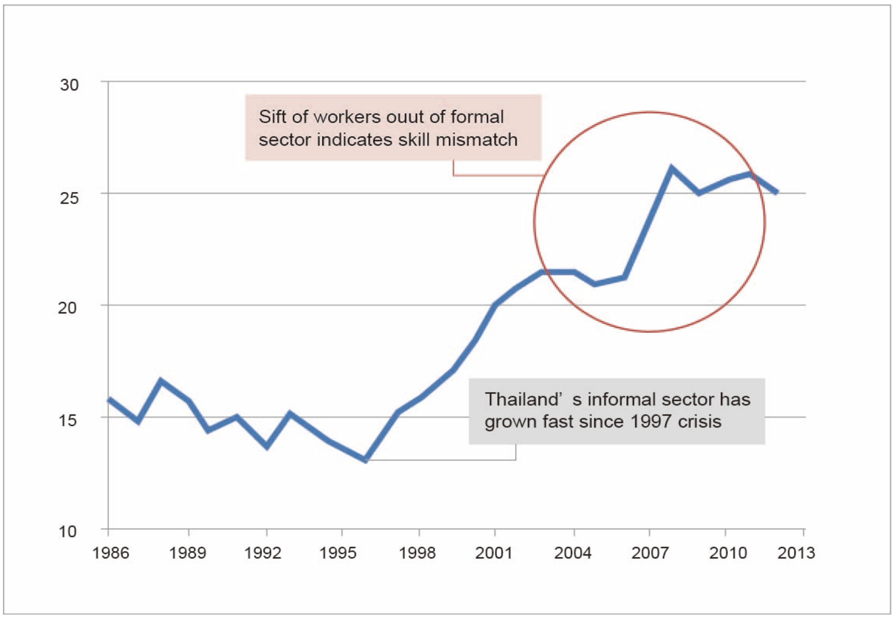
Source: STI (2016b)

Figure 27: Unemployed and graduates in S&T (2013-2015)

Our survey supports this data: 34% of companies in our survey (47% of Japanese companies and 20% of Thai companies) did not employ any new S&T graduates in 2015. Some companies have a policy not to employ any new graduates since they are not immediately useful and need to be trained for a

[72] ILO, 2016

couple of years, but they quit easily (see Annex 8). The 2015 Economic Intelligence Center (EIC) survey reveals that an increasing number of university graduates have been entering the informal labor market since 2004[73]. The informal labor market means self-employed, unpaid family workers and businesses with less than five workers, which is considered less stable, with lower pay and benefits, compared to the formal sector. EIC's assumption is that an increasing number of university graduates are simply unable to find satisfactory jobs in the formal-sector market (see Figure 28).

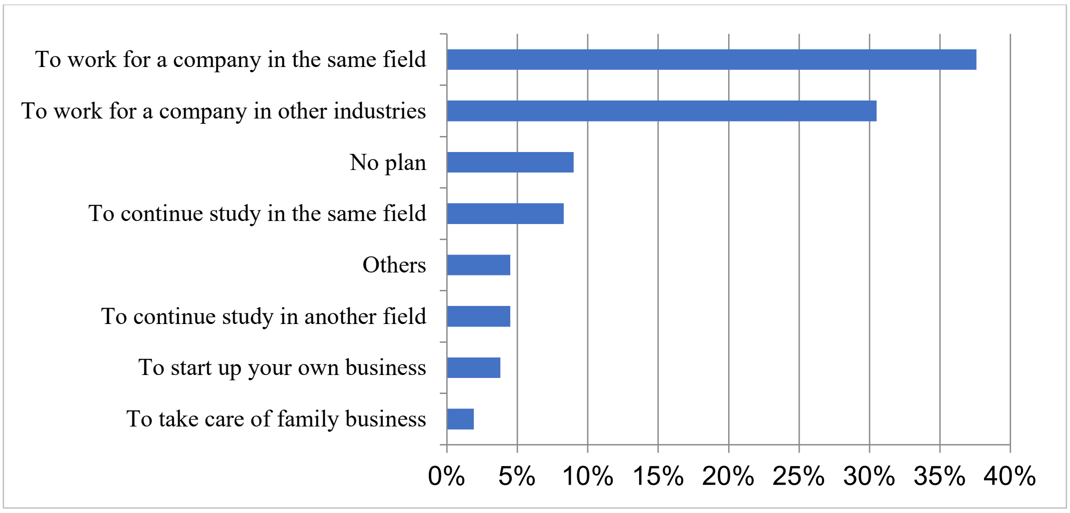


Source: Adopted from EIC (2015)

Figure 28: Share of Informal Employment (% of university-educated labor force)

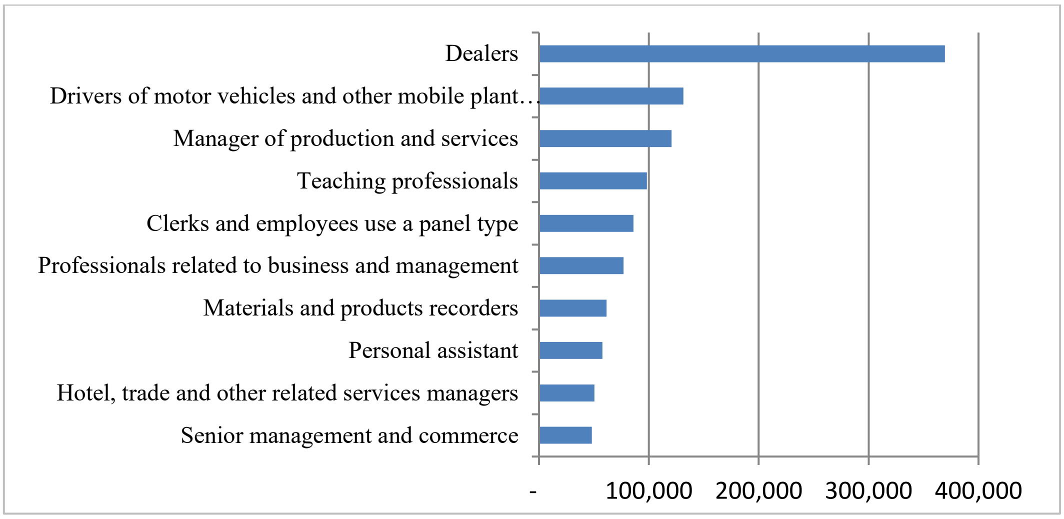
Another concern is that S&T majors are not prepared to work in S&T fields. Our survey of university students shows a trend in which a substantial number of engineering students are not planning to work in their field of study. While 38% of them plan to work in their fields of study, 31% of them plan to work in different fields. Nine per cent of them have no plan (see Figure 29). Among those who do not enter S&T labor market, sales is the top occupation, accounting for 25% of non S&T fields (see Figure 30).

[73] Economic Intelligence Center (EIC) (2015), Bridging Thailand's Labor Gap, SCB.



Source: Summarized by the survey team based on the results of an online survey given to university students

Figure 29: Engineering students plans after graduation



Source: STI (2016b)

Figure 30: Non-S&T occupations of S&T graduates

3.2.3 Challenges faced by Universities

There are many reasons that S&T university graduates are not entering S&T labor market, but a major issue is the insufficient skills of the university graduates. The university graduates are not equipped with the skills expected by the private sector. In our survey, 35% of companies (56% of Japanese companies and 12.5% of Thai companies) perceive the quality of production engineers to be insufficient and 37% of companies (67% of Japanese companies and 14.3% of Thai companies) perceive the quality of R&D engineers to be insufficient (see Annex 8). The major reasons causing the skills mismatch are as follows: 1) weak R&D capacity; 2) weak UILs; 3) disparities in the quality of universities and 4) lack of career guidance.

3.2.3.1 Weak R&D capacity in Thailand

Research capacity in Thailand has been weak, and higher education institutes are supposed to play a significant role in redressing this issue. However, Thai universities account for only 30% of total research expenditure and only 20% of academics conduct research continually[74]. The quality of higher education, as measured by the Global Competitiveness Report, ranks Thailand at 62nd out of 138 countries, far below neighboring countries such as Singapore (1st), Malaysia (18th), Indonesia (39th), and the Philippines (53rd)[75]. Also, Thailand ranks 47th out of 61 countries in terms of scientific infrastructure competitiveness, according to the 2016 International Institute for Management Development (IMD) report of world competitiveness ranking. The low ranking of scientific infrastructure is a result of low expenditure on R&D per GDP (51st), R&D personnel per capita (49th), patent application per capita (52nd), adequate enforcement of intellectual property rights (46th), and level of scientific research (45th)[76].

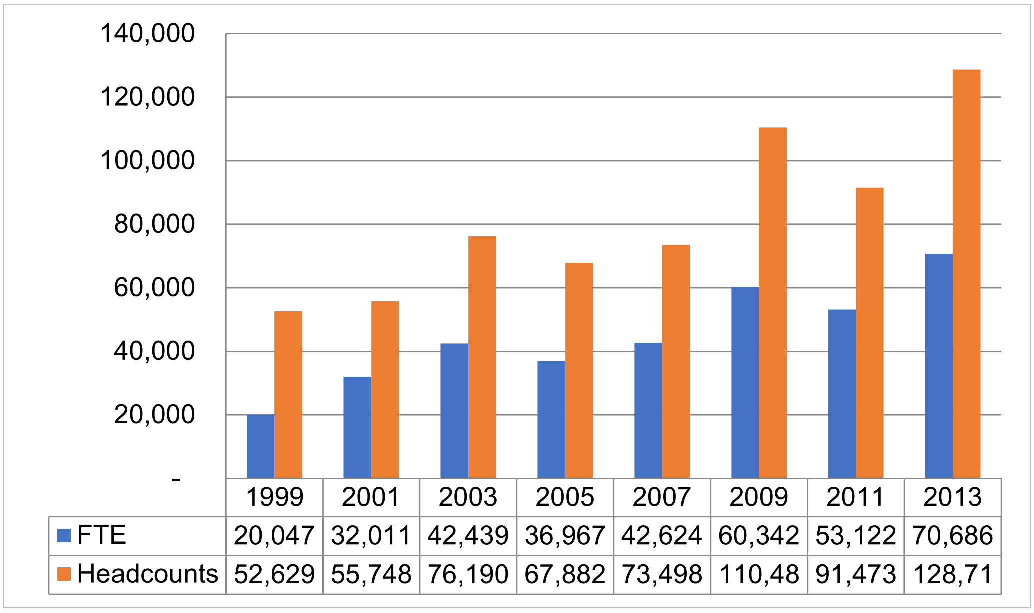
Thailand has substantially increased R&D investment and personnel over the decade, but the figures are still very low: R&D personnel has doubled from 53,000 persons in 1999 to 130,000 in 2013 and the number of full-time equivalent (FTE) employees have more than tripled from 20,000 persons in 1999 to 71,000 in 2013 (see Figure 31). Also, gross expenditure in research development (GERD) of GDP has doubled from 0.24% in 2002 to 0.48% in 2014 (see Figure 32). However, total R&D personnel nationwide per capita for FTE is 12.9 per 10,000 persons, which is much lower compared to 24.5 in Malaysia, 70.5 in Japan, and 77.8 in Singapore. Also, R&D expenditure and GERD of GDP is still much lower than 1.26% in Malaysia, 3.59% in Japan and 2.2% in Singapore in 2014 (see Table 18). The Thai government set the target to increase STI investment to 2% of GDP and R&D personnel to 25 persons per 10,000 persons in 2021[77]. Although the increase in R&D investment and personnel is significant over the last five years, the target seems ambitious.

[74] The World Bank (2012), *Putting Higher Education to Work Skills and Research for Growth in East Asia*, World Bank East Asia and Pacific Regional Report. World Bank.

[75] World Economic Forum (2016)

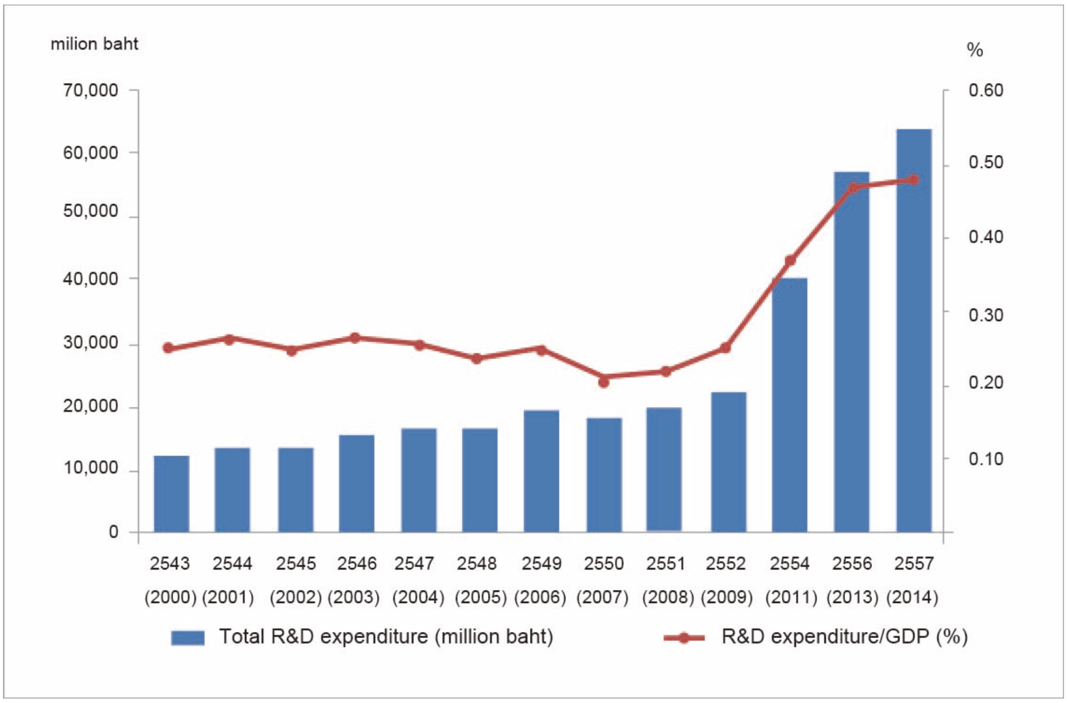
[76] International Institute for Management Development (IMD) (2016), *The World Competitiveness Yearbook 2016*.

[77] Durongkaveroj, Pichet (2014) *Thailand's Science, Technology and Innovation Policy and Institutional Framework* UNCTAD MULTI-YEAR EXPERT MEETING, Innovation for Productive Capacity-building and Sustainable Development: Policy Frameworks, Instruments and Key Capabilities, 19 -21 March 2014



Source: STI (2016b)

Figure 31: R&D Personnel (FTE and Headcount) 1999-2013



Source: Adopted from STI (2016b), p.109

Figure 32: R&D Investment (2000-2014)

Table 18: Comparison of R&D Capacity (2014)

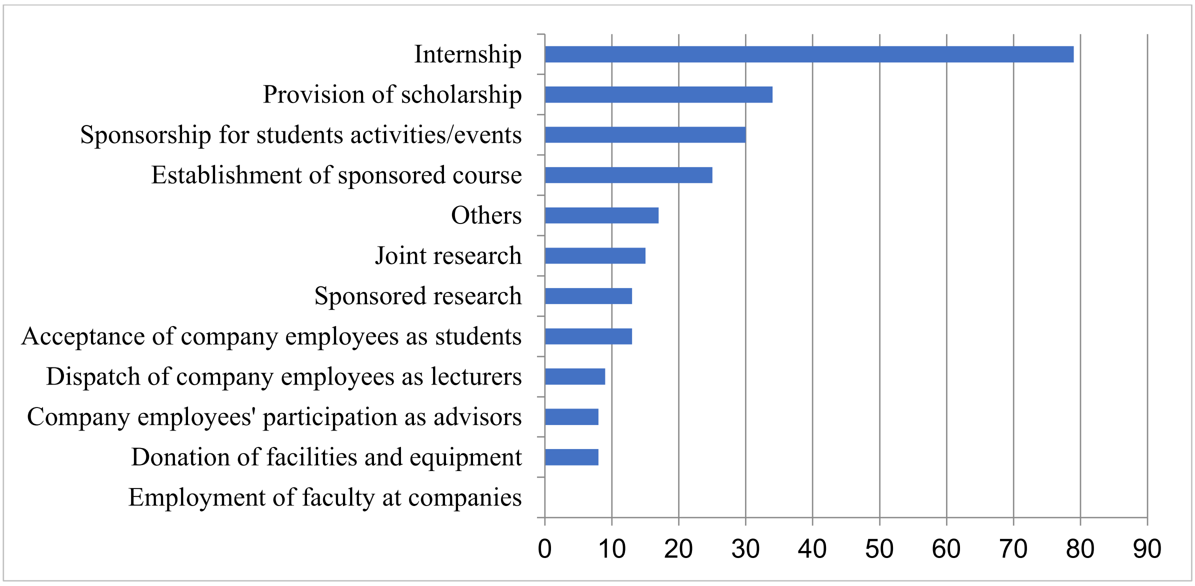
	Thailand	Japan	Malaysia	Singapore
R&D personnel per capita /10,000 (person)	12.9	70.5	24.5	77.8
Gross expenditure in research development of GDP	0.48%	3.59%	1.26%	2.2%

Source: STI (2016b)

3.2.3.2 Weak University Industry Linkages (UILs)

One of the major reasons for the skill mismatch for university graduates is a weak linkage between university and industry. UILs can play a significant role in the nation's economic development when the private sector benefits from technologies and innovations as well as highly skilled human resources provided by higher education institutes. Also, through active UILs, universities could identify the skills needed by industry, develop the capacity of teachers and update the curriculum. Despite this, Thailand's UILs are still at an initial stage of development. Its linkage mechanisms have begun to be institutionalized over the last decade and progress varies among institutions.

UILs cover a broad range of activities which could be categorized in the following levels: 1) training and education-related activities; 2) the provision of services and other consulting activities and; 3) research-related activities, which show the levels of progress in that order (see Schiller and Brimble, 2009 and Guimon, 2013)[78]. In our survey, the efforts for linkage are limited in the first category of training and education-related activities such as internships, provision of scholarships and sponsorship of student activities (see Figure 33).



Source: Summarized by the survey team based on the results of online survey to companies

Figure 33: Mode of UILs (%)

This pattern is also confirmed by the 2015 STI survey, which shows only 26% of the surveyed firms have some collaboration activities with universities. The main mode of collaboration is internships for students, which accounts for 17% of the firms' activities[79].

Thailand's UILs in research and development has been very limited. In comparison to other member countries in ASEAN, Thai universities place themselves only in the middle range of activeness in R&D with private sectors, as shown in Figure 34.

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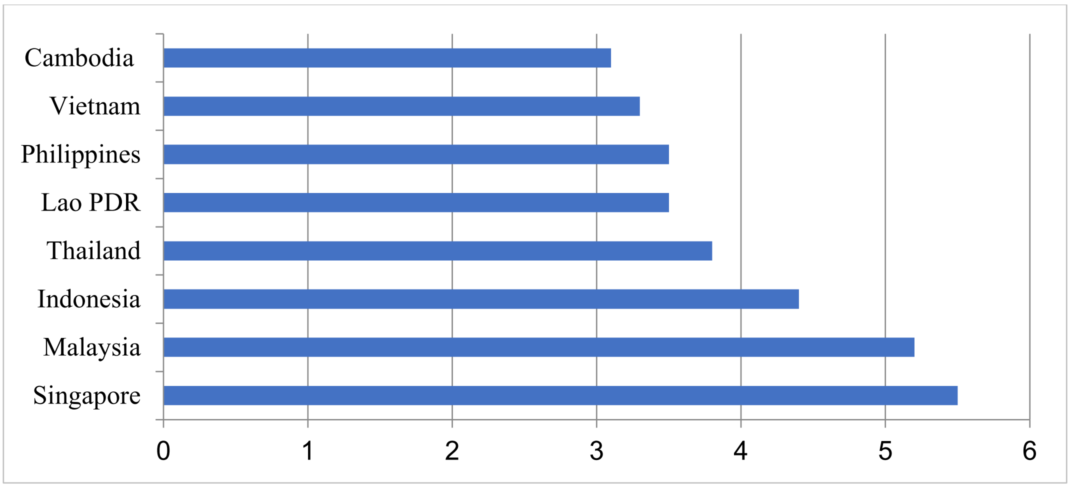
[78] Schiller, Daniel and Brimble, Peter *(2009) Capacity Building for University–Industry Linkages in Developing Countries: The Case of the Thai Higher Education Development Project*1, *Science, Technology & Society 14:1 (2009): 59–92.* SAGE Publications Los Angeles/London

Guimon, Jose (2013) Promoting University Industry Collaboration in Developing Countries. Policy Brief, World Bank.

[79] Kitipongwatana, Arum, Kaweekijmanee, Kittisak, Wiarachai, Oraphan and Kosseyaporn, Poolsak (2016) *An Empirical Study of Policy Implementation of Thailand Talent Mobility Programme*. STI



Source: IMD (2016), World Competitive Index 2016-2017
Note: The score is rated out of a seven point scale.
Figure 34: University-Industry Research Collaboration

Universities in Thailand have traditionally focused on teaching and there is little interest on either side in collaborating in R&D to commercialize the technology. Thai universities have not focused on contributing to the nation's economic development, at least directly. Faculties are evaluated based on the number of students educated and research papers published, but their collaboration with the private sector has not been established as a criterion for promotion. Accordingly, there is little incentive to be actively involved in the private sector. Consulting services and technical assistance to the private sector have been given on more informal personal basis since it does not contribute to their academic credentials, but only provides an honorarium. Joint research has not been active, since publication on joint research is difficult due to confidentiality issues and often the nature of the topic of research.

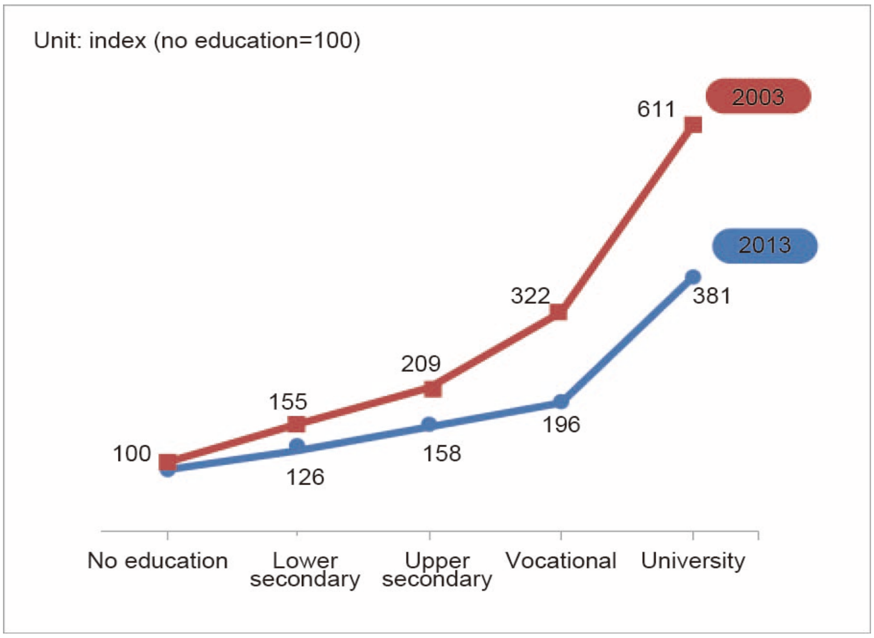
Also the needs of the private sector may not necessarily provide research issues that are of interest to the faculty. Furthermore, interviewees mention that there are cultural differences between universities and the private sector: while faculty pursues excellence of research, the private sector wants a practical application of the research. Also, faculty have other responsibilities such as teaching, and university bureaucracies take much longer than the private sector expects, while the private sector wants quick action.

On the other hand, the private sector has not approached universities for help with innovation either. Many SMEs do not have the personnel and financial resources to ask universities for help with innovation and often they do not even know the technological needs of their own business. Larger companies prefer to establish an internal R&D unit due to lack of confidence in the R&D capacity at Thai universities, a desire to avoid the bureaucratic process, confidentiality issues, and above all, the absence of a systematic channel linking university and industry.

The Thai government has implemented various programs to promote UILs: OHEC has started University Business Incubator (UBI) program in 2004 and the Technology Licensing Office (TLO) programs in 2007. NSTDA hosts national and regional science parks and also implement programs to promote human resource mobility among research institutes, universities and the private sector. While these programs are growing, they are still at an initial stage and progress varies among institutes. These programs are discussed later in this section.

3.2.3.3 Disparity among universities

Another concern with the skills mismatch in university graduates is disparity among universities. According to the government policy of expanding access to higher education, the number of universities was more than doubled over the decade, from 40 institutes in 1997 to 107 institutes in 2007 and the enrolment was also doubled from 23% to 51% over the same period. Although the private rate of return still remains higher for university graduates, their value has been declining over the years. In 2003, their wage premium is six times higher than non-skilled workers, but the premium went down nearly half in 2013 (see Figure 35). In our interviews, some companies have commented on the deteriorating quality of university graduates, and this perception can be due to a disparity in the quality of education among the universities that were increased so rapidly.

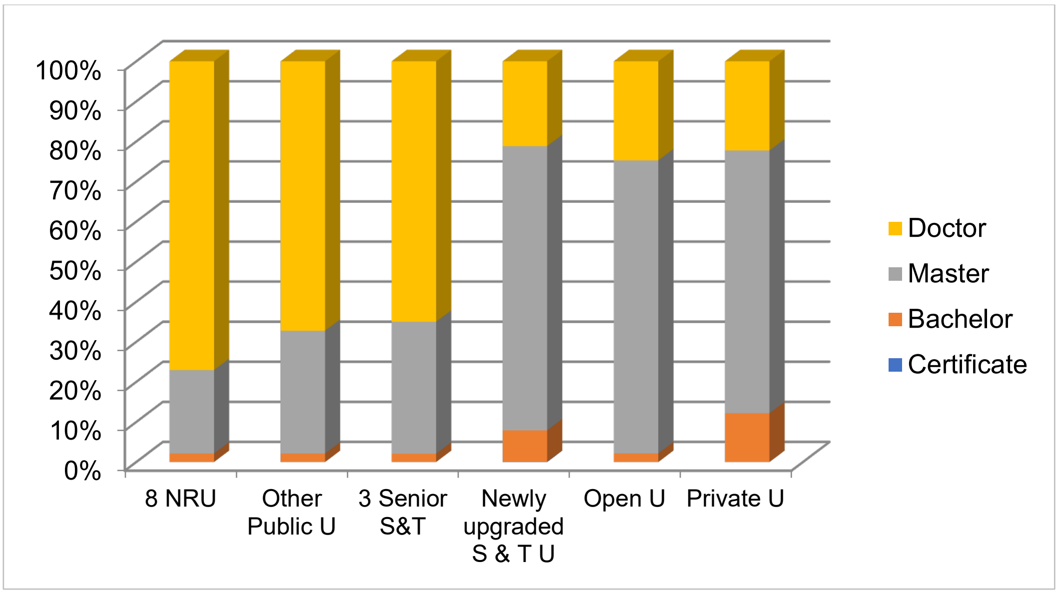


Source: Adopted from EIC (2015), p.14

Figure 35: Declining value of university graduates

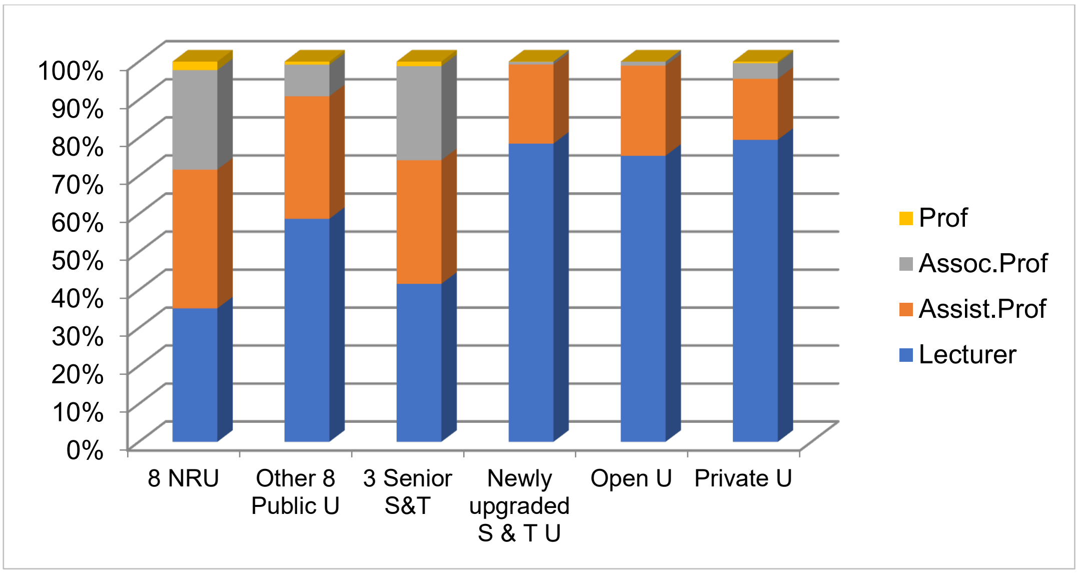
The quality of universities varies, with most of the better institutes concentrated in big cities, including Bangkok[80]. For example, indicators such as status and the academic background of faculty members are very different. 70 to 80% of faculties of NRUs and some S&T universities hold doctoral degrees, but only about 20-25% of instructors in new university groups and other open and private universities hold doctoral degrees. More than half of the faculty of NRUs (65%) hold professorships, but only about 20% of new university groups and private universities hold professorships (see Figure 36 and Figure 37).Also, the level of incoming students' academic achievement varies. The lowest score of admitted entrants at NRU's faculty of engineering is much higher than the highest score of the entrants of some newly upgraded S&T universities (see Figure 38).

[80] UNCTAD (2015)



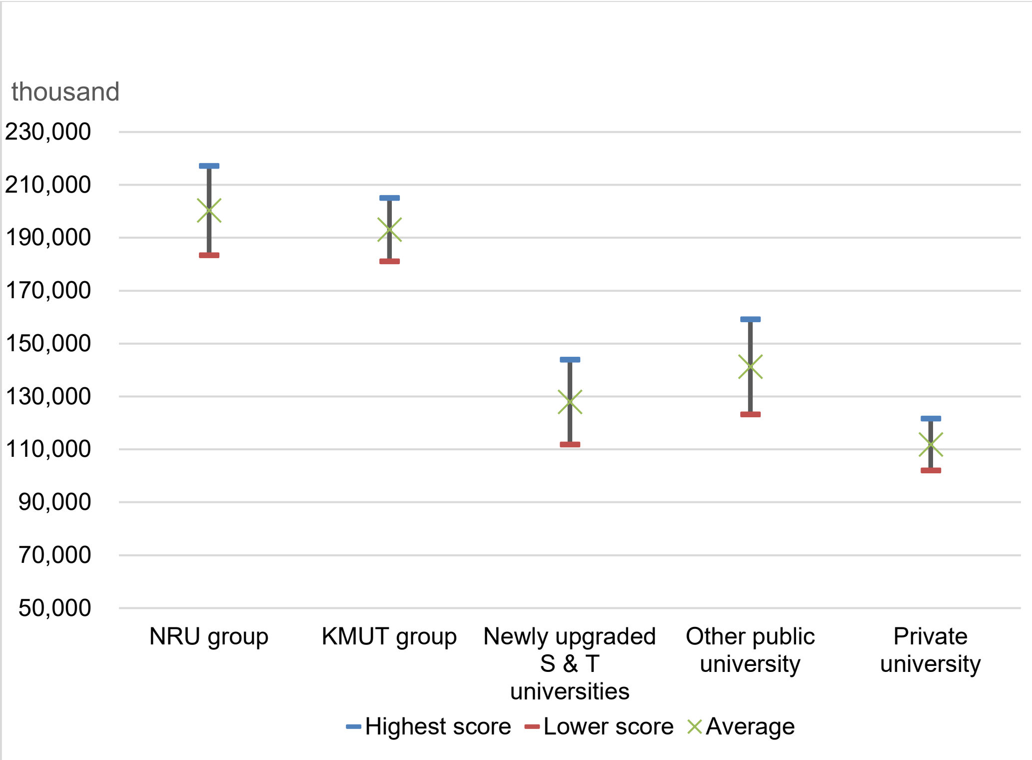
Source: OHEC

Figure 36: Ratio of academic background of faculties by degrees (2015)



Source: OHEC

Figure 37: Ratio of professorship (2015)



Source: OHEC

Figure 38: Entrance exam results in faculty of engineering

Table 19 shows the top ten organizations in Thailand that produce scientific and technological publications and the number of times cited per publication. These universities are dominant in R&D in S&T. In regards to the number of applications and granted patents, eleven universities, nine NRUs and two other KMUTNB and KMITL account for 68% of patents application and 66% of patents granted by all universities in Thailand (see Table 20).

Table 19: Top 10 organizations in terms of S&T publications and the number of times cited

	MU	CU	CM	KK	KU	PSU	PCM	NSTDA	SUT	KMUTT
Number of scientific and technological publications	1,230	1,161	680	570	523	472	466	368	265	240
Number of times cited per publication	0.80	0.74	0.46	0.47	0.37	0.47	0.67	0.66	0.54	0.40

Note: MU=Mahidol Univ. CU=Chulalongkorn Univ. CM=Chiang Mai Univ. KK=Khon Kaen Univ. KU=Kasetsart Univ. PSU=Prince of Songkla Univ. PCM=Phramongkutklao College of Medicine

Source: STI (2016b)

Table 20: Patent applications and patents granted: Accumulated over 2007-2014

	CU	KK	TU	CM	MU	KM UTT	KU	SUT	PSU	KM UT NB	KMI TL	% to the Total
Patent application	321	302	211	167	144	133	117	106	106	102	35	68%
Granted patents	35	53	6	3	12	18	21	10	0	22	21	66%

Source: Department of Intellectual Property and STI (2016b)

3.2.3.4 Lack of Career Guidance

Thai HEIs are weak in linking their students to employment opportunities. Universities do not traditionally take care of students' employment and they do not have the mindset that they are responsible for tracking job demand, providing counseling and getting feedback on their graduates. Accordingly, there is no systematic channel for students to obtain information on needed skills and potential jobs. In principle, the task of finding a job is largely left to the students and they face problems such as "a lack of practical experience, qualifications, and information about potential jobs and how to find one."[81]. As shown in Figure 27, the unemployment rate for the age group 20-29 is the highest. In addition to inadequate skills, they do not have access to the necessary information. In our survey, while most students have chosen the engineering field because it offers the prospect of becoming engineers, they struggle to find a job in the formal sector, as one would expect.

The 2016 ILO study finds that there is a definite shift from traditional recruitment practices to new media: 92% of Fortune 500 companies use social media platform such as LinkedIn, Facebook and Twitters for advertisement of job vacancies as well as conventional recruitment practices. These online platforms provide an inexpensive and effective way for both employers and applicants to reach a wider audience and selection. This trend is also growing rapidly in ASEAN communities: 54.7% of firms use online recruitment websites, which is the most popular approach, and 37.2% of firms use social media. In Thailand, more than half of students still use a traditional approach, such as contacts among family and friends. This approach is used most, followed by online recruitment websites and social media. Less than 30% of students use contacts at universities[82].

3.2.4 Initiatives/Efforts by the Thai Government, Universities and the Private Sector

Various programs are undertaken by the Thai government and individual universities in collaboration with the private sector. These programs aim at strengthening R&D capabilities, developing a network among universities, research institutes and the private sector, and meeting the needs of the private sector so that they can contribute to the nation's economic development. All these programs aim at promoting UILs, and some examples are discussed in the following categories: 1) the establishment of an institutional mechanism; 2) the promotion of the mobilization of human resources and 3) the development of a work-integrated learning program (WiL).

[81] World Bank (2012)
[82] ILO (2016)

3.2.4.1 Establishing an institutional mechanism

One of the obstacles in promoting UILs is a lack of institutional mechanisms to link academic institutes and the private sector. A common practice is to depend on personal contacts, which is limited and not sustainable. The Thai government initiated various programs to institutionalize the mechanism for UILs, and some examples are science parks, business incubator programs and technology licensing offices.

Science Park Thailand (SPT) was established in 2002, with the mission of promoting innovation development and R&D activities in the private sector. TSP is administered by NSTDA, hosting four national research centers with 2,000 full-time researchers, and over 70 corporate tenants, of which 30 percent are international companies. In order to spread this function to other regions, TSP established four regional science parks networks, namely Northern Science Parks Network at Chiang Mai University, North-eastern Science Parks Network at Kohn Kaen University, Eastern Science Parks Network at Burapha University, and Southern Science Parks Network at Prince of Songkla University in 2013. The Northern Science Parks Network that was visited has achieved impressive results, including establishing 39 R&D units in firms, serving 2,773 SMEs (of which 215 companies are repeated customers), and also providing technology transfer to 241 companies. According to the executives, the key factors are building a trusting relationship between universities and the private sector and the role of coordinators, who link the private sector to the academic institutes. The prestige of university professors makes the private sector, especially SMEs, difficult to reach for support at universities. Also, the faculty feels uncomfortable about reaching out to the private sector without a proper mechanism. Furthermore, bureaucracy involving cumbersome paperwork is a burden for both sides. However, the coordinators help to identify the experts using an extensive database through networks and take care of major paperwork for them, lowering the barrier for both sides. Currently, there are 130 staff working at seven network universities: 70% of them are female and the average age is younger than 30 years old.

OHEC started the UBI program in 2004 and the TLO programs in 2007 in order to promote entrepreneurship and technology transfer (see Box 5). The number of universities which host UBI is steadily increasing (see Table 21). However, in most cases they support start-up companies and the number of spin-off companies is still small (see Figure 39). Furthermore, this program does not focus on technology and most incubated companies involve low-tech activities in food processing, cosmetics and ICT.

Box 5: UBI and TLO

UBI (University Business Incubator) refers to a place or a unit within a university that nurtures and supports the formation of new ventures from the beginning of the set-up until entrepreneurs can launch their business fully.

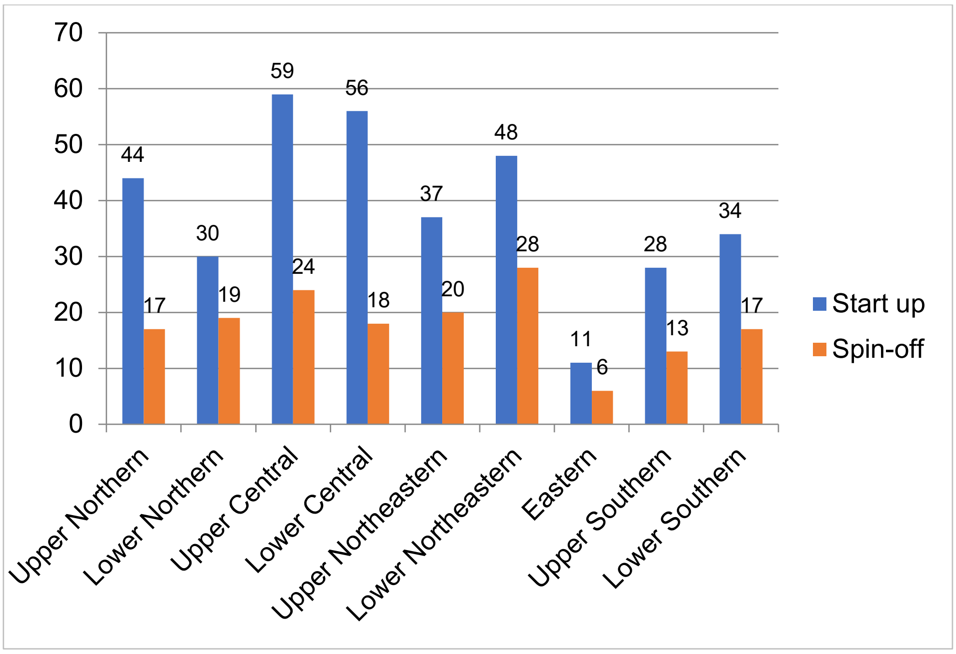
TLO (Technology Licensing Office) refers to a unit within a university that transfers high-end research content (or advanced technology content) from a university to industry with potential in order to add value, meet market needs and accelerate growth.

(Source: OHEC, “UBI, Entrepreneurs' step to succeed” (in Thai))

Table 21: Number of UBIs

Year	2005	2006	2007	2008	2013
Number of UBIs	25	35	45	56	63

Source: OHEC



Source: OHEC

Figure 39: Number of start-up and spin-off companies by region (2009-2014)

The challenge of UBIs and technology licensing offices is a lack of human resources who have the necessary skills to promote entrepreneurship and to support commercialization of research. The commercialization of R&D and IP management are at an initial stage in Thai universities. Major research universities and S&T universities set up TLOs, but the outcomes are still very limited. Only a handful of universities are active in this area, as shown in Table 22.

Table 22: Technology Licensing Offices

	CU	MU	KU	KK	CMU	SUT	PSU	KMU TT	Total
Year of establishment of TLO	1995	1998	1996	2006	2007	2007	2007	1995	
Number of staff (FTE) engaged in licensing activities, business development and spin-offs	4	--	--	2	2.5	2	2.5	2	15
Number of staff (FTE) engaged in patent filing and other technology transfer activities	6	--	6	4	4.5	6	4	--	30.5
Licensing agreements (2008-2011)	42	--	19	--	--	10	--	--	71

Revenue from licensing out (million baht) (2008-2011)	19.5	--	10.4	1.7	5.9	3.2	0.9	1.2	42.74
Number of invention disclosure	51	--	--	--	--	--	--	--	51
Local utility patents, 2011-2012 (applied/granted)	44/1	0/2	12/0	14/0	--	17/0	21/0	14/0	122/3
Cumulative local utility patents (applied/granted)	--	--/34	209/28	71/4	--/67	96/4	--/51	162/14	538/202

Source: Adopted from UNCTAD (2015), p. 87.

In addition to the above universities, KMITL established King Mongkut Research Innovation Services (KRIS) in 2015, which has consolidated separate UIL activities in the Faculty of Engineering to make it a one-stop service center for UILs. An executive of KRIS states that the obstacles of promoting UILs are to change the mindset of faculty and ease the bureaucratic process. Currently, only three staff are managing the office, but an additional seven will be recruited in 2017.

A benefit of these linking mechanisms is to raise awareness of the new mission of higher education institutions among faculty and the private sector. Traditionally the mission of universities has been to make intellectual contributions by providing education and research. However, laying out the institutional framework with governmental support provides an opportunity to realize a new mission of universities, which is to contribute to the nation's economic development, as well as provide a link to the private sector.

3.2.4.2 Promoting mobilization of human resources

Personal networks are a strong enabling factor to help facilitate active collaboration in UILs. Mobilizing human resources across organizations can facilitate the establishment of closer personal networks. Also, human resources mobility brings not only technology transfer, but also tacit knowledge transfer, which cannot be transmitted through codified information[83]. Promoting the mobilization of human resources is an effective policy instrument with which to strengthen UILs.

NSTDA initiated a program called "Innovation and Technology Assistance Programme" (ITAP), which aims at enhancing productivity of SMEs by providing expert consultancy and matching funds to help them to develop product or process. NSTDA established a pool of experts called Industrial Technology Advisors (ITAs) to mobilize these experts to SMEs.

Talent Mobility program evolved from ITAP. The Talent Mobility program promotes a flow of researchers from universities and public research institutes to the private sector to promote productivity and innovation. The program has gradually established a mechanism to facilitate the mobilization, establishing "clearing houses" at universities in four regions, namely, Chiang Mai University, Korn Kaen University, KMUTT and Prince of Songkla University. This network has expanded to a total of

[83] OECD (2008) *The Global Competition for Talent: Mobility of the Highly Skilled*. OECD, Paris.

20 universities in 2016, due to growing interest in the private sector. OHEC joined the program to help support the funding in 2015. Starting from 25 projects with 18 SMEs and four large companies in collaboration with 53 researchers in 2013-2014, the program expanded to 192 projects with 139 SMEs and 29 large companies with 312 researchers in 2016.

Box 6: Talent Mobility

STI has initiated a program called "Talent Mobility" to facilitate the mobilization of R&D personnel from universities and public research institutes to work in the private sector in 2013. The mobilized researchers will conduct the following: 1) research and development; 2) technical problem solving; 3) standardization and testing and; 4) innovation management. The program requires that researchers work for at least one day a week for three months and up to two years. The program will compensate for the absence of the mobilized researchers to the home organization if the hosts are SMEs. The large firms will be responsible for the compensation on their own. Moreover, the program will provide monthly allowances to undergraduate and graduate students who work as research assistants for the mobilized researchers.
(Source: Kitipongwatana et.al, 2016)

The talent mobility program has provided a channel through which the private sector can reach universities, as well as a regulatory framework for faculty. In the past, faculty's collaboration with the private sector in R&D has been on a more individual basis, but since the program has been supported by STI and OHEC, many universities have endorsed the program and some have adopted the program as a KPI, although the degrees of restriction and flexibility vary. The activeness of the program depends on the capacity of staff at clearing houses, network of faculty, proximity of industrial parks and leadership of the universities. Executives of the Talent Mobility program hope to expand the program to international companies, including Japanese firms.

3.2.4.3 Developing work-integrated learning (WiL) program

OHEC has been promoting WiL since it is considered "an essential tool to cultivate students' competencies and skills that would contribute to the productivity of their future work places, enabling them to become a capable workforce and stay competitive in an increasingly complex international environment." OHEC set a strategic plan in 2013 to accelerate WiL to enhance the quality of graduates that meet the demands of the international labor market. WiL is a general term which incorporates working experience in the curriculum and it includes various forms such as internships, cooperative education, clinical rotation and community service learning (see Annex 9). Internships are the most prevalent form and the cooperative education program is increasing, involving 106 universities with more than 10,000 workplaces. Cooperative education is "a process of learning" initiated by SUT in 1993 and considered to be a successful model case.

3.2.4.4 Programs to develop hands-on engineers

As mentioned in *3.2.3. Challenges of Universities*, Thai universities are criticized by industry for not sufficiently providing practical skills required at workplace. In response, several attempts are used to cope with the issue. The KMUT group is known for having a good balance of technical hands-on skills and theory. KMUTT recently established the Monozukuri Engineer program for undergraduate students, which incorporates a significant number of hours of work-integrated learning in collaboration with more than 20 companies, including six weeks' experience in working abroad, a summer session of work-integrated learning during the junior year and one semester of work-integrated learning in the senior year. The program accepted the first batch of students in 2016. KMUTT expects students to acquire not only theory and practical aspects, but cross-cultural values and working experiences in foreign organizations, so that they can build a career path as an engineer in transnational companies. This program is in accord with the Thailand 4.0 policy which uplifts Thai engineer's positions and promotes research, development and innovation. The program accepted 14 students in the first year and their progress should be monitored closely.

Box 7: Monozukuri Engineer Program at KMUTT

KMUTT's program for qualified hands-on engineers called the "Monozukuri Engineer" program aims at producing qualified students who share the Monozukuri Philosophy and have a hands-on knowledge and experience. They will develop the potential to work effectively, have profound knowledge, systematic thinking skills, learning skills, professional skills, communication skills and interpersonal skills that can be utilized in Thai and foreign workplaces.
(Source: KMUTT hands-on engineer brochure)

KMITL implements tailor-made programs in close cooperation with individual companies in electrical engineering at the master's degree level. The salient feature of such a program is that in the master's degree program, engineers from the same company enroll in the program and conduct research on a technical issue that they tackle in their companies and they continue to work in the same technical field in the company after the completion of their program. To date, KMITL has implemented three programs with three companies on such research topics as PV-invertor, EV-testing/Drives and batteries. All these programs were initiated through personal connections between academic staff and companies and later on developed into joint programs with institutional arrangements such as MOU.

The Thailand Advanced Institute of Science and Technology (TAIST) is an international joint graduate program between an alliance of Thai universities and the Tokyo Institute of Technology (Tokyo-Tech), supported by the NSTDA. Three master's degree courses (Automotive engineering, Information & Communication Technology for Embedded system and Advanced & Sustainable Environmental Engineering) are conducted each year in Thailand, accepting 30 students for each course. Tokyo-Tech supports the courses with dispatch of lecturers, curriculum development, remote teaching and the acceptance of selected students in the Institute's Ph.D. programs. The program has been in place since 2007 and more than 100 students have participated in the program so far. The program helps the students obtain jobs at large Japanese companies. The ratio of students who went into a Ph.D. course after the graduation is high (23%) and some obtained teaching positions at universities in Thailand. In the program, Tokyo-Tech lecturers directly guide students' practical training (e.g., prototyping and analysis/evaluation) in the latter half of each semester and they also act as thesis advisers to advise and guide students in Japanese manufacturing technology.

TNI has introduced a MONOZUKURI course in its bachelor's program as an optional subject, financially supported by the Third ASEAN Economic Ministers-Ministry for International Trade and Industry (AEM-MITI) Economic and Industrial Cooperation Committee (AMEICC). The syllabus was jointly developed with companies and the course is conducted either at TNI or the companies, depending on the topic and the availability of equipment.

3.3 Equipment at Technical Colleges and Universities

3.3.1 Basic equipment

(1) Universities

Mechanical Engineering

According to the survey results, most of the laboratories that responded in the seven subcategories in mechanical engineering are equipped with basic equipment, although lower possession rates of some necessary equipment are seen in some laboratories, such as the air duct systems and the heat pump unit for the thermodynamics and heat transfer laboratory. Also, it would be ideal to install various types of flow and pressure measurement equipment in the measurement laboratory and computer simulation program of Computer Numerical Control (CNC) machine (extremely useful for prototype development) in the machining and fabrication laboratory as many of them do not have such equipment useful for hands-on experience. Unlike other fields, not many universities have established a good automotive laboratory since it normally involves having a large number of equipment, while the cost of each single equipment unit is usually high. The objectives of teaching in this field of study also affect the decision to obtain related equipment. Those universities that focus on research may look only for equipment that can demonstrate the key principles, while those that emphasize on practical knowledge may look for equipment that can enhance hands-on experience. Based on the survey results, the majority of institutions which have this laboratory possess the type of equipment that can demonstrate the fundamental principles. Among the list of the type that enhances hands-on experience, the engine management training set and the wheel alignment system are the prime candidates for the final recommended equipment since these training sets can enhance student's experience from both the theoretical and practical point of views.

Electrical and Electronic Engineering

Most of the electrical circuits laboratories that responded are equipped with basic equipment. Most electronics laboratories are also equipped with basic electronic circuit experiment tools. The majority of universities provide both analog and digital electronics experiments. However, lab equipment for integrated circuits (ICs) is not as widely available. Basic training sets for the simple IC concept should be considered to enhance students' knowledge in addition to its applications. Training system for analog integrated circuits is recommended. In the communication laboratory, basic equipment is available. The important items include spectrum analyzer and simple analog and digital communication training systems. Also included is the antenna system training set. Those training systems are for traditional communication systems. However, it is found that many real-world communication systems were not usually offered because they are usually expensive. Training systems for microwave, satellite, and optical communications should be provided. Also, communication transmission lines training set should be included to increase measurement skills on communication systems. Many electrical machine laboratories are also equipped with basic tools such as motors, generators and controls experiment board.

For electric power system laboratories, most universities are equipped with simple equipment mostly for generating and measuring low power electricity. However, training systems for electric power transmission are not adequately offered due to the cost and complexity of the equipment. In many universities in Thailand, the high power electrical system subject is usually taught in a strictly theoretical way. Thus, the training system for AC power transmission is recommended to teach the students hands-on exercises for the principles of AC power transmission. The majority of universities in Thailand who have a microprocessor laboratory own most of the fundamentally necessary equipment. The survey shows that most universities offer different types of microcontroller tool kits for both analog and digital devices.

(2) Technical Colleges

Studying the structure of the current curriculum and educational programs being offered by most technical colleges reveals that part of the main objectives for most programs is to produce graduates with the basic comprehension and hands-on skills suitable for a particular area of a profession. According to OVEC, the 2013's version (B.E. 2556) industrial-related curriculum cover 18 majors for the vocational certificate level (Por-Wor-Chor), and 25 majors for the vocational diploma (Por-Wor-Sor) level. For effective teaching and learning of these many majors, a huge amount of equipment in terms of both kinds and quantity is required. This problem is part of the reason that many technical colleges offer a much lower number of programs than 18 and 25 for the certificate and the diploma levels, respectively. Even doing so, popularly majors in the majority of technical colleges still include automotive mechanic, industrial mechanic, welding mechanic, drafting mechanic, maintenance mechanic, electrical power mechanic, electronics mechanic, communication mechanic, and mechatronics mechanic. While all technical colleges are supported by the government, providing adequate and up-to-date equipment according to OVEC's standard, even just for those popular programs, has become a big burden for OVEC itself as it needs to request an adequate budget from the government and reasonably and fairly distribute the budget throughout the country.

Based on observations from interviewing and site visits to two technical colleges, i.e. Science-Based Technology Vocational College (Chonburi) (SBTC) and Chachoengsao Technical College as mentioned earlier, the kind and number of equipment currently owned by the institution are on average below the requirements suggested by OVEC. Effective classroom management such as student-group rotation is the main operational strategy ensuring that the existing equipment can be effectively used, and the teaching and learning objectives can still be maintained. While the detailed records of the current equipment inventory for both of the technical colleges visited are not obtainable, there is no doubt that the more equipment, the better. At the very least, OVEC's standard equipment should be the minimum.

One way of overcoming the budget shortfall is the introduction of problem-based classrooms in collaboration with industry. By this means, the equipment used by companies (e.g. commercial CNC, professional Computer Aided Design (CAD)/Computer Aided Manufacturing (CAM) software, robot welding machine, equipment for molding process, industrial automation system) can be made available for students. The involvement of engineers in the companies will improve the effectiveness of the use of the current equipment and the selection of new equipment for technical colleges.

3.3.2 Advanced equipment (Master level)

Mechanical engineering

In the measurement laboratory and machining and fabrication laboratory, quite a number of institutions already own the necessary equipment. Most of the measurement laboratories have both data acquisition training and spectrum analyzers, and some institutions own thermal image cameras and Coordinate Measuring Machine (CMM) systems. Many of the machining and fabrication laboratories have advanced machining testing and fast prototyping equipment such as 3D printing software and 3D printers, plastic injection molding, ultrasonic detector equipment, welding inspection, and visual surface inspection. Yet, unlike basic equipment, more advanced equipment is necessary for advancing studies in other fields, particularly simulation software. For example, few institutions have vehicle simulation and engine simulation software in their automotive laboratory. The limited number of computer simulation software is available for fluid flow in the fluid mechanics laboratory and thermodynamics and heat transfer simulation software and thermoelectric device training set for Thermodynamics and heat transfer laboratory.

Electrical engineering

Testing has become a vital process in manufacturing as effective production testing enables timely defect elimination and prevents late stage equipment failure. In the electrical circuits laboratory, mixed-domain oscilloscope has become valuable in quickly switching between the measurement of time and frequency domains to track down the root cause of problems in the design. The survey results show that only four out of 25 respondents indicate that the mixed-domain oscilloscope is available at the universities. Similarly, few universities have testing equipment such as low power oscilloscope to test electrical properties and signals of small and complex devices. Simulation software is essential to design and verify the design before implementation; however, such software as antenna design software, system-level simulation software and RF propagation software are available only in a limited number of communications laboratories.

3.3.3 Budgeting and procurement of equipment

The budgeting and procurement processes for all public universities and technical colleges are carried out by strictly following the same regulations given by the Bureau of the Budget, the Ministry of Finance, and the Office of Prime Minister. The study team visited one university and two technical colleges, namely KMITL, Science Based Technology Vocational College (Chonburi) (SBTC) and Chachoengsao Technical College, respectively. These institutes are among those whose high performance and quality are widely accepted. Four focus areas were examined in the interview, namely the budgeting for institutions in general, the budget management for equipment operation and maintenance, the equipment updating mechanism, and the equipment procurement process.

(1) General budgeting

For both universities and technical colleges, the budget planning is generally done at least a year and a half (18 months) before the fiscal years starts. The reason for this early budget planning is that not only are there time-consuming internal processes for an institution to finalize the budget as a whole, there are also time-consuming processes for the government to consider budget requests from all governmental units throughout the nation.

(2) Budget for equipment operation and maintenance (O&M)
Preparing budgets for equipment O&M for universities and technical colleges in general follow a similar framework. However, the means of getting the requested budget for different institutions is different. For the technical college, the budget covering general equipment operating costs along with the maintenance cost (keeping the maintenance cost around 2%-5% of the overall budget) is usually approved. This is also the case for the governmental universities. However, for both types of institutions, any unused budget must be returned to the government at the end of fiscal year.

In the case of the national universities, their budgets are partially supported by the government, for human resources, utilities, and a small percentage of the operating costs. They therefore rely on revenue from tuition fees, research, and other educational services. Since these universities use their own income, they tend to manage their budget according to their strategic plans, including the equipment O&M budget.

(3) Equipment updating and replacement mechanism
Processes for preparing budgets for equipment updating and replacement for universities and technical colleges are similar. For technical colleges, the equipment that is necessary for establishing new teaching programs or expanding teaching programs has the top priority, followed by the equipment with new technology and updated equipment. Gaining a budget for equipment procurement seems difficult for any technical college as OVEC has to maintain balance and distribute equal benefits among all 428 technical colleges.

For the governmental universities, the equipment that is necessary for establishing new teaching programs or expanding teaching programs has the top priority, follows by the equipment for research, and updated equipment. However, it is found that the chance of getting budget approval is extremely unpredictable. It is also found that the requests can be rejected for an extended period of 3-5 years in the case of a department or teaching unit within a faculty.

For the national universities (partially funded by the government), the process of requesting funding for new equipment is exactly the same as the governmental university. However, since the national university has other sources of funding from their income, it seems to be logical and more convenient to obtain new equipment by using their own savings. The chance of getting new equipment depends on the university's policies and protocols, which are generally different from one another.

One major problem and concern regarding budgeting for new equipment, either for updating or replacing the old equipment, besides the unpredictable chance of getting approval, is that the budget estimation and request has to be prepared too far ahead of time, i.e. 18 months. One commonly found problem is that the price of particular equipment is higher 18 months later. Another problem that is increasingly common is that the technology for particular equipment is changed 18 months later.

(4) Procurement process
There is no significant problem in terms of implementation following the procurement regulations set by the Office of Prime Minister. However, the equipment obtained by the price inquiry and competitive

bidding method can be problematic since the main mechanism for obtaining the equipment by both methods relies on selecting the vender that quotes the lowest price. There are cases in which the equipment that meets the required specification with the lowest price does not have the appropriate qualities, such as poor quality of parts, poor craftsmanship, or poor aftersales services. Putting these qualities into the equipment specification normally means that there is a need to buy the equipment with the specific brand and/or from a specific vender. This is prohibited by the government procurement regulations. In other words, the equipment specification must be generalized enough such that any vender can have a chance to make the sale. There is no practical method to resolve this problem.

Chapter 4 Industrial HRD from the Perspective of Companies

This chapter will discuss industrial HRD from the perspective of companies. First, how the manufacturing companies perceive the issue of mismatch in quantity and quality of the graduates of technical colleges and universities is discussed. Secondly, the current situation of recruitment and utilization of the graduates is presented for each level of education. Thirdly, the two major issues of companies concerning industrial HRD, namely 1) limited linkage with educational institutes and 2) limited career path for both technical college and university graduates are discussed. Then, the initiatives taken by the Thai government, the private sector and other organizations are introduced.

4.1 Mismatch in quantity and quality from the companies' perspective

Our online survey of companies shows that a substantial number of companies express mismatch in both quantity and quality for their technical staff. The mismatch is perceived more seriously by Japanese companies than Thai companies. Also, in regards to quality, not only technical knowledge and skills, but also other skills such as problem solving and English proficiency are considered necessary to improve.

4.1.1 The number of companies' technical staff

59.3% and 34.3% of the companies responding to the online survey reported difficulties in recruiting R&D engineers and production engineers, respectively (see Table 23).

Table 23: Supply of technical personnel (1)

Types of technical staff	"Sufficient" + "Sufficient to some extent"	"Insufficient" + "Insufficient to some extent"	Total
R&D engineers	24 (40.7%)	35 (59.3%)	59
Production engineers	41 (65.1%)	22 (34.9%)	63
Technicians	53 (75.7%)	17 (24.3%)	70

Source: Results of online survey given to companies

When comparing the supply situation for technical personnel by the nationality of the company, we find that Japanese companies feel a stronger need for technical personnel than Thai companies, particularly in the case of R&D engineers (69.0%) and production engineers (47.1%) (see Table 24).

Table 24: Supply of technical personnel (2)

Types of technical staff	"Sufficient" + "Sufficient to some extent"		"Insufficient" + "Insufficient to some extent"	
	Japanese	Thai	Japanese	Thai
R&D engineers	9 (31.0%)	15 (50.0%)	20 (69.0%)	15 (50.0%)
Production engineers	18 (52.9%)	23 (79.3%)	16 (47.1%)	6 (20.7%)
Technicians	22 (62.9%)	31 (88.6%)	13 (37.1%)	4 (11.4%)

Source: Results of online survey given to companies

4.1.2 The quality of companies' technical staff

The companies' level of satisfaction with their technical staff is not very high for any of the three types of technical staff, namely, R&D engineers, production engineers and technicians. 43.1%, 36.5% and 34.3% of the companies are either very unsatisfied or unsatisfied to some extent with the quality of their R&D engineers, production engineers and technicians, respectively (see Table 25).

Table 25: Companies' level of satisfaction with technical staff

Types of technical staff	Level of Satisfaction				Total
	"Satisfied"	"Satisfied to some extent"	"Not satisfied to some extent"	"Not satisfied"	
R&D engineers	1 (1.5%)	32 (47.1%)	21 (30.9%)	4 (5.9%)	58 (100.0%)
Production engineers	5 (7.6%)	35 (53.0%)	19 (28.8%)	4 (6.1%)	63 (100.0%)
Technicians	5 (7.2%)	39 (56.5%)	18 (26.1%)	5 (7.2%)	67 (100.0%)

Source: Results of online survey given to companies

There is a clear difference between Japanese and Thai companies in the level of their satisfaction with the quality of their technical staff. More than 80% of the Thai companies are satisfied with the quality of all three types, whereas the majority of the Japanese companies express dissatisfaction. This is probably because the Japanese companies have higher expectations and demand for their technical staff than the Thai companies. In particular, many Japanese companies (71.4%) feel that the quality of R&D engineers should be improved (see Table 26).

Table 26: Difference between Japanese and Thai companies in their level of satisfaction

Types of technical staff	"Satisfied" + "Satisfied to some extent"		"Not satisfied" + "Not satisfied to some extent"	
	Japanese	Thai	Japanese	Thai
R&D engineers	8 (28.6%)	25 (83.3%)	20 (71.4%)	5 (16.7%)
Production engineers	15 (44.1%)	25 (86.2%)	19 (55.9%)	4 (13.8%)
Technicians	16 (48.5%)	28 (82.4%)	17 (51.5%)	6 (17.6%)

Source: Results of online survey given to companies

4.1.3 Companies' views on the weaknesses of university and technical college graduates

While the quality of technical staff indicates various skills, the following are common issues that companies have pointed out in interviews and their expectations, as well as the results of a questionnaire survey given to companies.

4.1.3.1 Concerns about mathematics capability of new recruits

35 out of 100 companies interviewed by the survey team identified the weak mathematics capacity. Particularly, managers in many Japanese companies are very concerned about the numerical and mathematics capability of university and technical college graduates because their counterparts in other countries that compete with Thailand to attract foreign direct investment are better able to use their numerical and mathematical skills. Because of the weakness of technical staff in numeracy and

mathematics, they are not able to effectively tackle technical problems in a logical manner or perform their work properly. Some specific work also requires basic mathematics. For example, basic trigonometric function is necessary for drawing and designing. These companies suggest that technical college and university graduates should have minimum basic mathematical skills and they should be trained to use such skills to think critically and logically.

Box 8: Importance of basic knowledge

The survey team conducted in-depth career path study on ten successful engineers (Details of each case are shown in Annex 11). All of them have innovative products registered at the National Research Council of Thailand (NRCT). According to the results of the interviews, many of the successful engineers who had studied at a technical college re-studied basic subjects such as mathematics and science. They considered basic knowledge of mathematics, physics and other sciences to be highly important in developing products or doing innovative research in their careers. It is possible that a fundamental knowledge of mathematics, physics and other sciences was the most important basis for research and development in their future careers. On the other hand, most innovative engineers mentioned that they re-studied fundamental knowledge on their own, which obviously revealed weaknesses in the teaching of basic subjects at the TC level.

4.1.3.2 Foreign language proficiency

As mentioned earlier, the automotive/auto-parts and electric/electronic product industries are driven by foreign direct investment in Thailand. Many companies aspire for technical college and university graduates with good command of English as they would need to communicate not only with colleagues in the company, but also with clients and suppliers in English. Basic English at the very least is becoming a necessity because technical staff also need to write reports and enter data in English. 37 out of 100 companies interviewed by the survey team set a minimum English proficiency as one of the

Box 9: Language proficiency as a means for career development

According to the results of career path study conducted by the survey team, four out of five innovative engineers declared language proficiency as a means to acquire a chance to be involved in research and development. Those able to communicate with foreign experts (engineers) dispatched from the headquarters would be able to learn more techniques and skills from the dispatched engineers and likely gain their trust and be entrusted with assignment that require more responsibilities. They were also able to proposed new ideas to the dispatched staff since they had better language skills than other staff in the same position. The rest of the successful engineers also said that English proficiency was an important instrument in searching for more information. In the planning, trial and assessment processes to develop new things or find solutions, they needed to read English articles in books or on the Internet to find references for their research or product development. In Thailand where foreign companies have extensive business operations, language proficiency provides good advantages to new knowledge and skills necessary for future engineers.

eligibilities to apply to the companies and provide incentives to encourage technical staff to improve their language proficiency in English.

Japanese companies do not demand Japanese language proficiency, but it would be an asset to increase their prospects for promotion and salary increases. Also, many Japanese companies aspire for localizing their operations by transferring technologies from Japanese engineers to their local counterparts. Technology transfer is relatively fast and smooth in such countries as China and Vietnam because the engineers who are able to communicate in Japanese are more widely available in these countries than in Thailand. Therefore, improvement of Japanese language proficiency can be an important policy for the transfer of technology and knowledge from Japan to Thailand.

4.1.3.3 Basic technical knowledge and skills

Many companies expect technical colleges to devise a system that ensures that their graduates have the minimum required technical knowledge and skills in their field of study (for example, basic knowledge in designing, operation of 3D/CAD, mold assembling and dissembling, electric circuit, and the production process in accordance with design drawing). 36 companies out of the 100 companies interviewed are concerned with the competencies of technical college and university graduates in their knowledge and skills of their major.
More specific needs pointed out by the interviewed companies can be summarized as follows:

<u>O&M of machinery and facilities</u>
One need frequently mentioned by the interviewed companies is the need for competent technical staff (mainly technicians) for the O&M of production facilities and machinery. This is due to several factors. One factor is that many companies have invested in production machinery and facilities taking advantage of the recent government tax relief policy aimed at fostering advances in the manufacturing sector, and these companies need knowledgeable technical staff to operate and maintain new machinery and facilities. Also, many companies are replacing manual operations with automation technologies and thus they need more O&M technical staff than before. Other factors include the modification of production systems, the expansion of product lines, and the extension of operation hours, all of which require more O&M technical staff.

<u>Designing staff</u>
Technical staff (mainly engineers) are in demand for the localization and modification of products. For such purposes, the capacity of the design staff needs to be upgraded in terms of their knowledge and operation of CAD software. Since incumbent engineers, as well as new university and technical college graduates, usually do not have practical experience in product design and development, some companies find it difficult to employ properly trained design engineers who have sufficient knowledge and experience in the project cycle, from designing, producing a prototype, carrying out evaluations and making modifications to planning for mass production. They also need to train design engineers for a few years before they can actually be assigned for design work. In addition, design engineers are in such a high demand, their turnover rate is naturally very high in Bangkok. As a result, Japanese companies are increasingly interested in recruiting university graduates in rural areas and/or train technical college graduates to work as designing staff.

The difficulty in employing well trained design engineers has led companies to reduce or relocate R&D activities. The following illustrates some of such cases:

- Company A plans to establish a R&D center in Asia. At present, its preference is Thailand because of its long history of being in operation. However, the managerial and technical capacity of the technical staff in Vietnam has been developed very fast. The company may set the center in Vietnam.
- Company B has been planning to establish a R&D center in Thailand, but the implementation is slow-paced because the company is not able to retain reliable, trained engineers.
- Company C has decided to establish its R&D center in India instead of Thailand due to their weaknesses in mathematical and English abilities necessary for design and development work.
- Company D has established a R&D unit in accordance with the strong request from its OEM company. Yet, operation is in trouble because the company keeps losing trained staff to other companies.

<u>Production engineer</u>
Technical personnel who are knowledgeable about production systems are in high demand for production design, modification and adjustment of production system (often imported from Japan). Due to increased wage levels in Thailand, many companies are compelled to intensify their efforts to reduce costs by improving productivity. Therefore, production engineers who can contribute to cost reductions, increase productivity and solve problems (e.g., reducing product defect rates) are in high demand. Also, because of the increased introduction of automation technologies for production, production engineers are required to multi-task across their major disciplines. For this reason, mechatronics is in high demand among companies moving ahead with the introduction of automation technologies.

<u>Specific skills</u>
36 out of 100 companies interviewed are concerned about the shortage of technical staff with specific vocational skills. One strongly voiced concern is the shortage of mold and die making specialists. A specialist who can design with 3D simulation software and machining/finishing is also very difficult to find in Thailand. Several companies interviewed have decided to train engineers from other countries to work in Thailand as mold and die specialists. Another skill frequently mentioned by the interviewed companies is the need for practical skills in drawing with the use of 3D software. Other specific skills in short supply include programming for automated control in response to the introduction of automation technologies.

4.1.3.4 Problem solving

Companies expect the technical staff to solve problems, but find it difficult to find engineers who can do so. 23 out of 100 companies interviewed by the survey team pointed to the weak capacity of their technical staff in problem-solving. One issue frequently mentioned by the companies is that university graduates often lack the ability to learn from real cases as well as hands-on experiences, while technical college graduates lack the generic basis for problem-solving and tend to rely on engineers for decision-making, even though they have practical knowledge about production facilities and machinery.

Box 10: Logical thinking as a basis for research and innovation

It was observed from the interviews with successful engineers that logical thinking and experience with electrical circuits connection, electrical device repair or electric magnetic experiments were characteristics common to all engineers with innovative products. These engineers have gone through analysis of the causes of break-downs or malfunctions of electric circuits; experienced repetitive 'trial and error;" and searched for information in books or magazines* to find solutions until they are able to get the work done. When explored in details, it was found that all of them were inspired by family members or neighbours who performed similar experiments, and some of them started experiments after reading science magazines[1]. Such experiences appear to have been very important to lay the foundation for logical thinking, research-oriented minds and the habit of investigation for future innovative engineers. More and more experiments that would promote logical thinking and research into solutions should be added to the curricula and the teaching methods should also further focus on coaching to think rather than instruction at the universities and technical colleges.

* These science magazines were very famous in the 1980s, when these engineers were around 10-15 years old. There were around 10 types of science magazines in that period. Most terminated publication in the late 2000s.

4.1.3.5 Lack of discipline

According to our online survey, the most needed skill to be improved is attitude to work and discipline. This is not necessarily the skills to be educated at technical colleges or universities and it could be done at home, but it is considered prerequisite before any other skills. Also, many companies complain about the lack of aspirational and ambitious spirits among technicians. This is frequently mentioned by the Japanese companies (20 companies). This may be partly because of the limited career paths available to technicians.

Box 11: Fundamental work ethics as key factors for successful careers

The fundamental attributes of "diligence, patience, responsibility, leadership and punctuality" were believed to be factors for success in future engineering careers since there is a great need for such attributes in development and innovation. Half of the successful engineers interviewed by the survey team said that they gained a sense of responsibility and leadership in club activities, especially sport clubs after school when studying at KOSEN or university. Meanwhile, most Thai TCs do not have such after-school club activities. Those who were educated in Japan or who worked at Japanese companies stated that practices of the Japanese staff taught them the importance of diligence, patience and punctuality at work, as these attributes were important to fulfil their responsibilities. These attitudes have become rooted in their ways of living and have made significant contributions to their work in product/tool development and innovative research. Curriculum that promotes a sense of responsibility and other ethics among TC students is needed so that that those ethics can be properly and firmly rooted in the future engineers' lifestyle. As a reference, one KOSEN has added the Robot contest project as one subject in the curriculum. The interviewee believed that this is the way to foster work ethics in Japanese students' minds since they needed to individually prepare for and participate in the robot contest to earn credits to graduate from the school.

4.1.3.6 Management capacity

Some companies expect university graduates to have good management capacity (e.g., management skill and leadership) because they would be expected to be a future candidate for company director. For this reason, many companies expect that university graduates would have both technical and managerial capacities. 20 out of 100 companies interviewed mentioned the shortage of managers with such capacities as leadership to solve problems by closely working with their subordinates in the field/on the spot (not by assigning them to solve problems themselves), a strong sense of responsibility to complete what they started and numeracy to analyze data and identify problems (e.g., for cost-benefit analysis and production planning).

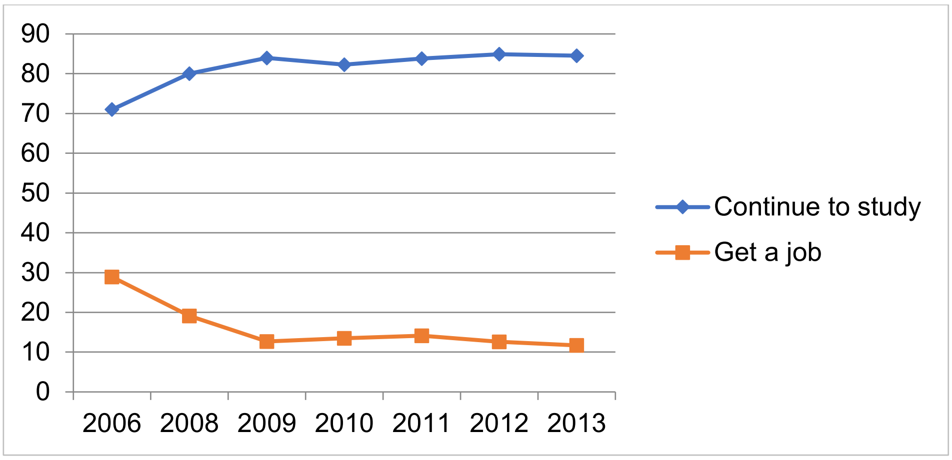
4.2 Current situation of recruitment and utilization of the graduates

In this section, the current situation of recruitment and utilization of the graduates is discussed at the three levels, namely, technical high school (PWC), technical colleges (PWS), and universities.

4.2.1 Technical high school (PWC)

In case of technical high school graduates, most graduates continue their studies. Most technical colleges, 99% of public schools and 70% of private schools offer both vocational certificates and higher vocational certificates at the same location. Accordingly, continuing their studies at a college in the same location is common practice. In our survey of the targeted schools, 67% of those continuing students study at the same college, followed by 11% of them who attend RMUTs.

There are multiple reasons that a high percentage of vocational high school graduates (85%) continue their studies. There is a general tendency to seek higher education, and Thailand values diploma highly. Directors interviewed under this mission mention that high school graduates are not mature enough to be disciplined in their work, and some companies do not hire those under 18 years old. Also, entrance to technical college is not competitive and basically all applicants are accepted unless they have serious problems. Advancement rate to higher education for vocational high school graduates has been stable at the level of more than 80% for the last decade, as shown in Figure 40.



Source: NESDB[84]

Figure 40: Ratio of Pathways for Vocational High School Graduates (%): 2006-2013

[84] http://social.nesdb.go.th/SocialStat/StatReport_Final.aspx?reportid=989&template=2R3C&yeartype=M&subcatid=23

4.2.2 Technical college graduates

4.2.2.1 Recruitment

About 30% of the total companies that responded employed 0-5 technical college graduates and 25% of them employed 20-100 technical college graduates. Among Japanese companies, about 50 % of them employed less than five technical college graduates, followed by "5-20 graduates." On the other hand, 33% of the Thai companies that responded employed "20-100 technical college graduates", followed by "5-20 TC graduates". Most of the interviewed companies prefer to recruit graduates from the technical college located close to the company because locally recruited technical college graduates tend to stay long term with the company. In the case of technicians, SMEs also prefer new technical college graduates because their turn-over rates are lower than new university graduates.

Table 27: Number of new Technical College graduates recruited by companies in 2016

Number of New Recruits	Number of Companies	%
Less than 5 graduates	23	29.90
5 - 20 graduates	16	20.80
20 - 100 graduates	19	24.70
100 - 200 graduates	8	10.40
200 - 500 graduates	6	7.80
More than 500 graduates	5	6.50
Total	77	100.00

Source: Results of online survey given to companies

4.2.2.2 Utilization of new recruits

At both Japanese and Thai companies responded to the survey, about 70-80% of them utilize technical college graduates as technicians at their companies. At Japanese companies, 32.3% of them utilized some technical college graduates as engineers; on the other hand, only 2.9% of Thai companies utilize technical college graduate as engineers. In the Thai companies, the career path for technical college graduates is distinct from that of university graduates and their salary scale is set accordingly. In contrast, Japanese companies are more flexible in this regard. In fact, several Japanese companies interviewed by the survey team promote technical college graduates to positions for engineers, taking account of their capacity and performance.

Table 28: Intentions of companies recruiting and utilizing technical college graduates

Intentions of Company	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Recruited for position as engineer	10	32.3	1	2.9	11	16.9
Recruited for position as technician	22	71.0	28	82.4	50	76.9
Recruited for position as worker	7	22.6	8	23.5	15	23.1
Recruited for position as technical staff with	8	25.8	5	14.7	13	20.0

Intentions of Company	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
special skill, qualification and/or experience						
Others	1	3.2	3	8.8	4	6.2
Total	31		34		65	

Source: Results of online survey given to companies

4.2.3 University graduates

4.2.3.1 Recruitment

According to the results of the online survey, 34% of the companies did not recruit university graduates in 2016. Unlike large companies with more than 1,000 employees, 63% of SMEs recruit less than 10 university graduates. It is difficult for SMEs to recruit new university graduates as they prefer to work for large companies. It was also confirmed in company interviews that 16 companies (all of them SMEs) recruit only engineers with work experience because few university graduates apply to the company and, in addition, they cannot afford to invest in new university graduates who would leave the company after a few years of in-company training. On the other hand, most of the large companies that were interviewed recruit new university graduates because these companies can attract competitive new university graduates, mainly from research universities, and have their own systems for training them (see Table 29).

Table 29: Number of new graduates recruited by companies in 2016

Number of new recruits	Number of Companies	%
0 persons	32	34.00
1 - 9 persons	31	32.98
10 - 49 persons	23	24.47
50 - 99 persons	1	1.06
More than 100 persons	7	7.45
Total	94	100.00

Source: Results of online survey given to companies

4.2.3.2 Universities from which companies recruit graduates

As the table below shows, more than half of the companies employed at least one graduate from the three KMUTs and Kasetsart University over the last three years. Interviews with companies also confirmed that the three KMUTs are usually the first names mentioned as their preference for recruitment because they are regarded as practical in their career orientation (see Table 30).

Table 30: Universities from which companies hired graduates over last three years

	Name of university	% of responses of Japanese Companies (n = 38)	% of responses of Thai Companies (n = 42)	% of responses in total (n = 80)
1	KMUTNB	34.2	78.6	57.5
2	KMITL	39.5	66.7	53.8
3	KMUTT	28.9	71.4	51.3
4	Kasetsart University	39.5	61.9	51.3

	Name of university	% of responses of Japanese Companies (n = 38)	% of responses of Thai Companies (n = 42)	% of responses in total (n = 80)
5	Burapha University	39.5	45.2	42.5
6	Khon Kaen University	23.7	57.1	41.3
7	Chulalongkorn University	28.9	42.9	36.3
8	SUT	21.1	45.2	33.8
9	Chiang Mai University	21.1	28.6	25.0
10	Mahidol University	15.8	28.6	22.5

Source: Results of online survey given to companies

4.2.3.3 Utilization of new recruits

53.7% (36 out of 67 companies) of the companies assigned the majority of the new recruits to production, but 48.1% (26 out of 54 companies) also assigned their employees to designing and product development, 21.8% (12 out of 55 companies) to O&M and 17.9% (7 out of 39 companies) to sales. This indicates that the companies expect engineers to work for production but also perform other functions such as drawing and design modifications.

In fact, the increasing number of companies has built R&D functions in Thailand. There are 43 automotive/auto-parts, electric and electronic companies registered as a R&D company with the Thai Government (Annex 12). According to a survey conducted by the Japanese Chamber of Commerce, Bangkok to its member companies in 2016, out of 488 respondents, 53 of them have established R&D and/or technical center in Thailand for such purposes as localization of their products, technology transfer to local staff, productivity enhancement and data collection and analysis. It is assumed that the actual number of companies engaged in R&D in Thailand in these fields is higher, considering the number of large companies that have R&D functions but not included in these figures. Although the scope is still small and the type of activity is also limited to development (not so much research), there is an increasing need for Design and Development engineers.

4.3 Issues of companies concerning industrial HRD

In order to establish effective industrial HRD system, both companies and educational institutes including technical colleges and universities need to collaborate in various aspects such as identifying the needs of industry, developing curriculum, updating the equipment and facilities, capacity building of all concerned and career development guidance for the graduates. However, the current cooperation is very limited. Furthermore, developing career as an engineer is not well established in a company, which could discourage aspiration of future engineers and technicians. In this section, these two issues 1) limited cooperation by companies with educational institutes; and 2) limited career path for both technical college and university graduates in companies are discussed.

4.3.1 Limited cooperation by companies with educational institutes

As discussed in Chapter 3, the linkage between educational institutes and the industry is weak. The mode of collaboration is primarily accepting students for internship. At technical college, an increasing number of technical colleges are introducing a dual system in which a second-grade student studies and works at a company for approximately 10 months. At university, the main support is provided in the form of the acceptance of internship students for one to six months and scholarships for the last three years.

The interviews of companies reveal that their main concern is to recruit competent graduates from HEIs and TCs. For this purpose, the internship program is regarded as the most effective way as internships provide an opportunity for companies to evaluate students' performance in their workplace. Scholarships are also a preferred approach, but some companies are not convinced of the effectiveness of scholarships as scholarship grantees do not necessarily join the company that provides the scholarship. Our survey finds that five out of 18 companies that provide scholarships would likely discontinue support for scholarship programs.

This narrow interest in early recruitment of competent students does not support Thailand to develop its human resource to the next level of knowledge-based economy. The companies should contribute to its HRD not only for a short vision, but also for a longer-term vision in order to benefit from better skilled engineers and technicians. Actually, Thai companies provide a wider range of support, such as joint and commissioned research, the dispatch of lecturers to universities, conduct of joint education programs and sponsorship of students' activities (e.g., robot contests and student projects), as well as the provision of scholarships and acceptance of internship students. On the other hand, Japanese companies tend to focus mainly on internships, and to some extent on scholarships.

Table 31: Types of cooperation by companies for the last three years

Types of cooperation by companies	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Joint research	1	4.5%	7	22.6%	8	15.1%
Commissioned research	1	4.5%	6	19.4%	7	13.2%
Internship (less than 1 month)	5	22.7%	1	3.2%	6	11.3%
Internship (more than 1 month)	13	59.1%	16	51.6%	29	54.7%
Internship (more than 6 month)	3	13.6%	4	12.9%	7	13.2%
Joint education program	0	0.0%	8	25.8%	8	15.1%
Lecture by company staff	3	13.6%	2	6.5%	5	9.4%
Endowed program	2	9.1%	3	9.7%	5	9.4%
Enrolling company staff in degree program	1	4.5%	6	19.4%	7	13.2%
Scholarship	5	22.7%	13	41.9%	18	34.0%
Advisory to university	1	4.5%	3	9.7%	4	7.5%
Transfer company staff to university	0	0.0%	0	0.0%	0	0.0%
Donation for facility construction	2	9.1%	0	0.0%	2	3.8%
Donation of equipment	0	0.0%	2	6.5%	2	3.8%
Sponsorship for student contests	2	9.1%	4	12.9%	6	11.3%
Sponsorship for student projects	1	4.5%	9	29.0%	10	18.9%

Others	2	9.1%	7	22.6%	9	17.0%
Total	22	100.0%	31	100.0%	53	100.0%

Source: Results of online survey given to companies

While corporate social responsibility has been promoted and many companies show willingness to contribute, our survey shows that companies are increasingly interested in taking more active roles in industrial HRD including supporting a longer internship program (more than six months), conducting joint research and providing advice and suggestions to universities. Although the number is limited, some Thai and Japanese companies are interested in donating the same type of equipment as they use in their production facilities, and some Thai companies are also interested in students' activities such as PBL, whereas few Japanese companies would likely support such activities although some large companies provide sponsorships to such activities. One of the reasons for this is that Japanese companies do not have as much connection with universities as their Thai counterparts.

Table 32: Types of support which can be provided to universities or technical colleges in the future

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Joint research	4	16.7%	11	33.3%	15	26.3%
Commissioned research	1	4.2%	6	18.2%	7	12.3%
Internship (less than 1 month)	7	29.2%	1	3.0%	8	14.0%
Internship (more than 1 month)	14	58.3%	13	39.4%	27	47.4%
Internship (more than 6 month)	9	37.5%	11	33.3%	20	35.1%
Joint education program	2	8.3%	11	33.3%	13	22.8%
Lecture by company staff	3	12.5%	4	12.1%	7	12.3%
Endowed program	1	4.2%	7	21.2%	8	14.0%
Enrolling company staff in degree program	2	8.3%	7	21.2%	9	15.8%
Scholarship	3	12.5%	10	30.3%	13	22.8%
Advisory to university	3	12.5%	7	21.2%	10	17.5%
Transfer company staff to university	0	0.0%	2	6.1%	2	3.5%
Donation for facility construction	1	4.2%	2	6.1%	3	5.3%
Donation of equipment	1	4.2%	6	18.2%	7	12.3%
Sponsorship for student contests	1	4.2%	4	12.1%	5	8.8%
Sponsorship for student projects	3	12.5%	9	27.3%	12	21.1%
Others	1	4.2%	1	3.0%	2	3.5%
Total	24	100.0%	33	100.0%	57	100.0 %
NA	47	-	29	-	76	-

Source: Results of online survey given to companies

4.3.2 Limited career path for both technical college and university graduates

Another issue needs to be addressed is a limited career path for both technical college and university graduates to become an engineer. According to a survey conducted annually by a private company given to approximately 1,500 children aged between seven and 14 in Thailand, engineer is one of the top five dream jobs among children in Thailand (see Table 33). Naturally, among students of technical colleges and faculty of engineering at universities, becoming an engineer is a goal of career path. However, there are limitations for both technical college and university graduates. The explanation for both levels will follow.

Table 33: Dream Job Ranking (2013 – 2016)

Ranking	2013	2014	2015	2016
1	Medical Doctor	Medical Doctor	Medical Doctor	Medical Doctor
2	Engineer	Soldier	Soldier	Professional Athlete
3	Police Officer	Police Officer	Police Officer	Chef
4	Business Person	Engineer	Teacher	Engineer
5	Teacher	Teacher	Engineer	Teacher

Source: ADECCO Thailand

4.3.2.1. Technical college graduates' limitation

Technical college graduates have a limited career path. Engineer is highly respected occupation and those majoring in industry-related subjects naturally dream of becoming engineers: 56% of vocational diploma level and 36% of higher vocational diploma level respondents in our survey want to become engineers, which is their top choice. However, their career path to become an engineer is limited (See Annex 8).

In our interviews of 100 companies, many companies mention that there are different tracks for technical college and university graduates. Simply stated, technical college graduates are often employed as technicians and university graduates are employed as engineers. In our online survey of companies, 76.9% of companies recruit and utilize technical college graduates as technicians. Some companies, 41.8% of our surveyed companies, state that they are ready to promote technical college graduates to be engineers if their competencies and skills are met. However, some companies have an established human resource management system which differentiates technical college graduates from university graduates. In our survey, 25.4% of companies state that they do not recruit technical college graduates as engineers even if their competencies are high and 13.4% of companies state that they have little interest in recruiting technical college graduates for engineering positions. This tendency of valuing diploma over competency is stronger among Thai companies (see Table 34).

Table 34: Company Interest in Recruitment of Technical College Graduates

Company Interest	Japanese companies	Thai companies	Total (Average)
It is possible to recruit TC graduates as engineers if their competencies are high.	60.6%	23.5%	41.8%
According to the internal regulations, it is not possible to recruit those without bachelor's degree as engineers.	6.1%	2.9%	4.5%

Even if their competencies are high, TC graduates will be recruited as technicians, but not engineers.	21.2%	29.4%	25.4%
We have little interest in recruiting TC graduates since the target of engineering positions are university graduates.	6.1%	20.6%	13.4%
We do not need engineers and have little interest in recruiting TC graduates.	3.0%	5.9%	4.5%

Source: Results of online survey given to companies

The higher vocational diploma is not highly valued by the Council of Engineers. It is very difficult for technical college graduates to pursue a career as a certified engineer. In Thailand, there is a system to certify "engineers" by the Council of Engineers and its minimum academic requirement is a bachelor's degree. Technical college graduates with higher vocational certificates are not eligible to apply for the license. Technical colleges started providing the bachelor of technology since 2008, but the bachelor of technology is not considered eligible for the engineering license, either. That is, technical college education does not structurally allow students to become certified engineers.[85]

Box 12: Upgrading technical skills of technical college graduates

After working in a company for a while, TC graduates mostly tried getting a university degree as a license for career progression. At the interviews to successful engineers, two TC graduates who pursued their studies at the university level after work selected non-engineering degrees, citing as their reason that the degree was just a guarantee for a management position, rather than studies that they could count on. Another KOSEN graduate who pursued his studies at a Thai university also stated this. If this trend of earning non-engineering degrees since they are easy to obtain and help lead to management positions continues, it would be a negative factor in ensuring the sufficient number of qualified practical engineers on the industrial side in the near future. On the other hand, one engineer who studied after work revealed that he applied knowledge just learned from the university to analyze data at work, and this contributed to the proper development of a manufacturing process. This indicates that appropriate education content tailored to work content with the right timing could make a significant contribution on the industry side.

Technical college graduates who have an ambition to climb a career ladder have to go back to school to obtain a bachelor's degree in engineering, however, the path for obtaining a bachelor's degree in engineering is limited. In 2005, Ministry of Education prohibited universities to accept the graduates of technical colleges to transfer to universities, except for the bachelor of industrial education and bachelor of technology programs, due to a shortage of technicians in the labor market and increasing number of graduates of technical colleges transferring at that time. Their diploma was not recognized as such and the graduates of technical colleges could transfer only credits which are scrutinized by each university. Even transferring to Rajamangala University of Technology group which used to be under OVEC administration and have close relationship with technical colleges, it usually takes 3-4 years, not two years, to graduate after transferring (see Table 35). Those technical college graduates transferred are considered very weak in academic knowledge, especially in math and English.

[85] It is not necessary to have the license to be employed as engineers, but still often the case, technical college graduates are not employed as engineers.

Table 35: Accepting TC Graduates as Transferring Students

Questions	Yes	No	Don't know
Does your university accept TC graduates from the 3rd year as transferring students?	18.3%	61.0%	20.7%
Does your university plan to accept TC graduates to transfer to 3rd year?	21.3%	51.3%	27.5%

Source: Results of online survey given to universities

Furthermore, those who transfer to universities tend to become teachers of technical colleges, rather than engineers, since the transfer possibilities are limited to the bachelor of technology and the bachelor of industrial education. The holders of the bachelor of technology are not eligible for engineering certificate. The holders of the bachelor of industrial education are eligible for associate engineer, the lowest level of engineer certificate, yet it is only limited to the graduates of KMUT group and one Rajamangala University of Technology since they are the only programs accredited by COE.

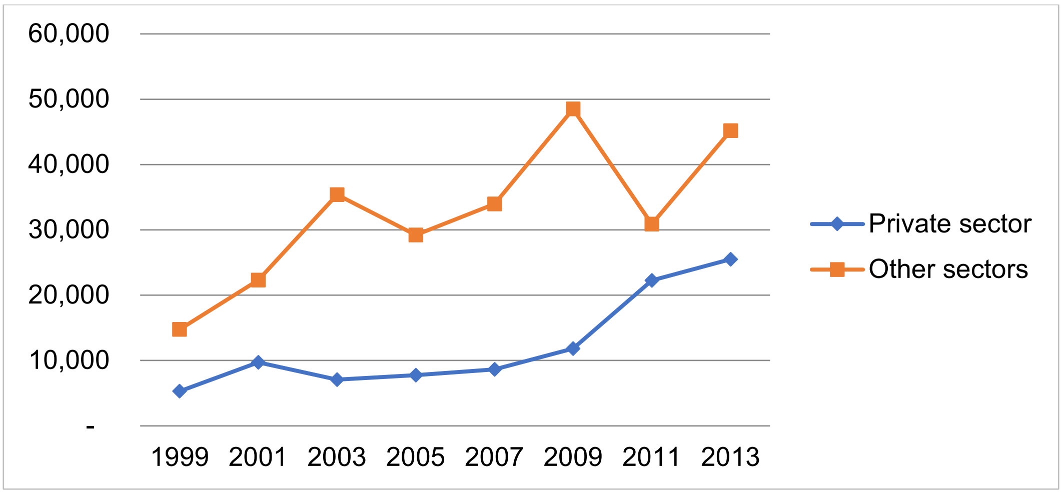
These structural constraints may have negatively affected the quality of technical college students. One of executives of KMUT group stated that the quality of technical college graduates entering university used to be very good since their hands-on skills were better than those from general track, but the quality deteriorated since 2005.

In 2016, MOE changed the regulation so that any engineering department at university now can accept the graduates of technical colleges. The first batch of students will start the program in the 2017 academic year. However, this does not mean that the graduates of technical colleges can transfer to any engineering department and graduate with two-year's further study. For example, KMITL will offer four programs for technical college graduates, namely civil engineering, information technology, computer engineering and industrial management. These programs are specifically designed for technical college graduates and will require three years, possibly two and half years, to graduate. However, only graduates of the civil engineering program will be eligible for engineering license, according to COE. The 2016 ministry regulation is expected to open up more career paths for technical college graduates. However, the options are still limited and close examination and monitoring of the progress will be needed.

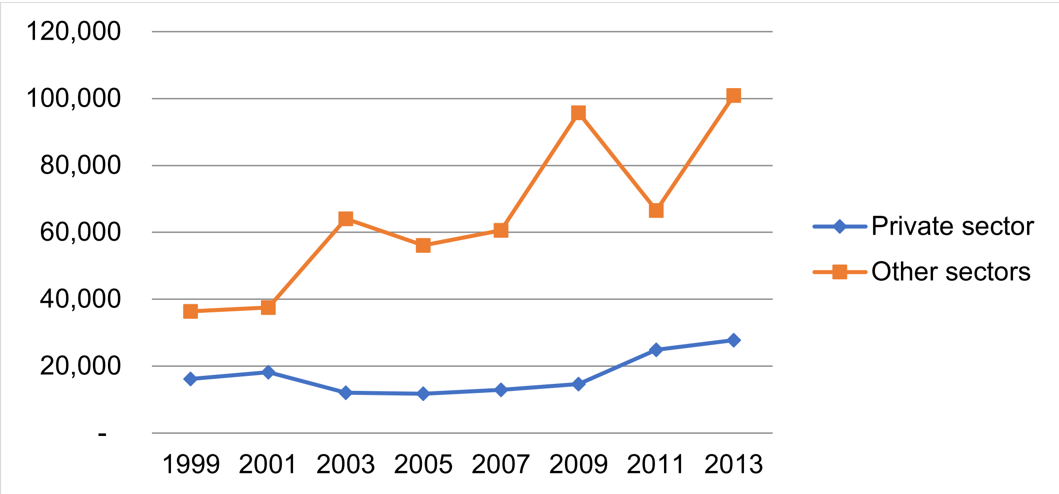
4.3.2.2 Limitation for university graduates

Pursuing an engineer career has a limitation due to two major reasons for university graduates. One is a lack of opportunity of R&D at private sector and another is that engineer's status in a company is not well established.

Private sector's involvement in R&D is still very limited in Thailand. The number of R&D personnel in the private sector accounts for only one third of the total (see Figure 41 and Figure 42). The private sector's contribution to R&D expenditure is around 50% for the last five years, which is much smaller compared to 77% in Japan and 61% in Singapore (see Figure 43). The Thai government set the target of the ratio, 70% to 30% (private versus government) during 2016-2021, but the progress has not met the target.[86]

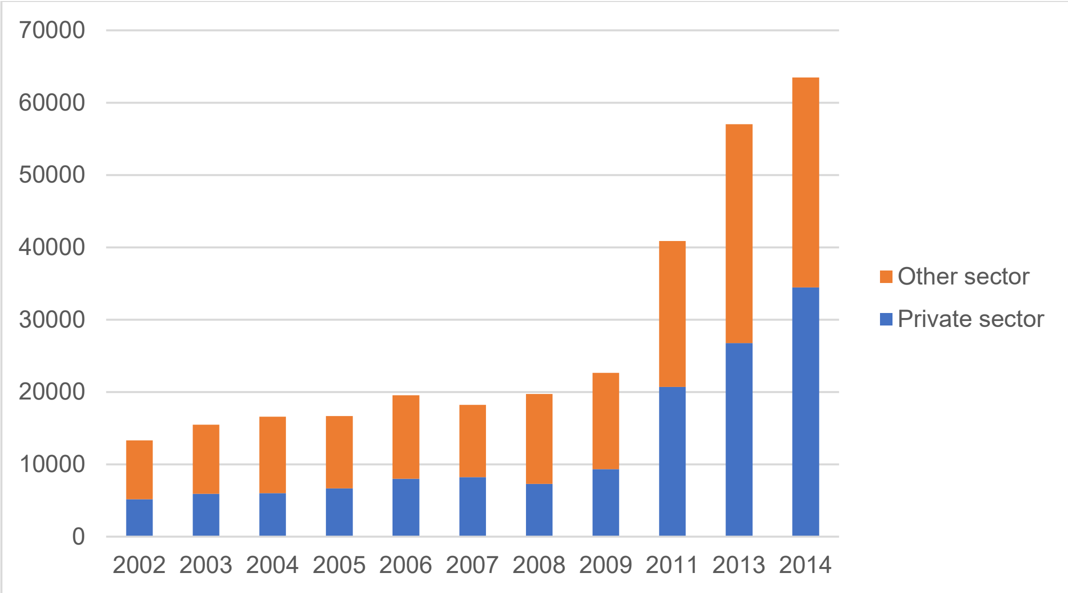


Source: STI (2016b)
Figure 41: R&D Personnel: Full Time Equivalent (FTE) 1999-2013



Source: STI (2016b)
Figure 42: R&D Personnel: Headcounts 1999-2013

[86] Although limited, there is a notable increase in R&D expenditure contributed by the private sector for the last five years. The amount has been more than doubled in value. The top five sector of contribution is seen in the following; 1. Refined petrochemical products; 2. Food products and beverages; 3. Chemicals and chemical products; 4. Research and development services; and 5. Other non-metallic mineral products. (STI, 2016)



Source: STI (2016b)
Figure 43: R&D Investment by sector (unit: million baht)

Ninety percent of SMEs do not conduct any innovation activities[87]. While larger companies have their own R&D departments, they focus more on process improvement rather than product development. Our interviews show that product development is done overseas partly due to limited confidence in the local capacity, which does not provide a challenging opportunity for engineers. Some of faulty of engineering encourage the private sector to establish R&D centers since their graduates do not have much choice to work as engineers unless they work for universities or the government sector. Our interviews of alumni also support this situation, saying their career as engineers was limited in the private sector. If they wanted to continue to pursue engineering career after 10-15 years, they needed to be independent.

Another reason is that status of an engineer is not a well-established position in a company. Given a limited opportunity to pursue engineering career for R&D, their promotion is limited. Changing a career to administration has better chance for promotion. Conversely, in our interviews, some Japanese manufacturing companies mention that when Japanese companies would like to transfer the authority of management to the local staff, they expect capable engineers to take over the management position since they have engineering background. It is very common for graduates of engineering to obtain master of business administration degree, which is considered to be an elite track of manufacturing companies. In fact, the 2015 survey by JCC Bangkok shows that lack of human resources at manager-level is the second biggest challenge for 53% of manufacturing companies (1st being competitiveness among firms) and the demand for management skill with engineering background is extremely high[88].

Our survey of university students show that they perceive pursuing a career as an engineer is not favorable in terms of salary, working condition, and promotion. Many of students prefer not working in production, since salary is not attractive enough for inflexibility of working hours, severe working condition as they get older, and the R&D work is limited and not interesting, as shown in Table 36.

[87] UNCTAD, 2015
88 Japanese Chamber of Commerce Bangkok (2015) *A Survey of Business Sentiment on Japanese Corporations in Thailand for the 1st half of 2015* (Summary)

Table 36: Students' perceptions of engineering and manufacturing

Perception (n = 235)	Agree/Agree to some extent (%)	Disagree/Disagree to some extent (%)
The image of manufacturing is not appealing.	69.78	30.22
Work style (working outside Bangkok) is not appealing.	55.98	44.01
Engineering is disadvantageous in terms of salary and benefits.	66.10	33.91
There are limited opportunities for promotions.	80.42	19.57
The scope of work is limited to production (not much in R&D).	82.48	17.53
Not interested in engineering since entering university.	36.17	63.83

Source: Results of online survey given to university students

The negative image of working in the manufacturing sector seems to be attributed to the limited scope of work and a narrow career path for engineers. Other factors such as lower salary and benefits than other sectors also help create a negative image, although the salary of an engineer is in fact relatively higher than that in other occupations.[89] In order to improve the perceptions, companies need to make efforts to develop the career paths they offer so that they are attractive to both students and engineers. Manufacturers' organizations should also promote the advantages of working in the sector to university students.

Box 13: Personnel system and effects on engineering careers

The personnel system in many companies limits the chance of success on an engineering track. After a certain period of work, most engineers would need to go to the management track as proof of progression in their careers. This resulted in the termination of their use of their engineering skills. At the interviews, more than half of the successful engineers who were promoted to management positions became less or never involved in engineering tasks after their promotion. Only two managers were still able to pursue their product development and innovation tasks after promotion. Two engineers revealed that they resigned from the company or the management position to get back to engineering tasks, even though the salary was lower. Two engineers established their own company after realizing that existing companies in Thailand provided no chance for R&D. It is clear from these occurrences that there is a great need for cooperation from the industrial side, a review of the extent to which opportunities are provided to Thai engineers in product development or innovation in the company, and a review of the personnel system and career plan in the company, with the aim of securing superb human resources.

4.4 Initiatives/efforts by the Thai government, the private sector and other organizations

Various efforts have been made by the Thai government, the private sector and other organizations in order to strengthen industrial HRD. In this section, the Thai government's initiatives, namely incentives for companies to support HEIs and TVET and establishment of professional, vocational and occupational qualifications are introduced. Then, the private sector's efforts to overcome the weakness

[89] According to a survey conducted by Personnel Consultant Manpower (Thailand) Co., Ltd. in 2016 and given to 1,102 Japanese companies in Thailand, the monthly salary of a newly graduated engineer ranges from 17,000 to 22,000 Baht, which is higher than any other occupation.

of the graduates are presented. Finally, other organizations' efforts, such as HCBI-FTI and TAPMA, TETA, AMATA are introduced.

4.4.1 Thai government's initiatives/efforts

4.4.1.1 Incentives for companies to support HEIs and TVET institutions

The Thai Government has introduced tax incentive policies to attract FDI that helps Thailand enhance national competitiveness. These primarily include the provision of incentives for the introduction of higher technologies, HRD, R&D activities, design activities and commercialization of the results of local R&D. The merit-based incentives for FDI to cooperate with HEIs and TVET institutions are as follows (see Table 37):

Table 37: Merit-based incentives

Types of eligible investment/expenditure	Additional cap[90]
Research, Technology Development and Innovation: In-house, outsourced in Thailand or joint R&D with overseas institutes	200%
Donations to technology and HRD funds, educational institutes, specialized training centers, R&D institutes or governmental agencies in the S&T field in Thailand	100%
IP acquisition/licensing fees for commercializing technology developed in Thailand	100%
Advanced Technology Training	100%
Development of local suppliers with at least 51% Thai shareholding in advanced technology training and technical assistance	100%

Source: BOI

The companies operating in the super clusters for automotive and auto-parts and electric and electronic product manufacturing are eligible for various incentives and benefits on the condition that they cooperate with HEIs and TVET institutions, utilizing the talent mobility program (see Box 6), WiL and the dual system (see Box3) (see Table 38).

Table 38: Conditions for receiving cluster incentives

Conditions for receiving cluster incentives	Incentives and benefits
• Must cooperate with academic institutions / research institutions / the Center of Excellence in the cluster area to develop human resources and improve the level of technology: • Cooperate with the Talent Mobility, Work-integrated Learning, Co-operative Education and/or Dual systems • Cooperate in developing human resources or technology as approved by the Board of Investment	• Eight-year corporate income tax exemption and an additional five-year reduction of 50% • The Ministry of Finance will consider granting 10-15 years' corporate income tax exemption for future-driven industries of significant importance • Import duty exemption on machinery • Personal income tax exemption for renowned specialists who work in the specified areas, both Thais and foreigners

[90] Corporate tax exemption: % of eligible investments or expenditures

	• Consideration of granting Permanent Residence to leading specialists • Permission for foreigners to own land to implement promoted businesses

Source: BOI

In addition, the Thai Government has designated Chachengsao, Chonburi and Rayong Provinces in the Eastern region for the development of the EEC. For this purpose, BOI provides incentives to investors similar to those for the supercluster development (e.g., financial incentives for investment in R&D, HRD in targeted industries including automotive and auto-parts, electronics and robotics related businesses[91]).

There are good incentives for manufacturing companies to cooperate with HEIs and TVET institutions for HRD; therefore, it is important for both companies and HEIs and TVET institutions to closely communicate with BOI and seek ways of receiving incentives and benefits offered by the Government when they plan cooperation activities.

4.4.1.2 Establishment of professional, occupational and vocational qualifications

Professional, occupational and vocational qualifications can be an effective instrument to improve the status of engineering occupations when the holders of the qualification standards are accepted by employers and/or users of services. There are three types of qualifications established in Thailand in the fields of engineering and industrial technology, namely, COE, DSD-MOL and TPQI. All three qualifications aim at establishing their own standards for different purposes, as follows (see Table 39):

Table 39: Types of Qualifications in Thailand

Organization	Type of Qualifications Established	Scope and Target
COE	Engineering professions	4 levels of engineering standards in 8 fields
DSD-MOL	Vocational skills	3 levels of standards for 217 technical skills
TPQI	Occupations and Professions	4 – 7 levels of standards for 25 occupations

Source: Based on the results of interviews by Survey Team

The following sections will show the current situations about each qualification system and how these qualifications are viewed by companies and students.

(1) Engineering profession: COE's National system

There are eight engineering fields (Civil Engineer - Mechanical Engineer, Electrical Engineer (power), Electrical Engineer (Telecommunication/Electronic), Industrial Engineer, Mining Engineer, Chemical Engineer and Environmental Engineer) licensed by COE. The types of qualifications and their eligibilities are shown below (see Table 40):

[91] The other target industries include aviation and its related businesses, bio-businesses and medical hub related businesses.

Table 40: Types of Professional Engineering Licenses

Type of License	Requirements / Licensed activities (example for electrical engineer)	Education C	Education D	Education B
Associate Engineer (AE)	• Be a member of COE • Studied more than 105 credits and hold at least bachelor degree from an institution certified by COE • Must pass a test and/or participate in training organized by COE Able to plan, design, supervise and implement projects on a limited scale/type (Cost: less than 50 million Baht, accommodation: less than 500 persons, machinery: requiring less than 350 kilowatts) in the case of electrical engineer			X
Professional Engineer (PE)	• Be a member of COE and hold AE licence • Must submit 1) a record of professional experiences for at least three years and 2) a report of outstanding work (2-5 projects) which are certified by a PE • Must pass a test and/or participate training organized by COE Able to plan projects of all types and on all scales. Able to design and implement projects on a moderate scale/type of projects (e.g., using less than 750 Kilowatts of electricity)			X
Senior Professional Engineer (SPE)	• Be a member of COE and hold PE licence • Must submit 1) a record of professional experiences for at least five years and 2) a report of outstanding works (2-5 projects) which are certified by a SPE • Must pass a test and/or participate in training organized by COE Able to plan, design, supervise, implement a project on all scales/types			X
Adjunct Engineer (ADE)	• Four years' professional experience for a BWC (engineering) graduate, six years' professional experience for a BWS (engineering) graduate, and 10 years' professional experience for a BWS (non-engineering) graduate • Must submit a record of relevant professional experiences certified by his/her supervisor who also have to be PE or SPE • Must pass a test, participate in training organized by COE or be interviewed by COE Able to perform jobs on the scale and of the type specified in the licence. The licence is issued on a project basis only.	X	X	X

Source: COE

C: Certificate (vocational high school graduate), D: Diploma (vocational college graduate), B: Bachelor degree (university graduate)

In total, there are 215,890 certified engineers (AE: 183,319, PE: 20,572, SPE: 4,468, ADE: 7,531) as of November 2016. Professional engineering qualifications are necessary for companies to plan, design, and manage facilities in Thailand in compliance with legal requirements; therefore, such qualifications are regarded as quite important for civil engineers and important to some extent for electric and mechanical engineers because of the demands for qualified engineers to implement projects. In the field, there are 72,802 civil engineers, 43,126 mechanical engineers, 50,519 EE-P engineers, 15,896 EE-C engineers, 24,974 industrial engineers, 1,348 mining engineers, 4,361 environmental engineers and, 2,864 chemical engineers licensed by COE as of December 2016.

However, these licenses are used in a limited scope and such qualifications are not required of every engineer engaged in business operations. Therefore, the companies that were interviewed and/or responded to the questionnaire are not interested in encouraging their staff to obtain professional engineering qualifications. University students are not also interested in obtaining professional qualifications as a means of upgrading their qualifications or career path as they are not eligible for this during their study period.

Bachelor degree holders whose programs are certified by COE are eligible for professional qualifications. According to COE, most state university graduates who majored in engineering are eligible to apply for AE after three years of work experience. On the other hand, the career path to become an engineer is limited for technical college graduates. First of all, only a few universities such as RMUT allow technical college graduates to transfer credits. Secondly, because they do not transfer enough credits, they need to spend more than three years to obtain an engineering degree. Those holding a bachelor of industrial education, which is the main career path for technical college graduates who transfer their credits to such universities as KMUTT and RMUT, are also eligible to apply for AE, although this takes more than three years. The bachelor of technology, which is granted by the institute of vocational colleges, is not eligible to apply to COE. Graduates are eligible to apply for an ADE, but it is issued only on a project basis.

(2) Engineering profession: Regional system

The ASEAN Chartered Professional Engineer (ACPE) was introduced in June 2015 based on the ASEAN Mutual Recognition Arrangement on Engineering Services to facilitate the mobility of engineering service professionals in alignment with the establishment of the ASEAN Economic Community. As of November 2016, 2,227 engineers are registered as ACPE engineers in the seven fields, as shown in the table below.

The number of ACPEs is still small because the ACPE system just started in January 2016 and only SPEs are eligible to apply for ACPEs. In order to work in other ASEAN countries, an ACPE must be registered as a Registered Foreign Professional Engineer (RFPE). However, very few ACPEs have applied for RFPE as this system is still new and only some countries, such as Singapore and Malaysia, have prepared the regulations to accept RFPEs.

Another system is the Asia-Pacific Economic Cooperation Engineer (APEC engineer), introduced in 14 member countries of APEC. Since 2009, COE has started accepting registration. So far, APEC engineers or ACPE registration requires any foreign engineer to apply for ADE. This means they cannot work independently when they are registered for the first time.

Table 41: Number of ACPEs/APEC engineers by country

	Member Countries	ACPEs (as of Dec. 2016)	APEC engineers (as of Dec. 2015)
1	Indonesia	844	15
2	Malaysia	284	404
3	Singapore	252	36
4	Myanmar	239	n.a.

5	The Philippines	205	58
6	Vietnam	196	0
7	Thailand	158	309
8	Cambodia	30	n.a.
9	Lao PDR	11	n.a
10	Brunei Darussalam	8	0
	Total	2,227	822

Source: COE

Table 42: Number of ACPEs/APEC engineers registered in Thailand by field (January 2017)

	Engineering fields	ACPEs	APEC engineers
1	Civil Engineering	185	76
2	Electrical Engineering	70	26
3	Mechanical Engineering	86	33
4	Industrial Engineering	14	13
5	Mining Engineering	4	2
6	Chemical Engineering	1	4
7	Environmental Engineering	2	4
	Total	362	158

Source: COE

In sum, professional engineering qualifications are necessary for engineers engaged in construction and civil engineering projects. However, the engineers engaged in manufacturing, particularly those who work for companies, are not very interested in obtaining such official qualifications because companies do not require or value such qualifications. Professional qualifications are still useful for individuals when applying for a new job or changing their career path. ACPE or APEC engineers can be effective in promoting the status of engineers as such professional qualifications could facilitate their mobility across the border. However, at present, the numbers of and the demand for ACPEs and APEC engineers are still very limited.

(3) Vocational skills of DSD-MOL

According to the JETRO report on occupational qualifications, DSD-MOL identifies 217 types of vocational qualifications in cooperation with FTI. However, DSD-MOL conducts tests for approximately 66 out of 217 types of vocational qualifications. Some qualifications are classified into three levels: the basic, the intermediate and the advanced levels. But as shown in the table below (see Table 43), applicants mostly apply for only the basic level. As shown in the above table, the vast majority of the applicants take tests at the lowest level.

Table 43: Results of vocational qualification tests for fiscal year 2015 (more than 1,000 applicants)

Type of Qualification	Level 1		Level 2		Level 3		Daily Minimum Wage[92] (in Baht)
	Applied	Passed	Applied	Passed	Applied	Passed	
Industrial qualifications	6,267	4,356	134	92	0	0	

[92] The daily minimum wages are based on the announcement made by the wage committee.

Mechanical qualifications	10,960	9,554	52	48	-	-	
Electric/electronic qualifications	24,930	16,798	62	62	0	0	
Metal Active Gas Welding	1,225	963	54	30	-	-	L1: 400, L2: 500, L3: 600
Computer Aided Mechanical Design	1,644	1,053	7	7	-	-	L1: 460, L2: 530, L3: 670
Automotive Mechanic	4,694	4,176	13	10	-	-	L1: 360 L2: 445, L3: 530
Automotive Maintenance	4,226	3,540	20	19	-	-	L1: 340, L2: 400
Electrician (Building)	4,988	3,617	51	51	-	-	L1: 400, L2: 500, L3: 600
Industrial Wiring	1,577	1,322	10	10	-	-	L1: 400, L2: 500, L3: 600
Air Conditioning (Building)	1,785	1,401	-	-	-	-	L1: 400, L2: 500
Electronic (Television)	1,777	1,061	-	-	-	-	L1: 400, L2: 500
Micro-computer Repair	1,914	1,530	1	1	-	-	L1: 400, L2: 500, L3: 600

Source: Statistics of the Ministry of Labor, 2015

These vocational qualifications can be an effective tool in upgrading the workforce in manufacturing. Nevertheless, the effectiveness needs to be improved, keeping the following facts in mind:

- The vocational standards of these qualifications are still not so reliable (according to interviews). Some companies do not trust the quality and standards of the qualification holders. Other companies mention that some skills do not match the required skills by the companies.
- One vocational skill constitutes only a part of the required capabilities. More and more companies require their technical staff to do more multi-tasking.
- Wages for highly demanded jobs exceed the minimum wages; therefore, there is less incentive for company employees to obtain vocational qualifications.

As a result, most of those interviewed and the respondents to online survey given to companies do not consider vocational qualifications to be so important. The results of the online survey given to companies also show that companies do not necessarily consider qualifications to be important (see Table 44).

Table 44: Companies' views on qualifications

Qualifications	Useful		Not useful		Total
	n	%	n	%	
Language certificate	47	75.81	15	24.19	62
Engineer Registration (COE)	31	57.41	23	42.59	54
DSD and other public qualifications	32	55.17	26	44.83	58
TPQI qualifications	23	43.40	30	56.60	53
Qualifications issued by private institutions	27	50.94	26	49.06	53
APEC engineer	20	37.74	33	62.26	53

Source: Results of online survey given to companies

University and technical college students do not have much incentive to study for vocational qualifications. First of all, most of the vocational qualifications require at least one year of work experience. Also, as mentioned earlier, many companies do not treat vocational qualification holders differently from other applicants. This is also confirmed by the focus group discussions with three technical college students from automotive, mechanic and electrical and electronic courses. Very few of them are aware of and are studying for vocational qualifications.

(4) Occupational qualifications of TPQI

TPQI was established in March 2011 under the Prime Minister's Office. While COE is in charge of the development of engineering professionals and DSD-MOL promotes vocational qualifications for mainly technicians and workers, TPQI has been developing a quality assurance system for occupational qualifications that are not covered by COE or DSD-MOL. TPQI's policy is to closely work with industry and improve the competitiveness of Thai professionals in ASEAN. The salient features of TPQI's system are as follows:

- Qualification standards are jointly developed with industry and academia with advice and reviews by relevant agencies such as DSD-MOL and OVEC-MOE.
- External organizations accredited by TPQI conduct qualification certification.
- TPQI plans to integrate professional standards into the curriculum of technical colleges and engineering universities so that the students of these universities can graduate with TPQI certified qualifications.
- TPQI is negotiating with other ASEAN countries to make its qualification standards compatible with those of other ASEAN countries in compliance with NQF.

To date, 60 qualification standards have been established (25 for the manufacturing sector) and certification examinations have been conducted for 17 qualifications (five for industrial technologies). Also, standards for Petroleum/Petro-chemical I, Production Design, High Tech Electronics, Robotics and Automation and Refrigeration will be established in 2017. In addition, 25 qualifications will be established for auto-parts manufacturing (e.g., Automatic Arc Welding, hot and cold forging, plastic injection, auto-parts production machinery maintenance, CAD drawing, Quality Assurance and Inspection).

Table 45: The results of TPQI qualification tests relating to manufacturing

Qualifications	Level	Applied	Passed	Certifying Organizations
The standards established and tests conducted				
Mechatronics Technicians	3	478	223	KMUTNB
Petroleum/Petro-chemical I	4	19	1	Petro-chemical companies
Mold and dye production	2	427	291	Samutsongkhram TC, Sattahip TC, Thai-German Institute, RMUTs (Tanyaburi, Lanna, Isan)
	3	138	105	
Automotive services	1	46	46	Samutsongkhram TC, Prachinburi TC, Siam TC, Sattahip TC, Theo Company, Ltd., Ubon Rachathani TC, Chaiya Vocational Education College
	2	1,445	1,353	
	3	69	58	

Source: TPQI

TPQI qualifications are new and not known to companies and tests have been conducted mostly for lower levels. For this reason, the companies or service users have not been assured of the standards of TPQI qualification holders. However, TPQI qualifications can be an effective tool for technical college graduates to develop their career paths to fill in the gap with the academic qualifications needed to be an engineer.

4.4.2 Measures taken by companies to deal with weakness of technical staff

According to the online survey results, in-company training, training in Japan and the use of experts and/or consultants are main measures to upgrade the capacities of engineers and technicians. The results of interview survey show that Japanese companies heavily rely on long-term training in Japan to upgrade the practical knowledge and skills of their engineers and technicians. For this purpose, many of them seek financial support by the Overseas Human Resources and Industry Development Association (HIDA). Training is usually conducted in the form of On-the-Job Training (OJT) and trainees are exposed to manufacturing in Japan. Such real field experience would also provide opportunities to learn corporate culture, discipline and the Japanese language, as well as various aspects of manufacturing(see Table 46).

Table 46: Measures taken by companies to cope with weaknesses of university and technical college graduates

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Training in company (in Thailand)	28	80.0	31	91.2	59	85.5
Training in company (in Japan)	18	51.4	16	47.1	34	49.3
Training in third countries	0	0.0	7	20.6	7	10.1
External training (public institutes)	9	25.7	16	47.1	25	36.2
External training (private organization)	13	37.1	18	52.9	31	44.9
External training (private enterprise)	6	17.1	19	55.9	25	36.2
External training (higher educational institutes)	1	2.9	8	23.5	9	13.0
Individual guidance such as mentor	2	5.7	28	82.4	30	43.5
Invite Japanese engineers	23	65.7	15	44.1	38	55.1
Invite engineers from third countries	2	5.7	4	11.8	6	8.7
No special training	1	2.9	0	0.0	1	1.4
Others	2	5.7	3	8.8	5	7.2
Total	35	100.0	34	100.0	69	100.0

Source: Results of online survey given to companies

According to an online survey given to companies, 65.7% (23 out of 36) of the Japanese companies that take such special measures as providing training in their headquarters in Japan and/or sending their staff to be trained by training service providers find the training cost to be very heavy or heavy to some extent. Therefore, it would be very helpful for Japanese companies if HEIs and TVET institutions could introduce a program to supplement the long-term training in Japan because training in Japan is particularly costly and there is a risk of losing trained technical staff. The Thai companies do not feel financial burden as much as the Japanese companies probably because they invest less in filling the gaps in the staff's technical capacity than the Japanese companies (see Table 47).

Table 47: Companies' views on the cost of measures to upgrade their engineers and technicians

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Feel very heavy burden	5	14.3%	1	3.0%	6	8.8%
Feel burden to some extent	23	65.7%	15	45.5%	38	55.9%
Not burden	7	20.0%	17	51.5%	24	35.3%
Total	35	100.0%	33	100.0%	68	100.0%

Source: Results of online survey given to companies

4.4.3 Organizational efforts made by industrial organizations in the manufacturing sector

Several industrial organizations are actively supporting universities and technical colleges in Thailand. The level of cooperation varies, depending on the type of industry. Such industrial bodies as FTI's Human Capacity Building Institute and TAPMA take the initiative in supporting universities and technical colleges for HRD. This is partly because of the nature of this industry, which requires strong links between Original Equipment Manufacturing (OEM) companies and suppliers. In the electric and electronic product manufacturing industry, organizations such as TETA act as advisory members to HEIs, yet cooperation with HEIs is not as common as seen in the automotive and auto-parts industry. This is probably because of the nature of industrial structure where OEMs and parts suppliers have strong ties and organizational support is more active in the automotive industry.

(1) HCBI-FTI and TAPMA

HCBI-FTI and TAPMA have been intensively involved in cooperation with HEIs and TVET institutions. Therefore, they would be important partners in the implementation of projects in the automotive and auto-parts industry. Their main activities are as follows:

- As a member of the PPP committee for TVET, HCBI-FTI and TAPMA are directly involved in the development of a model automotive course in three selected technical colleges[93] aimed at updating their existing curriculum and equipment and training the teaching staff. In particular, HCBI-FTI and TAPMA intend to change the mindset of the teaching staff so that they can cope with the changing needs of industry. HCBI-FTI and TAPMA encourage its member companies (approximately 80 companies) to participate in the dual system to train TC students at work.
- Based on a formal agreement, FTI supports the introduction of an undergraduate course to produce hands-on engineers for auto-parts manufacturing in KMUTT by sending lecturers and accepting students so that they can use the latest facilities and equipment in use by companies. Discussion is ongoing with other universities such as TNI and STI to introduce a similar course.

Apart from cooperation with HEIs and TVET institutions, HCBI-FTI has conducted a mobile training program with the support of DSD-MOL. This program is intended to function as refresher training for

[93] Rayong TC, Samutprakan TC and Chachoengsao TC

company staff (mainly for workers) to impart such soft skills as quality control and safety management, led by industry and taught mainly by lecturers from industry. In 2015, approximately 2,000 company employees were trained with a budget of 50 Million Baht. There is a possibility that a similar arrangement could be made to implement a program for technicians and engineers to upgrade their skills in response to the technical needs of the companies.

(2) TETA

TETA is under the umbrella of FTI, consisting of approximately 200 companies, many of which are local assemblers of electric and electronic products. According to TETA, it has not been directly involved in cooperation with HEIs or TVET institutions. TETA members are sometimes asked by the Government (OVEC and Ministry of Industry) about their views on industrial HR, etc. An institutional framework needs to be prepared to form a partnership with the electric and electronic product manufacturing industry.

(3) AMATA[94]

There are 48 industrial estates managed either by IEAT or as a joint venture between IEAT and private companies. In order to respond to the needs of their clients and attract new clients, these industrial estates are interested in industrial HRD. For example, AMATA PLC,[95] the largest company in the development and management of industrial estates in Thailand, has established the AMATA science city in cooperation with STI to provide facilities and equipment for R&D. In response to its clients' strong need for competitive technicians, AMATA is planning to establish an industry-led vocational school, taking advantage of the relationships with its clients. At present, 17 companies in AMATA's industrial estates accept technical college students through the dual system.

(4) Others

TCC organizes businesses in all sectors and can support an industrial HRD project in areas such as the establishment and promotion of professional qualifications, particularly qualifications in short supply in Thailand (e.g., facility maintenance technicians). Industry-wise, TCC mainly focuses on the service and agriculture sectors and FTI plays the main role in industrial HRD for the manufacturing sector.

TAI conducts short-term regular and tailor-made training courses for employees (mainly workers and technicians) of automotive and auto-parts companies, mainly in production technologies and skills. The trainers have been trained through the Automotive Human Resource Development Project[96] (AHRDP). The training topics requested by companies concern technologies useful in reducing costs and increasing productivity, such as Industry 4.0 and automation. Popular courses are Sequence Control (PLC), hydraulic and pneumatic systems, TQM, Job Instruction (JI)/Job Method (JM) and Job Relations (JR), etc. After the end of AHRDP, fewer regular training courses have been conducted due to budget

[94] The largest industrial estate in Thailand
[95] AMATA PLC operates two industrial estates in Rayong and Chomburi for approximately 700 companies, of which 70% are Japanese companies.
[96] The project was implemented during December 2006 – March 2011 with assistance from JICA, as well as JETRO, The Association for Overseas Technical Scholarship (AOTS) and Japanese private companies.

shortfalls. According to AHRDP, it is difficult to charge a training fee to Thai companies, particularly SMEs.

Chapter 5 Results of the domestic resource survey for industrial HRD in Thailand

5.1 Profiles of universities and national institutes of technology surveyed

As noted in Chapter 1, semi-structured interviews were conducted with thirty (30) universities with a faculty of engineering (with a course in ME and/or EE) and thirteen (13) interviews were conducted with colleges of KOSEN and a literature review was completed of the information provided by the universities and KOSENs targeted as well as their webpages and other literature relevant to the issues for this survey. The criteria for selecting universities and KOSENs for the survey were to 1) have sufficient knowledge and experience with production of industrial HRD and UIL 2) actively work on career education and employment support for students and have a high employment rate[97], and/or 3) promote collaboration with universities and TCs in Thailand and have records of receiving exchange students from them. Universities and KOSENs where an interview survey was conducted were listed in Annex 2[98].

5.1.1 Teachers and students

According to the information provided by the universities and KOSENs surveyed as well as the information available on their websites, the number of students per teacher is 9-49 at the universities surveyed, and 12-22 at the KOSENs surveyed. Generally, the employment criteria for teachers of specialized subjects at universities are a doctoral degree and research achievements, and at KOSENs 1) a doctoral degree, 2) the ability and willingness to guide students and 3) social contribution (e.g. UIL). The ability to provide educational guidance (including life guidance) to students with a wide range of ages (15-22 years old) is regarded as of utmost importance, particularly at KOSENs. The percentage of teachers with a doctoral degree is 83 - 100% at the surveyed universities and 67-100% at the KOSENs surveyed. Hence, excluding some teachers that have extensive experience working in specific skill demanding industries and professional achievements, almost all teachers have a doctoral degree. On the other hand, professional graduate schools such as the Advanced Institute of Industrial Technology are obliged to make sure that more than 30 % of their full-time teachers have long working experience in a related field as well as professional achievements. At the Institute, about 80% of teachers have a master's degree and about 40% have a doctoral degree.

The standard deviation scores of the surveyed universities vary widely from 43 to 67[99]. On the other hand, the scores of the surveyed KOSENs range between 51 and 68[100], which indicates that in general a KOSEN can be an option for the junior high students with very high academic performance. Even at universities and KOSENs with high standard deviation scores, due to the wide variety of methods of entrance examinations, it is often the case that enrollees' academic knowledge varies. Therefore, even these competitive universities and KOSENs are compelled to take measures to cope with the discrepancies in the basic academic performance of enrollees, according to the result of the interviews.

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[97] The ratio of students who obtain jobs out of students who seek employment
[98] The Advanced Institute of Industrial Technology provided a response to a questionnaire via e-mail.
[99] The list of the standard deviation scores of universities is available at https://manabi.benesse.ne.jp/ap/daigaku/search/nanido/ (in Japanese).
[100] The list of the standard deviation scores of KOSENs is available at http://xn--swqwd788bm2jy17d.net/kousen.php

5.1.2 Curriculum

At the surveyed universities and KOSENs, curriculums consist of specialized subjects and liberal arts, and the percentage of experiments and practical training sessions in curriculums tend to be about 12.5-50% of the total curriculum at universities, 20-30% at national universities of technology where many graduates of KOSENs go, and about 10-70% at KOSENs. With regard to how to connect lectures with practical training sessions, many teachers responded that they make sure to explain the relationship between relevant lectures and practical training sessions.

In most curriculums, students can learn the basics of science and mathematics (e.g. differential and integral calculus, linear algebra, physics and chemistry) during the first year. It is common that students study liberal arts for the first two years and then specialized subjects for the remaining years. At the universities and KOSENs surveyed, however, a “wedge-shaped curriculum” was adopted, which makes students study specialized subjects from the first year, and gradually increases the number of specialized subjects in subsequent academic years. By studying liberal arts and specialized subjects together, this type of curriculum enables students to maintain their motivation to study specialized subjects and apply a basic understanding of science and mathematics and wide perspectives from liberal arts to specialized subjects. At KOSEN, Numazu College, for the first two years students have the same curriculum as other students of different courses, and from the third year they have inter-disciplinary subjects as a minor. This makes students expand their technical expertise[101]. On the other hand, the Toyohashi University of Technology adopts a “spiral-up” curriculum, in which students repeatedly study basic and specialized subjects and take a long internship program. With this type of curriculum, students can naturally develop practical skills, creativity and leadership, understand the scientific basis and develop a new technology. At the graduate program, by incorporating basic subjects in the curriculum, the university tries to develop human resources who can fully present the scientific basis of specialized subjects. As an accreditation of a curriculum, several universities and KOSENs surveyed have programs accredited by the Japan Accreditation Board for Engineering Education (JABEE) [102]which authorizes them as an engineering education program of an international standard.

Regarding the status of incorporating internship programs into curriculums, almost all schools surveyed had an internship program[103]. There are cases where the program can be accepted for credits when meeting requirements or where they are provided as elective or required subjects. At Nagaoka University of Technology, fourth year students who pursue a master's degree participate in an internship for 5 months[104] instead of graduation research, learn what is required in the real world, and utilize the learning to select a research topic for master’s thesis. Additionally, according to the guidance from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) on “qualitative change in

[101] The curriculum is expected to be restructured soon.

[102] JABEE-authorized programs are considered to be largely the same as those authorized by member accreditation boards of the Washington Accord, which is an international accreditation agreement for professional academic engineering degrees, between the bodies responsible for accreditation in its signatory countries. The signatory countries include the U.S., U.K., and Canada. The graduates of JABEE-authorized programs are exempt from the primary qualifying examination of “P.E. Jp” (Professional Engineer Japan).

[103] According to a survey by the MEXT, 95.4 % of universities and 100% of KOSENs had internship programs in 2014. More KOSENs (61.4%) implemented international internship programs compared with universities (25.8% at the undergraduate level). Resource: MEXT (2016) “Regarding the implementation of internship programs at universities and other educational institutes in 2014” http://www.mext.go.jp/component/b_menu/other/__icsFiles/afieldfile/2016/03/15/1368428_01.pdf

[104] In case of international internships, the duration is 6 months.

university education to build a new future," many universities are trying to incorporate active learning into their curriculums, with PBL in particular being integrated into practical training sessions.

5.1.3 Facilities and equipment

Most universities and almost all KOSENs surveyed have a facility where students and teachers can freely use machines and equipment. A system has been set up in which students can receive operational guidance on machines from technical staff, engage in operation during practical training sessions, and use them to conduct experiments or manufacture parts for the experiments and extra-curricular activities after a usage application is approved and the safety of students is ensured. For example, the Institute of Technologists has a sufficient amount of equipment and machines for students to fully understand the mechanisms and the usage, and with regards to machines with a high versatility such as lathes, to the extent that each student can use one.

Regarding the procurement of machines and equipment, most respondents replied that machines and equipment are mainly procured by department budgets, and very expensive items are often procured by competitive research grants from inside and/or outside of the universities and KOSENs surveyed. At a graduate level, some universities utilize expensive and/or large machines belonging to other research institutions based on agreements. With regard to the latest machines which have become widely recognized in society such as 3D printers, there are some schools which actively procure them in order to increase the interest of students in their technical expertise. The following shows such efforts:

- Tokyo City University received a subsidy from MEXT's program on promoting common use of the most advanced infrastructure (a program to support the introduction of a new common use system) and established the *Research Center for Silicon Nano-science* in 2016 as research and development infrastructure at the top international level. Students at the university can utilize machines at the center for their research. The center is expected to be utilized with fees for teachers to conduct joint research projects together with companies or for local companies to conduct research at the center.
- The *Monozukuri Center* at the Osaka Institute of Technology is used for practical training sessions and experiments in the regular curriculum, student extra-curricular activities, support for manufacturing by primary and secondary students, and seminars on technologies.

Regarding the maintenance of machines and equipment, technical staff take charge of their operation and maintenance. They inspect, prepare and maintain machines and equipment, and discuss their maintenance and replacement with teachers. Technical staff also provide guidance on the operation of machines for students, approve usage applications from them, and ensure their safety when they use the machines.

5.1.4 Admission and employment

Both universities and KOSENs generally select students based on academic examinations or recommendations for enrollment. The competitive rate of enrollmentt [105] was 1.1 to 8.7 at the universities surveyed and 1.2 to 2.7 at the KOSENs surveyed by the survey team.

[105] The competitive rates of public universities in Japan are available at http://www.keinet.ne.jp/shutsugan/ and those of private universities and KOSENs are available on their websites.

KOSEN, Okinawa College (Department of Media Information Engineering) holds entrance examinations with a practical test focusing on specialty in addition to the ones by academic examinations and recommendation. The competitive rate of enrollment from the practical test is much higher than the other two examinations[106]. By screening applicants through a written application and a practical test, the College succeeded in attracting excellent students who are good especially in specialized fields.

The Toyohashi University of Technology, where about 80% of enrollees are from KOSENs and admitted to the third year, can take a special entrance examination by recommendation[107] in order to attract KOSEN students with high academic performance, and exempt them from paying some fees such as entrance and tuition fees. Students need to apply for this examination with a recommendation by a school head, pass an academic examination and pass an interview. Based on the results, an internal examination is conducted. From FY 2018, KOSEN students of advanced courses who do a long internship for a global leader training program at the university and get a good rating can be admitted to a doctoral program at the university after passing an internal examination when they graduate from the advanced course.

In order to accommodate as many excellent KOSEN graduates with experience in practical engineering education and conducting research as possible, Nagaoka University of Technology, which was founded to receive KOSEN graduates, also allows them to take an examination by recommendation, and about half (153 students) of the annual student limit (310 students) enter into the university through this examination. Applicants for the examination need to submit a letter of recommendation by a principal of KOSEN, and an academic transcript instead of an academic examination, and also take an interview.

Regarding employment, the employment rate for universities (at the undergraduate level) is 97.3% and that of KOSENs was 100% as of the 2015 school year according to a survey of MEXT[108]. The results were similar at the universities and KOSENs surveyed. The employment rate for universities at the undergraduate level tended to increase since 2011 (91.0%) and it is not difficult for students to obtain a job. The employment rate of KOSENs has been mostly about 98-100% for the past 20 years, irrespective of business trends.

5.1.5 Academia-industry collaboration

More and more universities and KOSENs have worked on academia-industry collaborations (e.g., UIL), and more research funds from private companies were spent than ever before (about 46.7 billion yen) in FY2015[109]. The most common manners of collaboration are joint or commissioned research projects

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[106] The competitive rates of enrollment in 2016 are as follows: Academic examination (1.8), recommendation (1.8), and a practical test (3.9) Resource: KOSEN, Okinawa College

[107] The quota is about 15 students.

[108] MEXT (2016) "The employment status of graduates from universities and other educational institutions for FY 2015" http://www.mext.go.jp/b_menu/houdou/28/05/1371161.htm Accessed on February 21, 2017

[109] MEXT (2017) "Regarding the implementation status of academia-industry collaboration at universities and other educational institutions for the fiscal year of 2015" http://www.mext.go.jp/component/a_menu/science/detail/__icsFiles/afieldfile/2017/01/13/1380185_001_1.pdf Accessed on February 21, 2017

and technical consultations. Additionally, some universities accept company employees in their laboratories, dispatch professors to companies for technical guidance, and support start-up companies. Generally speaking, each university and KOSEN tries to advertise research "seeds" of teachers by preparing a catalogue of them, uploading it on their website, and/or distributing it when they visit private companies or attend a matching event for UIL.

In recent years there is generally an office which promotes collaboration through an internal system. Coordinators who connect teachers with companies and negotiate with companies on the proceedings of the research projects, and staff who deal with other issues such as contracts are often posted in the office. Small universities and KOSENs often have one or more coordinators and staff members in the office on UIL. Larger universities sometimes have another department exclusively focusing on intellectual properties and promote their utilization. For example, such an office in Ritsumeikan University is staffed by 18 full-time coordinators exclusively working on UIL. At KOSENs, the head office in Tokyo deals with intellectual property. Major approaches to promote UIL are discussed in "5.2.2. Other approaches."

5.1.6 Career education and career/employment support

At the universities surveyed, career education is often implemented mainly by teachers at each faculty while career and employment support is provided by staff or career counselors/consultants (commissioned or contracted) at an office to provide career or employment support for the entire university. While some KOSENs also have a center to provide career support, teachers (in charge of employment support and a class teacher) generally take charges of both career education and career/employment support.

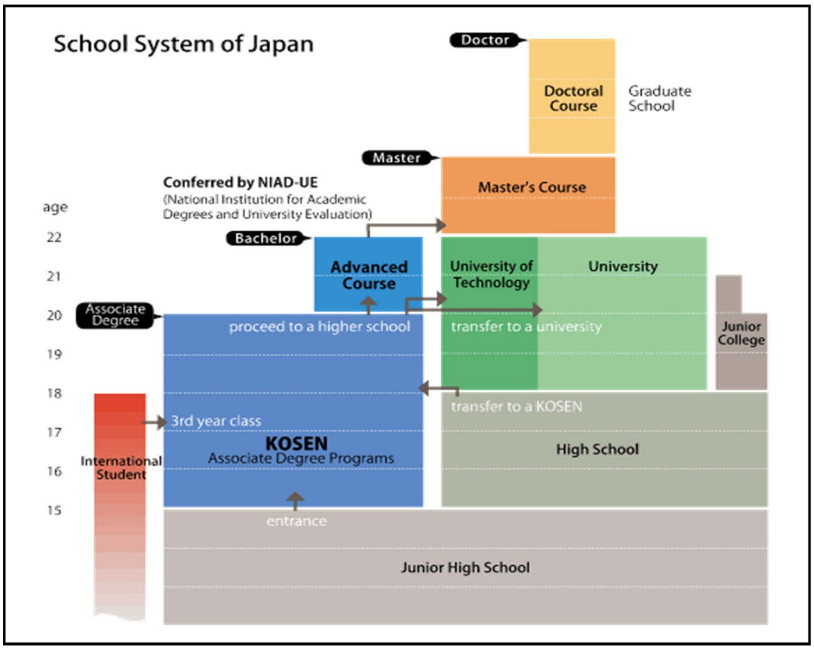
Major activities implemented at the surveyed universities and KOSENs to support career education include lectures by experts working on the front lines of industry (e.g. about the latest technology, the image of human resources sought by industries, and details of their work), provision of career development subjects (including PBL style practical training sessions), internship/co-op education, and assessments of their basic abilities as workers (e.g., Progress Report on Generic Skills (PROG) and Life Orientation (LIFO))."

As measures for students to prepare themselves for employment, seminars on business etiquette and practical training sessions for presentation and communication skills are provided, and obtaining qualifications and certificates is promoted. Qualifications and certificates that students are generally encouraged to obtain by the surveyed universities and KOSENs are "information technology engineers," "mechanical design engineers," "TOEIC," and "technical communication in English." Some universities and KOSENs surveyed provide financial support for examination expenses or approve the qualifications and certificates as credits.

Other activities to support the employment of students are the provision of "career and employment guidance," "seminars and workshops on self-analysis," "company information sessions (including ones by graduates)," "correction of entry sheets or resumes," "mock interviews" and "face-to-face consultations with a career counsellor." Some universities provide various support based on their policies on career and employment support according to characteristics of students at the universities, such as comprehensive implementation of these activities by e-learning, and/or face-to-face consultations with all students. Other distinctive approaches to support student employment are listed in “5.2.2 Other approaches”.

5.1.7 Profiles of KOSEN [110]

KOSEN was established in 1962 as a response to the strong requests from the industry for engineers who are able to deal with advanced industrial technology (see Figure 44). A KOSEN is an institution of higher education which provides engineering education over a five-consecutive year curriculum. There are 55 colleges of KOSEN throughout Japan as of 2017. Distinctive features of education provided by KOSENs include 1) five years of consistent engineering education from 15 years old, 2) practical and creative programs with a focus on experiments and practical training, 3) a two-year advanced course system, and 4) teachers of high educational and various professional backgrounds. More than 80% of teachers have doctoral or master’s degrees and more than 30% have work experience in private companies. The standard deviation scores of KOSENs are quite high and are often over 60 at the KOSENs surveyed (as shown in Table 48).



Source: The website of the head office, KOSEN

Figure 44 School System of Japan

110 National Institute of Technology (2016) “KOSEN : National Institute of Technology” http://www.kosen-k.go.jp/letter/kouhou/gaiyou28.pdf *Accessed on February 13, 2017

Table 48 Entrance and employment status of KOSEN

Colleges	Hakodate	Nagano		Nara			Tokuyama		Okinawa	
Courses	Production Systems Eng.	ME	EE	ME	EE	Control Eng.	MEE	CS and EE	MSE	Info and Comms
Standard deviation scores	63	61	61	67	67	67	67	67	57	57
Ratio of applicants to places (academic)	2.2	1.3	1.26	1.5	1.4	1.7	2.5	2.2	1.1	2.1
Job opening-to-application ratio	n.a	34.9		54.7	46.1	61.9	16.5	19.4	59.5	

Source: Summarized by the information based on the school pamphlets and homepages of several KOSENs surveyed, and the webpage of the standard deviation scores of all KOSENs[111]
Note: MEE: Mechanical and Electrical Engineering, MSE: Mechanical Systems Engineering, CS: Computer Science

After graduation, about 60% of the graduates of regular courses choose employment and about 40 % go on to universities or move on to advanced courses. About 65% of graduates of advanced courses choose employment and about 35% go on to graduate schools. Since graduates of KOSENs are academically excellent, there are quotas for their enrollment by recommendation to national universities at undergraduate and graduate levels. There was a private engineering university among those surveyed that gives graduates of KOSENs a 50% discount on tuition fees.

About 100% KOSEN graduates who choose to work obtain jobs and the job opening-to-application ratio is about 10 to 20 on average. The ratio of the control engineering course of KOSEN, Nara College was as high as about 62 in 2015. According to a survey on the career of KOSEN graduates[112], 54.6% of respondents (N=3,344) obtained jobs in the manufacturing industry after graduation. 30.0% of respondents worked on research and development, followed by production techniques (20.8%), which indicates that KOSEN graduates generally obtain jobs in fields related to their subjects.

5.2 Measures of universities and KOSENs in Japan that can be used as reference for universities and TCs in Thailand

5.2.1 Measures to enhance basic skills as engineers

As discussed in “2.8.2.4 What skills are needed?” five skills that industries in Thailand expect engineers to possess are 1) basic knowledge in mathematics and sciences (e.g. chemistry and physics), 2) technical/professional skills, 3) foreign language proficiency, 4) 21st century skills (e.g. problem-solving ability, collaboration, creativity, communication skills) and 5) work ethics and discipline (e.g. punctuality, commitment, responsibility). Measures to promote these five skills implemented in the

[111] Available at http://xn--swqwd788bm2jy17d.net/kousen.php *Accessed on February 19, 2017. The data are those of 2015 and 2016.
[112] Innovative Japan Project by KOSEN (2015) “the survey on the careers of KOSEN graduates (The results of simple totaling)” http://www.innovative-kosen.jp/?action=common_download_main&upload_id=795 *Accessed on February 21, 2017

universities and KOSENs surveyed that can be a reference to universities and TCs in Thailand are as follows.

5.2.1.1 Measures to improve basic knowledge in mathematics and sciences

While students with high academic performance enter into KOSENs in general, due to the entrance examination by recommendation, there are sometimes variations in their basic academic skills. Additionally, in universities, students who are not good at mathematics, which is a critical subject for engineering, and those who do not choose physics or chemistry as subjects for entrance examinations can still enter into the universities surveyed due to the wide variety of methods of entrance examinations. For this reason, most universities and KOSENs surveyed have measures to assist such students in improving their basic knowledge in mathematics and sciences. According to the results of a survey of MEXT on the implementation status of engineering universities (N=154) in Japan in 2009[113], the most common approaches to improving basic knowledge in mathematics and sciences are the "implementation of placement tests to measure students' proficiency in basic sciences (e.g. mathematics and physics) before or just after the entrance" and the "provision of classes on basic sciences such as physics and chemistry for students who did not take these classes in high school" (both 65.2%).

Also some universities surveyed oblige students who have low scores on mathematics and physics placement tests to take supplementary classes. Since the number of students who drop out or repeat years was increased due to a remarkable decline in students' basic knowledge, Daido University compels new students whose scores in each subject (mathematics, physics and English) on a placement test are in the bottom 30% of all students to take basic seminars (for which no credits are given) at a study support center, and completion of the seminars is a condition to taking graduation research during their 4th year. A total of 900 students have participated in the basic seminars[114], which seem to have contributed to a reduction in the number of students who dropped out. At the same time, since 2011, students who lack basic knowledge have been receiving assistance in remedial study through the high school-level at a study support center. Teachers request that students who perform poorly at the basic seminars study at the center. Since the establishment of this mechanism, no students were unable to reach a certain point at the basic seminars and therefore unable to graduate because of failing to conduct graduation research. Likewise, at Tokyo City University, if students receive a C (the lowest score) on a test to assess basic knowledge in mathematics, physics and English when they are entering the institution, the students need to take a "remedial class" in each subject for a year, though this is usually completed in 6 months. On the other hand, the Tohoku Institute of Technology divides students into levels according to the results of a placement test and provides education according to their academic level.

Other measures for improving basic knowledge in mathematics and sciences that can also be applied in Thailand are as follows.

(1) Study support room, study support center

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[113] http://www.mext.go.jp/b_menu/shingi/chousa/koutou/41/houkoku/__icsFiles/afieldfile/2010/06/07/1294583_1.pdf
154 national, public and private universities with a faculty and graduate courses of engineering responded to the survey.
[114] The basic seminar includes 15 classes per subject. One teacher assists 1 to 3 students.

Almost all universities surveyed have a study support room or a similar center where students can ask teaching staff or tutors questions about what they cannot understand during classes or when they study by themselves. Subjects students can study in the room are mainly mathematics and physics at most universities, and chemistry, biology, English and Japanese at some universities. Teaching staff are mainly ex-high school teachers, retired professors, or part-time lecturers. Senior students also work as tutors at the centers of some universities. At the *Mathematics and Science Education Research Center*, Kanazawa Institute of Technology, which provides similar services as a study support room, the number of students who came to the center each year was dramatically increased fourfold, from 6,320 in FY2000 to 24,847 in FY2015. More than 75% of students who came to the center were first year students. The main purposes of the visits were asking questions and supplementary study (57.6%), and the most common number of times for visits was 2 to 5 times a year per student (37%)[115]. Tokyo City University provides common spaces called "learning commons" where undergraduate students can study and graduate students act as learning supporters while assisting with questions, assignments, and concerns of undergraduate students. In order to respond to questions and assignments from all courses, a supporter is selected from each course and provides support in shifts in the afternoon, and receives hourly wages[116]. Learning supporters assist students in learning under the policy that supporters do not present answers and suggestions, but help students think by themselves and find their own course of direction. Although the quantitative impacts of such rooms are unclear, several universities surveyed pointed out that these rooms have a great impact on improving the basic knowledge of students.

(2) Pre-entrance education

Several universities also provide some assistance before prospective enrollees enter into universities for them to improve basic knowledge, especially of mathematics. The manners of assistance include intensive supplementary classes and educational guidance through the correction of assignments. In the case of Aoyama Gakuin University, where intensive supplementary classes are provided for prospective enrollees, almost all of them take the classes before they enter the university and the classes have a good reputation among them[117]. Kanazawa Institute of Technology[118] provides a correction system via a correspondence course on mathematics for prospective enrollees with the aims of checking basic understanding of mathematics at a high school level, providing supplemental assignments (or advice) and maintaining students' study habits and motivation (or inspiration) to study. According to a questionnaire survey given to participants of the course, 80% of respondents answered that they studied mathematics seriously before they entered the university, and 73% pointed out that they acquired the habit of studying independently through the course.

(3) The combination of assignment of class teachers in each class and a study support room

At the Department of Electrical and Electronic Engineering, the Tokyo University of Agriculture and Technology, a teacher takes charge of 4-5 students as a "class teacher" and students can consult with

[115] Kanazawa Institute of Technology, Mathematics and Science Education Research Center (2016)"The utilization status of the center " http://www.kanazawa-it.ac.jp/efc/3_data/2015_riyou_data.pdf *Accessed on February 13, 2017
[116] In February 2017, 23 supporters were available; all of them were students at a doctoral course.
[117] Aoyama Gakuin University "The overview of mathematics remedial class at the College of Science and Engineering " http://www.gem.aoyama.ac.jp/remedial/remedial.html *Accessed on February 13, 2017
[118] Obayashi H et al (2012) "A Practice of Pre-Entrance Education at the Kanazawa Institute of Technology" in the collected papers for Engineering Education Research for the fiscal year of 2012, p624-625 http://ci.nii.ac.jp/naid/110009620343 *Accessed on February 13, 2017

teachers anytime on academic or non-academic issues[119]. Meetings with class teachers are held regularly both during the first and the second semesters of the first two years, and during the meetings teachers encourage students to go to a study support room if it is deemed necessary. A university report notes that the effects of the meeting are "enhancing students' study habits, early detection of students who tend to be isolated and encouraging them to go to the study support room, an increase in study hours of students by energizing communication between teachers and students, and an increase in the number of students who ask questions during lectures and practical training sessions, and those who come to the study support room after the bi-annual meeting with their class teachers. This indicates that the meetings have a certain effect on the enhancement of students' study habits and motivation to study. Additionally, teachers also started to improve the content of their class sessions by reflecting on comments that students shared at the meeting. This contributed to enhancing undergraduate education." Via a two-phased support for all students by class teachers and then for students who need more assistance from the study support room, the number of students who were identified as students who require educational guidance largely decreased from 71 in FY2010 to 41 in FY2014.

Moreover, KOSEN, Kisarazu College, started a peer support system in 2017. One 3rd year student assists four or five 1st year students from the same department in studying. 3rd year students can choose either "a special research" (a required subject) or assisting 1st year students, which can be considered also as "a special research project." The manner in which they can support 1st year students is up to each department, but it is mostly done by assisting with their experiments and/or practical training sessions. The aim of this system is for 3rd year students to learn through their own experience how difficult it is to teach. This is a part of active learning, which is expected to have educational impacts on students through learning from each other, and also aims to build relationships among students.

5.2.1.2 Measures for improving basic technical skills

(1) Support for student projects and extra-curricular activities

Many universities and KOSENs try to improve the basic technical skills of students by supporting student projects and extra-curricular activities related to manufacturing such as participation in the Robot Contest ("Robocon") and "Student formula Japan[120]"(a competition of race cars developed by students). To support these activities, the universities and KOSENs surveyed mainly provide places, funds[121] and technical advice from teaching and technical staff. Because students generally participate in the activities as a group with other school years and departments, students can learn a wide range of knowledge from them. At most universities and KOSENs surveyed where extra-curricular activities are active, including KOSEN, Nara College, which won the first prize of Robocon at a national level two times, there was a system in which senior students provide technical advice for and guide junior students for the activities. Niigata University implements various projects (e.g. production of robots and race cars) through a "Smart Dormitory" as a part of an engineering design program at the Faculty of Engineering. Since the number of students with high academic performance increased after the

[119] Masahiko Hasumi (2016)"Learning Support Program at the Department of Electrical and Electronic Engineering", p37-42, Journal of Higher Education, Vol.12, Tokyo University of Agriculture and Technology, March, 2016
http://web.tuat.ac.jp/~ched/publish/pdf/jou_12_3.pdf *Accessed on February 13, 2017
[120] A competition of automobile technology skills by planning, designing, and constructing race cars by themselves.
[121] In most cases, 100,000 to 200,000 yen are provided to support the activities.

introduction of the program, the faculty thinks that the program is largely effective in improving technical skills.

It was pointed out that participation in an extracurricular activity does not only improve basic technical skills, but also has the effect of an engineering design education by providing experience in the manufacturing process from planning and designing to production. It was also pointed out that the activities are conducive to the improvement of communication through working with people outside universities and KOSENs and the enhancement of cooperative ability through group work.

Box 14: Outstanding Student Projects

Tokai University: Education program at the Challenge Center: For a number of students' projects under the program, the university provides funds (2 million yen at most), a coordinator for operational support, and an advisor for technical support. More than 2,000 students participate in the program every year. A project team of a solar car won an international competition two times in the past.

Niigata University: Smart Dormitory The first year students can start an extracurricular research activity with other students of different departments or school years, and continue the activity as far as s/he k maintains good academic performance, and can get awarded and certified as "Top Graduates" if s/he meets certain criteria till graduation such as maintaining a high GPA, excellent international academic results and research presentations at conferences. While the award needs to be more widely recognized, it is expected to have effects as a certificate of the quality of graduates as engineers, and hence support the employment of students.

(2) Internship/cooperative education: the way to match students with companies and to evaluate internship programs and cooperative education

According to the results of the aforementioned survey on the implementation status of engineering education, the most common approach to improving technical skills in terms of curriculum composition and education system was "the implementation of internships" (88.7%). Most universities and KOSENs surveyed also had an internship program or cooperative education for the purpose of acquiring practical skills through work experience. Although internships and cooperative programs are not uncommon in Thailand, there are challenges in terms of matching students with companies and the evaluation of programs.

Some universities and KOSENs surveyed tried to improve matching students with companies. KOSEN, Tsuruoka College implements a cooperative education program, in which students repeat a cycle of study at the college and an internship at a private company from the third year to the fifth year. In order to avoid a mismatch between companies and students to the greatest extent possible, a pre-internship period is set up in the first year of the program. Through the period, receiving companies learn the level of knowledge and techniques as well as the personalities of the students, while students learn the details of business operation at the companies. Before the second year, both are asked if they want to continue the internship based on the knowledge, and only when both agree does the internship continue.

With regard to the evaluation of internship programs, many universities surveyed have the system where students who participate in an internship program research the companies in advance, and fill in the results of that research and what knowledge, techniques and skills they want to improve through the internship in a sheet. After the internship, students again fill in what they actually did through the internship and the results of the capacity development in the sheet, and the company also provides comments on the internship in it. With this system, students can choose a company suitable to their objectives, proactively participate in the internship program, and utilize the experience as a reference for career selection, while the university and companies involved can learn the effects of the internship through the information, and junior students can use the information when they choose a company for their internship.

In general, each university explores and identifies companies which can work with them for an internship program individually and generally does not share this list with other universities. Shimane University, however, collaborates with 12 universities and junior colleges in the Chugoku and Shikoku regions, shares the lists the universities and colleges have, and expands students' opportunities to participate in internships. Since 80% of students who go to universities and colleges in the region are from the region, they tend to go back to their home town during the summer holidays when an internship is often programmed. Due to this inter-university collaboration, such students now can take an internship in their home town.

At KOSEN, Numazu College, a long-term internship program (4 months) is provided as a required subject in the second semester of the first year of the advanced course. About two-thirds of students participate in an internship at a private company, half of them take part in a PBL-style internship, and about 90% of them join an internship program that more or less includes PBL. This means that internships without PBL constitute less than 10%. According to the statistics of FY2015, about 70% of students were satisfied with the internship and 30% of them were almost satisfied. Therefore it can be assumed that most students were satisfied with the long-term internship program.

It has been pointed out that internship/cooperative education is conducive to improving not only basic technical skills, but also employability by enhancing communication skills and problem-solving skills, and also to increasing employment rates and decreasing turnover rates by promoting the understanding of students on related industries and the content of business operation.

5.2.1.3 Measures to improve English skills

As discussed in "2.8 What skills are needed?" a foreign language proficiency is one of the five skills Thai industries expect engineers to possess. Since students at KOSENs do not need to prepare for an entrance examination for universities, however, their English communication skills tend to be lower than students of general high schools or universities[122]. Measures to improve the skills which are often implemented or promoted at the universities and KOSENs surveyed include extensive reading and listening, a study support room, e-learning and studying abroad including international internships and/or PBL programs.

[122] Chizuko Mizuno (2015) "Consideration of extensive reading as a tool in motivating and promoting students" (in Japanese) English learning at National Institute of Technology, Kagawa College, Takuma Campus" National Institute of Technology, Kagawa College Research Journal, Vol 6. p.81-86

(1) Extensive reading

Many KOSENs adopt extensive reading as an approach to improve English communication skills of students. For extensive reading, schools prepare a lot of English books including very plain ones, and the more books students read, the more points they can get for the subject. Students gain confident in their English ability when they finish reading a book no matter how plain it is, and get motivated to read the next. This approach was introduced to KOSENs, Toyota, and Tokuyama Colleges in the beginning and proved quite effective in promoting students' English abilities. It was then widely implemented at almost all KOSENs surveyed. At Tokuyama College, the average TOEIC scores of graduating students went up about 150 points after extensive reading was introduced. At a survey of Toyota College[123], students who took extensive reading classes for 2.7 years scored higher than average general high school students, and students who took the classes for 4 years scored higher than average university students in terms of TOEIC.

(2) E-learning

Several universities provide an e-learning system to promote students' English skills. There are two kinds of utilization: self-learning and a combination of self-learning and the use during lectures. Educational research has provided support for the assertion that e-learning is effective in improving English abilities. Combining self-learning and lectures is particularly effective in improving some abilities such as listening comprehension and vocabulary, and motivates students to continuously use the e-learning system. Although e-learning allows students to study at any time in any place and any number of times, it has been pointed out that teachers have difficulty grasping the status of learning progress and the level of understanding of students who use an e-learning system. Saga University solved this problem by utilizing a learning management system. By visualizing the progress status with the system, it succeeded in maintaining the motivation of students to study. The university also promotes the use of the system by setting a deadline for assignments[124]. In light of the above, the effective use of e-learning systems can be conducive to improving English abilities.

(3) Studying abroad

Improvement of English communication skills was reported as an effect of study abroad programs[125]. It was also pointed out that an international internship program had the effect of motivating students to study English since students realized that their language ability was insufficient through participation in such programs. With the aims of improving English abilities and producing human resources who can work globally, Tokyo City University developed "the Australia Program." Under this program, the university approves study at Edith Cowan University in Perth, Australia for 5 months during the second year for credits. 200 to 250 students per year participate in the program, improve their English, and acquire a global perspective through studying and living together in a dormitory with students from all over the world. For the promotion of internationalization as a global KOSEN model project, KOSEN,

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[123] Nishizawa H., et al(2008)"Outcomes and challenges of extensive reading classes at KOSEN, Toyota College", The 7th Extensive Reading Education Workshop, March 16, 2008

[124] Fujii T., et al (2010) "Practical report on a blended type of online classes with the effective use of e-learning," University Education Journal, Volume 6, p80-86, March 2010

[125] For example, a research by Tokyo University of Agriculture and Technology shows that English abilities were improved after students participated in an international student exchange program.

Ibaragi College, started to cooperate with external organizations including universities in other countries in order to make it possible to offer classes in English in the associate degree program. In the advanced course, classes have been provided in English for 4 years.

5.2.1.4 21st century skills required for employment (Creativity, Communication, Cooperativeness etc.)

At the universities and KOSENs surveyed, it was found that curriculums were composed to acquire technical knowledge and skills required for a practical engineer in addition to 21st century skills that are more general skills required for employment, such as problem-solving skills, cooperative ability, creativity, and communication. Major measures to improve such skills are provisions of PBL-style class sessions such as active learning and an internship program for which credits are awarded.

In recent years, PBL has been introduced to many of the surveyed universities and KOSENs. In general, a group of students from different departments and courses work together outside of their schools on problems they identified or that were externally provided and discuss, research and examine possible solutions to solve them with the support of external organizations (e.g. companies and local governments). For example, KOSEN, Miyakonojo College, for the purpose of developing creativity, provided a subject called "Creative Design Practice" in the advanced course. During the class, students form groups with other students from the departments of mechanical and electrical engineering, architecture and material engineering respectively, discuss a provided theme, produce a product, make a presentation and receive an external evaluation on it. Interviewees stated that this subject provides students with an opportunity to acquire knowledge from other departments, and develop excellent teamwork and communication skills. At KOSEN, Akashi College, there is a teacher that specializes in active learning and visits other colleges in western Japan providing guidance on active learning as a leading school of this approach. Students of 12 classes at the college (4 departments and 3 school years) are divided into 63 groups, supported by teachers, take an active learning class together, and conduct research or manufacture something for a year through group work. Interviewees of the college thought that it was because of this class that students who had not been good at communication started to actively or frankly communicate with other students.

Lately more KOSENs and universities have promoted active learning as part of an approach to PBL not only in specialized classes but also at liberal arts classes such as English and Mathematics. At Shibaura Institute of Technology, teachers and staff learn active learning as a teaching method through Faculty Development (FD) and Staff Development (SD). Several universities (e.g. Tottori University, Kanazawa Institute of Technology[126]) also have curriculums in which students can learn PBL from the first year to gradually develop their capacities through PBL. While PBL evaluation methods face some challenges as

Project Design (PD) Education at the Kanazawa Institute of Technology [Required subject]:

1st	"*Introduction to PD*" (the methods of experiments), "*PDI*"(methods of extracting ideas)
2nd	"PDII"(extracting ideas, designing/materialization in a specialized field), "PD Practice" (demonstration experiments)
3rd	Identification of a research theme for the 4th year
4th	"*PDIII*" (graduation thesis)

[126] The website at the Kanazawa Institute of Technology "Project Design Education" (in English) http://www.kanazawa-it.ac.jp/kyoiku/pd/index.html *Accessed on February 13, 2017

discussed below, overall, the improvement of general skills through PBL was well recognized by the universities and KOSENs that introduced PBL.
The manner of evaluating PBL programs differs from school to school, and most of them face some challenges such as the clarification of evaluation criteria and improvements of the accuracy of the evaluation. Additionally, since a group of students generally works on assignments for a PBL program, one issue was that teachers found it difficult to grasp each student's activities and contributions to the group. Therefore, KOSEN Okinawa College introduced a group evaluation system which makes students evaluate other students in the same group. This contributed to making each student's activities and contributions to the group visible.

In order to encourage students to work collaboratively and actively discuss with other group members for active learning, there has been an increase in the number of universities (e.g. Kyushu Institute of Technology, Tottori University, and Fukuoka Institute of Technology) that provide a facility with furniture including movable tables and chairs and multiple white boards. Students and teachers rate such facilities highly as they are convenient for students to discuss with other students and work on activities, and for teachers to facilitate PBL class sessions.
When a PBL program is introduced in Thailand, if the PBL program aims to solve issues of external organizations, since students learn a lot when they fail, it has been pointed out that teachers need to offer only minimal advice and wait patiently for students to learn by themselves, and to let the external organizations know that there is a possibility that students cannot solve some issues.

5.2.1.5 Measures to instill discipline

As discussed in "2.8 what skills are needed?" possessing discipline such as being punctual and responsible is considered essential for engineers in Thailand. As a measure to instill this discipline in students, KOSEN dormitories can be a good reference. All KOSENs have a dormitory, which is recognized as an educational facility to develop self-reliance and cooperation. While not all students live in a dormitory, some colleges of KOSENs such as Okinawa College and Numazu College oblige all first-year students to live in a dormitory. There are daily routines to be observed by students such as the time to wake up, have a meal and go to bed. If a student breaks a routine, s/he loses (or adds) some points and needs to leave the dormitory if the points reach the limit[127].

As an effect of these dormitories, interviewees at several KOSENs pointed out that students living in a dormitory have better academic performance. Additionally, there is research conducted in KOSEN Kumamoto College[128] that students living in a dormitory are absent from classes less frequently than students not living in a dormitory. According to the survey on the career of KOSEN graduates, there was a response that the ability to cooperate was developed through life in a dormitory. In light of the above, a dormitory where students need to observe daily routines and live with other students has a certain effect in developing discipline and cooperation.

[127] At KOSEN, Okinawa College, in order to recover reduced points, students need to do volunteer activities such as cleaning the neighbourhood.
[128] Isogawa S., et al (2014) "On the management of school dormitories: with a view toward career education", Research Reports of the Kumamoto National College of Technology (6), p1-5, 2015-02

5.2.2 Other measures useful in training engineers

5.2.2.1 Measures to enhance engineering design education ("Monozukuri" programs)

In recent years, in order to train students as engineers who can conduct research and develop products and services, importance is more placed on engineering design education that makes students experience the entire process of manufacturing from extracting ideas, designing, making trial products to production. As a part of this education, many universities and KOSENs surveyed provide various "Monozukuri" programs which allow students to experience the above process while utilizing the knowledge and techniques acquired through lectures and practical training sessions and enjoy manufacturing itself. Some examples of such programs are as follows.

(1) Kyoto Institute of Technology: *Monozukuri practical training education through university-industry collaboration with a "going down the river" style internship program*

An internship program (a required subject) in the third year and during the summer holidays in which students repeatedly experience a "headstream" of manufacturing such as planning, designing, development and making trial products to a "downstream" such as production in order to solve practical problems provided by companies through manufacturing of "my product." The university, manufacturers, and a network of SMEs working on prototype development collaboratively support students by providing lectures and the opportunities through experiments and practical training sessions. Students who participated in the program listed "the skills of designing and drawing," "understanding the designing process," "the understanding of processing technology and its process," and "the importance of drawings as a common language" as the skills they enhanced through the program.

(2) Nippon Institute of Technology: *College Meister*

This is a dual system to provide 1) practical training sessions in which students manufacture concrete as well as real objects during which time they spend long hours at one of twelve studios such as a "Mechanical Processing Studio" and a "Formula Studio" on the campus and 2) lectures related to the sessions. Students can experience the entire process of manufacturing from planning to designing, drawing, production and implementation. Students who create very well-made products while completing required courses are regarded as having acquired expert knowledge and skills and awarded the title of "College Meister" as well as a medal. The purpose of this program is to provide students with expertise as well as the negotiation and management skills that are necessary for generalists.

(3) Iwate University : *On-campus company* at *Monozukuri Engineering Factory (EF)*

By establishing a virtual company ("On-campus company") that consists of faculty members, students and companies, the university provides the opportunity for students to experience the manufacturing process from making a business plan, designing, ordering parts, making prototypes and products, and understanding the performance of the on-campus company all the way to profits and losses. *Monozukuri EF* is composed of an *Advanced Manufacturing and Prototyping Center,* a *Monozukuri experiment center,* and a *Monozukuri Entrepreneurs Support Office.* The first two centers support the manufacturing process and the Entrepreneurs Support office provides supports for on-campus companies through funding, human resources, accounting and business operations. There were more than 10 on-campus companies at the university in 2016.

In addition, there are other various Monozukuri programs such as the “Monozukuri transmission program” of KOSEN, Hakodate College, in which students of advanced courses with other courses solve local issues through Monozukuri with the support of retired employees of companies registered as “Meister,” and the “Monozukuri education program” of Tottori University in which students gradually learn PBL from the first year and try to solve problems being faced by external organizations while experiencing the process of everything from extracting ideas to making products. In addition, some other KOSENs also have social implementation projects and similar projects in which students understand social needs and develop prototypes, products and services to address them and improve the products and services based on feedback from society.

By collaborating with external organizations such as companies and local governments, these programs enable students to acquire the knowledge and experience required for real manufacturing activities. Students who participated in the programs reported improvements in their technical knowledge and skills, and raised awareness of delivery dates and costs, while support companies (mainly local SMEs) rated students’ experience highly in their efforts to solve companies’ problems[129]. The increase in the rate of students who obtained jobs from local SMEs was also reported as an effect of the programs.

The universities and KOSENs with these programs provide an environment where students can learn how to operate machines from technical staff at facilities such as a “Monozukuri centers” and freely use the machines with the support of the staff to ensure the students’ safety. When these programs are introduced to Thailand, it is important to set up such an environment where students can work on manufacturing freely to some extent while securing their safety.

5.2.2.2 Industrial HRD program for engineers in South-East Asia

Some of the universities surveyed implemented programs to train engineers from Southeast Asian countries including Thailand. The following programs are possible candidates for collaboration with this project for the purpose of training industrial HRD in Thailand.

(1) Nagoya Institute of Technology: *International Graduate Program for Monozukuri* and *Training Program for Plant Managers*

The International Graduate Program aims to train superior students from universities in Asian countries including Thailand as human resources who can work as leaders of production bases in positions including company president or plant manager in their own countries in the future. The students can get scholarships from the industry during the program. The program offers classes including “introduction to engineering,” “production engineering,” “management of technology education,” Japanese language, and practical training sessions through an internship as well as the Training Program for Plant Managers (as noted below). The capacity of the program is 10 students. About 90% of the students that graduated from the previous program that focused exclusively on the automobile industry obtained jobs as engineers at Japanese companies.

129 Kobayashi J., et al (2008) “ Manufacturing Skills Succession Program Embracing Year 2007 Problems as a New Teaching Opportunity in the Hakodate National College of Technology”, Engineering Education, 56(5), p53-57

The Training Program for Plant Managers aims to train participants to become "plant managers who can identify, think and act on issues at manufacturing sites" and targets plant managers or applicants from SMEs who want to acquire know-how on production management and physical distribution management relating to the manufacturing industry in the Tokai region. The program combines 1) seminars at the Institute, 2) practical training sessions at mock factory lines, 3) practice at actual manufacturing sites of students' companies, and 4) a plant tour. During the practical sessions, 6 students (4 program participants, 1 graduate student and 1 participant form the above international graduate program) form one group and work on KAIZEN activities for companies that program participants work for.

Program participants are identified in collaboration and cooperation with financial institutions in the region. If this program is implemented in Thailand, it is imperative to examine the possibility and measures necessary to have a sufficient number of participants. There is also a need to conduct a survey to see if it is realistic for potential participants to take a 6 months-course and if engineers working at plants are interested in improvements of manufacturing sites and activities they should take toward this end in the first place.

(2) Tokyo Institute of Technology: *TAIST program*

As discussed in 3.2.4.4, this is an international joint graduate program (master's degree program) implemented collaboratively by the Institute, NSTDA and engineering universities in Thailand such as KMITL. The program has several courses including automotive engineering and information and communication technology for embedded systems. During the first year, lectures are provided by professors of the Institute as main lecturers and faculty members from universities in Thailand as co-lecturers. Professors of the Institute travel to Bangkok for one week a year to give lectures. During the second year, students work on master's theses at laboratories of NSTDA and professors of the Institute provide advice through a video conference bi-annually. The program has continued since 2007 and more than 100 students have participated in the program so far. Several students obtained jobs at Japanese large-scale companies such as Toyota, Nissan and Honda after graduation. The ratio of students who went on to doctoral courses after graduation is high (23%) and some obtained teaching positions at universities in Thailand or the students' home countries (e.g. Vietnam).

(3) Tokyo City University: *Short training course on monozukuri management for engineers*

While sending students to Japanese companies in Thailand as a part of an international internship program, in order to offer advantages to companies that receive students for the internship program and train engineers of the companies as managers, the university started a short training course focusing on monozukuri management and received 5-6 engineers in 2016. During the ten-day stay in Japan, course participants visited a distribution center and a manufacturing factory, attended lectures (e.g. PDCA of manufacturing and Kaizen guidance by a lecturer who has professional experience in monozukuri management) and conducted experiments. At the end of 2016, the university prepared to receive engineers from another two companies.

The University of Electro-Communications has assisted the hands-on engineering course at KMUTT which aims to "produce qualified students that possess a Monozukuri philosophy with hands-on knowledge and experience" by dispatching a lecturer with extensive working experience in the manufacturing industry and arranging factory visits for course participants.

5.2.2.3 A measure to understand the level of comprehension of students and promote further understanding: a rubric

In recent years, universities and KOSENs have increasingly introduced a "rubric," which is a scoring tool, and lists academic attainment targets for students to assess to what extent they attain them. For example, Tokyo Polytechnic University developed a system with a rubric that sets attainment targets of several points for each class session to evaluate achievements. The accumulation of the evaluation becomes a part of a study portfolio for each student. Students make a self-assessment of 3 to 5 small attainment targets per session. With this system, both students and teachers can check the degree of understanding of students for each session. Students can easily review the session by focusing on parts they do not understand, and teachers can recap the parts many students find difficult to understand in the beginning of the next session.
According to a questionnaire survey conducted at the electronics and information engineering course of KOSEN, Ishikawa College[130], where a rubric was introduced, students listed "comprehension of the status of understanding in terms of attainment targets," "the increased motivation to study based on their level of understanding (i.e. an increased motivation to understand better and obtain a higher attainment level)" as the effects of the rubric. Some students in the course commented, "I can study more efficiently as I can focus on what I do not understand with a rubric" and "I concentrate on lectures more (than before the introduction of the rubric) to make an assessment of the rubric."

5.2.2.4 Measures to attract excellent students to universities and KOSENs

Having excellent students is essential in producing high quality industrial HRD. One of the measures for the purpose is to have a quota for such students for an entrance examination by recommendation. The second one is to increase the number of applicants for entrance examinations. Major measures to increase the number of applicants implemented at the universities and KOSENs surveyed are as follows.

(1) Improvement of publicity

Many KOSENs surveyed make efforts to improve publicity through, for example, trial lessons at primary and secondary schools by teachers of KOSENs, and holding a robot contest for primary and secondary students since KOSENs are not generally well known as educational institutions. In order to improve its publicity, the Chiba Institute of Technology, which has the highest number of applicants in the field of science, mathematics and engineering in Japan, and whose numbers continued to increase for eight years in a row, set up a satellite campus inside a commercial facility near the Tokyo Sky tree, a popular sightseeing spot in Tokyo. At the campus, visitors can experience a wide range of technologies related to robot engineering and space engineering with machines and simulators that researchers at the

[130] The National Institute of Technology (2015) "A rubric which requires students to repeatedly make self-assessments provides students with feedback on their understanding" A Collection of Good Practices of Engineering Design Education, No.9, January 2015 http://www.kosen-k.go.jp/letter/kouhou/engineeringdesign_v09.pdf *Accessed on February 13, 2017

Institute developed or research. The Institute also increased the number of applicants by 1) appointing graduates of the Institute who successfully work for information sessions of the Institute to talk to high school students and their parents in provinces, and 2) conducting education reform to reduce repetition and dropout rates. Additionally, many universities hold university information sessions and entrance examinations on a nation-wide scale in order to attract applicants from all parts of the country. Moreover, one university pointed out that a system of exempting students with high academic performance from paying entrance and tuition fees has a measurable effect in terms of improving publicity and attracting excellent students.

(2) Strategic public relations (PR) activities through marketing

Several universities[131] conduct questionnaire surveys of new students about where and when they get information about the university, university events they participated in (e.g. open campus), and when they decided to apply to the university. They analyze this information and utilize it for PR to attract more applicants. At KOSEN Tsuruoka College, a marketing team in which 7-8 teachers and staff voluntarily participate in visits about 100 secondary schools in the prefecture a year in total, holds PR events such as a science festival, and utilizes the results of a questionnaire survey for PR. In addition, since engineering universities in Japan tend to have significantly fewer female students than male students, some of them increased the number of female applicants (and students) by visiting numerous girls' high schools for PR.

(3) Special entrance examination by recommendation

As noted in "5.1.4 Admission and employment," Toyohashi University of Technology, where about 80% of enrollees are from KOSENs and admitted to the third year have a special entrance examination by recommendation in order to attract KOSEN students with high academic performance, and exempt them from paying some fees such as entrance and tuition fees. From FY2018, KOSEN students of advanced courses who have a long internship for global leadership training at the university and get a good rating can be admitted to a doctoral course at the university when they graduate from advanced courses.

5.2.2.5 Measures to support student employment

Interviewees of universities and KOSENs with high employment rates responded that the reasons for the high rates were good evaluations from companies, thanks to the existence of graduates who successfully work for the companies, (which result in a large quota for entrance examinations by recommendations,) how well-known the universities and KOSENs are, and their physical proximity to industrial clusters. Among measures to support student employment, the following ones can also be possibly implemented in Thailand.

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[131] For example, Tsunehito Fujii (2016) "The analysis of new students survey in TUAT over the most recent three years," p29-35、University Education Journal Vol.12, Tokyo University of Agriculture and Technology, March, 2016 http://web.tuat.ac.jp/~ched/publish/pdf/jou_12_3.pdf *Accessed on February 13, 2017

(1) Employment support utilizing networks of graduates

Ritsumeikan University effectively utilizes a network of graduates for employment support. By accrediting graduates who work for companies that are well known and/or high regarded, or those that work for government agencies as Career Advisors classified by industry and inviting them to seminars and workshops for job searching, students can have opportunities to receive individual consultations with them or visit them later. Career Advisors try not to advertise or encourage students to come to their companies or organizations, but rather try to help students understand their industries and think about their future career instead of just looking for a job. By answering questions from students, graduates also have the opportunity to think about their own career vision, which has a positive impact on their current job. This approach and method can be applied in Thailand when universities and colleges support student employment.

(2) Optimization of selection of students to be recommended for jobs

Universities and KOSENs with high employment rates, thanks to a good reputation among companies often have quotas for jobs by recommendation. For example, at the Kyushu Institute of Technology, there are 5 to 10 companies each student can apply for with the recommendation of the university, and when students take job interviews with the recommendation, one student can receive unofficial job offers from 1.4 companies on average. In general, there are two types of quotas for jobs by recommendation, one by university recommendation and the other by a laboratory recommendation. Professors tend to give laboratory recommendation jobs to their own students. At the Faculty of Engineering, Kindai University, teachers in charge of employment guidance have interviews with all students and select optimal students for jobs by recommendation irrespective of what laboratory they belong to, based on a comprehensive evaluation of students' academic performance, characteristics and interests, and the company's business and the type of position to be filled. With this selection process, the university avoids mismatching students and companies and reduces turnover in the future, which results in maintaining a large number of job offers.

Additionally, at Tokyo Polytech University, where the employment rate largely increased from 67% (2013) to 98 % (2016), students can take career-related subjects (e.g. presentation practices) from the first year. As an effect of these subjects, students who take the subjects from the first year tend to get unofficial job offers earlier than other students who do not. Additionally, staff at the career office have interviews with all students and provide optimal support that student needs in close collaboration with teachers, career counselors and sometimes the parents of students. Since job hunting requires the support of parents, the university also holds a seminar for parents. Moreover, some universities and KOSENs surveyed pointed out that their internship programs are effective as a measure to support the employment of students since it can increase their employability and hence the employment rate, and prevent graduate turnover by enhancing their understanding of industries and their business.

5.2.2.6 Measures to promote UIL

The universities and KOSENs surveyed work on various measures to conduct joint or commissioned research projects by identifying technological needs of companies and publicizing technological "seeds" of teachers. Additionally, some of them also reflect industrial needs into their education and contribute to local industry. Major measures to promote academia-industry collaboration are as follows.

(1) Connecting teachers with companies

In general, companies often participate in conference presentations and/or lectures given by teachers and request joint or commissioned research projects on the themes presented. Teachers pursue the possibility of collaboration by identifying whether they can conduct research responding to the needs of the company with the support of an office which promotes collaboration. There are some universities like Ritsumeikan University where coordinators are posted in an office in charge of such collaborations and promote matching between teachers and companies. There are also cases where teachers with work experience in private companies maintain relationships with companies. The connection between teachers and companies leads to not only joint and commissioned research, but also invitations being extended to company employees to lectures, practical training sessions and experiments in regular curriculums as resource persons as well as support for extra-curricular activities. This connection has been developed from individual collaborations between a faculty member and a person in charge of a company to organizational collaborations between a university and a company, and promoted further collaboration. At Meiji University, for example, practical training sessions have been provided partly by company employees by maintaining relationships with companies whose employees were originally invited as lecturers. The sessions are provided for 2nd and 3rd year students over 6 lecturers (3 university faculties and 3 company employees). University faculties provide lectures on theories, followed by practical guidance on drawing plans by company lecturers. By experiencing their on-site insights and capabilities, students gain interest in the business operation of companies, which has an impact on their career choices and decisions.

(2) Membership organisations to promote the collaboration

Many universities and KOSENs promote collaboration with companies by organizing a network with member companies (in most cases companies where graduates work and/or local companies) and holding regular meetings with them. For example, the Technology Promotion Network of KOSEN, Nagano College, has 270 member companies and training sessions, technical consultations for and exchange meetings of member companies that are conducted almost every day. Besides, Techno Academia, which is an organisation to promote collaboration between KOSEN, Tokuyama College and companies, expedites the collaboration by providing a research grant to joint research projects between them and contributes to solving issues that companies have. Other KOSENs also often have local organizations with member companies that support KOSENs, and promote collaboration through the organisations. The Kyushu Institute of Technology has a similar membership organization with 500 member companies and persons. By holding a seminar where teachers share their research and an exchange meeting every month, the Institute can regularly grasp the needs of member companies, and present research conducted by teachers to them. The Graduate School of Engineering, Osaka Prefecture University, established a joint study group with industry[132] and the government 20 years ago, and holds seminars and laboratory tours with them.

[132] The number of membership companies used to be 200, but is now around 80. 20 to 30 companies attend the regular seminars and tours in general.

(3) Visits to companies and participation in events to promote UIL

At several universities and KOSENs surveyed, staff and coordinators of an office promoting the collaboration visit companies, grasp their needs and receive requests for joint or commissioned research projects. At Ritsumeikan University, with its substantial experience in university-industry collaboration, staff at an office promoting collaboration actively visit companies one by one, explore and identify their needs, connect them with teachers who can technically respond to those needs, or contrarily explore and identify companies that are interested in research projects carried out by the teachers. Several universities also pointed out that participation in events to promote the collaboration is effective. Since companies that attend such events are interested in collaboration, there is a higher possibility of finding potential partners for the collaboration. In particular, universities away from Tokyo mentioned that participating in such events in Tokyo where a larger number of companies operate often led to finding potential partner companies. The University of Electro-Communications holds a similar event on campus annually, and provides opportunities for companies to directly visit each laboratory and learn about their research projects, which is useful in promoting collaboration with companies.

(4) Collaboration with financial institutions

At universities surveyed, there are several cases where they collaborate with local banks and shinkin (credit union) banks whose mission include developing local industry and assisting SMEs. The Fukuoka Institute of Technology utilizes banks' networks to publicize research "seeds" of faculties. The Institute has built relationships with the Bank of Fukuoka and the Nishi-Nippon City Bank as they are also interested in HRD and UIL. At the University of Electro-Communications and Osaka Prefecture University, staff of local shinkin banks work full-time at the offices promoting collaboration and expedite matching utilizing networks with local companies. At Osaka Prefecture University, after the cooperation with the banks, the number of technological consultations increased significantly, and 44% of them led to outcomes such as securing research grants[133]. Nagoya Institute of Technology concluded a basic agreement on academia-industry collaboration with Nisio Shinkin Bank in 2016, and plans to provide a program on HRD and organizational development for company presidents and applicants to company executives of the next generation to develop new businesses. In addition, there are many cases where engineering universities conduct technical training seminars for engineers at local SMEs funded by local and shinkin banks.

(5) Nurturing engineers at local SMEs according to a regional cluster strategy

The eastern region of Shizuoka prefecture where KOSEN, Numazu College is located, is a top producer in the quantity of medical machines nation-wide, but it is difficult for engineers of SMEs to enter into the market since they do not have the technical knowledge and skills necessary to produce such machines. Therefore, KOSEN, Numazu College in collaboration with Shizuoka Prefectural Government and Tokai University, implemented a two-year training program funded by MEXT, by providing lectures, practical training sessions and experiments to nurture core industrial human resources to develop medical equipment. Numazu College is in charge of manufacturing technologies

[133] The increased number of consultations was 326 in the first year of the cooperation with the banks and 246 in the second year. Resource: Japan Science and Technology Agency (2006) "The case of university-bank collaboration: Environmentally friendly water: Juju" (in Japanese), A journal of academia-industry-government collaboration, September 2006, https://sangakukan.jp/journal/journal_contents/2006/09/articles/0609-03/0609-03_article.html *Accessed on February 13, 2017

at the program. The program achieved its outcomes and largely surpassed its original targets in terms of the number of engineers trained, the number of prototypes developed, and the number of joint research projects, and one of the prototypes has already been made into a product and distributed. Responding to strong demand from the industry, after the MEXT program was finished, the program was restructured as a one-year paid program for a maximum of 10 students and lectures are provided at Numazu College every Saturday.

(6) HRD of niche markets with high demand

Because of a plan to invite an aircraft maintenance business to Naha airport, Okinawa and a serious lack of aircraft maintenance technicians due to the increase of LCCs (Low Cost Carrier), KOSEN Okinawa College established a program to produce aircraft maintenance technicians with the full-fledged support of the aircraft industry. An experienced aircraft maintenance technician trainer from All Nippon Airways (ANA) was invited as a professor to the College, and teaches the knowledge and technologies students need to know before they start to work at the industry with an internal training manual and a set of information materials from ANA. An internship program at an airport is also provided two times during the program. Aircraft industries in Okinawa have actively supported the program by dispatching staff as lecturers and providing the internship program and the opportunity to experience a simulator that pilots and aircraft maintenance technicians actually use for their training. In spite of the fact that lectures and practical training sessions are provided only once a week under the program, all students who participated in the program and wanted to work for the industry were offered jobs in the industry including positions in a company that is very popular and difficult to join.

5.2.2.7 Measures to prevent repetition of a school year and drop out

Repetition of school years and dropouts have large negative impacts on the career development of students and the finance and public relations of universities and KOSENs. Therefore, they take various measures to prevent students from repeating years or dropping out. For examples, some universities and KOSENs surveyed responded to various consultations from students with a student counselling room where a psychology counselor is available, and provide a system to appoint a class teacher as already noted and a mentor system of senior students. There were universities such as Shimane University that holds an annual meeting with parents of students and reports the learning situation of students to their parents and requests their support if necessary, as well as conducts career counselling.

As other measures, many KOSENs hold a one-day trial class of each course, and some pointed out that this event assists applicants in choosing the optimal course for their interests. Besides, KOSEN Hakodate College listed the implementation of supplementary classes, re-examination[134] and the introduction of a system in which students can choose their course from the second year, not before they enter the college, which enables students to choose the course that best fits their interests, as the reasons of reduction of repetitions and dropouts. As noted above, the Chiba Institute of Technology[135]

[134] If students pass the re-examination, a credit will be awarded.
[135] Summarized the information from an interview with the institute and a review of an article on the institute ("Measures for the reform to connect high schools with universities better at the Chiba Institute of Technology" (in Japanese) Case studies on university management, December 17, 2016)

succeeded in a vast reduction of the repetition rate and dropout rate due to various measures implemented as noted above.

Box 15: Measures to prevent repetition and dropouts by the Chiba Institute of Technology:
Since failure to catch up in classes and isolation from other students tend to lead to missing classes, repetition and dropouts, the Institute worked on the following measures and both the repetition rate (13.6% (2008)→5.3% (2015)) and the dropout rate (5.46% (2012)→2.68% (2015)) were largely reduced from 2008 to 2015.

- Study support by a study support room and pre-entrance education
- Re-examination of the evaluation system of academic performance
- Securing time for teachers to work on research and education by reducing their workloads (e.g. by streamlining curriculums)
- Raising awareness to improve class sessions through "a good lecture award" and "a best teacher award"
- Prevention of student isolation through support for extra-curricular activities and various social events on campus

5.3 Interests in International Cooperation

Table 49 shows the fields of international cooperation the universities and KOSENs surveyed were interested in or found possible to cooperate with. The most popular one is receiving exchange students and trainees, followed by support to improve educational programs in Thailand through sharing experience, knowhow and curriculums, dispatching teachers and receiving Thai teachers. More detailed information on each field is as follows (see Table 49).

Table 49: Interest in industrial HRD in Thailand

Interest/Possibility of cooperation	# of schools
Receiving and accepting students and trainees	36
Sharing experience and knowhow	31
Dispatch of students	23
Dispatch of teachers	22
Sharing curriculums	21
Training of teachers	17

Note：N=41 Source：Summarized based on the result of interviews

5.3.1 The current status of the support for improving educational programs in Thailand

Among universities surveyed, some universities actively receive over 1,000 overseas students such as Ritsumeikan University (1,806 students) and Tokyo Institute of Technology (1,239 students)[136], or other

[136] Japan Student Services Organization (2017) "*Result of an Annual survey of International Students in Japan 2016*", March 2017, http://www.jasso.go.jp/sp/en/about/statistics/intl_student_e/2016/index.html *Accessed on June 26, 2017

universities such as Tokai University and Nagaoka University of Technology receive many Thai students or send Japanese students to Thailand based on their long-term relationships with Thai universities. On the other hand, there are other universities that place little importance on international exchange, or that do some international exchange, but not at all or hardly with Thailand. Regarding KOSEN, the head office of KOSEN has signed a comprehensive education exchange with KMITL, TNI and OVEC. In 2015, 112 Japanese students were sent to Thailand and 171 Thai students were received by all the KOSENs[137].

The surveyed universities and KOSENs receive overseas students based on academic agreements, utilizing various schemes, projects, and subsidies for overseas students. The number of the accepted students varies in each school. In the most cases, a limited number of overseas students in the field of engineering are received at a graduate level. Since an annual enrollment limit and no or few English curriculum, it is limited for undergraduate students to be received for a long term. A short term (within a few weeks) international exchange is a common way to receive overseas students.

On the other hand, not a few universities surveyed were interested in receiving students from abroad as Table 49 shows. One of the reasons is that universities with a policy of internationalization have a quantitative target of the increase in the number of foreign students. Additionally, several teachers welcome foreign students, expecting positive educational impacts on Japanese students. Some of them pointed out that having foreign students in their laboratories can improve Japanese students' English abilities and expand their horizons. Furthermore, in order to promote joint research projects with teachers, many teachers are ready to receive students in graduate or advanced courses. The universities and KOSENs that have close relationships with local companies were also interested in connecting excellent foreign students with those companies. It should be noted, however, that while surveyed schools show interests in receiving overseas students, they expect that the students have a certain level of academic knowledge. In fact, some interviewees pointed out some cases that overseas students cannot work on research assignments or it took some time to assist students with a limited understanding of mathematics. Therefore, with regard to receiving overseas students or researchers, it is essential to know what the minimum level for a certain school to receive overseas students would be.

Regarding the dispatch of students, many universities and KOSENs encourage students to go abroad for educational reasons as part of internationalization. Therefore, half of them were interested in dispatching students to go to universities in Thailand.

With regard to receiving Thai students and dispatching Japanese students, there is a need to note that both Thai and Japanese students need to pay fees including tuition fees if they go to or come from non-affiliated universities. Besides, most universities have limited capacity for dormitories. In order to receive teachers and students from Thailand, there is a high possibility that accommodation for them needs to be secured outside universities.

[137] National Institute of Technology (unknown) "*Receiving overseas students and promotion of international exchange*" Head office of National Institute of Technology, http://www.kosen-k.go.jp/hj_2-26ryugakusei.html *Accessed on June 26, 2017

5.3.2 Support for improvement of education program

(1) Sharing of experience, know-how and curriculums

Most universities surveyed already have some educational programs (such as a master's program or international PBL) with counterparts in Thailand; they are interested in supporting the production of industrial HRD in Thailand through utilization and/or expansion of existing programs. Since curriculums are already available on the homepages, many universities and KOSENs surveyed had no problem sharing the curriculums with universities and colleges in Thailand.

(2) Dispatch of teachers and staff members

As incentives for dispatching teachers, some universities that plan to establish a course or a department where students can study all subjects in English pointed out that teachers can gain experience teaching in English. Besides, several teachers were also interested in making connections with teachers in Thailand through the cooperation and exploring the possibilities of joint research projects. At universities that mentioned the possibility of dispatching staff for the cooperation, there was an expectation to enhance the capacity of staff as a part of Staff Development (SD).

(3) Training of teachers

With regard to the training of Thai teachers, there can be three approaches such as 1) training several teachers for a short period (e.g. 1 week or 10 days), 2) training one teacher for a long period (e.g. 1 year), and 3) training teachers at a graduate course and assisting them in obtaining a doctoral degree. In order to promote joint research projects, many universities and KOSENs welcome students to their graduate or advanced courses. They can also receive a group of teachers for a short period such as 1 week to 10 days. Some universities and KOSENs have experience or plan on receiving a teacher for a long period, and some responded that they can receive one teacher per course for a long period.

5.3.3 Participating in collaborative research

While many teachers were not interested in joint research projects with teachers in Thailand since the academic levels of ME and EE are not as high as the U.S and Europe, some universities and KOSENs were positive about joint research projects with teachers in Thailand. Besides, as noted above, in order to work on research projects together, many teachers were interested in receiving foreign students to their advanced or graduate courses. Some pointed out that since universities in Thailand do not equip sufficient machines and equipment for research, they want to work on joint research in Japan if they do. Other interests that were mentioned at the interviews include cooperation with TC for the preparation of the system and the environment for international internship programs as well as the conclusion of an agreement with educational institutions in Thailand for student exchange. Moreover, when universities and KOSENs have experience in cooperating with JICA, or interviewees have working experience as JICA experts (e.g. Tokyo City University, Tohoku Institute of Technology, Tottori University, Iwate University, and Toyohashi University of Technology), and/or universities, KOSENs or interviewees have a long relationship with teachers or educational institutions in Thailand (e.g. Tokai University and

KOSEN Okinawa College), they were generally positive about the cooperation for industrial HRD in Thailand irrespective of the content of the cooperation.

5.4 Possibility of cooperation for the project on industrial HRD in Thailand

With regard to the cooperation for industrial HRD in Thailand, some universities and KOSENs were generally positive about the cooperation and others expressed the possibility of cooperation depending on the content. The former universities and KOSENs include KOSEN, Colleges of Tsuruoka, Numazu, Nara, Tokuyama, Okinawa and Iwate University, Shibaura Institute of Technology, University of Electro-Communications, Nippon Institute of Technology, Tokai University, Aoyama Gakuin University, Tokyo City University, Nagoya Institute of Technology, Kanazawa Institute of Technology, Toyohashi University of Technology, Kyoto Institute of Technology, Shimane University, and Kyushu Institute of Technology.

Possibility of cooperation per domestic resources which could be utilized for industrial HRD in Thailand are as follows (see table 50). It should be noted, however, that the following possibilities for cooperation are based on the opinions of interviewees and not always officially authorized by the universities or KOSENs surveyed. Additionally, at the time of the interviews, concrete plans to support industrial HRD in Thailand were not decided or presented to interviewees. Therefore, when implementing plans, it is essential to re-confirm the possibility and content of the cooperation with the surveyed universities and KOSENs.

Table 50. Possibility of cooperation per domestic resources for the project on industrial HRD in Thailand

Resources	Universities/ KOSENs	
Application in Thailand		
Collaboration with and/or utilization of existing programs	【Engineering design education】 -Kanazawa Institute of Technology (PD Education) -Kyoto Institute of Technology ("going down the river" internship program) -Tottori University (Monozukuri program) -Iwate University (On-campus company) 【Engineering education at the graduate level】 -Tokyo Institute of Technology(TAIST program) -University of Electro-Communication (Global Alliance Laboratory) -Niigata University (Double degree program) 【Employment support】 -Tokyo Polytech University -Ritsumeikan University	【Extra-curricular activity】 -Niigata University (Smart Dormitory) -Nippon Institute of Technology (College Meister) -Tokai University (Challenge Program) 【UIL】 -Numazu College (Contribution to an industrial cluster) -Nagano College (Technology Promotion Network) -Tsuruoka College (Cooperative education), -Ritsumeikan University 【Prevention of repetition and dropouts】 -Chiba Institute of Technology

Dispatch of faculty members	KOSEN, Colleges of Tsuruoka, Ibaragi, Nagano, Nara, Tokuyama, Kurume and Okinawa. Niigata University, Iwate University, Tohoku Institute of Technology, Shibaura Institute of Technology, University of Electro-Communications, Nippon Institute of Technology, Tokai University, Aoyama Gakuin University, Tokyo City University, Tokyo University of Agriculture and Technology, Tokyo Institute of Technology, Tokyo Polytechnic University, Nagoya Institute of Technology, Kanazawa Institute of Technology, Ritsumeikan University, Kyoto Institute of Technology, Shimane University, Tottori University and Kyushu Institute of Technology. Notes: Only when a faculty member prefers to be dispatched. Most universities responded that only one faulty member can be dispatched at a time, although multiple faculty members could be dispatched in rotation. In most cases, the dispatch of faculty members would be possible only during summer holidays. With regard to KOSEN, it is possible only when the head office of KOSEN approves it and colleges can find a substitute for a faculty member to be dispatched.
Dispatch of staff	Shimane University, Shibaura Institute of Technology, Kyushu Institute of Technology
Other resources	• Provision of study materials (Aoyama Gakuin University, Tottori University College of Tokuyama) • Introduction of universities and companies (University of Electro-Communications)
Application in Japan	
Collaboration With and/or utilization of existing Programs	• Nagoya Institute of Technology (International Graduate Program and Training Program for Plant Manager) • Shibaura Institute of Technology (Hybrid Twining Program[138]) • Tokyo City University (Short training course for engineers)
Receiving exchange students and trainees	KOSEN, Colleges of Hakodate, Tsuruoka, Ibaragi, Nara, Numazu, Tokuyama, Kurume, Miyakonojo and Okinawa Niigata University, Iwate University, Tohoku Institute of Technology, Shibaura Institute of Technology, Institute of Technologists, Chiba Institute of Technology, University of Electro-Communications, Toyohashi University of Technology, Nippon Institute of Technology, Tokai University, Aoyama Gakuin University, Meiji University, Tokyo Institute of Technology, Tokyo City University, Tokyo University of Agriculture and Technology, Tokyo Polytechnic University, Nagoya Institute of Technology, Kanazawa Institute of Technology, Ritsumeikan University, Kyoto Institute of Technology, Osaka Institute of Technology, Osaka Prefecture University, Shimane University, Tottori University and Kyushu Institute of Technology.
Training of teachers for short or long terms	KOSEN College of Tokuyama, Tottori University, Shibaura Institute of Technology, Institute of Technologists For receiving teachers at graduate courses, refer to "receiving exchange students and trainees".
Other resources	Introduction of universities and companies, paid internship programs for exchange students, adoption of teachers for faculty members

Source: Summarized based on the result of interviews

[138] A program which receives excellent students at post graduate courses from affiliated engineering universities in Asia.

Chapter 6 Effective approaches for industrial HRD

6.1 Issues with Industrial Human Resources in Thailand

As shown in Chapter 4, weaknesses of university and technical college graduates pointed out by the interviewed companies can be summarized as follows:

- Basic mathematics capability required for logical thinking and problem-solving as well as performing technical work
- Language proficiency (English and Japanese) to effectively communicate with clients and suppliers
- Basic technical knowledge and skills in high demand (e.g., mold and die and 3D/CAD)
- Problem-solving capability – particularly the lack of the mind-set for challenge and hands-on experience
- Management capacity (management skill and leadership, team building)
- Discipline and aspirational/ambitious spirits

These are all fundamentally important for a practical and innovative engineer. Therefore, measures to improve these capacities and aptitudes should be included in the forthcoming JICA intervention.

In addition, such interventions need to address the important issues and their ramifications caused by changes in technology and the labor market. As discussed in Chapter 4, the survey team identifies three issues for manufacturing companies, namely, (1) Shortage of quality technical staff and engineers in production, (2) Shortage of engineers who can cope with industrial advances and (3) Shortage of middle level and senior engineers.

For (1), the surveyed companies mention that there are sufficient job applicants and recruits but insufficient supply of technicians with requisite qualities (e.g., multi-tasking technicians who can manage production, technicians who can properly maintain advanced facilities and equipment). This causes such problems as the lack of multi-tasking technicians leads to the recruitment of technicians with a particular job skill (increased labor costs) and unreliable operation of new facilities and equipment by ttechnicians (hesitation to invest in new technologies).

For (2), there are sufficient job applicants and recruits but insufficient supply of engineers who can cope with new technical changes and demands (e.g., engineers with multi-disciplinary engineering knowledge who can manage an entire production process and contribute to productivity improvement, engineers who have basic knowledge and know-how on product design and development). Lack of multi-disciplinary engineers leads to the recruitment of several engineers with a particular specialization (increased labor costs). Engineers are not able to effectively contribute to automation, productivity enhancement and cost reduction. Some companies argue that they are not able to strengthen R&D unit in the company due to shortage of engineers with Product Design and Development knowledge and know-how.

For (3), A majority of students with engineering majors do not get employment in the manufacturing sector. Those who work in the manufacturing sector do not pursue engineering careers in a company as they prefer to be transferred to non-engineering work and/or a management position. The age-group in their 20's and 30's is the precious time for engineers to accumulate technical experience and knowledge and establish themselves as practical and innovative engineers. One very critical issue for Thailand is that many talented engineers give up their opportunity to gain such assets by frequently changing jobs that do not necessarily help add value to their engineering career. For the companies, very high turnover rate of engineers leads to low return on investment in HRD and loss of experienced and senior engineers.

The diagram (see figure 45) on the next page shows the overview of the needs of industry for industrial HRD based on the survey results.

Weaknesses of U/TC graduates pointed out by manufacturing companies

- Basic mathematics capability required for logical thinking and problem-solving as well as performing technical work
- Management capacity (management skill and leadership, team building)
- Language proficiency (English and Japanese) to effectively communicate with clients and suppliers
- Problem-solving capability – particularly the lack of the mind-set for challenge and hands-on experience
- Basic technical knowledge and skills in high demand (e.g., mold and die and 3D/CAD)
- Discipline and aspirational/ambitious spirits

Issues for companies

(1) Shortage of quality technical staff in production: Insufficient supply of technicians with requisite qualities (e.g., multi-tasking technicians who can manage production, technicians who can properly maintain advanced facilities and equipment)

(2) Shortage of engineers who can cope with industrial advances: insufficient supply of engineers who can cope with new technical changes and demands (e.g., engineers with multi-disciplinary engineering knowledge who can manage an entire production process and contribute to productivity improvement, engineers who have basic knowledge and know-how on product design and development)

(3) Shortage of middle level and senior engineers: Those who work in the manufacturing sector do not pursue engineering careers in a company as they prefer to be transferred to non-engineering work and/or a management position.

Problems for companies

- Lack of multi-tasking technicians leads to the recruitment of technicians with a particular job skill (increased labor costs).
- Technicians cannot reliably operate new facilities and equipment (hesitation to invest in new technologies).

- Lack of multi-disciplinary engineers leads to the recruitment of several engineers with a particular specialization (increased labor costs)
- Engineers are not able to contribute to automation, productivity enhancement and cost reduction.
- Inability to strengthen R&D unit in the company due to shortage of engineers with Product Design and Development knowledge and know-how

- Very high turnover rate of engineers (low return on investment in HRD)
- Loss of experienced and senior engineers to maintain and/or expand business operation

Figure 45: The needs of industry for industrial HRD based on the survey results

6.2 Approaches to tackle the issues with industrial human resources in Thailand

In response to the issues for industry in industrial human resources development in Thailand, the study team recommends the following projects:

Approach No.1: The Project for Advanced Industrial Human Resources Development in TC – in order to tackle the issues (1) shortage of quality technical staff in production and (2) shortage of engineers who can cope with industrial advances

Approach No. 2: The Project for the Development of Industry-Ready Technicians in TC – in order to tackle the issue (1) shortage of quality technical staff in production

Approach No. 3: Engineering Career Development Support Project – in order to tackle the issue (3) shortage of middle level and senior engineers

Approach No. 4: The Project for the system development of teacher education at technical colleges – in order to tackle the issue (1) shortage of quality technical staff in production

Approach No. 5: Program for the Development of Highly-Skilled Industrial Human Resources in Thailand (Establishment of MONOZUKURI Program) – in order to tackle the issue (2) shortage of engineers who can cope with industrial advances

The following section describes the details of each proposed project.

3 Main Issues for Manufacturers

(1) Shortage of quality technical staff in production

Insufficient supply of technicians with requisite qualities (e.g., multi-tasking engineers/technicians and maintenance technicians in response to technical changes)

(2) Shortage of engineers who can create innovation in both product development and production

insufficient supply of engineers who can cope with new technical changes and demands (e.g., engineers with multi-disciplinary knowledge who can contribute to productivity improvement, engineers who have basic knowledge and know-how on product design and development)

(3) Shortage of middle level and senior engineers

The number of engineering graduates is sufficient, but the problem is that these graduates do not work in manufacturing sector, and if they do, they do not pursue engineering careers in a company as they prefer to be transferred to non-engineering work and/or a management position.

5 Proposed Approaches

(1) Establishment of KOSEN Model

Key feature: producing engineers (associate degree) with 5-year program through and the model will be expanded to other universities and TCs. Target: New two KOSEN with two selected courses (Mechanics, Electric, Electronic, Mechatronics, Automotive courses) to be established as a demonstration KOSEN. Japanese inputs: equipment, scholarships in Thailand and Japan, Japanese experts. Thai inputs: budget for maintenance/renewal of the installed equipment, recruitment of new teaching staff and a budget for lecturers from industry. Requirements: Talented students, associate Degree accredited by COE, MOU for mobility programs with Japanese universities and KOSEN

(2) Development of Industry-Ready Technicians

Key feature: Modeling after V-ChePC/PPP in line with TPQI and DSD. Main inputs: updated equipment for hands-on training, scholarship in Japan, Inputs from Japanese side: experts, equipment for training, e-learning system and self-learning materials, Inputs from Thai side: a budget for 0&M and renewal of equipment, assignment of teaching staff

(3) Engineering Career Development Support

Key feature: Establishment of Central center and Career Center in each U/TC, capacity dev. of teachers & staff in career education, Data collection and analysis, and policy making on career education, Target: KMUTT/KMITL and TC, Japanese inputs: experts, Thai inputs: staff assignment, establishment of career centers, operation costs

(4) Improvement of Teacher Education for TC

Key feature: Upgrading teachers through faculty development and improvement of pre-service education to meet the updated standards of industrial education, Target: engineering universities, Japanese inputs: experts on STEM and FD, operation costs and training of teachers, Thai inputs: assignment of teaching staff

(5) Establishment of MONOZUKURI Degree Program

Key feature: Master/diploma/certificate to produce innovative engineers in design & development and production, Components: one year in Thailand + one year in Japan, Japanese inputs: scholarship, equipment and experts, Thai inputs: assignment of lecturers, cost-sharing (e.g., tuitions, boarding, etc.)

Figure 46: Issues on Industrial Human Resources and the Solutions Proposed by the Survey Team

Approach 1: The Project for Advanced Industrial Human Resources Development in TC (Development of KOSEN model

(1) Rationale

TC graduates tend to have a high retention rate at companies. Motivated and hard-working TC graduates are highly evaluated by manufacturing companies in Thailand. Some companies have high expectations for the role that competitive TC graduates can play as engineers. There is an extremely high potential need for talented TC graduates. In Japan, KOSENs (51 Colleges of Technology) play an important role in producing practical and competent engineers for industry whereas the majority of the surveyed companies (See Table 51.) in Thailand do not recruit technical college graduates as engineers. Therefore, to develop new technical colleges that can produce engineers is a valid approach for industrial human resource development in Thailand.

(2) Objective

The establishment of a model KOSEN that can produce practical engineers.

(3) Key Strategies

1) To introduce a KOSEN model (a five-year education program) that can produce engineers (associate degree) comparable to a university program, equipped with teachers with high academic qualifications and research environment (e.g., the equipment and library system for experiments and research activities).
2) During the Project duration, to establish pilot technical colleges as KOSEN model college in cooperation with engineering universities such as KMUTT and KMITL[139] to develop curriculum, learning materials and the capabilities of teaching staff (Because the current technical colleges and SBTCs do not satisfy the required standards of teachers' academic qualifications and research environment, it is difficult to upgrade these technical colleges to a KOSEN from the initial stage of project implementation. Substantial investment and time would be required to prepare such an enabling environment).
3) In five to ten years after the commencement of the Project, to expand the developed KOSEN model to other universities with the faculty of industrial education and/or technical colleges, considering the capacity and environment of these institutions.
4) To attract talented students by offering attractive incentives and career perspectives. The project needs to provide incentives such as scholarships and free full board system. In addition, various career options such as studying abroad in Japan, credit transfer to well-known universities in Thailand, obtaining professional qualification by TPQI would be necessary for this purpose.
5) To closely work with industry, KOSEN and other organizations such as industry and COE for the development and assurance of curriculum so that the quality of KOSEN education and its associate degree is well accepted by industry in Thailand.
6) To assign new teachers who obtain a master degree in Japan for the model KOSEN to sustain the quality of education after the Project duration. Teachers' quality needs to be ensured by recruiting

[139] As shown in Chapter 3, potential partners include the faculty of engineering and the faculty of technical education. It is assumed that KMUTT and KMITL would be potential partners at an initial stage as they are leading institutions in the Thailand Industrial Education Network and show a strong interest in dispatching lecturers to KOSEN and supporting teacher education.

experienced engineers and providing teacher training as well as updating necessary equipment and facilities.

7) To promote the change in companies' personnel system that provides engineering career for the college graduates with associate degree and also strengthen the management to accommodate companies needs in its programs.

(4) Target and the scope of the Project

Newly established Two Engineering Colleges – five courses (mechanics, electric, electronics, automotive and mechatronics) that would produce engineers for industry.

(5) Project components

The Project's components include;

1) Identification of competency requirements and curriculum development (from three-year PWC + two-year PWS to a five-year program) to meet the needs of the manufacturing sector.
2) Teaching staff development by upgrading academic qualifications, recruiting new staff with both extensive work experience in industry and academic qualifications as well as improving teaching staff's pedagogy.
3) Installation of necessary facilities and equipment for the upgraded curriculum.
4) institutional development including aligning the new curriculum compatible with TPQI/DSD and COE standards and career path development for students.
5) Measures to attract students (e.g., provision of scholarship, boarding and public relations).
6) Strengthen students' ability by introducing effective science and mathematics education and PBL.
7) Capacity development for the KOSEN management.

(6) Expected outcomes and indicators

<u>Overall goals (to be achieved three to five years after the end of the Project duration):</u>

1) New industrial colleges are established under other universities and/or OVEC.
2) The supply – demand gap for hands-on engineers is reduced in the manufacturing sector.

Indicators to measure to what extent the overall goals are achieved:

- The number of colleges established, following the KOSEN model is increased.
- The upgraded curriculum is introduced to other industrial technical colleges.
- The number of the companies satisfied with industrial human resources provided by industrial colleges is increased.

<u>Project Purpose (to be achieved by the completion of the project):</u>

An industrial college model that can produce hands-on engineers is established.

Indicators to measure to what extent the project purpose is achieved:

- The students of the two model colleges are able to obtain associate degrees and other highly accepted professional and vocational qualifications.
- The students of the model colleges are highly evaluated as competent engineers.

<u>Outputs (to be produced in the course of project implementation):</u>

1. A new associate degree program in engineering is introduced.
2. Competitive students enroll in the program.

3. The graduates of the program get employment in the manufacturing sector.

Indicators to measure to what extent the outputs are produced:

- A five-year program is developed to meet the needs of the manufacturing sector.
- All necessary sets of equipment are set up and used by teachers and students.
- Effective evaluation is conducted on the performance of managers, teachers and students.
- An increasing number of secondary high school students apply to the model technical colleges.
- The average GPA of the enrollees is as high as that of a research university.
- Mobility programs (e.g. credit transfer) are implemented with other universities in Thailand and Japan.
- More than XX% (to be decided before the commencement of the Project) of the graduates get employment in manufacturing companies as an engineer.

(7) Main inputs

1) Japanese side:

a. Scholarship to Thai students
b. Scholarship to outstanding students to study in Japanese universities and KOSEN
c. Equipment for experiments and practices and construction of laboratories
d. Dispatch of Japanese lecturers (Japanese universities and KOSEN)
e. Training of teaching staff in Japan (Master programs in Japan)

2) Thai side:

a. Securing a budget for O&M and also an earmarked budget for upgrading equipment
b. Securing the sufficient number of teaching staff and a budget for lecturers from companies and universities
c. Cost sharing to students during their study in Thailand in such forms as the wavier of tuitions, free boarding and payment for students' transportation

(8) Important considerations

- It would be critically important to enrol competent students from secondary high schools in the model KOSEN. The experience of SBTCs indicates that full boarding and scholarship are not sufficient to attract students with high academic scores. Incentives such as opportunities for a certain number of top students to study in Japan and/or transfer to engineering universities would be necessary. For this purpose, the Project needs to make institutional arrangements with universities to create pathways for students to get an engineering degree by making credit transfer possible.

- KOSEN is supporting two SBTCs in curriculum development (electric and electronic and mechatronics) by dispatching lecturers form Japan and accepting students from SBTCs to KOSEN. The Project needs to closely coordinate with KOSEN to create synergistic effects. For example, KOSEN supports the improvements of curriculum and pedagogy, while the Project trains teaching staff and installs necessary facilities and equipment to introduce the improved curriculum by KOSEN.

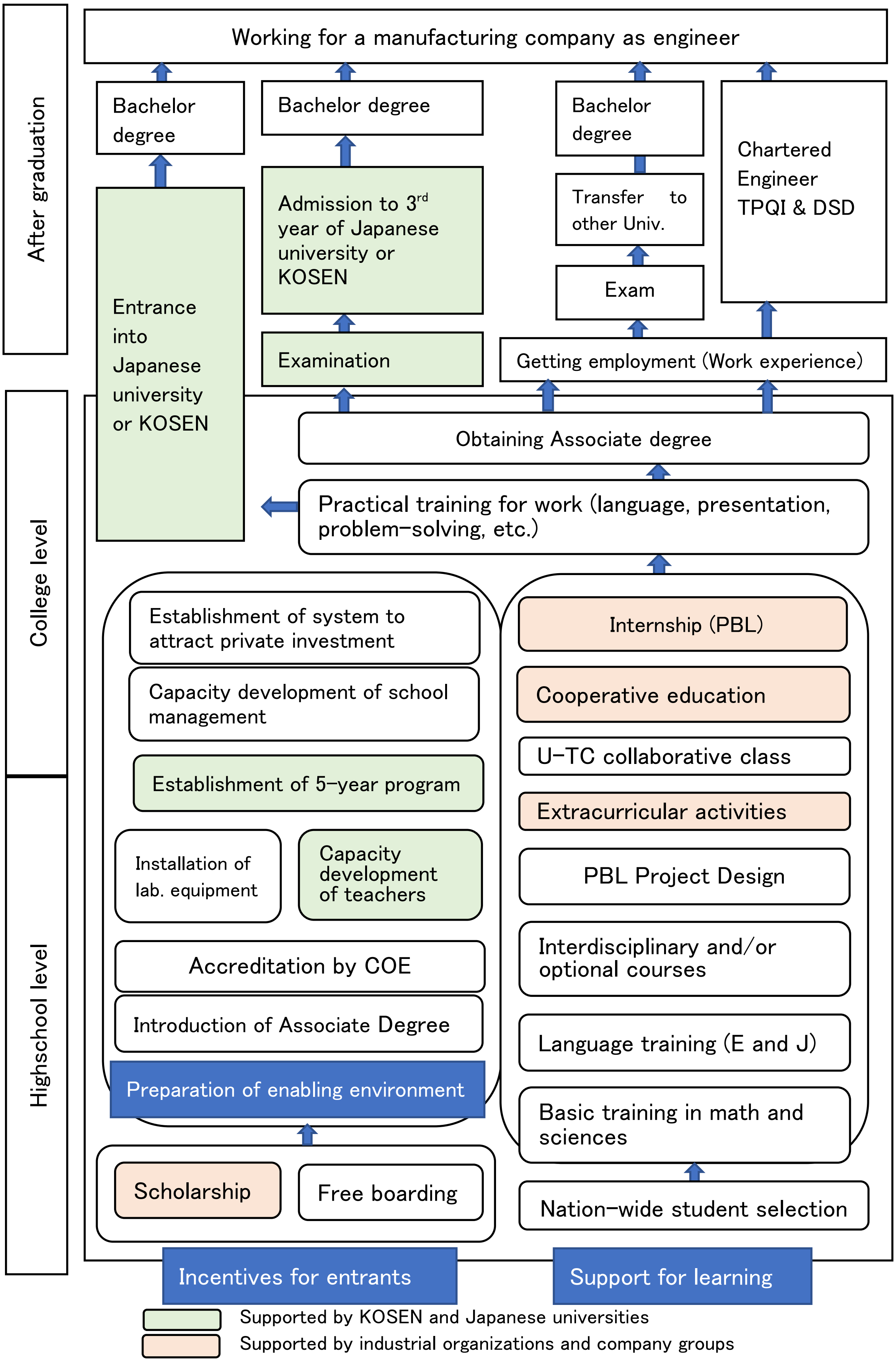
- It is necessary to ensure the quality of the model technical college graduates. According to the online survey given to companies, 41.8% of the companies are interested in employing technical college graduates as engineers if their technical capacity is improved. Particularly the Japanese companies are interested in utilizing technical college graduates as engineers. Therefore, there is likelihood that the graduates of the model technical colleges would be accepted as an engineer (see table 51).

Table 51: Companies' interest in employing technical college graduates

	Japanese companies		Thai companies		Total	
Answers	Res. Count	%	Res. Count	%	Res. Count	%
Likely to consider employing technical college graduates as engineers	20	60.6	8	23.5	28	41.8
Unable to use technical college graduates as engineers due to company regulations or labor-management agreement	2	6.1	1	2.9	3	4.5
Continue to employ technical college graduates as technicians even if their capacity is improved.	7	21.2	10	29.4	17	25.4
Not interested in employing technical college graduates because the company employs only university graduates	2	6.1	7	20.6	9	13.4
No scope or need to employ technical college graduates	1	3.0	2	5.9	3	4.5
Others	3	9.1	8	23.5	11	16.4
Total	33	-	34	-	67	-

Source: the results of the online survey given to companies

Figure 47: Approach 1: Development of KOSEN model



Approach 2: The Project for the Development of Industry-Ready Technicians in TC

(1) Rationale

There is a strong need for competent technicians in both Japanese and Thai companies in the manufacturing sector. It is vitally important that Thailand produce competitive technicians who are able to cope with increasing technical demands (e.g., automation) and the changing environment (e.g., higher wages) for production in order to keep the country competitive in the leading manufacturing sector. Industrial technical colleges are the key producer of technicians for the manufacturing sector in Thailand. Although TC graduates are evaluated highly on their specific skills, many companies notice skill gaps in such areas as basic knowledge of mathematics and sciences, logical thinking and discipline. All these skills are necessary to solve problems and improve productivity in production. Also, companies have expressed a strong need for new competencies such as multi-tasking in production and maintenance of automated new facilities and equipment, but TCs' present education is not sufficient to produce technicians with these competencies. Therefore, it is important to fill the gap between the immediate need of the companies and the competency of TC graduates. The Project would also contribute to the reduction of regional disparities between Bangkok and outlying regions by targeting TCs located close to regional hubs, super clusters and EEC.

(2) Objective:

The development of industry-ready technicians in TC.

(3) Key Strategies

1) To produce the technicians with skills highly required by industry (e.g. multi-tasking technicians who can manage production system as well as O&M, those who can maintain advanced equipment) through cooperation with industry in curriculum development and improvement of the dual system.
2) To establish regional alliances of companies to facilitate their investment in TC.
3) To match up the competency standards of TC with the professional and vocational qualifications required by industry and promote TPQI and DSD qualifications to companies and encourage. companies to integrate professional and vocational qualifications into their personnel system
4) To uplift the professional standards of teachers and improve TC students' learning through distance education and supplemental self-learning particularly in mathematics and science.
5) To offer effective measures to instill discipline that is one of the high priorities needs of companies for new graduates.
6) To strengthen the management of the college to effectively respond to the needs of industry.

(4) Target and the scope of the Project

TCs with mechanics, electronics, mechatronics and automotive courses.

(5) Project components

The project components include;

1) Identification of competency requirements for technicians in collaboration with industry.
2) Introduction of occupational qualifications such as "production technician" and "production facilities maintenance technician" (Level 1 – 7).

3) Review and improvement of curriculum and the dual system in compliance with the set standards.
4) Introduction of effective learning methods in mathematics and sciences.
5) Introduction of group activities and other measures to strengthen discipline and the strengthening of TC management.

(6) Expected outcomes and indicators

<u>Overall goals:</u>

- The supply-demand gap in the quality of technicians is reduced in the manufacturing companies.
- The other TCs not included in the Project improve their education, utilizing the outputs produced by the Project.
- The selected TCs are able to sustain the quality of education after the end of the project duration.

Indicators to measure to what extent the overall goals are achieved.

- Evaluation by companies on the performance of technicians is improved.
- OVEC develops and implements a plan to upgrade other TCs after the end of the Project duration.
- The number of TCs adopt and/or introduce the improved curriculum, the dual system, teacher & manager evaluation, etc. introduced by the Project.
- A system is in place to maintain the learning environment (facilities, equipment, a system to train TC personnel, the dual system, etc.).

<u>Project Purpose:</u>

Industry-ready technicians are developed in selected technical colleges.

Indicators to measure to what extent the project purpose is achieved:

- % of TC graduates get employment in the companies in the areas located close to regional hubs, super clusters and EEC.
- The numbers and types of vocational and professional qualifications obtained by TC students are increased before their graduation.
- The graduates of the selected TCs are highly evaluated by companies.

<u>Outputs:</u>

1. The competency standards are established and a five-year program is established in collaboration with industry.
2. The dual system is improved to produce hands-on technicians.
3. TC students' learning is improved through distance education and supplemental self-learning.
4. TC management is improved.

Indicators to measure to what extent the outputs are produced:

- The established standards and the new programs are accepted and approved by all the relevant organizations (e.g. industrial organizations).
- The necessary environment (facilities and equipment) is made available for the program.
- The key players of the dual system (facilitators, mentors and coordinators) are trained to run the system.
- % of the students who participated in the dual system is highly evaluated by the companies.
- The students' academic scores are improved in math and science and English.

- The management (director, vice directors and department heads) are well informed of the industrial needs and the concrete measures to improve TC.
- Evaluation of managerial staff is aligned with the personnel management system of OVEC.

(7) Main inputs

Japanese side:

a. Scholarship to TC students to study in Japan (short/long-term training in KOSEN and/or Japanese universities and internship in Japanese companies)
b. Experts in cooperative education, vocational education system, distance education, UIL
c. Equipment for training
d. Facilities and equipment for e-learning and self-learning material
e. Costs of teacher training in Thailand and in Japan

Thai side:

a. Assignment of coordinators and monitors in TC
b. Assignment of mentors in industry and dispatch of company engineers to lecture in college
c. Costs for recruiting additional teaching staff (e.g., English teachers)
d. A budget for O&M of equipment and a budget for renewal of equipment

(8) Important considerations

- It is critically important to appoint appropriate managers with vision and a willingness to improve model technical colleges. The Project should carefully select and assign such managers at the beginning of project implementation.
- OVEC has identified 20 candidate technical colleges as shown in the table below (see Table 52). In order for the Project to directly link up with industry, the Project should select technical colleges that are located in proximity to super clusters/EEC or industrial estates for automotive/auto-parts and electric and electronic manufacturers, in the regional hub and/or ASEAN gateways.

Table 52: List of candidate technical colleges to be targeted by the Project

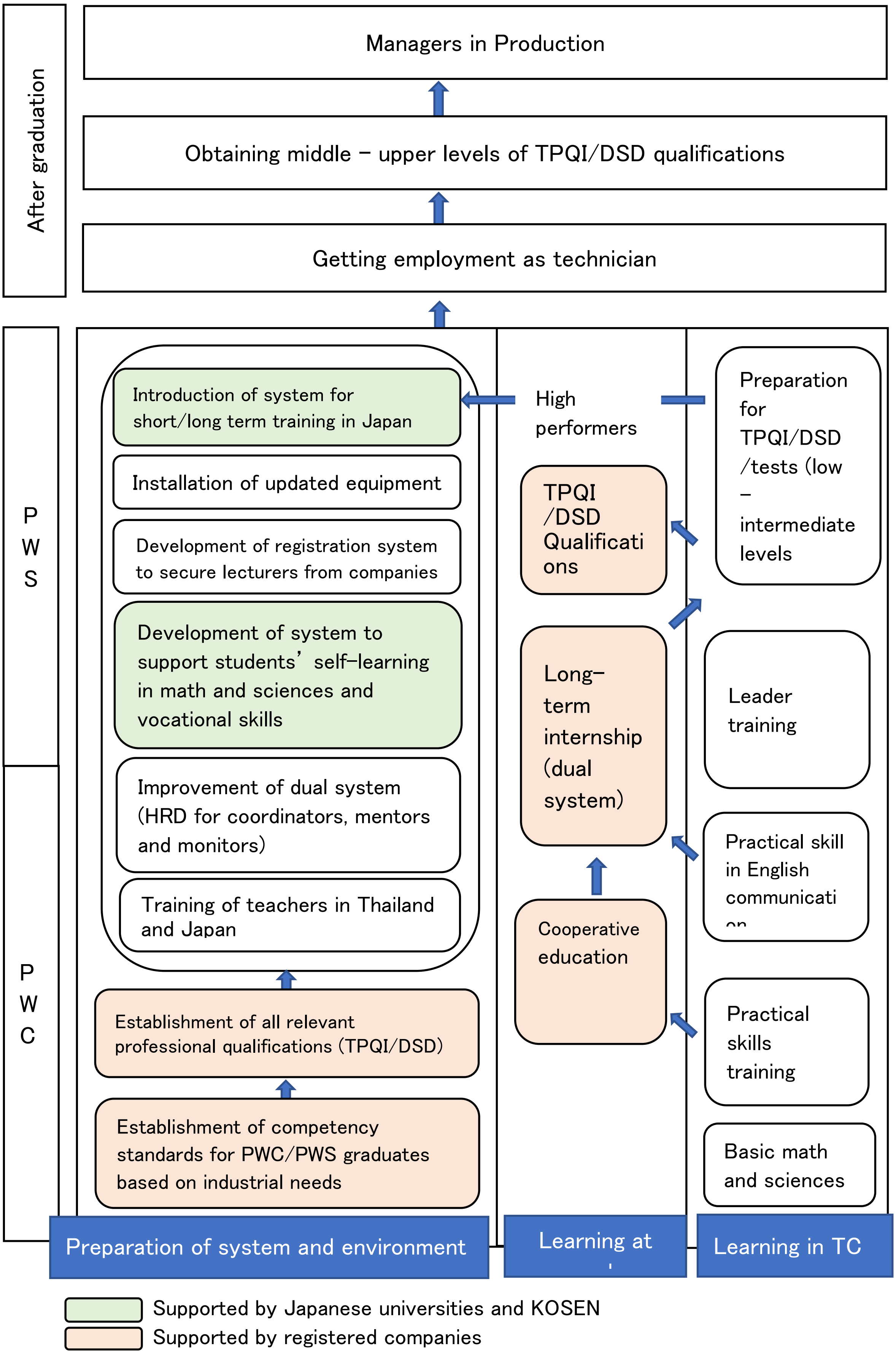
No.	Vocational Education Colleges	Locations
1.	Ratchasitharan Technical College	Bangkok
2.	Minburi Technical College	Bangkok
3	Chonburi Science-based Technical College	Eastern region
4	Suranaree Technical College	Northeastern region
5	Phra Nakhon Si Ayuttaya Technical College	Eastern region
6	Chachoengsao Technical College	Central region
7	Rayong Technical College	Eastern region
8	Bankhai Technical College	Eastern region
9	Chonburi Technical College	Eastern region
10	Maptaphut Technical College	Eastern region
11	Kanchanapisek Mahanakorn Technical College	Bangkok
12	Prachinburi Technical College	Central Region
13	Samutprakarn Technical College	Central Region

14	Kanchanaburi Technical College	Central Region
15	Chiangrai Technical College	Northern Region
16	Udonthani Technical College	Northeastern Region
17	Ubonratchathani Technical College	Northeastern Region
18	Surin Technical College	Northeastern Region
19	Suratthani Technical College	Southern Region
20	Hat Yai Technical College	Southern Region

Source: OVEC

- Institutional development would be critically important. The Project needs to closely coordinate and work together with OVEC/MOE, TPQI, DSD/MOL and industrial bodies such as FTI and the Thai Chamber of Commerce to develop curriculum in order to meet the required professional qualification standards.
- Provision of effective incentives is important to strengthen the capacity of teaching staff and encourage them to meet the required standards. The Project needs to introduce a system to evaluate teachers' performance that is linked with their career path and promotion. Vocational teachers' standards are being developed by TIEN, which can be used as a tool to measure teachers' performance.

Figure 48: Approach 2: Development of Industry-Ready Technicians in TC



Approach 3: Engineering Career Development Support Project

(1) Rationale

The retention of engineers is a serious issue for many manufacturers in Thailand. Students with engineering majors tend not to get employment in the manufacturing sector, and those who do take employment in the manufacturing sector tend to shift to non-engineering positions or jobs instead of seeking engineering careers. In order to change this situation, a new approach is necessary to make engineering study and work more attractive to students and appealing to teachers and parents through joint efforts made by universities/technical colleges and industry.

(2) Objective: To increase retention rates of engineers through career development support to university and technical college students and engineers.

(3) Key Strategies

1) To establish the central career center to set overall policy, data collection and sharing on students' careers and match-making between students and companies.
2) To establish a career center in the university/technical college to network with industry and alumni association.
3) To develop the capacity of both teaching staff and faculty staff in career education.
4) To distribute career information to companies and encourage them to improve their personnel system and/or their engineers' career development plans.
5) To utilize experiences and know-how of Japanese universities, KOSEN and Japanese industrial high schools in upgrading industrial and technological education.
6) To improve the status of engineers and engineering jobs through promotional activities such as engineers' career paths and their achievements.

The Project aims at expanding career paths/options in the engineering fields by developing opportunities to upgrade vocational, occupational and professional qualifications and promoting measures to increase their perspectives on engineering careers in partnership with COE, DSD and TPQI. For this purpose, the Central Career Center will be established for data management, analysis and policy making regarding career education. At the same time, each TC and university will establish a career center on the campus that would provide career development services to students as well as collect necessary data (e.g., tracer survey of alumni members) and closely communicate with companies to receive their views on and evaluation of graduates and students. The Project will also collect detailed data on the career paths of university and TC graduates and the results and implications from the data can be shared with and used by companies to improve their personnel system and/or career development plan for technical staff.

(4) Target and the scope of the Project: Engineering university and technical college students, secondary high schools, parents, companies.

(5) Project Components

The Project's components include;

1) Establish the central career center.
2) Establish a career center in each participating university and technical college,
3) Develop career paths and help TCs and universities align their curriculums with professional and vocational standards.
4) Introduce a system to conduct a tracer survey on alumni members and develop a career development and counseling program.
5) Share successful cases with companies so that they can use them to develop their own career development plan.
6) Conduct public relations and marketing through the media and on the internet, as well as directly approach secondary high schools, parents and students to promote engineering careers and engineering universities and technical colleges.

(6) Expected outcomes and indicators

Overall goal:

Retention rates of engineers are improved through career development support to university and technical college students and engineers.

Indicators to measure to what extent the overall goal is achieved:

- The percentage of engineers who continue their service in the company increases by XX %.
- The number of the engineering universities and technical colleges that introduce career education, emulating the outputs and experiences of the Project

Project Purpose:

The increased number of graduates of engineering universities and technical colleges who get employment in the manufacturing sector.

Indicators to measure to what extent the project purpose is achieved:

- The percentage of graduates who are willing to get employment in the manufacturing sector and/or work in the fields relevant to their major.
- The number of alumni members who get employment though activities by universities and technical colleges

Outputs:

1. The central career center collects and analyze data on students' careers and sets policy directions on career development.
2. Each university and technical college's career center provides services to students and alumni members for their career support, and conduct public relations to the public.
3. Faculty staff help students develop and implement their career plan.
4. Teaching staff develop their ties with companies to support students' career development.

Indicators to measure to what extent the outputs are produced:

- Functioning of the central career center (has a sufficient budget and staff, results of tracer surveys are made available, information and policy documents etc) .
- An increasing number of students who acquire professional and vocational qualifications .
- An increasing number of secondary high school students who apply to engineering universities and technical colleges.

- The career center at universities and TC are functioning (have sufficient budget and staff, results of tracer surveys are made available, research for career paths, career counselling services, support for alumni members, etc.) .
- The number of effective career development materials are produced and distributed.

(7) Main inputs

Japanese side:

a. Experts in career education, UIL system development and employment support
b. Introduction of student portfolio system management and training
c. Establishment of a career center in each university/college

Thai side:

a. Assignment of faculty staff for the career center
b. Office space for the career center
c. A budget for UIL and tracer survey (fees for industry personnel for career education, networking)
d. A budget for the management of the central career center (for the strengthening of alumni associations, staff salary and remunerations

(8) Important considerations

- It is very important to plan and implement the Project in close consultation with COE, DSD and TPQI, as well as industrial organizations and companies in manufacturing, in order for all the participating organizations to play their assigned roles and benefit from the Project.

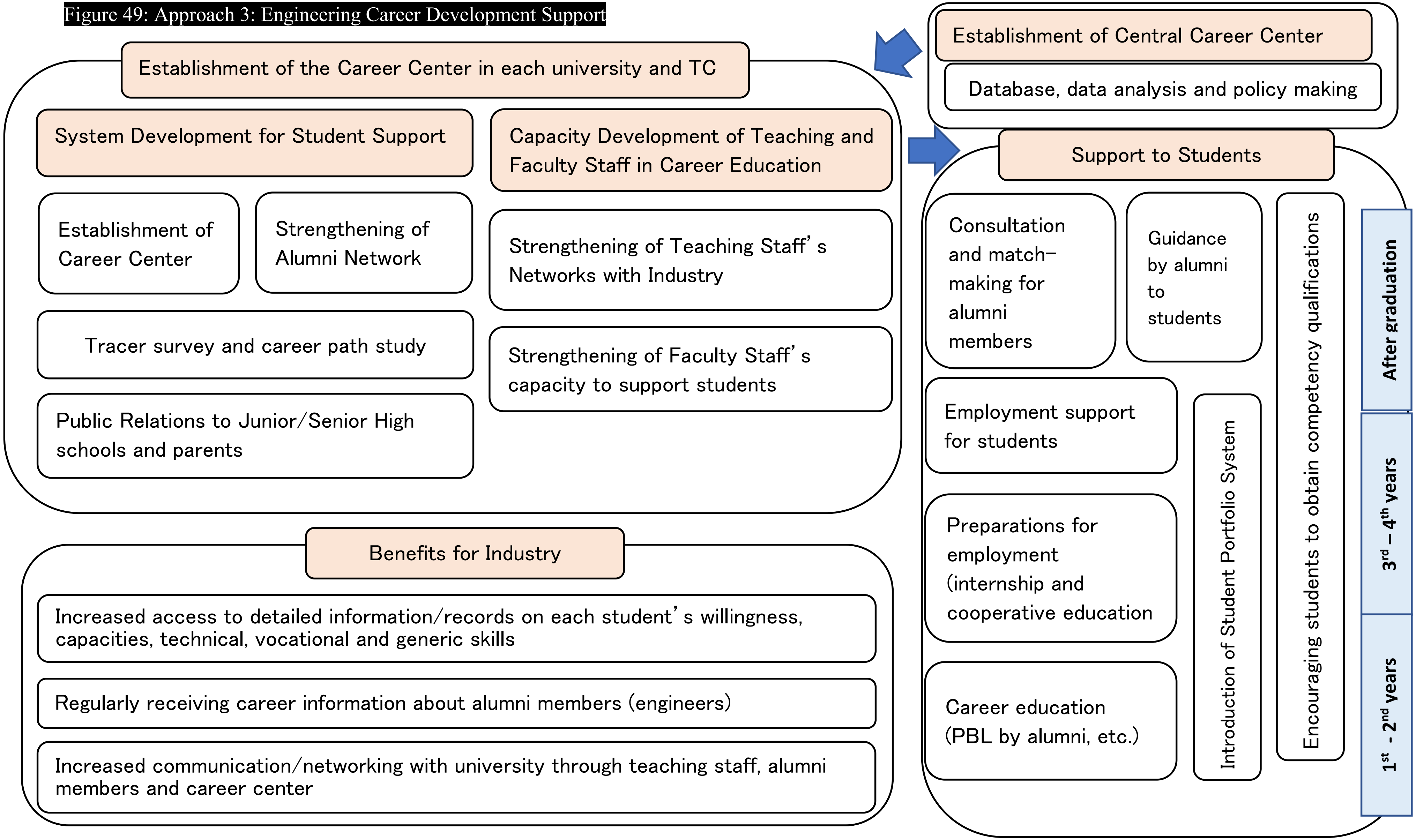
Table 53: Roles and responsibilities of the participating organizations

Participating organizations	Roles and responsibilities
Engineering Universities and technical colleges (PWS/PWC)	• To establish or strengthen the career center (for support of career development, orientation, employment promotion to industry, and career path study) and alumni association (networking, tracer survey on members and sponsorship for scholarships, etc.) • To develop a system to support students (e.g., student portfolio[140] management and counseling services/orientation for students) • To encourage students to obtain vocational, occupational and professional qualifications
Private Sector	• To identify and share issues regarding career development of their technical staff • To develop and/or improve career paths at each company based on sharing of successful cases
DSD, COE and TPQI	• To study and identify measures to encourage students to apply for vocational, professional and occupational qualifications before their graduation • To promote such qualifications to students and the public • To ensure the standards of qualifications

[140] Collections of objectively verifiable records and evidence (e.g. academic achievements, academic work, obtained awards/certifications) and other documentation (e.g. description and self-evaluation of their learning process) that show students' efforts towards their goals

- Japanese universities can provide various good practices (e.g., student counseling and career orientation, alumni management, PR targeting prospective students) that can be introduced to the participating universities and technical colleges. The applicability of such practices needs to be carefully examined from the perspectives of organizational rules and regulations and social acceptability in Thailand.
- The Project needs to be implemented in cooperation with other support projects that help TCs and/or universities to improve the quality of their graduates (quality assurance of graduates).

Figure 49: Approach 3: Engineering Career Development Support



Approach 4: Strengthening of Teacher Education System for technical colleges

(1) Rationale

The majority of TC teachers do not have work experience in the industry relevant to their subject. This is because the majority of teaching staff in TCs became teachers after receiving a degree in industrial education without work experience in industry. Moreover, since a teaching licence is required to be a teacher in TC, engineers are not able to teach at TC. OVEC has tried to upgrade teachers' skills by providing OJT in industry but the scope is still limited. As a result, teaching staff at TCs do not necessarily understand the needs and the latest technical requirements of industry. Another issue frequently pointed out by industry is the weakness of TC graduates in their basic knowledge of mathematics and sciences and low motivation. Therefore, it is important to upgrade the existing curriculum and pedagogy to motivate students and improve their performance in these subjects.

(2) Objective:

To improve the quality of TC teachers

(3) Key Strategies

1) To develop teaching staff for KOSEN model and upgraded TCs by strengthening universities' industrial education in accordance with the set competency standards.
2) To make institutional arrangements and/or organizational changes to mobilize industrial personnel for teaching in TC.
3) To identify and analyze the required competencies and establish evaluation methods on students and teachers.

(4) Target and the scope of the Project:

Students in the departments of industrial education in the 10 universities. 6 RMUTs including Patumwan Institute of Technology (PIT) (universities that have the industrial education course for technical college teachers) will also participate in the Project (e.g., development of curriculum, teaching methods and relating training in Thailand).

Target group: Students in the departments of industrial education in the seven universities. Beneficiaries: Approximately 20,000 students in 141 technical colleges each year.

(5) Project Components

The Project's components include;

1) Review the existing syllabus of the universities,
2) Introduce teaching methods, teaching materials and other support measures through faculty development activities (e.g., the supplemental use of e-learning and introduction of PBL) to improve students' learning,
3) Introduce a performance measurement on competencies/evaluation of TC teachers, including the review of requirements for teacher licenses and/or use of non-licensed teachers from industry
4) Define the roles of teaching staff for successful implementation of the dual system and develop their capacities accordingly.

Most mathematics and science teachers come from teacher's universities; therefore, the Project will review the existing syllabus of the universities and introduce effective teaching methods.

(6) Expected Outcomes and Indicators

Overall goals:

The standards of all technical college teachers are improved in their knowledge and pedagogy.

Indicators to measure to what extent the overall goal is achieved:

- The improvements of test scores of newly recruited technical college teachers
- Improved scores of TC students and improved evaluation of TC students by the companies in Thailand

Project Purpose:

- The standards of the teachers of technical colleges targeted by the Project are improved in their knowledge and pedagogy.
- The program for teacher education in the target universities is improved.

Indicators to measure to what extent the project purpose is achieved:

- The number of teachers who meet the competency standards set by the Project.
- The results of teacher evaluation.

Outputs:

1. The competency standards for industrial education and the guidelines for implementation is introduced.
2. Technical colleges teachers improve their teaching skills in compliance with the newly established standards and industrial needs.

Indicators that measure to what extent the outputs are produced:

- The number of TC teachers who are trained in the established competency standards and the guidelines.
- The number of teaching staff with industry experience
- The contents of faculty development activities conducted by each technical college.
- Improved scores of TC students and improved evaluation of TC students by the companies participating in the dual system.

(7) Main inputs

1) Japanese side:

a. Experts in STEM[141] education, career education, faculty development[142]

b. Operation costs for faculty development and strengthening of STEM education

2) Thai side:

a. Assignment of teaching staff from the faculty of industrial education

b. Assignment of lecturers and researchers as required

(8) Important Considerations

[141] STEM（Science, Technology, Engineering and Mathematics）: Integrated learning of the four disciplines to produce STEM professionals

[142] FD（Faculty Development）:Organized efforts by academic staff to improve their teaching and educational capabilities

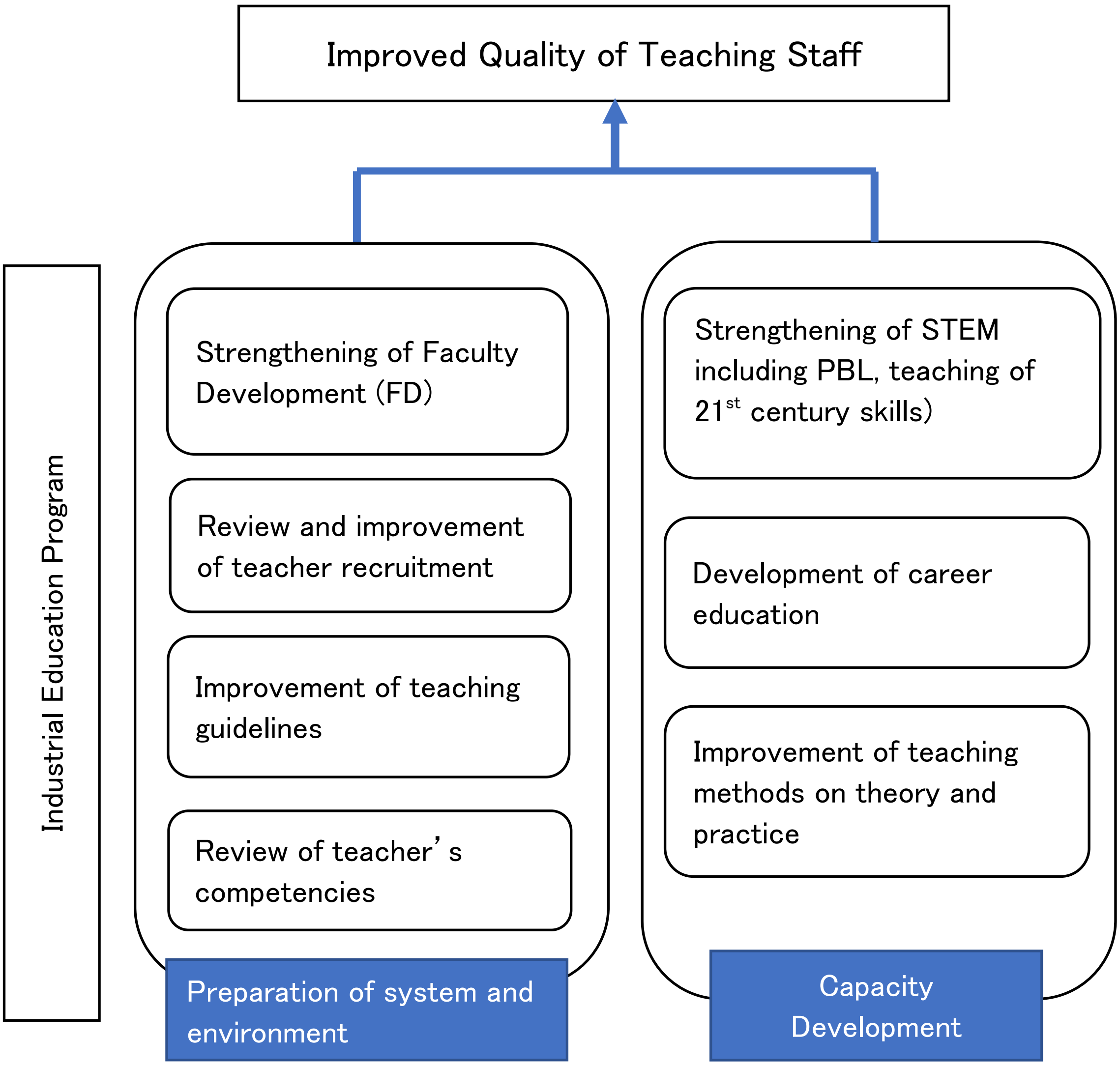
- Institutional development would be important (e.g., regulations on teaching licences, eligibility requirements for teacher recruitment) to improve the standards of TC teachers.
- The profile of the faculty of Industrial Education is as follows (see Table 54):

Table 54: Teachers and students in industrial education programs in KMUTT and KMITL

	KMUTT	KMITL
Teaching staff (Total)	(83)	(85)
Ph.D.	55	51
Master degree	27	33
Bachelor degree	1	1
Total number of bachelor students per year (all departments)	420	320
The number of bachelor students in Teacher Training Programs per year	60	30
Electrical	60	
Mechanical	60	
Production Technology		30
Computer		30
Telecommunication		
Employment after graduation in 2016		
- Teachers and other public services	15%	12%
- Private sector	50%	85%
- Others (seeking higher education, unemployed and unknown)	35%	3%

Source: KMUTT and KMITL

Figure 50: Approach 4: Strengthening of Teacher Education System for Technical Colleges



Approach 5: Program for the Development of Highly-Skilled Industrial Human Resources in Thailand - Establishment of MONOZUKURI Program

(1) Rationale

An increasing number of companies have established Research and Development units for product development and localization of foreign products for the ASEAN market. Therefore, it is important for Thailand to strengthen the educational and/or training system to develop the engineers who have hands-on experience in product development, utilizing appropriate technologies and new materials. At the same time, many manufacturing companies in Thailand mainly focus on production. Their immediate need is the development of engineers who can greatly contribute to innovation in production in terms of quality improvement, cost reductions, increased productivity, reduction in production period, stock management and streamlining of the production process. The development of such highly-skilled industrial human resources is also a priority national policy of Thailand to cope with the changing environment, which has forced Thailand to compete with other Asian countries and shift to a more technology-oriented and value-added economy. By implementing industry-driven training and educational programs, the participating Thai universities would be able to learn how to incorporate industry needs into their curriculums and strengthen UIL.

(2) Objectives

The establishment of a MONOZUKURI program (Master level and graduate diploma) to produce innovative engineers in design & development and production.

(3) Key Strategies

1) To target engineers and/or technical staff who have work experience so that they would be able to return their companies or get employment at manufacturing companies and contribute to innovation at their workplace (A number of Japanese companies send their engineers to Japan to impart necessary knowledge in production and design & development. This program intends to supplement such training.)
2) To involve industry from selection to evaluation of students to ensure employability.
3) To align with and/or integrate the existing MONOZUKURI programs (e.g., KMUTT's practical hands-on engineer program, TAIST) to create synergy effects.

The Project have two types of target groups. One type is incumbent junior and middle level engineers and the other type is students (Bachelor or Master level). An alliance of engineering universities and industrial organizations or groups of interested companies will jointly establish a training program (Diploma or Certificate) that would help produce innovative engineers in both R&D and manufacturing based on formal Memorandum of Agreement. Measures should be taken to ensure the active participation of industry. For example, participating companies list the companies' needs for R&D and problem resolution in production and the students propose solutions or prototypes to the participating companies for evaluation. Another measure is to assign company engineers to act as lecturers and implement students' projects as a joint research project among a university lecturer, an engineer from a participating company and a group of students. The Project will make institutional arrangements with TPQI and other relevant organizations to provide degrees, diplomas, or certificates as professional qualifications (e.g., quality management specialist in electronic product manufacturing, Auto-parts product designer, Automated Machinery Management Specialist, etc.). The Project needs to ensure that students' projects are implemented as UIL. Japanese universities that implement similar programs would support the development and implementation of programs.

(4) Target and the scope of the Project:
Engineers interested in acquiring skills commensurate with highly-skilled engineers

(5) Project components
The Project's components include;
1) The development of programs.
2) Development of a framework to implement programs, and establishment of alliances of companies and universities in Thailand as well as an alliance of Japanese universities.
3) Institutionalization of programs to be implemented by participating universities (e.g., accreditation by TQPI and/or COE) and promotion of outcomes in collaboration with university liaison offices of Thai universities (e.g., commercialization of developed prototypes).
4) Installation of necessary equipment for students' projects.

(6) Expected outcomes and indicators
<u>Overall goals:</u>
- The graduates of the program play active roles in production as well as design and development in the manufacturing sector.
- University – Industry Linkage is strengthened.

Indicators that measure to what extent the overall goals are achieved:
- The number and percentage of the graduates who are engaged in production, design and development
- Outstanding achievements of the graduates (e.g. registered new products, obtained patents, innovation in production)
- Newly developed ties between industry and university (e.g. joint research, academic staff & student exchange, internships, scholarships and sponsorships for student projects)

<u>Project purpose:</u>
The University-Industry joint MONOZUKURI program to produce innovative engineers is instituted.
Indicators that measure to what extent the project purpose is achieved:
- The number and percentage of enrollees who completed the program
- The number and percentage of the students who get employment in the manufacturing sector as an engineer
- The number and percentage of the incumbent engineers who work as an engineer after their completion of the program

<u>Outputs:</u>
- The degree, diploma and certificate of the program are well accepted by relevant organizations.
- Talented and enthusiastic about manufacturing engineers participate in the program.
- The outputs of the students' projects are highly evaluated by the participating companies.

Indicators that measure to what extent the outputs are produced:

- The number and types of MOU/MOA signed and collaborative activities conducted between industry and university
- Accreditations by relevant organizations such as TPQI, COE and DSD-MOL
- Achievements of students' projects adopted by companies
- The number of applicants and the GPA of the enrollers

(7) Main inputs

1) Japanese side:

a. Scholarship to highly evaluated students to study in Japan
b. Equipment for R&D (for prototyping and simulation) not available in the partner universities
c. Dispatch of Japanese lecturers (Japanese universities)
d. Distance lectures by Japanese lecturers
e. Long-term experts to facilitate project activities
f. Tuition, living expenses and free boarding to first year student in Thailand (or making arrangement with industry to provide scholarship to company employees)

2) Thai side:

a. Securing a budget for O&M and also an earmarked budget for upgrading equipment
b. Securing the sufficient number of teaching staff and a budget for lecturers from companies

(8) Important considerations

- There are three programs that aim to produce practical and innovative engineers, as shown in the table below (see Table 55). All the universities that are participating in their program show interest in participating in implementing the Project. An institutional framework for implementation needs to be developed to establish an effective program.

Table 55: List of relevant programs

Program	University	Descriptions
TAIST-Tokyo Tech (Thailand Advanced Institute of Science and Technology)	Tokyo Tech, KMITL, KMUTT, Kasetsart U and Thammasat U	Three Master courses (Automotive engineering, Information & Communication Technology for Embedded system and Advanced & Sustainable Environmental Engineering) are conducted each year, accepting 30 students for each course. Tokyo Tech supports the courses in the forms of dispatch of lecturers, curriculum development, remote teaching and accepting selected students in Tokyo Tech's Ph.D. programs.
Hands-on Engineers	KMUTT	Second major (certificate program) for bachelor students for four years, hands-on training on MONOZUKURI, Japanese language, Japanese business practices are taught; 20 students are accepted for each year with scholarship.
MONOZUKURI course	TNI	TNI has introduced a MONOZUKURI course in its Bachelor Program as an optional subject, financially

		supported by AMEICC. The syllabus was jointly developed with companies.

Source: The results of interviews

- It is critically important that incentives are prepared for applicants. For engineers, the program needs to offer opportunities to upgrade their qualifications, look at their careers with a new perspective, and earn scholarships to study in Japan. If the program offers students the chance to tackle real issues or problems and produce tangible outputs as solutions to companies, the program can be attractive to students looking to increase their employability. Scholarships such as Tokyo Tech's scheme to provide scholarships for Ph.D. programs in Japan are also effective incentives for students and can attract competitive students.

- In order to make the program useful to industry, the industrial organizations and/or groups of companies should be involved beginning with development of curriculum to the evaluation and assessment of students' performance.

- The following should be also considered to ensure the sustainability of the program:
    - ✓ The Talent Mobility Program of STI should be used for teaching staff and students to implement the program in participating companies so that personnel costs could be partly shouldered by the Talent Mobility Program.
    - ✓ The program should make arrangement with companies and other organizations (e.g., MOU) so that the program can be implemented, using company facilities, national research institutions and science parks (under STI) where necessary facilities and equipment are available to conduct research.
    - ✓ The Project should make efforts to institute the program as a prerequisite or popular preparation program for professional qualifications under TPQI/NQF so that the program can be institutionally well entrenched.
    - ✓ The Project can also seek cooperation with DSD to institute short-term training programs as DSD's refresher training courses. DSD can organize short-term training (up to one or two months) intended to upgrade the skills of technicians and engineers on a request basis from companies or industrial organizations.

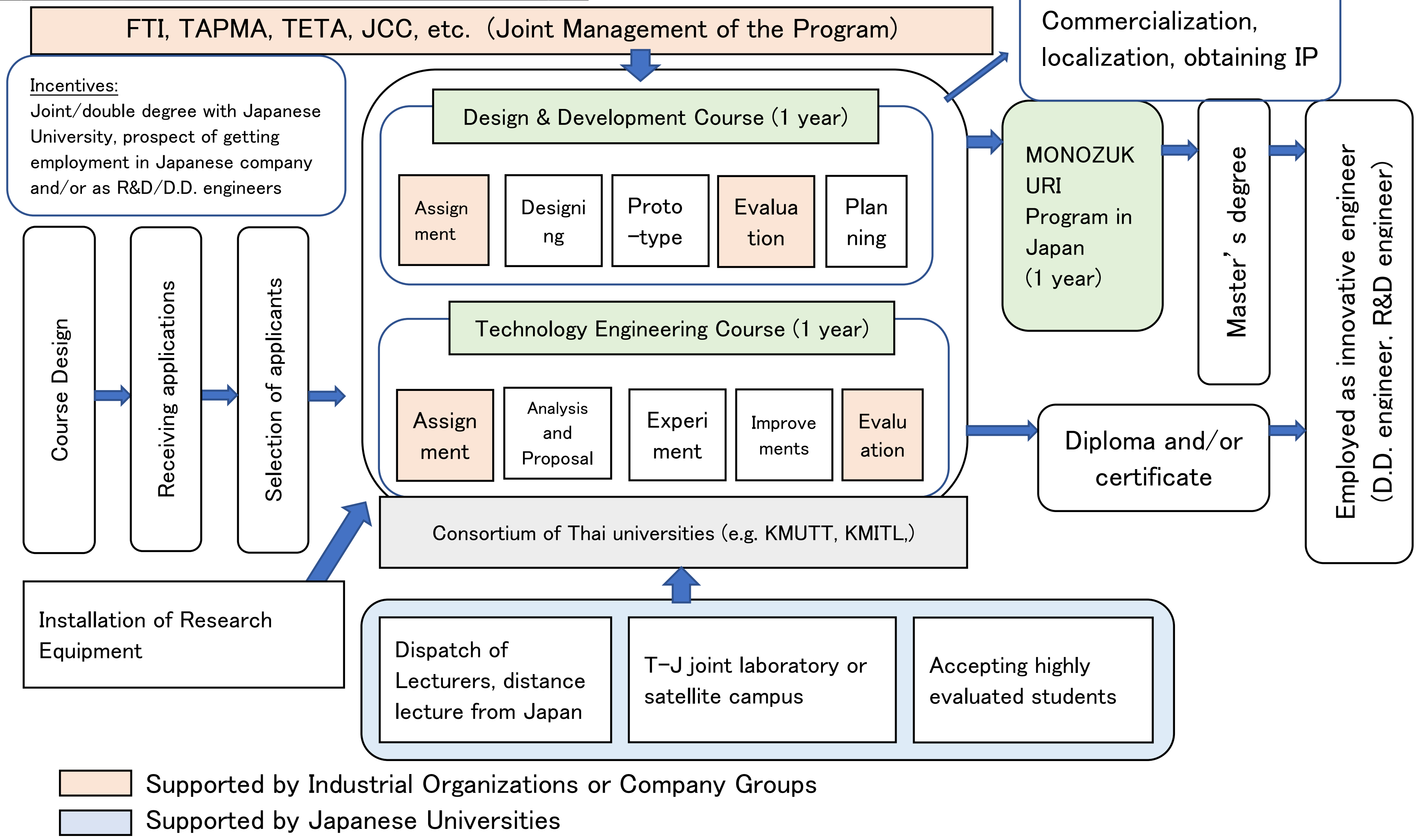
- According to the online survey given to both Japanese and Thai companies, it is likely that the companies would be interested in the MONOZUKURI program as a measure to upgrade the technical capacities of their employees. Therefore, it would be important to closely communicate with both Japanese and Thai companies to encourage their participation (see Table 56).

Table 56: Companies' interest in diploma or master course for MONOZUKURI

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Likely to recruit diploma or degree holders of MONOZUKURI program	16	57.1	17	51.5	33	54.1
Likely to consider subsidizing the fee of the MONOZUKURI program as a means of retraining and upgrading company's technical staff	11	39.3	6	18.2	17	27.9
Likely to encourage company's technical staff to participate in the MONOZUKURI program	4	14.3	10	30.3	14	23.0
Others	2	7.1	7	21.2	9	14.8
Total	28	100.0	33	100.0	61	100.0

Source: The results of online survey to companies

Figure 51: Approach 5: Establishment of MONOZUKURI Program



Chapter 7 Human Resource Development for ICT industry

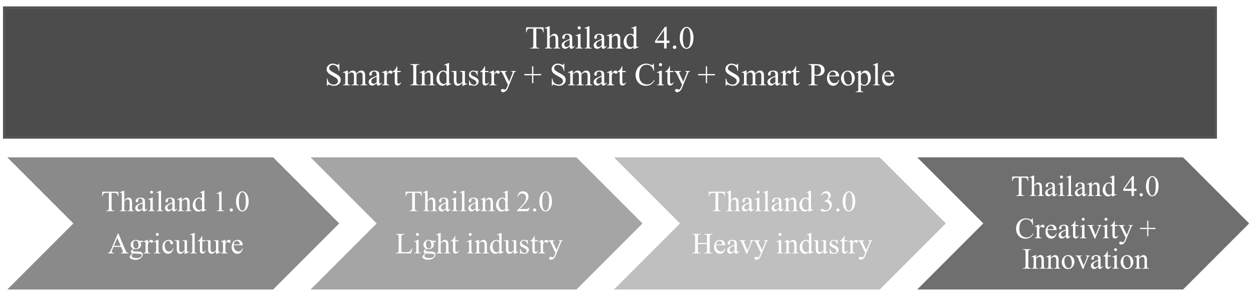
The earlier chapters focus on the manufacturing sector, elaborating the supply and demand situation and gaps, issues for educational institutions, the required competencies for students and workforce by industry and proposed five approaches for industrial human resource development in Thailand. This chapter turns its focus on Information and Communication Technology (ICT) industry, describe government policies and programs for human resource development, the supply and demand gaps of the current labor market and suggest the areas for and the scope of future cooperation. As ICT is becoming a part of our daily lives, ICT literacy is considered needed for all citizens and these policies refer to both ICT professionals and workforce in all sectors. This report will focus on developing ICT professionals rather than ICT literacy for all citizens.

7.1 ICT policy for the nation

7.1.1 Government policy

The Thai government has been promoting a new economic model, so called "Thailand 4.0" which aims at transforming the nation towards "the value-based economy". As shown in Figure 52, Thailand is in the third stage emphasizing heavy industry for economic growth but faces a risk of "middle-income trap." In order to climb the next step of development ladder, Thailand is trying to develop competitive advantage with five groups of technology and target industries which comprises of:

1. Food, agriculture and bio-tech;
2. Health, wellness and biomedical;
3. Smart devices and robotics –mechatronics
4. Digital, Internet of Things (IoT), Artificial Intelligence (AI) and embedded technology; and
5. Creativity, culture and high-value services.



Source: Thailand 4.0. Royal Thai Embassy, Washington DC.[143]

Figure 52: Thailand 4.0

Information and Communication Technology (ICT) is considered to play an important role for Thailand to achieve this ambition and a number of policy/plan documents have been announced. Ministry of Digital Economy and Society (MDES) is a government agency responsible for establishing a national

[143] Royal Thai Embassy, Washington DC. Thailand 4.0 accessed on May 18, 2017 at http://thaiembdc.org/thailand-4-0-2/

policy for ICT in Thailand.[144] MDES is formally known as Ministry of Information and Communication Technology (MICT) which was established in 2002 but the new ministry, MDES replaced MICT in 2015 according to restructuring the government organizations.

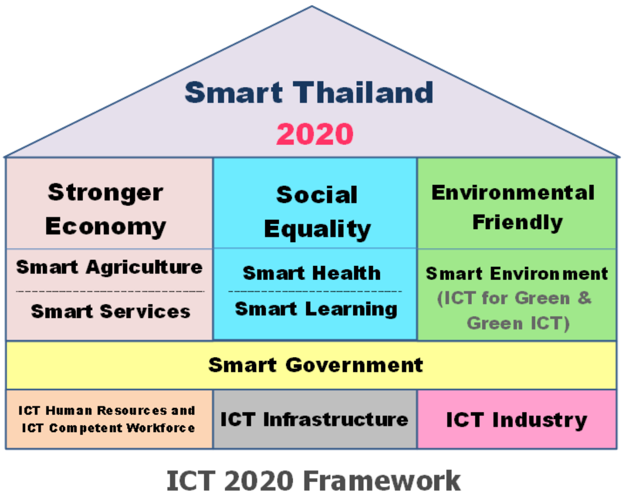
Thailand's ICT policy is set by 10-year span of ICT framework and 5-year span of ICT master plan. Currently, "ICT 2020" serves as a national framework for ICT development and promotion over the period of 2011 to 2020. It aims at "enhancing the economy and quality of life of the Thai people and lead Thailand towards a knowledge-based economy and society." "ICT 2020" is founded on the principles of sustainable development in the social, economic and environmental dimensions, reduction of inequality, "sufficiency economy" philosophy, continuity of policy and strategy and private sector involvement. Main goals of ICT 2020 are set as follows:

1. A universal broadband access to all people: By 2015, 80% of the population will be able to access the broadband, which will increase to 95% by 2020.
2. Sufficient high-quality human resources to shift to a service economy and a creative economy: At least 75% of the population will have information literacy and at least 3% of the workforce will be ICT professionals.
3. Increase of ICT industries role in the Thai economy: ICT value added including digital content industry will account for at least 18% of GDP.
4. Enhance overall national ICT readiness: Thailand will be in the top quartile of the Networked Readiness Ranking.
5. Increase opportunities in creating revenue and improving quality of life, especially for disadvantaged groups by creating new internet-based employment.
6. Awareness of the importance and role of ICT in developing the economy: At least 50% of the population will be aware of the importance of ICT in environmentally-friendly growth.

In order to achieve the above six goals, seven strategies are set in so called "Smart Thailand" diagram as follows. (See Figure 53.)

1. Universal and secure ICT and broadband infrastructure;
2. ICT human resources and ICT competent workforce
3. ICT industry competitiveness and ASEAN integration
4. Smart government: ICT for government service innovation and good governance
5. ICT for Thailand competitiveness and vibrant economy
6. ICT to enhance social equality
7. ICT and Environment: the Green ICT

[144] Ministry of Science and Technology (MOST) which was established in 1979 also oversees ICT and some responsibilities overlap with MDES. While MDES focuses on ICT benefits for the whole economy and society, MOST focuses on development of ICT as a specific field of science and technology.



Source: MOST (2011)

Figure 53: Smart Thailand Diagram

In accord with this framework of "ICT 2020," "3rd ICT Master Plan" (2014-2018) was drafted but halted due to the coup in 2014. However, the current government has strongly promoted ICT development and "Thailand's Digital Economy and Society Development Plan", so called "Digital Thailand Plan" is co-developed by MICT (currently MDES) and MOST to leverage digital technology to drive the country forward, following "ICT 2020" and substituting "3rd ICT Master Plan". The four goals are set as follows:

1. Raising the country's competitiveness with digital innovation,
2. Creating equal opportunities with information and digital services,
3. Developing human capital for the digital era
4. Revolutionizing government operations for better transparency and effectiveness.

"Digital Thailand Plan" divides the 20-year period into four phases: 1) Digital foundation (one and half years); 2) Inclusion (5 years); 3) Full transformation (10 years) and 4) Global digital leadership (10-20 years) and has six strategies as follows.

1. Build country-wide high-capacity digital infrastructure,
2. Boost the economy with digital technology
3. Create a quality and equitable society through digital technology
4. Transform into digital government
5. Develop workforce for the digital era
6. Build trust and confidence in the use of digital technology

Policy matrix related to ICT is shown in Annex 13.

7.1.2 Policy and planning for software industry

The major government agencies which support software industry are the Digital Economy Promotion Agency (DEPA) and Thailand Software Park (TSP). While the DEPA sets the policy and planning, TSP supports software industry in more practical ways. Software industry has been promoted by the Digital Economy Promotion Agency (DEPA) which was established in 2017, replacing the Software Industry Promotion Agency (SIPA), to "promote the development of digital industry and innovation and the digital technology adoption in order to achieve the economic, social, cultural and security benefits." DEPA's responsibilities are as follows:

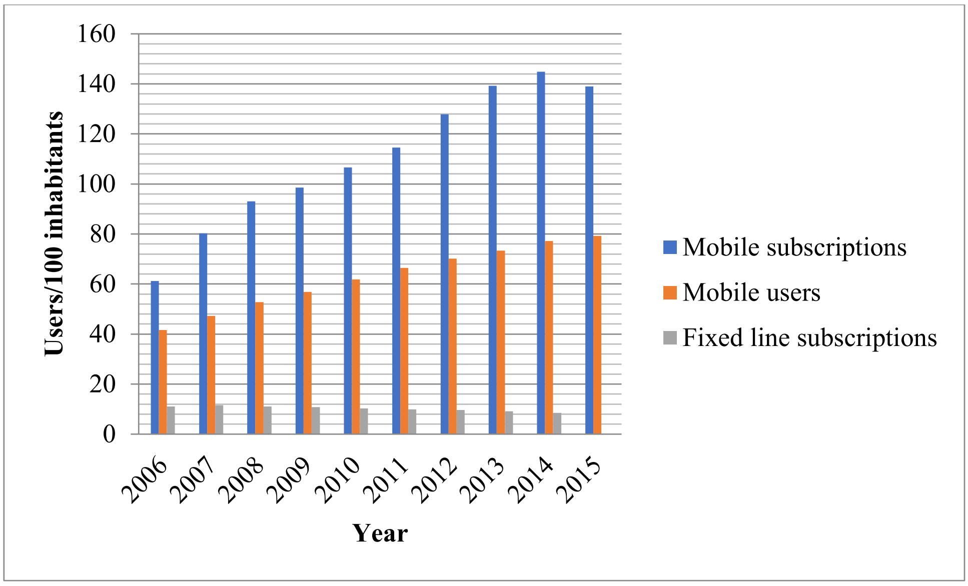
1. To prepare the digital economy promotion strategy in accordance with the national policy and plan,
2. To promote the investment or business operation in the digital industry and innovation,
3. To promote other public agencies or private companies to achieve the development of digital industry and innovation,
4. To promote, support and implement the human resource development with regard to digital industry and innovation,
5. To strengthen the law amendment, regulations and measures in relation to the intellectual property protection of digital industry and innovation,
6. To conduct other duties assigned by the National Committee for Digital Development for Economy and Society,
7. To cooperate with other international or domestic organizations to implement the objectives of the DEPA, and
8. To cooperate with others to achieve the objectives of the DEPA.

Software Park Thailand (SPT) under the National Science and Technology Development Agency (NSTDA), MOST, promotes software industry in more practical ways providing high-end training courses for IT professionals, promoting quality standard of local companies, supporting both local and international collaboration for new market opportunities, promoting the usage of technology to all sectors, and providing office facilities, conference, meeting and training rooms for software companies.

In all these policies and plans, developing ICT human resources is one of major components. DEPA would be the key organization for policy and institutional development particularly for the socially vulnerable. SPT would be the key implementer of ICT related programs.

7.2 Overview of ICT Industry in Thailand

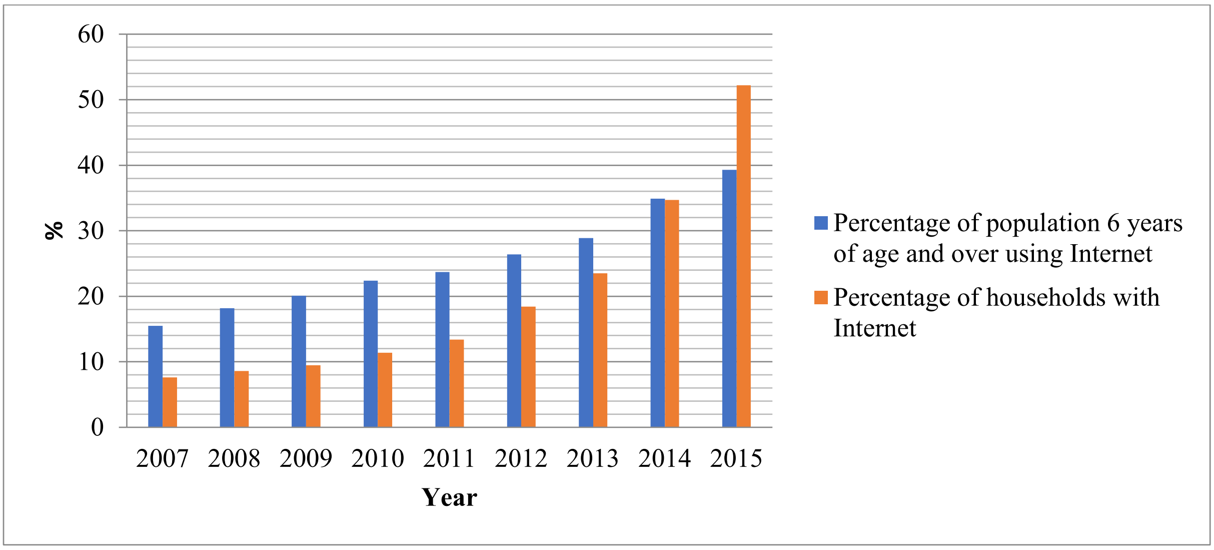
Access to ICT has been increasing rapidly over the decade in Thailand as shown in Figure 54 and Figure 55. Mobile telephone users nearly doubled and Thailand ranked 4th for mobile telephone subscriptions per 100 inhabitants (144.4%) among ASEAN countries, following Singapore (158.1%), Cambodia (155.1%), Malaysia (148.8%) and Vietnam (144.4%) in 2014. (STI, 2016) In regards to the percentage of individuals using internet, the number has more than doubled and the number of households with internet increased more than six times over the decade. Thailand ranked 6th (34.9%) among ASEAN countries, following Singapore (82%), Brunei (68.8%), Malaysia (67.5%), Vietnam (48.3%) and Philippines (39.7%). (STI, 2016)



Source: National Statistical Office, ICT household survey report 2015 (The survey covers population 6 years of age and over.) Office of the National Broadcasting and Telecommunications Commission and TOT Public Company Limited, Ministry of ICT. Cited from STI (2016)

Note: The decrease of number of mobile subscriptions in 2015 is due to statistical modification excluding non-active pre-paid subscriptions.

Figure 54: Fixed-line and mobile telephone use (2006-2015)

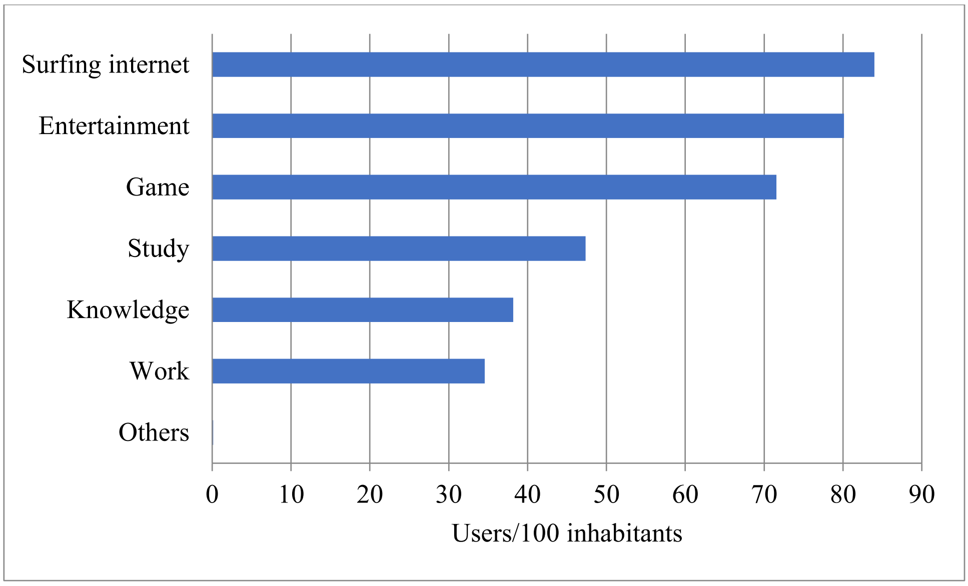


Source: National Statistical Office, ICT household survey report 2015

Figure 55: Use of Internet (2007-2015)

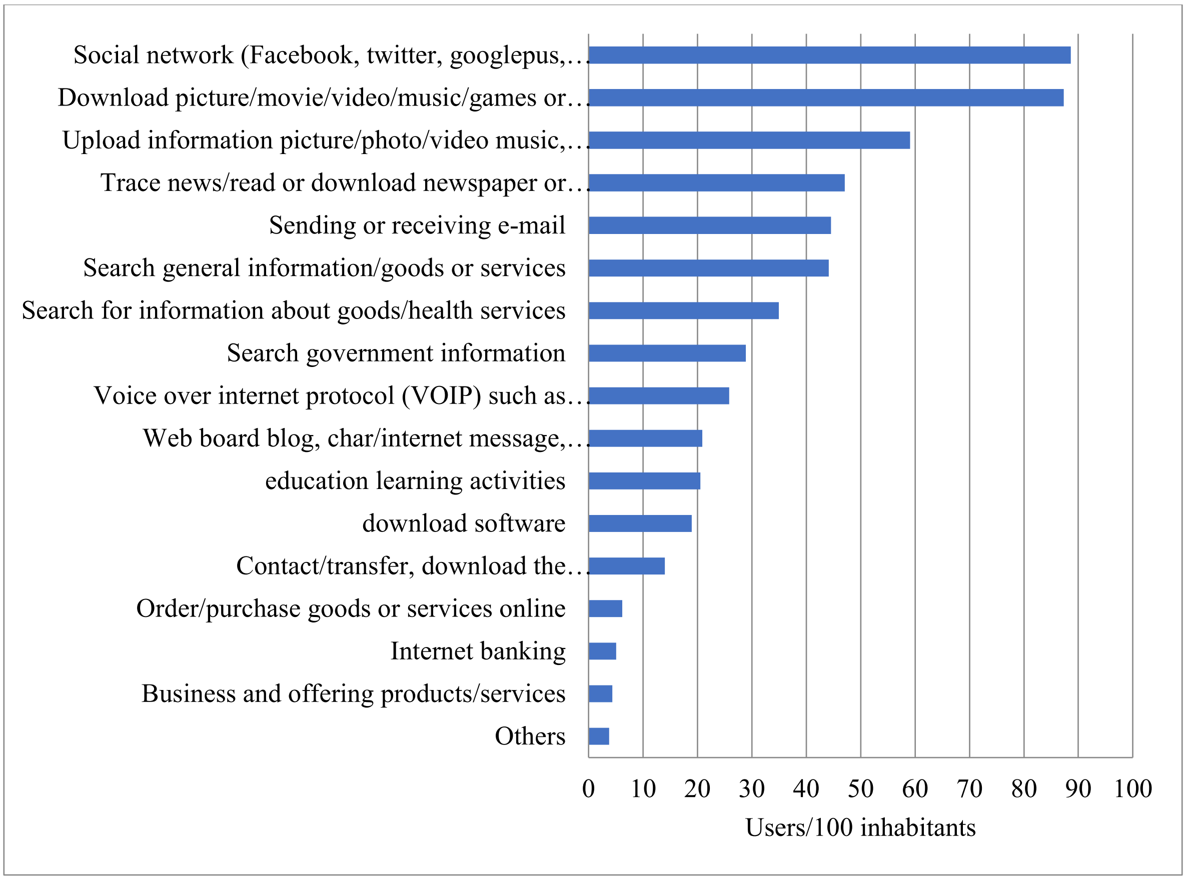
In 2015, the percentage of mobile telephone users is 79.3%, computer users 34.9% and Internet users 39.3%, respectively among the population of 6 years of age and over. In regards to the percentage of household with computer, Thailand ranked 4th (33.9%) among ASEAN countries, following Brunei (92%), Singapore (88%) and Malaysia (66.5%). (STI, 2016)

In regards to activities using computer, major activities are surfing internet, entertainment and game. (See Figure 56.) In regards to activities using internet, using social network and downloading picture/video/music are the major activities. (See Figure 57.)



Source: The 2015 Information and Communication Technology Survey in Household, National Statistical Office, Ministry of ICT

Figure 56: Activity using computer



Source: The 2015 Information and Communication Technology Survey in Household, National Statistical Office, Ministry of ICT

Figure 57: Activities using Internet

7.3 ICT Industry in general

While ICT has been strongly promoted by the Thai government, ICT industry has been growing rapidly in Thailand. The scale of the software market in Thailand in 2015 is approximately 100 Billion Baht as shown in Table 57. The total sales value generated by Thai ICT companies (sales of locally produced software and exported software combined) account for more than 50% of the total market value (52,561 Million Baht), where 26.7% (14,068 Million Baht) is generated from the sales of packaged software and the remaining 73.3% (38,493 Million Baht) comes from ICT related services such as customization and maintenance of software and user training. (SIPA, 2015)

Table 57: Thailand's Software market (2015)

Sales of software	Amount (Unit: Million Baht)	Share of the market
Sales of imported software	32,944	32.8%
Sales of locally produced software	49,231	49.0%
Sales of exported software	3,330	3.3%
Sales of in-house software	14,903	14.8%
Total	100,408	100.0%

Source: SIPA

The sale of embedded software (e.g. software developed for industrial and electronic produces) has increased from 5,832 Million Baht in 2014 to 6,035 Million Baht in 2015. (SIPA, 2015)

The Government has played an important role in the expansion of ICT businesses. The public-sector accounts for 32.4% of the total sales of packaged software in 2015 (SIPA, 2015). Also, Thailand's Internet Service Provider (ISP) was initiated by a state-owned enterprise (current CAT Telecom) but after liberalization of IPS, True, 3BB and TOT are the major IPST and share more than 90% of the market. (JETRO, 2015) Mobile telephone services are provided by three major companies, namely AIS, DTAC and True, accounting for more than 98% share of the market[145].

Another emerging market is digital-content market. Digital-content market in 2015 achieved 12,400 Million baht, expected to be 13,650 Million baht in 2016, with gaming software valued at an estimated 9,700 Million Baht with animation at 3,950 Million baht. These figures expanded 9.56% and 2.8%, respectively on year-on-year basis. The gaming software market is projected to grow to about 10,800 Million Baht in 2017, with the support of the digital-economy plan of the Government. [146]

7.4 Challenges of Thai ICT industry

Thailand faces some challenges in developing software industry. According to the Global Information Technology Report[147], Thailand is gradually improving its ranking in networked readiness, but progress

[145] JETRO (2015) "Survey on information communication and information technology situation in Thailand"(in Japanese)
[146] http://www.nationmultimedia.com/news/business/EconomyAndTourism/30300067 accessed on May 25, 2017, Jirapan Boonnoon, Sipa projects solid growth in Thai digital content market, The Nation, November 16, 2016.
[147] World Economic Forum. Global Information Technology Report 2016. Accessed on May 20, 2017 at http://reports.weforum.org/global-information-technology-report-2016/economies/#economy=THA

is slow and still far behind the neighboring countries such as Singapore and Malaysia as shown in Table 58. It will be difficult to achieve the goal of "ICT 2020" to be ranked in 35th within a few years, unless Thailand addresses some major issues.

Table 58: Networked Readiness Ranking (2012-2016)

	2012	2013	2014	2015	2016
Singapore	2	2	2	1	1
Malaysia	29	29	30	32	21
Thailand	77	77	67	67	62
Indonesia	80	76	64	79	73
Philippines	86	86	86	76	77
Vietnam	83	83	84	85	79
Japan	18	21	16	10	10

Source: The Global Information Technology Report, each year.

The challenges of ICT industry in Thailand can be summarized as the following four issues: 1) Piracy; 2) Shortage of highly skilled workforce; 3) Digital divide, and 4) Slow IT adoption among SMEs. Especially, the first two, piracy and shortage of highly skilled workforce are considered significant threats confronting the software industry[148].

7.4.1 Piracy

Software piracy is an ongoing issue in Thai ICT industry. In fact, what staggers Thailand's networked readiness ranking are political and regulatory environment, ranked at 80th out of 139 countries, including intellectual property protection (113th) and software piracy rate (70th). (World Economic Forum, 2017) Illegal usage of software indicates deprivation of revenues from legitimate sales for software purveyors, deprivation of tax revenues from the software sales for the government and bereft of the motivation for software developers and programmers. According to Microsoft Asia, the software piracy rate in Thailand in 2016 was 70%. It ranked among the top 10 countries in Asia-Pacific most at risk of malware threats, behind Bangladesh, Indonesia and Vietnam. Ninety two percent of new computers installed with non-genuine software were infected by malware, facing the damage caused by cyber security risks as well as the economic loss[149].

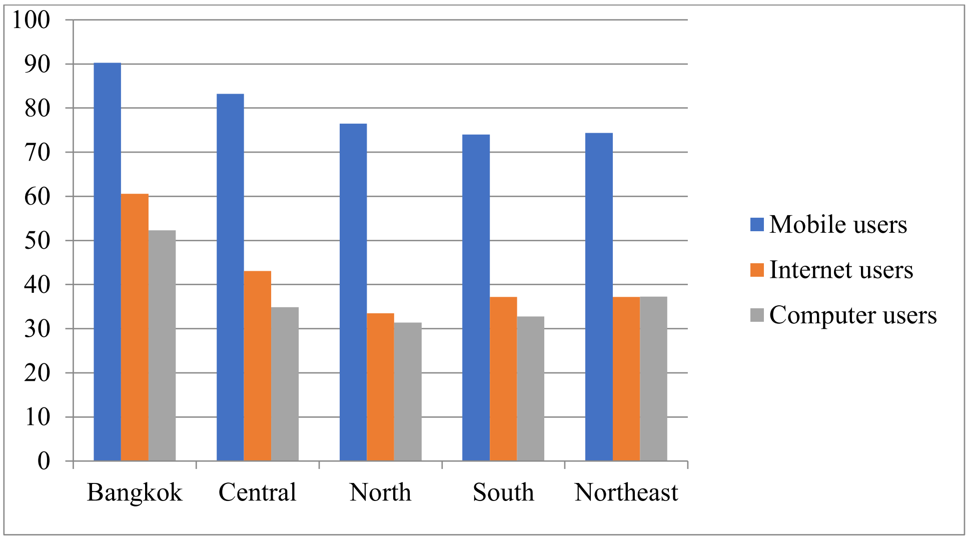
7.4.2 Shortage of highly skilled workforce

Shortage of highly skilled workforce in the ICT industry is another significant pressing issue confronting the ICT industry. This report will discuss this issue in more details in the following section. In a global market of software industry, emerging economies such as China, India and Vietnam are competitors in both lower-cost software production as well as a higher level of software development skills.

[148] Danuvasin Charoen (2013) "The Analysis of the Software Industry in Thailand" in International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering. Vol: 7, No.6, 2013. Pp.1640-1644.
[149] Bangkok Post, June 24, 2017, "Thailand in top 10 for malware in Asia." By Suchit Leesa-Nguansuk.

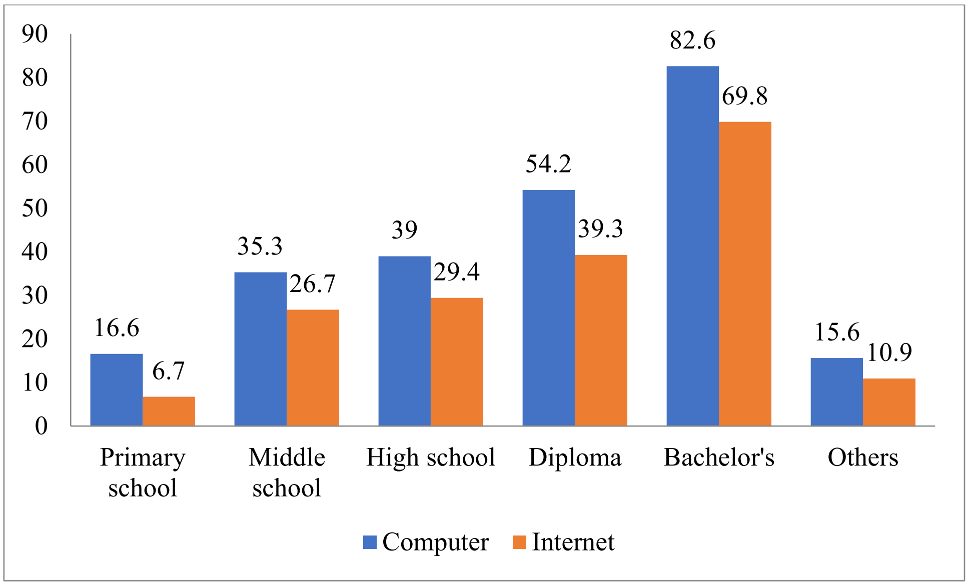
7.4.3 Digital divide

Digital divide is "a situation associated with differences between groups and societies in the deployment and diffusion of ICTs, especially computers and the Internet." (Danuvasin, 2013) The digital divide is seen in Thailand, among age groups, geographical area, education level, and social economic status. While the use of mobile phones, computers and the Internet is rapidly increasing, the percentage of individuals (age 6-year-old and above) with computers is still 34.9% and with the Internet access 39.3%, one third of the populations. The highest number of users of mobile phone, computers and the Internet are in Bangkok. (See Table 60.) The gap is also distinct by education level: Bachelor's degree holders have the highest percentage of computer and the Internet users as seen in the Figure 59.



Source: STI (2015)

Figure 58: Percentage of users of mobile phone, Internet and computers by region (2015)



Source: Danuvasin, 2013

Figure 59: Percentage of users of computer and the Internet by education level (%)

The digital divide can create differences between those who have and those who have not access to ICTs, in aspects such as social equality, social mobility, economic equality, and economic growth and innovation. The digital divide is an obstacle for Thailand to progress in both social and economic development. According to the 2014 World Economic Forum Report[150], 10% increase of the Internet access can lead to 1.2% increase in per capita GDP growth in emerging economies.

7.4.4 Slow adoption of ICT among SMEs

Small and medium sized enterprises (SMEs) play an important role in Thai economy. In terms of numbers, SMEs accounts for 99% of Thai enterprises and provides 78% of the total employment of the nation. Furthermore, SMEs contributes to 37.9% of the GDP and 28.4% of the export (Danuvasin, 2013). SMEs can be benefitted from ICT for improving organizational effectiveness, promoting innovation and seeking new market for their products or services. However, ICT application among SMEs is still very low as shown in Table 59.

Table 59: ICT application by size of company (%)

Size (persons)	Ratio of PC used	Ratio of the Internet used	Ratio of MIS used	Ratio of having Website
1-9	22.6	18.3	15.3	5.2
10-15	65.1	56.0	57.4	25.8
16-25	75.8	67.6	66.8	33.7
26-30	83.0	77.8	74.7	47.1
31-50	88.8	82.7	79.4	50.8
51-200	95.9	92.7	91.1	66.9
More than 200	99.6	98.4	96.9	83.2
Average	24.9	20.5	17.7	6.7

Source: National Statistical Office, ICT Survey 2014 Adopted from JETRO

While large enterprises can bear the cost of ICT including highly skilled workforce specialized in ICT, SMEs cannot afford it in both financial and operational capacity. SMEs may be losing an opportunity to develop to innovate their businesses due to lack of ICT application.

7.5 Overview of ICT Human Resources

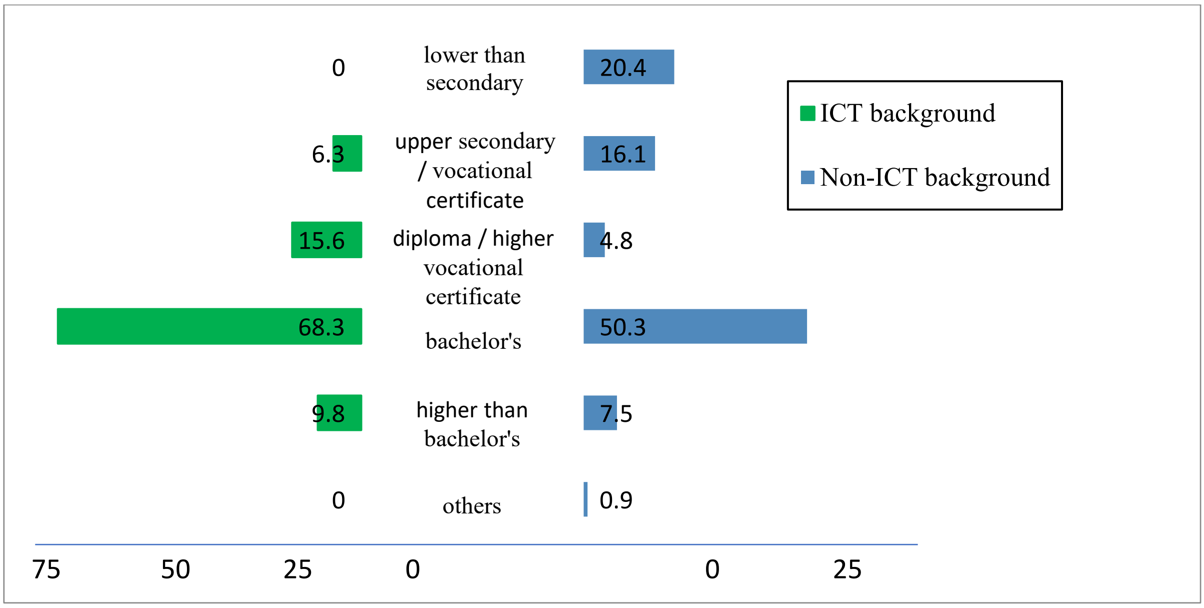
7.5.1 ICT human resources in general

ICT human resources cover a wide range and various levels of workforce related to ICT. According to "the Summary of ICT Personnel 2015[151]" by the National Statistical Office (NSO), there are about 364,500 persons working in the ICT industry. Among them, 56% are categorized as ICT professional, 20.5% as practical technicians who solve problems for ICT users, 14.2% as software and applied program analyst and developer, 5.7% as database and network professional and 3.6% as communication

[150] World Economic Forum, 2014. "Delivering Digital Infrastructure Advancing the Internet Economy" at http://reports.weforum.org/delivering-digital-infrastructure/acknowledgements/..

[151] National Statistical Office, "Summary of ICT Personnel 2015" in Thai. http://service.nso.go.th/nso/nsopublish/themes/files/ictwkRep58.pdf. Accessed on May 18, 2017.

technicians, respectively. The categories of ICT personnel are shown in Annex 14 (NSO, 2015). ICT personnel do not necessarily have academic background of ICT. In fact, half of them (51.3%) do not have ICT background and the levels of academic background vary although bachelor's and higher degree holders account for more than half of them as shown in Figure 60.



Source: NSO (2015)

Figure 60: Academic background of ICT personnel (%)

ICT personnel are concentrated in Bangkok (45%). Two thirds are male. Eighty percent of them are in private and services sector. Their demographic data is shown in Table 60.[152]

Table 60: Demographics of ICT personnel (2015)

	Ratio
Gender	Male vs. Female = 70 : 30
Region	Bangkok 45.1%, Central 30.0%, North 8.9%, Northeast 8.6%, South 7.4%
Sector	Services vs. Manufacturing = 79 : 21 Public vs. Private = 19 : 81

Source: NSO 2015

7.5.2 Small pool of software personnel

This report focuses on ICT personnel specifically in software industry. There are more than 350,000 persons working in ICT industry, but when limiting to software industry, the pool is very small. In 2015, there are 55,000 personnel working in software industry. Among them, those who are engaged in

[152] According to the Software Park Thailand, there are 447,922 persons working in ICT industry at 218,783 organizations in 2016. Among them, only 25,891 persons (5.7%) have academic background of ICT. (Software Market Survey 2015)

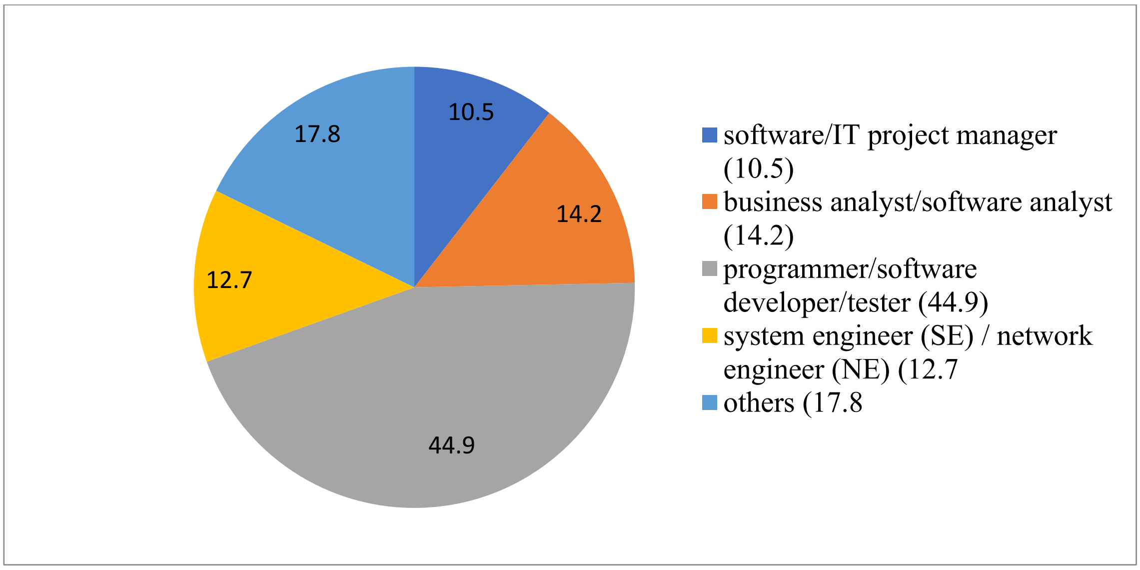
software engineering including software developers and freelancers are about 80% of the total, 35,000-45,000 personnel.[153] (See Table 61.)

Table 61: Number of personnel in software and software development industry

Year	2014	2015	Ratio (2015)	
Software and Software services	35,668	36,376	65.1%	78.9%
Freelancer	5,838	7,711	13.8%	
Marketing and sales	3,151	5,833	10.4%	
Management level	2,808	2,809	5.0%	
Others	3,469	3,144	5.6%	
Total	50,934	55,873	100%	

Source: Software Market Survey

When looking at the type of work, about half of them are engaged in software development and testing. The rest of them are divided in business analyst, system engineer, project manager and others evenly. (see Figure 61.)



Source: SPT (2015)

Figure 61: Proportion of software workforce by type of work (%)

Software personnel are highly educated: 53% of them hold bachelor's degree, 46% has master's and 1% has doctoral degree, according to the Adecco Thailand survey. More than half of them (54%) are in the range of 25-35 years old and only 7% of them are older than 46 years old. Seventy percent of them have longer than 5 years working experience and 60% are female. (SPT, 2015)

Software personnel are relatively highly paid. While the average salary of overall ICT personnel is 22,168 baht per month in public sector and 22,514 baht per month in private sector, software personnel

153 The interviewees mention that most of software engineers are providing services such as installation, maintenance, and testing and those who are engaged in software development can be very limited to a few thousand personnel.

are paid higher than them. Also, in comparison to other sectors, software personnel are paid better. (see Table 62.)

Table 62: Average salaries of ICT personnel (Baht)

Type of work	Less than 5-year experience		Longer than 5-year experience	
	Minimum	Maximum	Minimum	Maximum
ICT-related				
IT project manager	n/a	n/a	70,000	150,000
Business analyst/ software analyst	n/a	n/a	50,000	100,000
Software engineer	20,000	45,000	50,000	80,000
System engineer	18,000	45,000	45,000	65,000
Programmer	18,000	45,000	50,000	80,000
Manufacturing				
Project manager	n/a	n/a	65,000	120,000
Electrical and mechanical engineer	18,000	40,000	45,000	55,000
Office positions				
Accounting officer	15,000	30,000	35,000	55,000
R generalist/specialist	18,000	35,000	40,000	90,000
R & D specialist	20,000	40,000	50,000	70,000

Source: Adecco Thailand Salary Guide 2017

7.5.3 Demand and supply: Quantitative situation

(1) Demand for IT workforce is high, following engineers.

In regards to quantity, the demand for ICT workforce exceeds to the supply by far. According to Software Park Thailand (SPT) report in 2016, workforce in ICT is the third highest demand in Thailand, following those in engineering and sales. According to STI estimate, computer-related occupations is the second highest demand among STEM workforce, following to engineers, as shown in Table 63.

Table 63: Projected industry demand of STEM workforce in 2023

Computer occupations	Engineer & engineering technicians	Life & physical science occupations	Architects, surveyors & technicians	Mathematical science occupations	Total
116,905	406,727	82,798	10,122	8,741	625,293

Source: STI Thiti

According to the 2014 survey by NSO, the total of ICT personnel needs is about 17,000 workers: Most needed personnel are computer associate professionals followed by computer system designers and programmers. Business, trade and service sector needs most ICT personnel (11,000 persons) followed by manufacturing sector (2,800 persons). Small size companies need more computer associate professionals while the larger the companies, the more system analysts and programmers are needed. (see Table 64.)

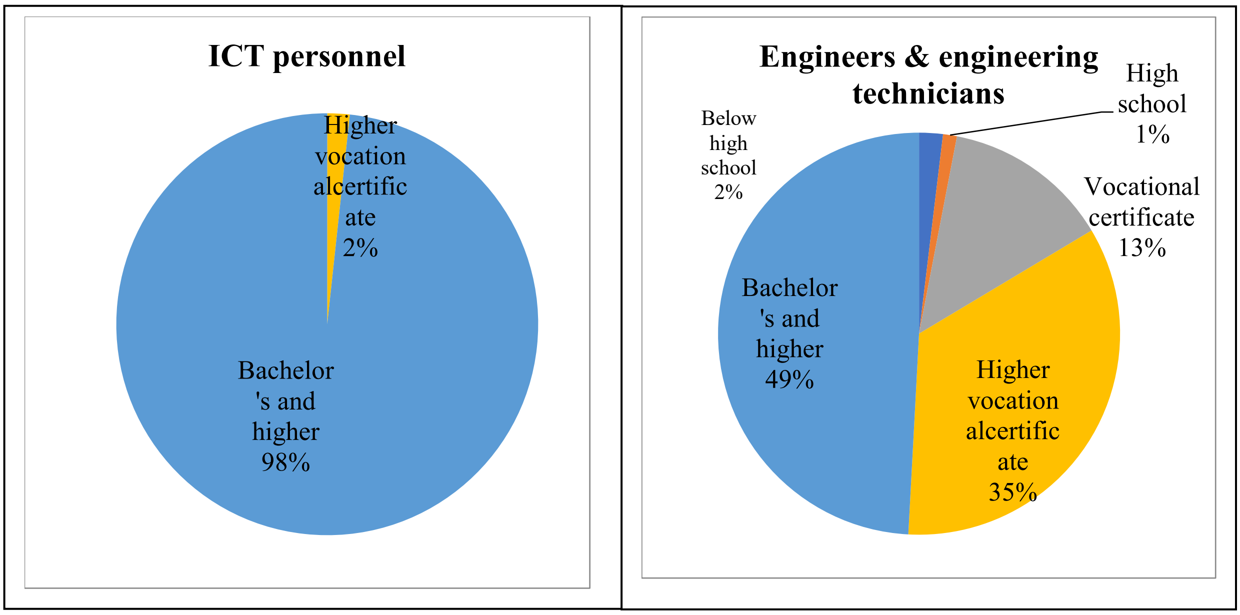
Table 64: Need of ICT personnel by economic activity and size of establishment (2014)

Economic Activity/ Size of Establishment (Number of Persons Engaged)	Number of Establishments	Total	Needs of ICT Personnel					
			Chief Information Officer - CIO	IT Department Manager	Computer System Designers and Analysts	Computer Programmer	Computer Associate Professionals	Others
Economic Activity	8,693	16,837	137	441	3,589	3,627	8,737	306
Business Trade and Services	6,442	10,948	40	220	1,710	1,895	6,841	241
Manufacturing	1,395	2,830	33	93	814	801	1,068	21
Construction	230	846	40	53	325	167	261	-
Land Transport and Storage	111	209	4	8	49	42	106	-
Private Hospital	76	212	1	6	83	46	73	2
Information and Communication	437	1,792	19	61	608	676	387	41
Size of Establishment	8,693	16,837	137	441	3,589	3,627	8,737	306
1 - 9 persons	4,496	7,145	40	50	986	1,001	5,069	-
10 - 15 persons	640	1,379	-	5	255	278	736	104
16 - 25 persons	776	1,475	15	90	423	355	586	7
26 - 30 persons	185	306	2	16	89	113	87	-
31 - 50 persons	552	1,151	8	16	307	363	429	28
51 - 200 persons	1,350	2,980	26	134	803	773	1,112	133
More than 200 persons	693	2,401	47	132	725	744	719	34

Source: The 2014 Establishment on the use of information and communication technology, National Statistical Office, Ministry of Information and Communication Technology

(2) Demand for Bachelor's and higher degree is notable for ICT workforce.

While the demand for both engineers and ICT workforce is high, a notable difference is that ICT workforces are expected to have higher degrees, namely bachelor's degree and above. For example, STI estimates that 98% of ICT workforce is expected to have bachelor's and higher degrees, while only half of engineers (49%) is expected to have bachelor's and higher degrees. (see Figure 62.) This is an interesting trend in contrast to Japan where 32.9% of the IT companies do not set bachelor's degree as a requirement and 22.1% prefer vocational school graduates. (p.25, ITPA data)



Source: Thiti Estimated by STI

Figure 62: Projected demand by level of education for ICT workforce and engineers

(3) Supply of ICT workforce is limited.

In regards to supply, the number of students that universities produce is limited. At the university level, two hundred twelve ICT and software development-related courses are offered at 91 institutes under OHEC in 2015. However, the number of students is not steadily increasing. About 12,000 -13,000 students graduate from computer science, computer engineering and information technology programs for the last couple of years. Majority of them are from public universities as shown in Table 65. (Software Market Survey)

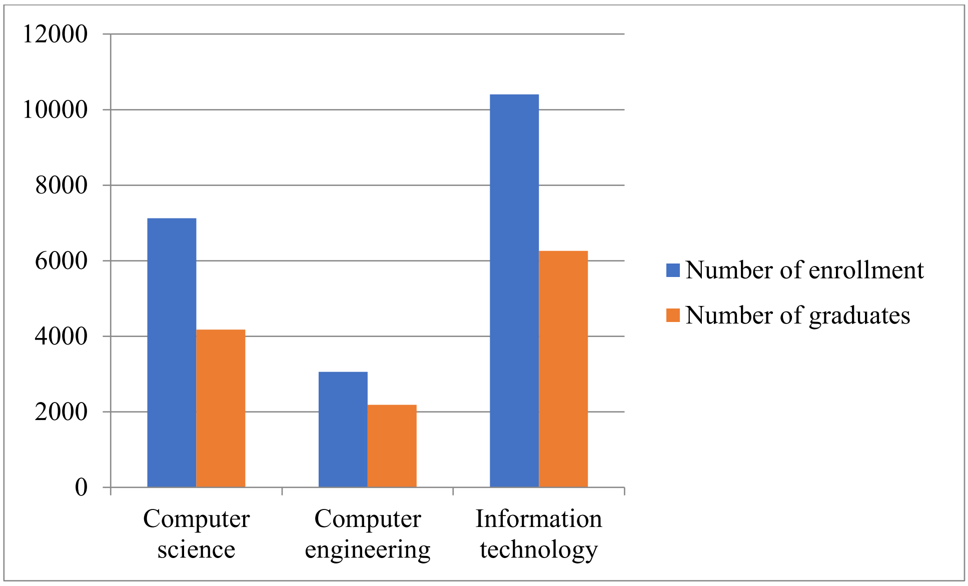
Table 65: Number of graduates in computer-related program (2012 and 2013) *

Year	Computer science	Computer engineering	Information Technology	Total
2012	4,356 (90%)**	2,054 (77%)	6,590 (78%)	13,000 (82%)
2013	4,174 (91%)	2,183 (79%)	6,262 (75%)	12,619 (81%)

Source: Software Market Survey

Note: *2014 and 2015 data are incomplete. ** The number in parenthesis indicates the percentage of students at public institutes.

While university is a major producer of software personnel, low graduation rate of students in the computer-related programs is a concern. According to the SPT survey, only 55-60% of students in ICT-related programs graduate as shown in Figure 63. The reasons are unknown: KMUTT and KMITL that the team visited report that the dropout is not a significant issue at their universities, ranging 5-10% which happens mostly in the first year. The interviewees mention two possible reasons are: 1) there is a disparity among universities in students' intake and content of curriculum; and 2) students' expectation for ICT does not necessarily match the content of curriculum. An interviewee at a computer science program at a rural Rajaphat University mentions that about 30% of the first-year students drop out and a major reason is the weakness of their basic math and English skills.



Source: SIPA executive summary

Note: 2014 and 2015 data is incomplete.

Figure 63: Number of enrollment and graduates of ICT related departments (2013)

(4) Technical colleges are not equipped to produce software personnel.

In regards to technical colleges, the number of students in ICT program is very limited. Most of ICT programs started to be offered in 2000's, which is relatively new compared to industry-related programs and the program is not well-established yet. There is a need to improve in various aspects including resources, curriculum and awareness. Table 66 shows that the number of students studying in ICT program and industry-related programs.

Table 66: Number of students at technical college in ICT and industry-related programs

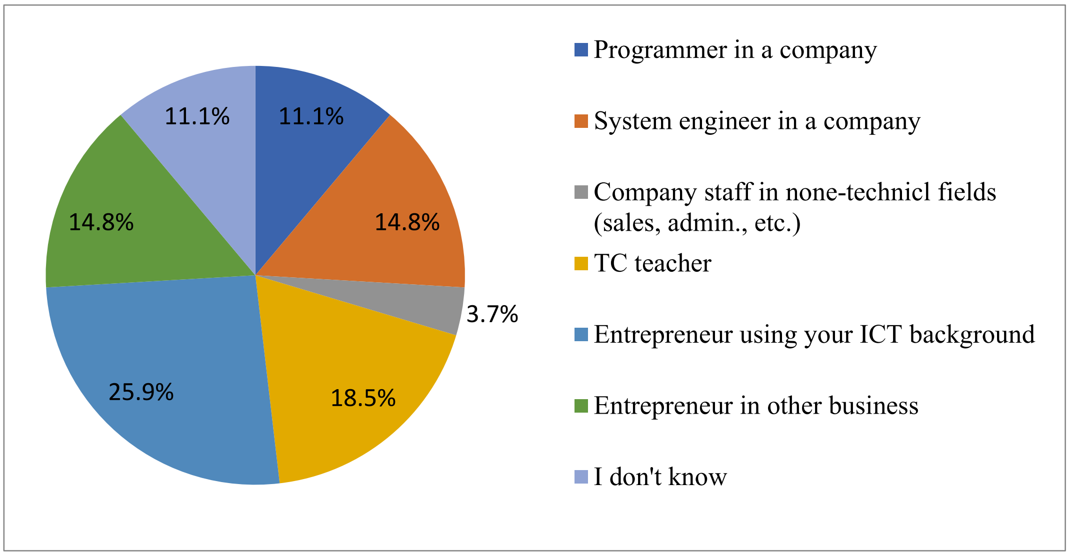
Type	Public School (2015)			Private school (2012)		Total
Level of education	PWC	PWS	Bachelor of Technology	PWC	PWS	
ICT	2,625	3,503	192		1,771	8,091
Industry-related	241,457	126,124	2,292	74,823	24,817	469,513

Source: OVEC

There are more than 450 public technical colleges and only 123 schools offer ICT program. The number of students in ICT program is only 2% to those in industry-related program and the number is not increasing. While ICT human resource development is the focus of attention in the policy arena, ICT program at technical college is not necessarily the program to attract students. For example, one school visited has a total of 4,000 students and about 70% of them, 3,000 students, study in industry-related subjects, while only 130 students are enrolled in ICT program. Another school visited reports the same trend and the number of students is actually decreasing over the years. Some administrators mention that the term "ICT" is not well-understood by parents and they do not recommend their children to study in that program since they do not have a clear idea of what kind of jobs are available upon graduation. This is supported by the fact that in Thailand, software industry expects bachelor's degree holders than technical college graduates.

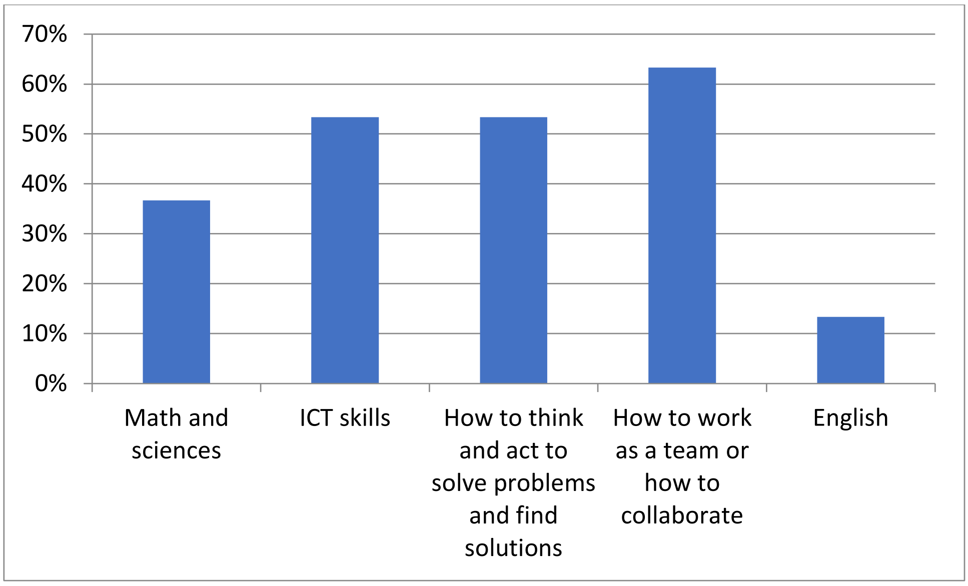
Technical colleges face lack of resources as well: they do not have enough computers for each student so that they have to divide a class. They also mention that there is not enough budget to purchase licensed software so that they depend on an open-source software. This is in contrast to the ICT program at university level since they do not have any particular issue in resources.

In our survey of the technical college students majoring in ICT program, while more than 90% of students (30 respondents) choose the program due to the employment prospect, only quarter of students plan to become system engineer or programmer. (see Figure 64.) Also, they are not confident enough to acquire ICT skills by the time of graduation: Only half of them are confident. They are more confident in developing teamwork skill, but they are not confident in their math, science and English skills, which are highly valued in the software industry. (see Figure 65.)



Source: The online survey

Figure 64: ICT program students' plan at technical college



Source: The online survey

Figure 65: Technical college students' confidence level in skills

Note: The percentage indicates the ratio of those who have answered that they agree to have each skill by the time of graduation.

7.5.4 Issues of software personnel: Qualitative situation

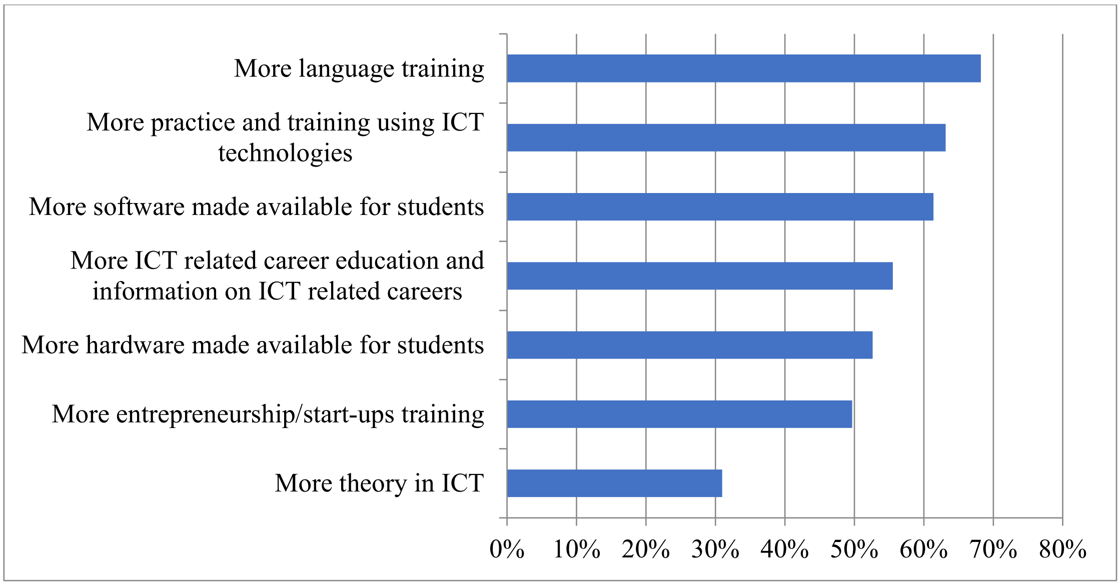
(1) Keeping up with the technology advancement is a challenge in quality

ICT is a field that technology advances rapidly and keeping up with the technology is a challenge. According to the ICT workforce capability survey in 2017, about half of software personnel (56%) use cloud computing, but new languages like Swift for mobile development and R for data science and machine learning are not well utilized as only 5.5% and 3.1% of them know them[154].

For those ICT professionals in-service, SPT provides extensive training programs: The categories include executive program, data management, IT management, mobile application, PSP/TSP professional, security, software architecture and design, software engineering, Java technology, Microsoft technology, certification program, online learning and IT seminars for various levels. The fees range depends on the content, level and duration, averaging three-day workshop for 10,000-15,000-baht range.

At the university level, as technology advances fast in this field, more new courses are being offered: For example, 26 cloud technology courses, 22 big data courses, 11 data science courses, 26 IoT courses and 28 embedded system courses are newly offered in the past year. (Software Market Survey) However, it is difficult for universities to keep up with the speed of software progress. In our survey of the university students, they wish to have more practice of ICT technologies and training of more computer languages. Also, they wish to have more software available for them, including 30+ software including Adobe products and Microsoft office. (see Figure 66.)

[154] Bangkok Post, May 31, 2017 "Survey says Thai IT workforce has room to grow." (Suchit Leesa-Nguansuk)



Source: The online survey

Figure 66: University students' request for course content

(2) Students' perception of ICT professional is good, but they are not confident in their level of understanding of ICT knowledge.

ICT professional is favorably considered as an occupation, according to our student survey. Nearly half of university students in ICT-related programs consider the image of ICT professional is very appealing. About two-thirds of students think ICT professional is advantageous in terms of salary and welfare and the promotional aspect is good. (see Table 67.) In fact, our survey shows that the reasons to have chosen the ICT-related program as major is prospect of employment (65%), next to liking of computer (71%).

Table 67: University students' perception of ICT professional

Statement	Agree	Agree to some extent	Not agree much	Not agree at all
The image of ICT professional is not appealing.	6%	13%	34%	47%
ICT professional is disadvantageous in terms of salary and welfare.	7%	20%	42%	31%
Promotional aspect for ICT professional is limited	11%	22%	41%	26%
The scope of work is limited, not much in R&D.	11%	26%	39%	24%
I was not so interested in ICT fields since entering university.	6%	8%	27%	59%

Source: The online survey

However, when asked their understanding of basic ICT knowledge, their confidence level is not high. The basics of algorithms and database design are the only subjects that more than one-fifth of students consider they understand very well. For the rest of subjects, the majority of students answer that they understand to some extent, but not very well. In regards to the basics of system reliability, nearly half of them have not studied and less than one fifth of students answer they understand it. (see Table 68.)

Table 68: University students' perception of level of understanding of ICT basics

	Studied but do not understand at all	Studied but do not understand much	Studied and understood to some extent	Understand very well	Have not studied
Basics of computer (architecture, operating system, file system, etc.)	3%	20%	61%	16%	1%
Basics of algorithms (complexity, data structure, search/sort, etc.)	4%	12%	55%	29%	0%
Basics of object-oriented programming (DFD, data normalization, etc.)	3%	17%	61%	11%	9%
Basics of database design (data dictionary, DBMS, SQL, etc.)	3%	13%	45%	39%	0%
Basics of testing (software quality control, testing method, etc.)	3%	25%	54%	9%	9%
Basics of software metrics and estimation (estimation method, estimation model, function point, etc.)	3%	24%	51%	5%	17%
Basics of project management (PMBOK, EVM, etc.)	5%	18%	33%	5%	38%
Basics of network technologies (protocol, telecommunication, etc.)	5%	37%	43%	13%	1%
Basics transaction processing (multithread, data maintenance, etc.)	1%	30%	41%	9%	18%
Basics system function (evaluation of function, calculation of function, etc.)	3%	20%	55%	16%	7%
Basics of system reliability (MTBF, MTTR, RAS, etc.)	5%	28%	18%	1%	47%

Source: The online survey given to university students

(3) Serious lack of supply does not encourage software personnel's motivation for quality improvement

As discussed in the previous section, shortage of software personnel is acute despite an increasing demand. The graduates of computer-related major do not have any problem in obtaining a job and they are relatively highly paid. According to our interviewees, this situation does not encourage software personnel to improve the quality of their knowledge and skills, although the fast-developing industry requires continuous learning.

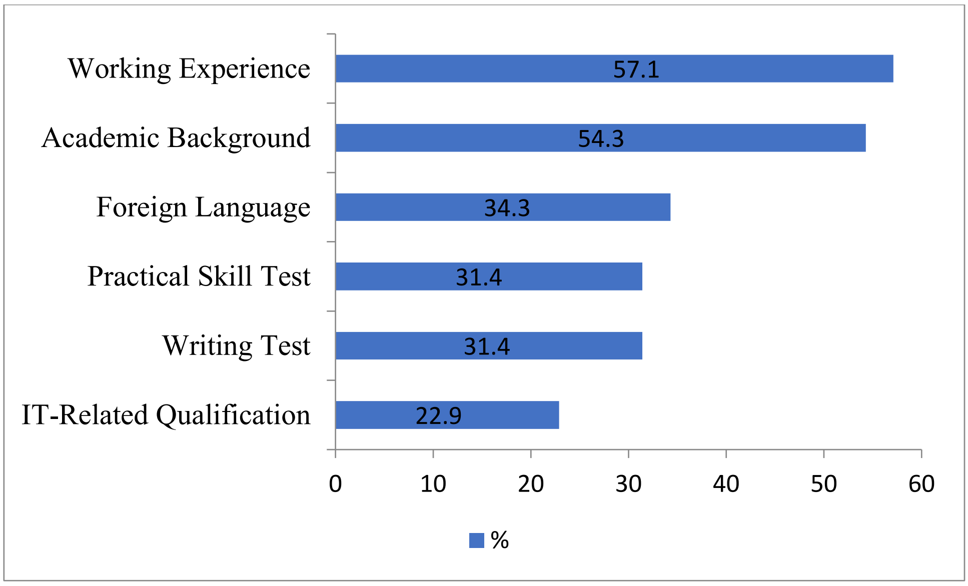
Turn-over rates of IT personnel are high since the market is supply-driven. It is very easy for IT personnel to get employment in the software development and IT support businesses. They tend to change jobs, seeking for a better job. Universities interviewed mention that their students do not necessary move around the jobs for only remunerative reasons, but also the worthiness of the job content. There is not much opportunity to develop software at companies, but often they are engaged in maintenance and testing, which is not challenging enough for them.

Also, currently start-up business is encouraged by the government and since software business does not require a significant investment, there are opportunities for software developers. In our student survey, 11% of ICT-related major students plan to start up a business using their ICT background after graduation, while only 3.8% of mechanical/electrical engineering students plan to do so. Universities interviewed mention that start-up business is not as successful as it is being promoted. However, the graduates can get an outsourced project related to software, which does not necessarily demand innovation, but highly paid. Accordingly, they tend to become free-lancers.

The current situation of lack of software personnel and also lack of challenging opportunity to utilize their skills is not supporting to strengthen the industry. Thai ICT personnel have only 1-5 years experiences on average, which is much shorter than the global average of 10-15 years and Thai ICT industry is not accumulating the knowledge in the industry[155].

(4) Practical experience and academic background count.

According to the JETRO survey in 2015, what Japanese IT companies value most in recruiting ICT personnel is working experience, followed by academic background and English language proficiency. They do not value the IT-related qualifications much. (see Figure 67.)



Source: JETRO 2015

Figure 67: Recruitment standards for ICT personnel by Japanese companies

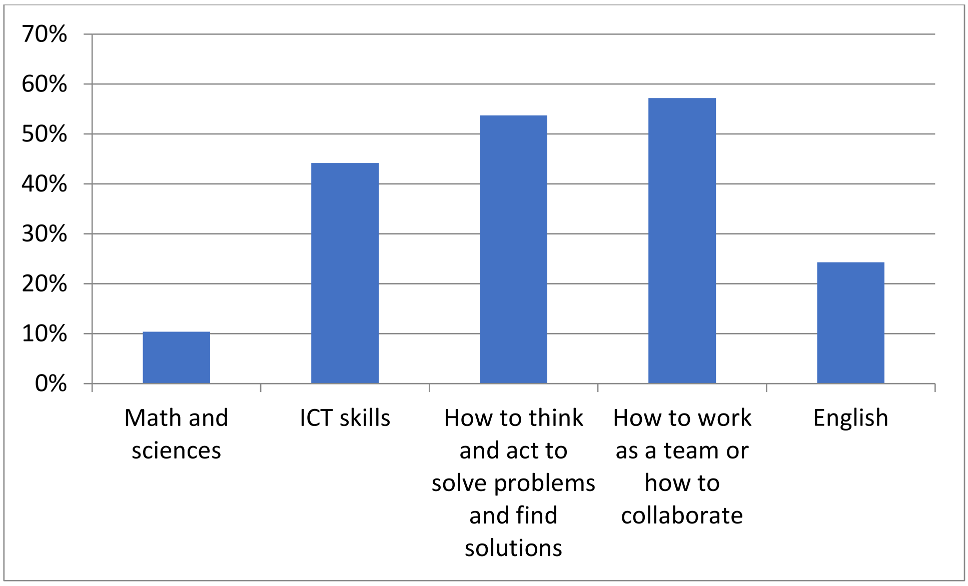
Working experience includes installation of Enterprise Resource Planning (ERP) and accounting system and establishing network and servers. These experiences are evaluated through interviews. Practical skill test is given to measure the programming and coding skills, and writing test is given to measure logical thinking and mathematical thinking. IT-related qualification is not valued much but qualifications by Oracle, Microsoft and Cisco are considered to some extent. (JETRO, 2015)

155 W3Techs.com. "Usage of content languages for websites" accessed on June 4th, 2017 at https://w3techs.com/technologies/overview/content_language/all

More than half companies value the majors in ICT-related programs and some companies target specifically the science-emphasized universities such as King Mongkut group of universities. This trend is significantly different from the recruitment standards in Japan where 45.9% IT companies do not care if an applicant is IT or science major or not. (p.25, ITPA data)
In our survey of students, in regards to technical college students majoring in ICT, only 25% of the students plan to work for an ICT company after graduation, while another 25% of the students plan to continue to study for bachelor's degree. On the other hand, nearly 70% of university students plan to work for an ICT company. This survey result may reflect the IT companies' recruitment trend.

(5) English proficiency can be a barrier.

English language proficiency can be an issue for software personnel. As shown in Figure 67 (JETRO), English language proficiency, often measured by TOEIC (500-750), is an important recruitment standard for Japanese IT companies in Thailand. Japanese language is preferable but not a requirement. In our university student survey, their level of confidence in English is low, as shown in Figure 68.



Source: The online survey

Figure 68: University students' confidence level in skills

English is still a most used language online. According to the 2009 UNESCO report, its relative ratio was declining from 75% in 1998 to 45% in 2005, but English still remains as a most used language at around 50% of the most visited website in 2017, followed by Russian (6.6%), Japanese (5.6%), German (5.6%) and Spanish (5.1%). (W3Techs.com)

The interviewees mention that English is compulsory for those who study computer science, and the weakness of English can be a barrier for ICT personnel. Yet, English barrier is protecting Thai ICT personnel in both positive and negative ways: Due to weak English proficiency, international mobility, for example among ASEAN countries, is not happening for Thai ICT personnel. At the same time, inflow of ICT personnel from overseas is not happening, either, since Thai ICT companies do not welcome them. This situation is not providing a challenge for Thai ICT professional. When industry cannot survive without advancing in a global market, English can be a barrier for Thai IT industry.

7.6 Why is the gap happening? Immature software industry

7.6.1 Weak institutional linkage with educational institutions

There are quite a few associations organized by industry as shown in Table 69. They are active in such fields as networking, advocacy, policy dialogue with the Government and corporations, information sharing and distribution among members, provision of technical training etc. Yet, they are not so active in human resource development through collaboration with higher education institutions.

Table 69: Main IT related associations in Thailand

Associations	Features of association and Focused activities
The Federation of Thai Industry (FTI)	Development of System Integrators, promotion of digitization among member companies. Approximately 160 IT companies. The main activities include policy recommendations to the Government.
The Association of Thai ICT Industry (ATCI)	Members include computer hardware and software manufacturers, distributors, and service providers, which represent over 80% of Thailand's ICT market.
The Association of Thai Software Industry (ATSI)	Members are mostly SMEs, promoting the development of software industry and acting as a hub and distributes software related information.
Thai Embedded Systems Association	A developer's network for electronic design industry
Institute of Field Robotics (FIBO)	Robotics related business association and KMUTT acts as the secretariat office
Thai Programmer Association	Strengthening network and building skills of software developers among 20,000 members
Agile 66	Promotion and education about agile software development
Thailand SPIN	Introducing good practices to IT companies and IT related information
Thailand Tech Start-up Association	To support tech start-ups in cooperation with business and government

Source: interviews and web search

In terms of academic society, there is one software-related society, but not very active. Academics and experts in computer-related disciplines are more informally associated and there is not much opportunity to encourage innovation in software industry.

7.6.2 Efforts made by individual companies

On the individual company level, some software vendor companies such as Oracle provide training to universities. Yet, with respect to IT companies, the scope of cooperation is very limited. The survey team conducted interviewing with nine IT companies and their cooperation is limited to accepting interns from universities. Some IT companies are very active in supporting internship programs with universities. This is due to the increasing competition among IT companies to recruit university students. Some companies cooperate with technical colleges in the form of dual system in the fields of multimedia and computer graphics.

Box 16: Oracle University

Oracle cooperates with universities to development the capacity of teachers and students to use oracle database and JAVA software. There are sub-programs under Oracle University, such as 'CU-Oracle for Student Excellence' which is a program that Oracle cooperated with Chulalongkorn University that uses Oracle software to teach students in classes. This curriculum is available for both BA and MA level (available to Commerce students). Oracle Academic Initiative (OAI) is also another program for software developers. Oracle has expanded the cooperation to technical colleges. However, it is still at an earlier stage. No MOU has been signed. The main activity is also to promote the usage of oracle database and software (JAVA) includes:

- Training of teachers in technical colleges
- Training of technical college students (by organizing training courses and forums)
- Issuing certificate to those who passed the standard tests (Oracle Certificate Professional)
- Promotion of e-learning system

(Source: The results of interview survey by the survey team)

7.6.3 Limited scope for cooperation with industry by universities

It seems that there is not much incentive for universities to seek cooperation. For the universities, currently the demand exceeds far to the supply and the graduates are not concerned with job opportunities; therefore, the universities do not need to promote their students to industry. In Thailand IT companies mainly focus on software development and the application of developed technologies, and there is little scope for research or development of new technologies. Therefore, companies are not keen on seeking cooperation with universities in the field of research and development.

7.7 Thailand's efforts to strengthen ICT industry

7.7.1 Government Programs

SPT is planning to launch a long-term training (3-6 months) called "Change the World with Your Research" which aims at marketing research outcome for researchers at universities. This project is expected to be a framework collaboration between industry and research institutes by providing a solution to an issue presented by a company.

7.7.2 Qualification standards

(1) TPQI

One way of facilitating the development of human resource development of IT personnel is the establishment of occupational standards. There are several types of qualifications certified by public organizations and vendors. TPQI has introduced some qualifications in such fields as IT project management, software development, network and security system. The level of occupational proficiency is set on a scale from 1 (the lowest) to 7 (the highest). As the table below shows, the development of the certification system is still at a rudimental stage as the number of the certified is still very small and certification for higher levels have not been fully established(see Table 70).

Table 70: IT related occupational qualifications of TPQI

Sub-sector	Occupations	Level	Applied	Passed
IT Project Management	IT Project Manager	3	191	93
IT Project Management	IT Project Manager	4	37	20
IT Project Management	IT Project Manager	5	14	6
IT Project Management	IT Project Manager	7	1	
Telecommunication	Optical Distribution Network termination technician	2	72	40
Telecommunication	Radio base station (RBS) technician	2	39	26
Network and Security	Technical support technician	3	236	70
Network and Security	Technical support technician	4	58	37
Network and Security	Technical support technician	5	1	
Network and Security	Technical support technician	6	1	
Network and Security	Computer/network system security manager	4	4	
Network and Security	Computer/network system security manager	6	1	
Network and Security	Computer Network system manager	4	26	18
Network and Security	Computer Network system manager	5	2	
Software and Applications	Systems tester	3	36	
Software and Applications	Systems developer	3	471	185
Software and Applications	System developer	4	53	29
Software and Applications	System developer	5	2	
Software and Applications	Business needs analysist	3	10	3
Software and Applications	Business needs analysist	4	1	
Software and Applications	System design analysist	3	478	81
Software and Applications	System design analysist	4	3	
Software and Applications	System design analysist	5	2	
Animation	Animation editor	3	3	
Animation	Animation characters producer	3	175	68

Animation	Computer and computer system service provider	3	28	21
Animation	Computer and computer system service provider	4	27	19
Animation	Computer and computer system service provider	5	2	

Source: TPQI, as of April 2017

(2) DSD

DSD mainly targets the workers and technicians for skill improvement. IT industry is generally perceived to be an industry for university graduates; therefore, its occupations are often seen as out of the scope to workers and technicians. As a result, most of the skill certifications issued by DSD are for the users of computer software and clerical work (e.g., how to use word processing and split sheet applications). At present, DSD organizes three types of training programs, namely, pre-employment training for 12 months, refresher training for company employees (18 – 60 hours) and skill training for those who want to change their jobs or earn additional income (18 – 60 hours). Some IT techniques are also included in the certifications of manufacturing related qualifications such as programming for PLC. Given the increasing demand for IT personnel, DSD is preparing the introduction of certificates for programmers (e.g., HTML and C language).

(3) Qualifications of private organizations

There are various certification systems promoted by software vendors. According to universities and IT specialists and consultants interviewed by the survey team, some certifications in such fields as network is popular, yet because of the very high demand for IT personnel, it is not important for university students to get desired employment without such certification.

In sum, as shown earlier, companies or students do not place much importance on occupational qualifications as the demand for IT personnel is very high and companies value more on what degree the job applicants have and what university they graduated from. There is also little incentive for the students to obtain a qualification as they have no difficulty in getting employment. One type of qualification that should be valued by employers and mandated or regulated by the Government is the network security related qualifications, given the importance of network security to the general public.

7.8 Recommendations

Cooperation with universities

- As shown in 7.5.3, IT personnel is almost exclusively university graduates with IT related majors in Thailand. In order to increase the pool of diverse human resources for IT industry, it would be helpful to introduce IT related courses (e.g. programming) to students in other disciplines in the national universities.
- Turn-over rates are very high among IT personnel. Career education and career support would help reduce drop-out rates of university students and turn-over rates of graduates.
- One weakness of IT personnel in Thailand is that they are slow in obtaining and adopting new and advanced IT technologies. The establishment and expansion of a training program for incumbent IT personnel and students on such new IT technologies in collaboration with Software Park would help reduce the technical gap.

Cooperation with technical colleges

- The current curriculum of the technical colleges does not fit the industry's needs for IT personnel. Therefore, its curriculum needs to be upgraded to impart basic vocational skills such as programming to technical college students.

Cooperation with TPQI

- Currently IT related qualifications are not so valued by either companies or university students. Yet, one type of qualification worth supporting is the strengthening of network security related qualifications, given the importance of network security to the general public.

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ANNEXES

ANNEX 1

Annex 1: List of relevant organizations interviewed in Thailand by the team

Government and public organizations:

- The Automotive Human Resource Development Project (AHRDA)
- Board of Investment
- Council of Engineers (COE)
- Samutprakarn Skill Development Institute, Department of Skill Development (DSD)
- The Federation of Thai Industries (FTI)
- The Institute of Promotion of Teaching Science and Technology (IPST)
- Kenan Institute Asia
- National Science and Technology Development Agency (NSTDA)
- Office of the Higher Education Commission (OHEC)
- Office of the Vocational Education Commission (OVEC)
- National Science Technology and Innovation Policy Office (STI), Ministry of Science and Technology (MOST)
- Thailand Automotive Institute (TAI)
- Thai Auto-part Manufacturers Association
- Thai Chamber of Commerce
- Thai Electrical, Electronics and Telecommunication Industries Association
- Thai Professional Qualification Institute (TPQI)

Technical Colleges:

- Chachoengsao Technical College
- Chiang Mai Technical College
- Chiang Rai Technical College
- Kanchanaburi Technical College
- Institute of Vocational Education, Bangkok (IVEB)
- Kanchanapisek Technical College Mahanakorn
- Maptaphut Technical College

- Minburi Technical College
- Nakorn Nayok Technical College
- Pathumthani Technical College
- Phang Nga Technical College
- Phisanulok Technical College
- Phra Nakhon Si Ayutthaya Technical College
- Prachinburi Technical College
- Rayong Technical College
- Samut Songkram Technical College
- Samutprakarn Technical College
- Science-Based Technology Vocational College (Chonburi)
- Suranaree Technical College
- Suratthani Technical College
- Satahip Technical College

Universities:

- Burapha Univesrity
- Chiang Mai University
- King Mongkut's Institute of Technology Ladkrabang (KMITL)
- King Mongkut's University of Technology Thonburi (KMUTT)
- Pathumwan Institute of Technology
- Rajamangala Univesrity of Technology Lanna (RMUTL)
- Rajamangala Univesrity of Technology Thanyaburi (RMUTT)
- Suranaree University of Technology
- Thai-Nichi Institute of Technology (TNI)

ANNEX 2

Annex 2: List of the universities and KOSENs that the survey team interviewed in Japan

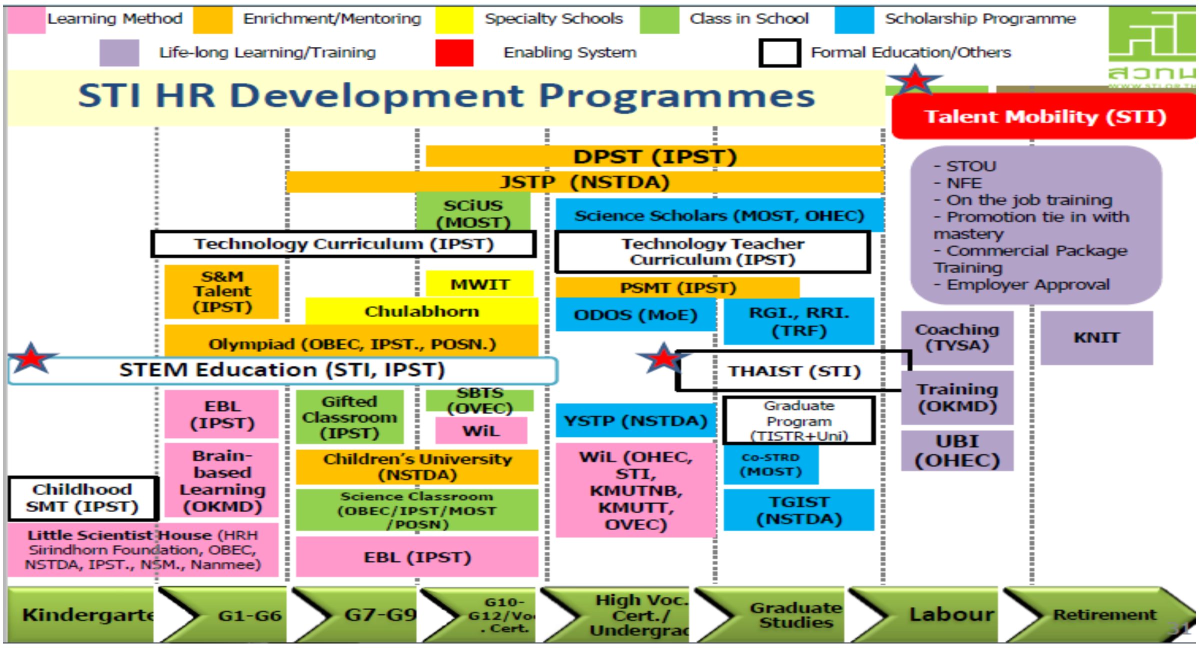
Universities	
1	Niigata University
2	Iwate University
3	Tohoku Institute of Technology
4	Shibaura Institute of Technology
5	Institute of Technologists
6	Chiba Institute of Technology
7	University of Electro-Communications
8	Toyohashi University of Technology
9	Nippon Institute of Technology
10	Tokai University
11	Aoyama Gakuin University
12	Meiji University
13	Tokyo Institute of Technology
14	Tokyo City University
15	Tokyo University of Agriculture and Technology
16	Tokyo Polytechnic University
17	Advanced Institute of Industrial Technology
18	Nagoya Institute of Technology
19	Daido University
20	Kanazawa Institute of Technology
21	Ritsumeikan University
22	Kyoto Institute of Technology
23	Osaka Institute of Technology
24	Osaka Prefecture University
25	Shimane University
26	Tottori University
27	Kindai University
28	Kyushu Institute of Technology
29	Fukuoka Institute of Technology
30	Nagaoka University of Technology
31	Kanazawa University
KOSEN colleges	
30	Hakodate
31	Ichinoseki
32	Tsuruoka
33	Ibaragi
34	Kisarazu
35	Numazu
36	Nagano
37	Nara
38	Akashi
39	Tokuyama
40	Kurume
41	Miyakonojo
42	Okinawa

ANNEX 3

Annex 3: Policies and programs for human resource development in Thailand

	Policy and Plan	In-charge Agency	Major Strategies having relation to STI HRD	Sub-strategies / Guideline	'Key' Indicator relevant to STI HRD	Actual
National Level	**2007-Constitution**	**Prime Minister's Office**	Section 86, Part 9: The State shall act in compliance with the science intellectual properties and energy	1) **enhancing the development of science, technology and innovation in all aspects;** 2) supporting an invention, and 3) promoting and supporting continuously and systematically of the research, the development and the use of natural alternative energy	n.a	n.a
	The 11th National Economic and Science Development Plan (2012-2016)	**NESDB**	**Development Strategy** 'To restructure the economy toward quality growth and sustainability'	**Development Guideline** 1) utilizing science, technology, innovation and creativity as fundamental factors for economic restructuring; 2) using S&T and creativity to promote quality and sustainability in the industrial sector and to move Thailand's development toward becoming increasingly knowledge-based and environmentally friendly; and 3) enhancing the country's competitiveness by promoting development of science and technology, innovation and creativity as key elements in economic restructuring	R&D PoP (FTE):10,000 PoP = 15:10,000	11:10,000 (2013)
	National Science, Technology and Innovation Master Plan (2012-2021)	**STI, MOST**	To attain quality society and sustainable economic growth' **Strategy 4:** 'developing and enhancing STI human capital' **Strategy 5:** "promoting and supporting the development of infrastructure and enabling factors for STI development'	**Programs under Strategy 4:** science education improvement, vocational skills improvement through WiL and enhancement of University-Industry-Research Institute collaboration **Programs under Strategy 5:** regional science parks, tax incentives for research and development and etc.	1) R&D/GDP to 2.0% in 2) R&D PoP (FTE) / 10,000 = 25:10,000Full-time Equivalents) from 9.01:10,000 to 25:10000 3) R&D expenditure (private : government) = 70:30 in 2021	1) 0.37% (2013) 2) 11:10,000 (2013) 3) 28:62 (2012)
	National Research Policy and Strategy (2012-2016)	**Office of National Research Council of Thailand (NRCT)**	high quality researches conducted based on partnerships of government, private and civil sectors and increasing in research findings that can be utilized for economic, social and public benefits.	**Research Strategy 4:** development of innovation and research personnel potential and capability, with the objective to promote the country's competitive edge and self-reliance through the utilization of science, technology and other forms of knowledge.	Based on targeted indicators in the Master Plan	Based on targeted indicators in the Master Plan
Ministerial Level	**Ministry of Science and Technology's Strategic Plan (2012-2016)**	**MOST**	To promote and accelerate the development of human resources in science and technology	**Strategy 1:** Promotion of the development of human capital on STI. **Strategy 2:** Raising awareness and promoting development of STI education to realize the knowledge-based society.	Based on targeted indicators in the Master Plan	Based on targeted indicators in the Master Plan
	National Science and Technology Development Agency (NSTDA)'s Strategic Plan (2012-2016)	**NSTDA, MOST**	To stimulate research and development for all sectors by being a solution provider through providing research services	human resource development for entrepreneur and infrastructure support by having a Thailand Science Park (TSP)	Based on targeted indicators in the Master Plan	Based on targeted indicators in the Master Plan
	The 2nd 15-year Long Range Plan on Higher Education (2008-2022)	**Office of Higher Education Commission ,MOE**	To enhance all aspects of teaching and learning, research promotion, higher education system and its finance	To nurturing human resources with the skills and capabilities necessary to raise national competitiveness	Enrollment ratio of students in S&T: health science: social science = 40:10:50.	22:5:73 (2012)
	The 11th Higher Education Development Plan (2012-2016)	**MOE**	-Raising quality of entire education system, upgrading teacher training and development, using ICT to enhance learning efficiency and developing quality and standards of HEIs. - Focusing on research promotion by having National Research Universities, Research and Innovation for Technology Transfer to the Rural Communities Project, Technologies Licensing Office, UBIs and etc	Strategy 2: Human resource development of educators Strategy 3: Providing qualified graduates to meet with industry's needs	Enrollment ratio of students in S&T: health science: social science = 31:6:63 for the FSY 2016	22:5:73 (2012)

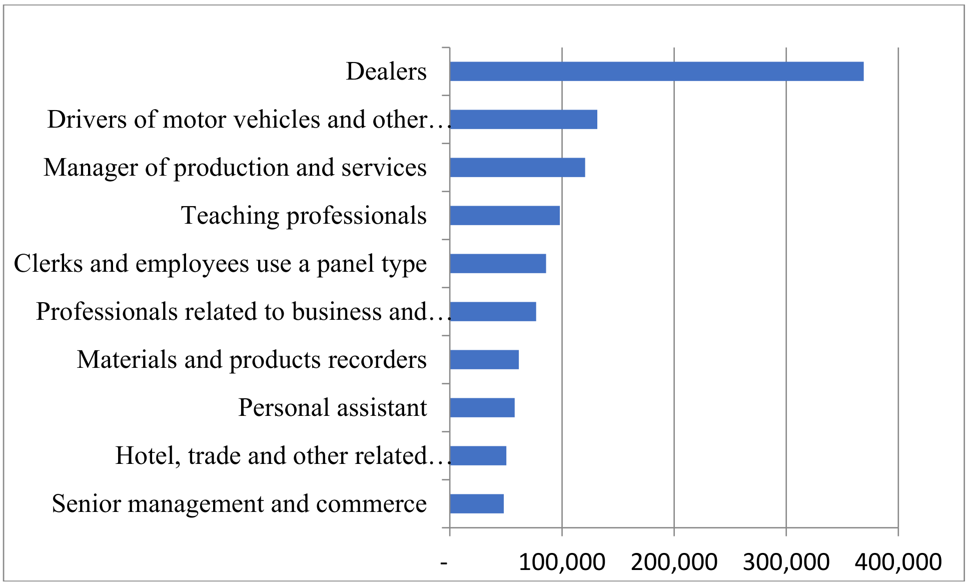
STI HR Development Programs



Source: STI Office (2014b)

ANNEX 4

Annex 4: Top 10 occupations for the S & T graduates not working in S & T fields



Source: STI (2016)

ANNEX 5

Annex 5: Term for Key Work Competency

Country/Region/Organization	Term
Australia	Generic skills
France	Transferable skills
Germany	Key qualifications
Latin America	Work competencies
New Zealand	Essential skills
Singapore	Critical enabling skills
Switzerland	Trans-disciplinary goals
United Kingdom	Core skills
United States	21^{st}-century skills
ASEAN	Employability skills
ILO	Core skills for employability
OECD	Key competencies

Source: ILO (2015)

ANNEX 6

Annex 6: Thai Education System

Stages in Thai Educational System (based on public shools/universities) / Blue Highlight >>Targets of Survey

<table>
<tr><th>Typical age</th><th colspan="2">Stage</th><th colspan="9">Level/Grade</th><th>Notes</th></tr>
<tr><td>4</td><td rowspan="16">Basic education</td><td>Early childhood</td><td colspan="9">Variable</td><td rowspan="2"></td></tr>
<tr><td>5</td><td>(Kindergarten)</td><td colspan="9">(Typically Anuban 1–3)</td></tr>
<tr><td>7</td><td rowspan="6">Elementary</td><td colspan="9">Prathom 1</td><td rowspan="9">Compulsory education</td></tr>
<tr><td>8</td><td colspan="9">Prathom 2</td></tr>
<tr><td>9</td><td colspan="9">Prathom 3</td></tr>
<tr><td>10</td><td colspan="9">Prathom 4</td></tr>
<tr><td>11</td><td colspan="9">Prathom 5</td></tr>
<tr><td>12</td><td colspan="9">Prathom 6</td></tr>
<tr><td>13</td><td rowspan="3">Lower-secondary</td><td colspan="9">Mattayom 1</td></tr>
<tr><td>14</td><td colspan="9">Mattayom 2</td></tr>
<tr><td>15</td><td colspan="9">Mattayom 3</td></tr>
<tr><td rowspan="5">16-18</td><td rowspan="5">Upper-secondary</td><td colspan="2">Science-based Academic High School</td><td colspan="2">Academic-based High School</td><td colspan="2">Level</td><td colspan="2">Science&Technology-based</td><td>General</td><td rowspan="5"></td></tr>
<tr><td colspan="4">Autonomous under MOE</td><td rowspan="4">Matthayom 4
Matthayom 5
Matthayom 6</td><td rowspan="4">Por Wor Shor 1
Por Wor Shor 2
Por Wor Shor 3</td><td colspan="3">Autonomous unider MOE</td></tr>
<tr><td colspan="2">Mahidol Wittayanusorn High School (1)</td><td colspan="2">n/a</td><td colspan="2">n/a</td><td>n/a</td></tr>
<tr><td colspan="4">Under OBEC</td><td colspan="3">Vocational Schools Under OVEC</td></tr>
<tr><td colspan="2">Chulaborn Super Science High Schools (12)</td><td colspan="2">General Academic High Schools</td><td>5 Technical and Vocational Shools with Science-based Course</td><td colspan="2">426</td></tr>
<tr><td rowspan="3">19-20</td><td colspan="2" rowspan="4">Higher Education</td><td colspan="5">Under OHEC</td><td colspan="4">Higher Vocational Schools Under OVEC (426 public collegs)</td><td rowspan="4"></td></tr>
<tr><td colspan="2">Engineering-based</td><td colspan="2">Academic-based</td><td colspan="2">Level/years needed</td><td>Specialized</td><td colspan="2">General</td></tr>
<tr><td rowspan="2">Rajamangala Univerities of Technologies (9 schools)</td><td rowspan="2">Engineering-based universities (KMITL, KMITT, KMUTB, PIT, TNI, SUT)</td><td rowspan="2">Academic Universities with reputation in engineering faculty</td><td rowspan="2">Other academic universities</td><td rowspan="2">4 years
5 years for pharmacy/architecture
6 years for medical and dentistry</td><td>Por Wor Sor 1, Por Wo Thor 1
Por Wor Sor 2, Por Wor Thor 2
(2 years)</td><td>"Center of Exelent" (Total 19 pilot colleges in 16 fields)</td><td colspan="2">70% of 426 schools had courses on industry related subjects</td></tr>
<tr><td>21~</td><td colspan="4">Bachelor-level theoritically available</td></tr>
</table>

ANNEX 7

Annex 7: List of Industry-related Technical colleges in Thailand

(Number of Industry-related Students (vocational track) in 2016, categorized by course, level of education and sex)

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
1	Krabi Technical college	Construction	Construction							4		4													4
			Construction Technology													5	1	6							6
		Mechanical Engineer	Automotive Technology													11		11							11
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							2		2													2
			Plastic Tools and Die							2		2													2
		Machine Tools Technology	Machine Tools	41	1	42	23		23	14		14													79
		Construction Technician	Construction	47	14	61	30	9	39	36	4	40	13	1	14	7		7							161
		Metal Welding Technician	Structure	9		9																			9
			Products							10		10													10
		Power Electric Technician	Power Electric	68	2	70	41	1	42	26		26													138
		Automotive Technician	Automobile Body and Color							2		2													2
			Automobile	105		105	61		61	46		46													212
		Electronics Technician	Electronics	40	3	43	22	2	24	29		29													96
		Production Technology	Mechanical Tools										37	1	38	14		14							52
			Plastic Tools and Die													12		12							12
		Mechanical Technology	Automotive Technology										27		27	20		20							47
		Automotive Technology	Automotive Technology																11		11	12		12	23
		Electric	Power Electric										40		40	15		15							55
		Power Electric	Electronics installation													10		10							10
		Electric and Electronics	Computer Technology							2		2													2
			Power Electric							3		3													3
			Electronics							4		4													4
		Electronics	Computer Technology													1		1							1
			Picture and Sound System										17		17	9		9							26
2	Kantharalak Technical College	Construction	Construction Control Technology													13		13							13
		Mechanical Engineer	Industrial Machines							16		16													16
			Industrial Machine Technology										51	1	52	42		42							94
			Automotive Technology										47	1	48	38		38							86
			Automobile							31		31													31
		Mechanical Tools and Maintenance	Mechanical Tools							6		6													6
		Machine Tools Technology	Mechanical Tools	67	5	72	54		54	40	1	41													167
		Construction Technician	Construction	12	2	14	8	1	9	9	1	10													33
		Metal Welding Technician	Products	16	2	18	10		10	6		6													34
		Power Electric	Power Electric	76		76	47		47	53	1	54													177
		Automotive Technician	Industrial Machines	83		83	63	1	64	58		58													205
			Automobile Body and Color				11		11																11
			Automobile	148	2	150	87	2	89	120		120													359
		Electronics Technician	Electronics	50	18	68	37	4	41	47	2	49													158
		Production Technology	Mechanical Tools										12		12	20		20							32
		Metal Technology	Industrial Welding Technology													7		7							7
		Electric	Power Electric										37		37	28		28							65
		Power Electric	Electrical Mechanical Tools													9		9							9
			Electricity Installation													22	1	23							23
		Electric and Electronics	Power Electric							10		10													10
			Electronics							9	1	10													10
		Metallurgy	Metal Welding							12		12													12
		Electronics	Computer Technique														1	1							1
			Industrial Electronics										19	6	25	38	4	42							67
3	Kanthararom Technical College	Mechanical Engineer	Automotive Technology													15		15							15
			Automobile							13		13													13
		Machine Tools Technology	Mechanical Tools	57	3	60	47	5	52																112
		Power Electric Technician	Power Electric	26	5	31	17	6	23	15	2	17													71
		Automotive Technician	Automobile	73	8	81	127		127	181	2	183													391
		Electronics Technician	Electronics	29	8	37	44	5	49	66	1	67													153
		Mechanical Technology	Computer Technique	11	11	22	5	1	6																28
		Machine Tools Technology	Automotive Technology										42	1	43	47	1	48							91
		Electric	Cooler and Air-condition										15		15										15
		Electric and Electronics	Electronics							20		20													20
		Electronics	Industrial Electronics										32	1	33	42	1	43							76
4	Kanchanadit Technical College	Mechanical Engineer	Automotive Technology													3		3							3
			Automobile							1		1													1
		Mechanical Tools	Mechanical Tools	17		17	12		12	13		13													42
		Construction Technician	Construction							1		1													1
		Power Electric Technician	Power Electric	24	2	26	12	4	16	12		12													54
		Automotive Technician	Automobile	61		61	32		32	52		52													145
		Machine Tools Technology	Automotive Technology										13		13	24		24							37
		Electric	Power Electric										10		10	4	1	5							15
		Civil Engineer	Civil Engineer	7	2	9							8		8	7	1	8							25
		Construction	Construction							11	1	12													12
			Construction Technology													9	1	10							10
		Mechanical Engineer	Automotive Technology													31		31							31
			Automobile							40		40													40
		Mechanical Tools	Mechanical Tools							39		39													39

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
5	Kanchanaburi Technical College	and Maintenance	Industrial Machine Maintenance							11		11													11
			Metal Tools and Die							1		1													1
		Machine Tools Technology	Mechanical Tools	128	1	129	52		52	45		45													226
		Construction Technician	Construction	59	9	68	28	8	36	27	4	31	46	4	50	41	5	46							231
		Metal Welding Technician	Structure	42	1	43				11		11													54
		Maintenance Technician	Industrial Maintenance	81	5	86	25		25	23		23													134
		Power Electric Technician	Power Electric	117	4	121	71	4	75	88	4	92													288
		Automotive Technician	Automobile	129		129	66		66	90		90													285
		Electronics Technician	Electronics	41	12	53	20	1	21	29	1	30													104
		Production Technology	Mechanical Tools										88	2	90	93		93							183
		mechanic Technology	Automotive Technology										53		53	32	1	33							86
		Metal Technology	Metal Welding and Metal Work Technology													4		4							4
		Industrial Technology	Installation and Maintenance										35		35	36		36							71
		Electric	Cooler and Air-condition										19	1	20	20	1	21							41
			Power Electric										59	6	65	63	6	69							134
			Electric Control										23		23	22		22							45
		Power Electric	Electrical Mechanical Tools													10	1	11							11
			Electricity Installation													28		28							28
		Electric and Electronics	Power Electric							24	1	25													25
			Electronics							17		17													17
		Metallurgy	Metal Welding							4		4													4
		Architecture	Architecture	11	5	16																			16
		Electronics	Industrial Electronics										6	1	7	11		11							18
6	Kanchanapisek Chiang Rai Technical College	Construction	Construction							1		1													1
		Mechanical Engineer	Automotive Technology										2		2										2
			Automobile							5		5													5
		Construction Technician	Construction	12	1	13	6		6	9	2	11				4		4							34
		Metal Welding Technician	Products	5		5	2		2	4		4													11
		Power Electric Technician	Power Electric	47		47	21		21	17		17													85
		Automotive Technician	Automobile	79	3	82	42		42	61		61													185
		Electronics Technician	Electronics	15	1	16	2		2	4		4													22
		mechanic Technology	Automotive Technology										8		8	18		18							26
		Metal Technology	Metal Welding and Metal Work Technology													4		4							4
		Electric	Power Electric										4		4	11		11							15
		Electric and Electronics	Power Electric							4		4													4
		Metallurgy	Metal Welding							3		3													3
		Architecture	Architecture		2	2				1		1													3
		Electronics	Computer Technique													1		1							1
			Image and Sound System										2		2	2		2							4
7	Kanchanapisek Pattani Technical College	Mechanical Engineer	Automotive Technology													2		2							2
			Automobile							4		4													4
		Construction Technician	Construction	12	8	20	6	3	9	11	1	12				18		18							59
		Metal Welding Technician	Products	10		10	5		5	1		1													16
		Power Electric Technician	Power Electric	31	1	32	18	6	24	17	4	21													77
		Automotive Technician	Automobile	70	5	75	29	4	33	25		25													133
		Electronics Technician	Electronics	20	11	31	5	6	11	6	3	9													51
		Mechanical Technology	Automotive Technology										31		31	37		37							68
		Electric	Power Electric										53	2	55	65		65							120
		Power Electric	Electrical Mechanical Tools													11		11							11
		Electric and Electronics	Power Electric							3		3													3
			Electronics							3	1	4													4
		Electronics	Computer Technique													1		1							1
			Industrial Electronics										8		8	4	4	8							16
8	Kanchanapisek Mahanakhon Technical College	Machine Tools Design	Machine Tools Design										1	2	3	5	1	6							9
			Production Design													2	1	3							3
		Mechanical Engineer	Automotive Technology													33		33							33
			Automobile							16	1	17													17
		Mechanical Tools and Maintenance	Machine Tools Design							1	1	2													2
			Mechanical Tools							5		5													5
			Industrial Machine Maintenance							2		2													2
			Metal Tools and Die							2		2													2
		Machine Tools Technology	Mechanical Tools	36	2	38	32	1	33	44	1	45													116
		Machine Tools Design	Machine Tools Design	3	8	11	1	15	16	9	14	23													50
		Metal Welding Technician	Structure	33	1	34	46		46	16		16													96
		Power Electric Technician	Power Electric	49	4	53	20	3	23	41	3	44													120
		Automotive Technician	Automobile	128	1	129	89		89	78		78													296
		Electronics Technician	Electronics	35	7	42	22	1	23	17	1	18													83
		Production Technology	Mechanical Tools										24		24	18		18							42
		Mechanical Technology	Automotive Technology										27		27										27
		Metal Technology	Metal Welding Technology													1		1							1
		Die Technology	Tools and Die Technology																9		9	19		19	28
		Electric	Power Electric										26	1	27	19		19							46
		Power Electric	Technician for large facilities													1		1							1
		Electric and Electronics	Power Electric							25		25													25
			Electronics							2		2													2
		Metallurgy	Metal Welding							11		11													11

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Industrial Electronics										12	2	14	13	2	15							29
9	Kanchanapisek Samutprakarn Technical College	Construction	Construction Technology													34	2	36							36
		Mechanical Engineer	Automotive Technology													12		12							12
			Automobile							4		4													4
		Mechanical Tools and Maintenance	Metal Tools and Die							3	1	4													4
		Machine Tools Technology	Mechanical Tools	48	7	55	50		50	75		75													180
		Construction Technician	Construction	20	6	26	33	7	40	25	4	29	72	6	78	56	10	66							239
		Metal Welding Technician	Products	2		2	7		7	1		1													10
		Power Electric Technician	Power Electric	31	4	35	29	5	34	30	1	31													100
		Automotive Technician	Automobile	35		35	35		35	21		21													91
		Electronics Technician	Electronics	7	4	11	10	4	14	8	3	11													36
		Production Technology	Mechanical Tools										64	2	66	63	5	68							134
			Metal Tools and Die										17		17	10	1	11							28
		Mechanical Technology	Automotive Technology										9		9	27		27							36
		Electric	Electric Control										39	2	41	34	2	36							77
		Power Electric	Electricity Installation													14	1	15							15
		Electric and Electronics	Power Electric							3		3													3
			Electronics							1		1													1
		Electronics	Industrial Electronics										5		5	9		9							14
10	Kanchanapisek Udornthani Technical College	Construction	Construction							1		1													1
		Mechanical Engineer	Automotive Technology													24		24							24
			Automobile							21		21													21
		Machine Tools Technology	Mechanical Tools	46	1	47	42		42	21		21													110
		Construction Technician	Construction	21	9	30	18	8	26	10	1	11													67
		Metal Welding Technician	Products	10		10	19		19	9		9													38
		Power Electric Technician	Power Electric	66	4	70	36		36	58	1	59													165
		Automotive Technician	Automobile	55	1	56	43		43	60	1	61													160
		Electronics Technician	Electronics	32	14	46	21	17	38	14	6	20													104
		Production Technology	Mechanical Tools										13	1	14										14
		Mechanical Technology	Automotive Technology										37		37	42		42							79
		Metal Technology	Industrial Welding Technology													1		1							1
			Metal Welding and Metal Work Technology										5		5	2		2							7
		Computer Technology	Computer Software										4	24	28										28
		Electric Technology	Electric Technology																8		8	15		15	23
		Electric	Power Electric										20	3	23	36	1	37							60
		Electric (power)	Electricity Installation										1		1	29	1	30							31
		Electric and Electronics	Power Electric							7		7													7
			Electronics							4	1	5													5
		Civil Engineer	Civil Engineer										20	2	22	65	13	78							100
		Metallurgy	Metal Welding							2		2													2
		Electronics	Computer Technique													7	2	9							9
			Industrial Electronics										5	3	8	30	1	31							39
11	Kalasin Technical College	Construction	Construction				3	1	4	22	3	25													29
		Mechanical Engineer	Automotive Technology										8		8	17		17							25
			Automobile	1		1	12		12	52		52													65
		Mechanical Tools and Maintenance	Mechanical Tools	7		7	6	2	8	22		22													37
			Industrial Machine Maintenance	2		2	4		4	21		21													27
		Machine Tools Technology	Mechanical Tools	162	8	170	154	7	161	73		73													404
		Construction Technician	Construction	10	4	14	54	13	67	30	5	35													116
		Metal Welding Technician	Structure	25		25				2		2													27
		Maintenance Technician	Industrial Maintenance	43		43	29		29	23		23													95
		Power Electric Technician	Power Electric	161	11	172	75	1	76	48	1	49													297
		Automotive Technician	Automobile	223		223	145		145	116	1	117													485
		Electronics Technician	Electronics	76	14	90	63	14	77	47	12	59													226
		Production Technology	Mechanical Tools										121	1	122	54		54							176
		Mechanical Technology	Automotive Technology										141		141	67		67							208
		Metal Technology	Metal Welding Technology													20		20							20
			Metal Welding and Metal Work Technology										18	2	20										20
		Industrial Technology	Installation and Maintenance										31	1	32	53		53							85
		Computer Technology	Computer Network										18	10	28										28
		Electric Technology	Electric Technology																19		19	12		12	31
		Automotive Technology	Automobile Technology																26		26	26		26	52
		Electric	Cooler and Air-condition													11		11							11
			Power Electric										126	5	131	44	1	45							176
		Power Electric	Cooler and Air-condition													4	1	5							5
			Electricity Installation										3		3	19		19							22
		Electric and Electronics	Computer Technique				1	1	2	9		9													11
			Power Electric	1		1	3		3	30		30													34
			Electronics	2		2				19	2	21													23
		Civil Engineer	Civil Engineer										52	11	63	43	9	52							115
		Metallurgy	Metal Welding	3		3				2		2													5
		Electronics	Industrial Electronics										31	5	36	32	7	39							75
		Construction	Construction							3		3													3
			Construction Technology													4		4							4
			Architecture							1		1													1
		Mechanical Engineer	Automotive Technology													6		6							6
			Automobile							2		2													2

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
12	Kampangpetch Technical College	Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
		Machine Tools Technology	Mechanical Tools	120	1	121	75	1	76	83		83													280
		Construction Technician	Construction	59	12	71	35	10	45	22	3	25	47	20	67	36	7	43							251
		Metal Welding Technician	Products	16	1	17	17		17	18	1	19													53
		Power Electric Technician	Power Electric	112	6	118	100	2	102	106	2	108													328
		Automotive Technician	Automobile	131		131	97	2	99	95		95													325
		Electronics Technician	Electronics	63	14	77	50	5	55	73	6	79													211
		Production Technology	Mechanical Tools										155	4	159	112	3	115							274
		Mechanical Technology	Automotive Technology										100		100	88		88							188
		Metal Technology	Industrial Welding Technology													13		13							13
			Metal Welding and Metal Work Technology										8		8										8
		Industrial Technology	Production Industry										75	3	78	55	1	56							134
		Electric Technology	Electric Technology																37	1	38				38
		Automotive Technology	Automobile Technology																13		13	16		16	29
		Electric	Cooler and Air-condition										9		9	19		19							28
			Power Electric										110	4	114	63	1	64							178
			Electric Control										27		27	21	1	22							49
		Power Electric	Electrical Mechanical Tools													2		2							2
			Cooler and Air-condition													1		1							1
			Electricity Installation													5		5							5
		Electric and Electronics	Power Electric							8		8													8
			Electronics								1	1													1
		Metallurgy	Metal Welding							1		1													1
		Architecture	Architecture	12	8	20	5	7	12	5	10	15													47
		Electronics	Computer Technique													1		1							1
			Image and Sound System										14	7	21	17	4	21							42
			Industrial Electronics										36	3	39	41	6	47							86
13	Khon Kaen Technical College	Construction	Construction							3		3													3
			Construction Technology										1		1	53	1	54							55
			Civil Engineer							8	1	9													9
			Architecture							2	4	6													6
			Survey							2		2													2
		Machine Tools Design	Machine Tools Design										44	6	50	41	8	49							99
			Production Design													9	1	10							10
		Mechanical Engineer	Industrial Mechanical Technology													21		21							21
			Automotive Technology													45		45							45
			Automobile							24		24													24
		Mechanical Tools and Maintenance	Machine Tools Design							3	2	5													5
			Mechanical Tools							16	1	17													17
		Machine Tools Technology	Mechanical Tools	215	5	220	186	1	187	192		192													599
		Construction Technician	Construction	42	7	49	34	2	36	49	5	54	48	2	50										189
		Machine Tools Design	Machine Tools Design	30	4	34	26	9	35	22	14	36													105
		Metal Welding Technician	Structure	48	1	49	27	1	28	41		41													118
		Power Electric Technician	Power Electric	183	6	189	147	3	150	153	1	154													493
		Automotive Technician	Automobile	257	1	258	180		180	200		200													638
		Electronics Technician	Electronics	98	10	108	82	13	95	104	11	115													318
		Production Technology	Mechanical Tools										117	2	119	121	1	122							241
			Metal Tools and Die										71		71	82		82							153
		Mechanical Technology	Industrial Mechanical Technology										9		9										9
			Automotive Technology										163	1	164	134		134							298
		Metallurgy Technology	Metal Welding Technology													56		56							56
			Metal Welding and Metal Work Technology										41		41										41
		Architecture Technology	Architecture Technology										13	10	23	13	2	15							38
		Industrial Technology	Installation and										89	1	90	91	1	92							182
			Logistics Industry													21	12	33							33
		Computer Technology	Computer Network										33	9	42										42
		Telecommunication Technology	Telecommunication System Technology										33	30	63										63
			Telephone System													37	27	64							64
		Electric Technology	Electric Technology																17		17				17
		mold Technology	Tools and Die Technology																6		6				6
		Electronics Technology	Electronics Technology																21	1	22	11	4	15	37
		Telecommunication	Telecommunication	18	27	45	25	8	33	28	19	47													125
		Electric	Maintenance and Sale System of Electric Equipment										10		10	15		15							25
			Power Electric										134	2	136	108	2	110							246
			Electric Control										84	1	85	84	1	85							170
		Power Electric	Electrical Mechanical Tools													8		8							8
			Cooler and Air-condition													6		6							6
			Electricity Installation													11		11							11
		Electric and Electronics	Telecommunication							9	1	10													10
			Power Electric							14		14													14
			Electronics							10	1	11													11
		Civil Engineer	Civil Engineer	86	10	96	36	9	45	38	9	47	51	13	64	67	12	79							331
		Metallurgy	Metal Welding							9		9													9
		Architecture	Architecture	21	13	34	14	10	24	8	21	29													87
		survey Technician	Survey	30	6	36	23	3	26	23	9	32	40	10	50	47	3	50							194
		Electronics	Computer Technique													7		7							7
			Industrial Electronics										62	13	75	93	7	100							175
		Mechanical Engineer	Automotive Technology													22	1	23							23
			Automobile							14		14													14

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
14	Khemmarat Technical College	Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	35	1	36	54		54	34		34													124
		Metal Welding Technician	Structure	15		15	19		19	13		13													47
		Power Electric Technician	Power Electric	49		49	40		40	36		36													125
		Automotive Technician	Automobile	88		88	100		100	63		63													251
		Electronics Technician	Electronics	34	8	42	25	10	35	36		36													113
		Production Technology	Mechanical Tools										30	2	32	42	2	44							76
		Mechanical Technology	Automotive Technology										67		67	59		59							126
		Metallurgy Technology	Industrial Welding Technology										12		12	11		11							23
		Electric	Power Electric										42	5	47	48	3	51							98
		Power Electric	Electricity Installation													8		8							8
		Electric and Electronics	Power Electric							2		2													2
			Electronics							1		1													1
		Metallurgy	Metal Welding							1		1													1
		Electronics	Industrial Electronics										30	7	37	25	12	37							74
15	Kaowong Technical College	Construction	Construction							3		3													3
			Construction Technology													2		2							2
		Mechanical Engineer	Automotive Technology													18		18							18
			Automobile							4		4													4
		Construction Technician	Construction	18	5	23	20	3	23	12		12	13		13	14		14							85
		Metal Welding Technician	Products	22	3	25	16		16	13		13													54
		Power Electric Technician	Power Electric	38		38	47		47	24		24													109
		Automotive Technician	Automobile	66	3	69	50		50	49		49													168
		Electronics Technician	Electronics	12		12	11		11	11		11													34
		Mechanical Technology	Automotive Technology										49		49	23		23							72
		Metal Technology	Metal Welding and Metal Work Technology										14		14	11		11							25
		Electric	Power Electric										64		64	54		54							118
		Power Electric	Electricity Installation													15		15							15
		Electric and Electronics	Power Electric							1		1													1
		Metallurgy	Metal Welding							1		1													1
		Electronics	Industrial Electronics										7		7	13		13							20
16	Kuumuang Technical College	Construction	Construction							7	2	9													9
		Mechanical Engineer	Automotive Technology										2		2	7		7							9
			Automobile							28		28													28
		Mechanical Tools and Maintenance	Mechanical Tools							25		25													25
		Machine Tools Technology	Mechanical Tools	72	4	76	64	4	68	53		53													197
		Construction Technology	Construction	9	5	14	3		3	12	1	13				4	1	5							35
		Power Electric Technician	Power Electric	31	8	39	35	3	38	19	2	21													98
		Automotive Technician	Automobile	54		54	42		42	57		57													153
		Electronics Technician	Electronics	13	8	21	27	6	33	16	5	21													75
		Production Technology	Mechanical Tools										47	1	48	52	1	53							101
		Mechanical Technology	Automotive Technology										14		14	10		10							24
		Electric Technology	Electric Technology																6	1	7				7
		Electric	Power Electric										19		19	33	1	34							53
		Power Electric	Electricity Installation													16		16							16
		Electric and Electronics	Power Electric							20		20													20
			Electronics							6	2	8													8
		Civil Engineer	Civil Engineer										5		5										5
		Electronics	Industrial Electronics										11	5	16	18	3	21							37
17	Khoksamrong Technical College	Mechanical Engineer	Automobile							5		5													5
		Metal Welding Technician	Products							6		6													6
		Maintenance Technician	Industrial Maintenance	18		18																			18
		Power Electric Technician	Power Electric	36	8	44	59	6	65	50	3	53													162
		Automotive Technician	Automobile	82	1	83	69		69	57	4	61													213
		Electronics Technician	Electronics	9	5	14	17	2	19	22		22													55
		Mechanical Technology	Automobile Body and Color Repairing Technique										15		15	12	1	13							28
			Automotive Technology										16		16	17		17							33
		Electric	Power Electric										36	3	39	17	2	19							58
		Power Electric	Electricity Installation													2		2							2
		Electric and Electronics	Power Electric							2		2													2
		Electronics	Industrial Electronics										11	2	13	18	4	22							35
18	Chana Technical College	Construction	Construction							5	1	6													6
		Mechanical Engineer	Automotive Technology													4		4							4
			Automobile							14		14													14
		Construction Technician	Construction	9	1	10	9	1	10	4	4	8													28
		Metal Welding Technician	Products	28		28	15	1	16	13		13													57
		Power Electric Technician	Power Electric	42	3	45	29		29	38	1	39													113
		Automotive Technician	Automobile	97		97	69		69	59		59													225
		Electronics Technician	Electronics	10	9	19	7	4	11	8	3	11													41
		Mechanical Technology	Automotive Technology										40		40	23		23							63
		Metal Technology	Metal Welding and Metal Work Technology										7		7										7

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Rubber and Polymer Technology	Rubber and Polymer Technology													2	4	6							6
		Rubber Products	Rubber production								3	3													3
		Electric	Power Electric										37		37	16		16							53
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Power Electric							3		3													3
			Electronics							2		2													2
		Civil Engineer	Civil Engineer										7	3	10	8	4	12							22
		Metallurgy	Metal Welding							1		1													1
		Rubber Industry	Rubber Industry	2	10	12	1	11	12	2	9	11													35
19	Chanthaburi Technical College	Mechanical Engineer	Automotive Technology													4		4							4
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	83	1	84	38		38	40	1	41													163
		Construction Technician	Construction	60	26	86	46	14	60	40	15	55	40	3	43	27	8	35							279
		Metal Welding Technician	Structure	61	1	62	29	2	31	30		30													123
		Power Electric Technician	Power Electric	79	2	81	49	1	50	60	2	62													193
		Automotive Technician	Automobile	120	2	122	83		83	87	1	88													293
		Electronics Technician	Electronics	63	4	67	30	3	33	60	3	63													163
		Production Technology	Mechanical Tools										54		54	53	1	54							108
		Computer Technology	Computer Technique	40	7	47	26	2	28																75
		Mechanical Technology	Automotive Technology										67	2	69	90		90							159
		Metal Technology	Industrial Welding Technology													24	2	26							26
			Metal Welding and Metal Work Technology										40		40										40
		Construction Technology	Construction Technology																15	9	24	16	1	17	41
		Computer Technology	Computer Network										13	4	17	25	9	34							51
		Electronics Technology	Electronics Technology																12		12				12
		Electric	Electric Control										71	1	72	64	2	66							138
		Electric and Electronics	Mechatronics							1	1	2													2
			Electronics							1		1													1
		Mechatronics	Mechatronics	20	2	22	19		19	19		19				16		16							76
		Mechatronics and Robots	Mechatronics and Robots										18		18										18
		Electronics	Industrial Electronics										31	2	33	30		30							63
20	Chulabhorn (Ladkwang) Technical College	Mechanical Engineer	Automobile Body and Color							7		7													7
			Automotive Technology													46		46							46
			Automobile							73		73													73
		Mechanical Tools and Maintenance	Mechanical Tools							27		27													27
			Industrial Machine Maintenance							8		8													8
			Metal Tools and Die							9	1	10													10
		Machine Tools Technology	Mechanical Tools	79		79	27	2	29	27		27													135
			Metal Tools and Die							1		1													1
		Metal Welding Technician	Products	18		18	22		22	8		8													48
		Maintenance Technician	Industrial Maintenance	18	1	19	13		13	36		36													68
		Power Electric Technician	Power Electric	16	6	22	18		18	18	3	21													61
		Automotive Technician	Automobile	100	3	103	57	3	60	84		84													247
		Electronics Technician	Electronics	7	5	12	8	1	9	7		7													28
		Production Technology	Mechanical Tools										30		30	26	1	27							57
			Metal Tools and Die													15	1	16							16
		Mechanical Technology	Automotive Technology										63	6	69	68	10	78							147
		Metal Technology	Metal Welding Technology													5		5							5
		Industrial Technology	Installation and Maintenance													6		6							6
			Production Industry										44	4	48	56	3	59							107
		Electric	Power Electric										16	5	21										21
			Electric Control										14	1	15	25		25							40
		Power Electric	Electrical Mechanical Tools													25		25							25
		Electric and Electronics	Power Electric							17		17													17
			Electronics							4		4													4
		Metallurgy	Metal Welding							15		15													15
		Electronics	Industrial Electronics										11	1	12	10	1	11							23
21	Chachengsao Technical College	Construction	Construction							13		13													13
			Construction Technology													16		16							16
		Mechanical Engineer	Automotive Technology													2		2							2
			Automobile							17		17													17
		Mechanical Tools and Maintenance	Mechanical Tools							9		9													9
		Machine Tools Technology	Mechanical Tools	122	2	124	78	6	84	82		82													290
		Construction Technician	Construction	65	4	69	42	7	49	43	5	48	47	10	57	48	11	59							282
		Metal Welding Technician	Structure	80	1	81	27		27	40	1	41													149
		Power Electric Technician	Power Electric	217	15	232	186	6	192	206	5	211													635
		Automotive Technician	Automobile	127	2	129	110	3	113	122		122													364
		Electronics Technician	Electronics	73	13	86	73	8	81	95	8	103													270
		Production Technology	Auto-part Production										11		11										11
		Mechanical Technology	Automotive Technology										79		79	63		63							142
		Metal Technology	Metal Welding Technology													25		25							25
			Metal Welding and Metal Work Technology										39		39										39
		Industrial Technology	Installation and Maintenance										32		32	61		61							93

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Telecommunication Technology	Communication Information System and Network Technology										11	1	12										12
			Communication Information System and Network													25	1	26							26
		Telecommunication	Telecommunication	16		16	11		11	12	6	18													45
		Electric	Power Electric										243	7	250	188	4	192							442
		Power Electric	Electrical Mechanical Tools													7		7							7
		Electric and Electronics	Telecommunication							10	1	11													11
			Power Electric							34		34													34
			Electronics							13	1	14													14
		Metallurgy	Metal Welding							7		7													7
		Electronics	Computer Technique													3		3							3
			Industrial Electronics										48	9	57	117	11	128							185
		Construction	Construction							2		2													2
			Construction Technology													3		3							3
			Architecture							1		1													1
		Machine Tools Design	Machine Tools Design										10	1	11	11	2	13							24
			Production Design													6	1	7							7
		Mechanical Engineer	Automotive Technology													17		17							17
			Automobile							22		22													22
		Mechanical Tools and Maintenance	Machine Tools Design							1		1													1
			Mechanical Tools							13		13													13
			Industrial Machine Maintenance							4		4													4
		Machine Tools Technology	Mechanical Tools	133	1	134	90	5	95	90	3	93													322
			Metal Tools and Die				19	2	21	26		26													47
		Construction Technician	Construction	42	4	46	22	2	24	30	2	32	9	3	12	9		9							123
		Machine Tools Design	Machine Tools Design	7	4	11	10	5	15	16	3	19													45
		Metal Welding Technician	Products	39	1	40	17	1	18	29		29													87
		Maintenance Technician	Industrial Maintenance	59	2	61	18	3	21	38	2	40													122
		Power Electric Technician	Power Electric	128	9	137	91	9	100	77	3	80													317
		Automotive Technician	Automobile Body and Color	20		20																			20
			Automobile	156	3	159	141		141	134		134													434
22	Chonburi Technical College	Electronics Technician	Electronics	31	7	38	32	3	35	43	10	53													126
		Production Technology	Mechanical Tools										49	4	53	87	5	92							145
			Auto-part Production										18		18										18
			Metal Tools and Die													13		13							13
		Computer Technology	Computer Technique	16	3	19																			19
		Machine Tools Technology	Automotive Technology										50		50	80		80							130
		Metal Technology	Industrial Welding Technology													10		10							10
			Metal Welding and Metal Work Technology										4		4										4
		Architecture Technology	Architecture Technology										10	15	25	14	21	35							60
		Industrial Technology	Installation and Maintenance										24		24	45		45							69
		Electric	Power Electric										64	6	70	39	2	41							111
			Electric Control										24		24	34	1	35							59
		Power Electric	Electrical Mechanical Tools													5		5							5
			Electricity Installation													19		19							19
		Electric and Electronics	Power Electric							13		13													13
			Electronics							9		9													9
		Metallurgy	Metal Welding							5		5													5
		Architecture	Architecture	15	8	23	13	9	22	11	6	17													62
		Electronics	Telecommunication System													4		4							4
			Industrial Electronics										35	14	49	43	4	47							96
		Construction	Construction							6		6													6
		Mechanical Engineer	Automotive Technology													17		17							17
			Automobile							9		9													9
		Mechanical Tools and Maintenance	Mechanical Tools							8		8													8
		Machine Tools Technology	Mechanical Tools	112	7	119	86	2	88	81	3	84													291
		Construction Technician	Construction	37	12	49	26	5	31	34	2	36	23	8	31	17	6	23							170
		Metal Welding Technician	Products	25		25	19	1	20	13		13													58
		Maintenance Technician	Industrial Maintenance	36	14	50	24		24																74
		Power Electric Technician	Power Electric	90	18	108	72	14	86	81	10	91													285
		Automotive Technician	Automobile	172	3	175	120	1	121	136	2	138													434
		Electronics Technician	Electronics	28	16	44	40	5	45	43	19	62													151
23	Chainat Technical College	Production Technology	Mechanical Tools										60	3	63	82	1	83							146
			Metal Tools and Die										8		8	4		4							12
		Computer Technology	Computer Technique	11	6	17																			17
		Mechanical Technology	Automotive Technology										122	1	123	115	1	116							239
		Metal Technology	Industrial Welding Technology													16		16							16
			Metal Welding and Metal Work Technology										6		6										6
		Industrial Technology	Production Industry										42	6	48	33	7	40							88
		Computer Technology	Computer Hardware										27	15	42										42
		Tools and Die Technology	Tools and Die Technology																10	3	13				13
		Electric	Power Electric										81	12	93	63	6	69							162
		Power Electric	Electricity Installation													7		7							7
		Electric and Electronics	Electronics							2		2													2
		Electronics	Computer Technique														2	2							2
			Industrial Electronics										31	2	33	40	8	48							81
		Construction	Construction Technology													1		1							1
			Architecture								1	1													1

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
24	Chaiyabhumi Technical College	Mechanical Engineer	Automotive Technology													12		12							12
			Automobile							1		1													1
		Mechanical Tools and Maintenance	Mechanical Tools							2		2													2
		Machine Tools Technology	Mechanical Tools	120	19	139	101	12	113	114	11	125													377
		Construction Technician	Construction	7		7	9		9	8		8	7	2	9	5		5							38
		Metal Welding Technician	Structure	11		11	18		18	8		8													37
		Power Electric Technician	Power Electric	121	17	138	76	2	78	66	2	68													284
		Automotive Technician	Automobile Body and Color	29		29	21		21																50
			Automobile	170	2	172	119		119	107		107													398
		Electronics Technician	Electronics	43	18	61	35	9	44	27	10	37													142
		Production Technology	Mechanical Tools										141	34	175	118	10	128							303
		Mechanical Technology	Automotive Technology										137		137	110	1	111							248
		Metal Technology	Industrial Welding Technology													23		23							23
			Metal Welding and Metal Work Technology										21	1	22										22
		Architecture Technology	Architecture Technology										12	17	29	11	8	19							48
		Electric Technology	Electric Technology																19		19	10		10	29
		Tools and Die Technology	Tools and Die Technology																20		20	4		4	24
		Automotive Technology	Automobile Technology																12		12	4		4	16
		Electronics Technology	Electronics Technology																13	5	18	4	4	8	26
		Electric	Cooler and Air-condition										7	1	8	5		5							13
			Power Electric										188	2	190	103	3	106							296
		Power Electric	Electricity Installation													10		10							10
		Civil Engineer	Civil Engineer	38	7	45	20	3	23	26	6	32	39	5	44	47	3	50							194
		Architecture	Architecture	8	17	25	9	8	17	6	2	8													50
		Electronics	Industrial Electronics										51	11	62	41	11	52							114
25	Chumporn Technical College	Construction	Construction Technology													3		3							3
		Mechanical Engineer	Automotive Technology													23		23							23
			Automobile							4		4													4
		Mechanical Tools and Maintenance	Mechanical Tools							2		2													2
			Industrial Machine Maintenance							3		3													3
		Machine Tools Technology	Mechanical Tools	62		62	47		47	32		32													141
		Construction Technician	Construction	66	16	82	44	4	48	46	5	51	21	1	22	20		20							223
		Metal Welding Technician	Structure	31		31	11		11	9		9													51
		Maintenance Technician	Industrial Maintenance	41		41	20		20	9		9													70
		Power Electric Technician	Power Electric	73	4	77	40	3	43	48		48													168
		Automotive Technician	Automobile	170		170	115	1	116	113		113													399
		Electronics Technician	Electronics	24	5	29	20	1	21	22	2	24													74
		Production Technology	Mechanical Tools										8		8	13		13							21
		Computer Technology	Computer Technique	22	3	25	18	1	19	13		13													57
		Mechanical Technology	Automotive Technology										103		103	66		66							169
		Metal Technology	Industrial Welding Technology													1		1							1
			Metal Welding and Metal Work Technology										4		4										4
		Industrial Technology	Installation and Maintenance										10		10	3		3							13
		Computer Technology	Computer Hardware										14		14	13		13							27
		Automotive Technology	Automobile Technology																15		15				15
		Electric	Power Electric										14	2	16	11	3	14							30
			Electric Control										42		42	33		33							75
		Power Electric	Electrical Mechanical Tools													3		3							3
			Electricity Installation													3		3							3
		Electric and Electronics	Computer Technique							3	1	4													4
			Power Electric							2		2													2
		Electronics	Industrial Electronics										6	1	7	17	1	18							25
26	Chumpae Technical College	Mechanical Engineer	Automotive Technology										1		1	81	2	83							84
			Automobile							67		67													67
		Mechanical Tools and Maintenance	Mechanical Tools							38		38													38
		Machine Tools Technology	Mechanical Tools	53	3	56	78		78	127		127													261
		Metal Welding Technician	Structure				19		19	17		17													36
		Power Electric Technician	Power Electric	79	2	81	96		96	142		142													319
		Automotive Technician	Automobile	134	1	135	141		141	186		186													462
		Electronics Technician	Electronics	20	4	24	37	12	49	52	5	57													130
		Production Technology	Mechanical Tools										62	2	64	52		52							116
			Production Technology													15		15							15
		Mechanical Technology	Industrial Mechanical Technology										1		1										1
			Automotive Technology										63		63	91		91							154
		Metal Technology	Metal Welding Technology													8		8							8
			Metal Welding and Metal Work Technology										6		6	4		4							10
		Industrial Technology	Installation and Maintenance										2		2	11		11							13
		Electric	Cooler and Air-condition										16		16	11		11							27
			Power Electric										87		87	56	1	57							144
		Power Electric	Cooler and Air-condition													7		7							7
			Electricity Installation													70		70							70
		Electric and	Power Electric							67		67													67

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Electronics							42	1	43													43
		Metallurgy	Metal Welding							18		18													18
		Electronics	Computer Technique													13		13							13
			Telecommunication System													12	1	13							13
			Industrial Electronics										20	1	21	20	3	23							44
27	Chiang Kham Technical College	Mechanical Engineer	Automotive Technology													11	1	12							12
			Automobile							2		2													2
		Power Electric Technician	Power Electric	35		35	25		25	41		41													101
		Automotive Technician	Automobile	73		73	53		53	51		51													177
		Electronics Technician	Electronics	11	7	18	3	1	4	9	4	13													35
		Mechanical Technology	Automotive Technology										28		28	17		17							45
		Electric	Power Electric										24	1	25	17	2	19							44
		Power Electric	Electricity Installation													9	2	11							11
		Electric and Electronics	Power Electric							1		1													1
28	Chiang Rai Technical College	Construction	Construction							14	2	16													16
			Construction Technology													24	1	25							25
		Mechanical Engineer	Automotive Technology													24	1	25							25
			Automobile	1		1				8		8													9
		Mechanical Tools and Maintenance	Mechanical Tools							7		7													7
		Machine Tools Technology	Mechanical Tools	128	2	130	81		81	90	1	91													302
		Construction Technician	Construction	143	6	149	95	8	103	118	7	125	99	4	103	88	8	96							576
		Metal Welding Technician	Products	52		52	24		24	34	1	35													111
		Power Electric Technician	Power Electric	146		146	86	2	88	97	3	100													334
		Automotive Technician	Automobile	189	1	190	130		130	185	1	186													506
		Electronics Technician	Electronics	129	10	139	71	3	74	97	5	102													315
		Production Technology	Mechanical Tools										99	1	100	116		116							216
		Mechanical Technology	Automotive Technology										193	1	194	155		155							349
		Metal Technology	Industrial Welding Technology													47		47							47
			Metal Welding and Metal Work Technology										27		27										27
		Industrial Technology	Installation and Maintenance										30		30	36		36							66
		Electric Technology	Electric Technology																17		17				17
		Automobile Technology	Automobile Technology																23		23	22		22	45
		Electric	Cooler and Air-condition										20		20	27		27							47
			Power Electric										119	2	121	103	3	106							227
		Power Electric	Cooler and Air-condition													3		3							3
			Electricity Installation													3		3							3
		Electric and Electronics	Power Electric							13		13													13
			Mechatronics							3		3													3
			Electronics							20	1	21													21
		Mechatronics	Mechatronics	8	2	10	9	1	10	11	1	12				7	1	8							40
		Mechatronics and Robots	Mechatronics and Robots										11		11										11
		Civil Engineer	Civil Engineer										107	11	118	121	2	123							241
		Metallurgy	Metal Welding							7		7													7
		Electronics	Computer Technique													24	1	25							25
			Image and Sound System										18	4	22										22
			Industrial Electronics										60		60	50	3	53							113
29	Chiang Mai Technical College	Construction	Construction							5	1	6													6
			Construction Technology													24	1	25							25
			Architecture							10	5	15													15
		Mechanical Engineer	Automotive Technology													90		90							90
			Automobile							9		9													9
		Mechanical Tools and Maintenance	Mechanical Tools							9		9													9
		Machine Tools Technology	Mechanical Tools	86		86	85	1	86	64		64													236
		Construction Technician	Construction	106	26	132	106	12	118	106	9	115	110	8	118	110	12	122							605
		Metal Welding Technician	Products	28		28	25		25	59		59													112
		Maintenance Technician	Industrial Maintenance	7		7	9		9	17		17													33
		Power Electric Technician	Power Electric	150	3	153	139	3	142	140	3	143													438
		Automotive Technician	Automobile	170		170	149		149	150		150													469
		Electronics Technician	Electronics	70	8	78	85	14	99	128	6	134													311
		Physical therapy	Physical therapy										19	3	22	20	5	25							47
		Production Technology	Mechanical Tools										52		52	62		62							114
		Computer Technique	Computer Technique	70	2	72	31	2	33																105
		Mechanical Technology	Automotive Technology										232		232	203		203							435
		Metal Technology	Industrial Welding Technology													84	2	86							86
			Metal Welding and Metal Work Technology										81	1	82										82
		Architecture Technology	Architecture Technology										17	9	26	23	13	36							62
		Industrial Technology	Installation and Maintenance										23		23	33		33							56
		Computer Technology	Computer Network										120	14	134										134
		Telecommunication Technology	Telecommunication System Technology										32	3	35										35
		Automobile Technology	Automobile Technology																66	1	67	80		80	147
		Electric	Cooler and Air-condition										38		38	35		35							73
			Power Electric										155	4	159	156	4	160							319
			Electric Control										42		42	41		41							83
		Power Electric	Electrical Mechanical Tools													8		8							8

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
			Cooler and Air-condition													7		7							7
			Electricity Installation													41	1	42							42
		Electric and Electronics	Computer Technique							1		1													1
			Power Electric							8		8													8
			Mechatronics							4		4													4
			Electronics							4		4													4
		Mechatronics	Mechatronics	9	2	11	18	1	19	21	1	22				3	1	4							56
		Mechatronics and Robots	Mechatronics and Robots										9		9	24	4	28							37
		Metallurgy	Metal Welding							3		3													3
		Architecture	Architecture	42	20	62	39	26	65	51	23	74													201
		Electronics	Computer Technique													152	19	171							171
			Telecommunication System													38	2	40							40
30	Dokkhamtai Technical College	Mechanical Engineer	Automotive Technology													7		7							7
			Automobile							16		16													16
		Power Electric Technician	Power Electric	14		14	7		7	18		18													39
		Automotive Technician	Automobile	72		72	31		31	26		26													129
		Computer Technique	Computer Technique				14		14																14
		Mechanical Technology	Automotive Technology										20		20	17		17							37
		Electric	Power Electric										13		13	14	2	16							29
		Power Electric	Electricity Installation													7		7							7
		Electric and Electronics	Computer Technique							34	1	35													35
			Power Electric							6	1	7													7
31	Donmuang Technical College	Construction	Construction							9	1	10													10
			Furniture and Interior							26	13	39													39
			Construction Technology													11		11							11
			Civil Engineer							3		3													3
		Mechanical Engineer	Automotive Technology													13	1	14							14
			Automobile							3		3													3
		Machine Tools Technology	Mechanical Tools	38	2	40	13	1	14	15	2	17													71
		Construction Technician	Construction	36	7	43	13	1	14	11	1	12	76	9	85	72	11	83							237
		Facilities and Interior	Furniture and Interior	8	6	14	2	4	6	11	5	16													36
		Metal Welding Technician	Structure	17		17	8		8	15	1	16													41
		Power Electric Technician	Power Electric	82	3	85	46	7	53	38	5	43													181
		Automotive Technician	Automobile	115	4	119	82	1	83	70		70													272
		Aircraft Technician	Aircraft Technician										17	3	20										20
		Electronics Technician	Electronics	45	20	65	25	5	30	41	5	46													141
		Production Technology	Mechanical Tools										13		13	4		4							17
		Computer Technique	Computer Technique	24	7	31	9		9																40
		Mechanical Technology	Automotive Technology										35		35	23		23							58
		Metal Technology	Metal Welding and Metal Work Technology										5		5										5
		Techniques of eyewear and optics	Techniques of eyewear and optics													1		1							1
			Eyewear and Optics				1	1	2	4		4													6
		Architecture Technology	Architecture Technology													6	5	11							11
		Industrial Technology	Production Industry										47	6	53	76	9	85							138
		Computer Technology	Computer Network										11	1	12										12
		Electronics Technology	Electronics Technology																18		18				18
		Electric	Power Electric													23		23							23
			Electric Control										59	4	63										63
		Power Electric	Electrical Mechanical Tools													7		7							7
		Electric and Electronics	Computer Technique							2	2	4													4
			Power Electric							8		8													8
			Mechatronics							2		2													2
			Electronics							2	1	3													3
		Mechatronics	Mechatronics	9		9	6	3	9	4	1	5													23
		Civil Engineer	Civil Engineer	27	4	31	7	3	10	3	2	5													46
		Architecture	Architecture	13	12	25	3	7	10	37	4	41													76
		Electronics	Computer Technique													3		3							3
			Industrial Electronics										33	7	40	45	3	48							88
32	Dusit Technical College	Construction	Civil Engineer							4	1	5													5
			Survey							1		1													1
		Construction Technician	Construction	36		36	13	3	16	11	5	16	16	8	24	12	3	15							107
		Furniture and Interior	Furniture and Interior	8	2	10	1		1	3		3													14
		Architecture Technology	Architecture Technology										2	2	4	9	6	15							19
		Construction Technology	Construction Technology																16		16	26	3	29	45
		Civil Engineer	Civil Engineer	20	2	22	14	2	16	8	3	11	13		13	12	4	16							78
		Architecture	Architecture	8	1	9	4	3	7	6	4	10													26
		Survey	Survey	40		40	23	3	26	8	1	9	3	2	5	1	1	2							82
		Furniture and Interior Design Industry	Interior Design										3	1	4	3		3							7
		Construction	Construction							14	1	15													15
		Mechanical Engineer	Automotive Technology										1		1	49		49							50
			Automobile							70		70													70
		Mechanical Tools and Maintenance	Mechanical Tools							31		31													31
		Machine Tools Technology	Mechanical Tools	92		92	88	4	92	60		60													244
		Construction Technician	Construction	29	33	62	44	19	63	41	17	58													183
		Metal Welding Technician	Structure	34	3	37	34	2	36	44		44													117
		Power Electric Technician	Power Electric	91	2	93	87	3	90	91		91													274
		Automotive Technician	Automobile	129	1	130	148		148	133	1	134													412

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
33	Dejudom Technical College	Electronics Technician	Electronics	39	1	40	50	8	58	53	8	61													159
		Production Technology	Mechanical Tools										45	2	47	65	6	71							118
		Mechanical Technology	Automotive Technology										64		64	66		66							130
		Metal Technology	Metal Welding Technology													1		1							1
			Industrial Welding Technology													20		20							20
			Metal Welding and Metal Work Technology										6		6										6
		Construction Technology	Construction Technology																7	1	8	32	1	33	41
		Electric	Power Electric													30		30							30
			Electric Control										106	2	108	87		87							195
		Power Electric	Electrical Mechanical Tools													82	2	84							84
		Electric and Electronics	Power Electric							45	1	46													46
			Electronics							35	6	41													41
		Civil Engineer	Civil Engineer										57	15	72	157	20	177							249
		Metallurgy	Metal Welding							9		9													9
		Electronics	Industrial Electronics										7		7	34	3	37							44
34	Trakan Phuet Phon Vocational College	Mechanical Engineer	Automotive Technology													33		33							33
			Automobile							40		40													40
		Mechanical Tools and Maintenance	Mechanical Tools							13		13													13
		Machine Tools Technology	Mechanical Tools	69	2	71	61		61	69		69													201
		Power Electric Technician	Power Electric	50	2	52	51	2	53	50		50													155
		Automotive Technician	Automobile	133	1	134	158		158	165		165													457
		Electronics Technician	Electronics	17	8	25	26	4	30	27	4	31													86
		Production Technology	Mechanical Tools										19		19	63		63							82
		Mechanical Technology	Automotive Technology										44		44	55	1	56							100
		Electric	Power Electric										28	1	29	20		20							49
		Power Electric	Electricity Installation													6		6							6
		Electric and Electronics	Power Electric							8		8													8
			Electronics							5		5													5
		Electronics	Industrial Electronics										10	1	11	29	1	30							41
35	Trang Technical College	Construction	Construction							1		1													1
			Construction Technology													2		2							2
			Civil Engineer							7		7													7
			Architecture							4	4	8													8
		Mechanical Engineer	Automotive Technology													37		37							37
			Automobile							17		17													17
		Mechanical Tools and Maintenance	Mechanical Tools							4		4													4
		Machine Tools Technology	Mechanical Tools	25		25	15		15	13		13													53
		Construction Technician	Construction	22	3	25	21		21	20		20	6		6										72
		Metal Welding Technician	Products	6		6	6	1	7	3		3													16
		Power Electric Technician	Power Electric	87	1	88	67		67	59		59													214
		Automotive Technician	Automobile	114		114	83		83	89		89													286
		Electronics Technician	Electronics	31	9	40	25	1	26	26	1	27													93
		Production Technology	Mechanical Tools										9		9	13		13							22
		Mechanical Technology	Automotive Technology										44		44	47		47							91
		Metal Technology	Metal Welding Technology													14		14							14
			Industrial Welding Technology													1		1							1
			Metal Welding and Metal Work Technology										8		8										8
		Architecture Technology	Architecture Technology														1	1							1
		Rubber Technology and Polymer	Rubber Technology and Polymer										7		7	8	4	12							19
		Automobile Technology	Automobile Technology																15		15	22		22	37
		Rubber Products	Rubber Production							5		5													5
		Electric	Power Electric										13		13	18		18							31
			Electric Control										13		13	18		18							31
		Power Electric	Electrical Mechanical Tools													4		4							4
			Electricity Installation													15		15							15
		Electric and Electronics	Power Electric							16		16													16
			Electronics							10	1	11													11
		Civil Engineer	Civil Engineer	26	4	30	15	3	18	11		11	5	4	9	26	2	28							96
		Metallurgy	Metal Welding							5		5													5
		Architecture	Architecture	7	7	14	1	4	5	7	3	10													29
		Electronics	Computer Technique													16	1	17							17
			Telecommunication System													18	1	19							19
			Industrial Electronics										24		24										24
		Rubber Industry	Rubber Industry	4	4	8	2	5	7	10	5	15													30
36	Trad Technical College	Construction	Construction							5	1	6													6
			Construction Technology													9		9							9
		Mechanical Engineer	Automotive Technology													16		16							16
			Automobile							14		14													14
		Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
		Machine Tools Technology	Mechanical Tools	52	2	54	29		29	34	1	35													118
		Construction Technician	Construction	55	11	66	22	10	32	35	7	42	11	3	14	20	3	23							177
		Metal Welding Technician	Products	11		11	9		9	15		15													35
		Power Electric Technician	Power Electric	81	3	84	56		56	73	1	74													214
		Automotive Technician	Automobile	126	1	127	65	2	67	75	1	76													270
		Electronics Technician	Electronics	46	13	59	40	4	44	65	1	66													169

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Production Technology	Metal Tools and Die										40	3	43	36		36							79
		Mechanical Technology	Automotive Technology										18		18	23		23							41
		Metal Technology	Metal Welding Technology													6		6							6
			Metal Welding and Metal Work Technology										8		8										8
		Electric	Power Electric										13		13	26		26							39
		Power Electric	Electricity Installation													9		9							9
		Electric and Electronics	Power Electric							5		5													5
			Electronics							20	2	22													22
		Electronics	Telecommunication System													17		17							17
			Image and Sound System										13		13										13
			Industrial Electronics													38	1	39							39
37	Tak Technical College	Construction	Construction Control													2		2							2
		Mechanical Tools and Maintenance	Automotive Technology													1		1							1
			Automobile							7		7													7
		Machine Tools Technology	Mechanical Tools	70	9	79																			79
		Construction Technician	Construction	25	23	48	29	9	38	22	12	34	18	13	31	33	6	39							190
		Metal Welding Technician	Structure	52	1	53	35	4	39	35	1	36													128
		Power Electric Technician	Power Electric	75	16	91	60	12	72	61		61													224
		Automotive Technician	Automobile	149		149	99	1	100	127		127													376
		Electronics Technician	Electronics	43	10	53	39	15	54	36	12	48													155
		Mechanical Technology	Automotive Technology										58		58	56		56							114
		Metal Technology	Industrial Welding Technology													35		35							35
			Metal Welding and Metal Work Technology										28	1	29										29
		Electric	Power Electric										70	10	80	46	3	49							129
		Electric and Electronics	Power Electric							4		4													4
		Metallurgy	Metal Welding							5		5													5
		Electronics	Industrial Electronics										23	3	26	27	6	33							59
38	Thalang Technical College	Mechanical Engineer	Automobile				1		1	1		1													2
		Construction Technician	Construction	12	2	14	5	1	6				4	1	5	6		6							31
		Power Electric Technician	Power Electric	40	1	41	7		7	13		13													61
		Automotive Technician	Automobile	55		55	23		23	22		22													100
		Aircraft Technician	Aircraft Technician										28	2	30	21	2	23							53
		Electric	Power Electric										16		16	2		2							18
		Power Electric	Electricity Installation													4		4							4
		Architecture	Architecture	4	6	10	4	1	5	7	2	9													24
39	Thaluang Cementhaiaunus orn Technical College	Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	134	5	139	95	1	96	105		105													340
		Metal Welding Technician	Structure	44		44	18		18	12		12													74
		Maintenance Technician	Industrial Maintenance	23		23	27		27	17		17													67
		Power Electric Technician	Power Electric	105	15	120	89	9	98	78	7	85													303
		Automotive Technician	Automobile	51		51	36		36	35		35													122
		Electronics Technician	Electronics	15	10	25	18	11	29	16	5	21													75
		Production Technology	Mechanical Tools										180	5	185	155	3	158							343
		Computer Technology	Computer Technique	7	1	8	6	1	7																15
		Mechanical Technology	Automotive Technology										49		49	46		46							95
		Metal Technology	Metal Welding Technology													13	1	14							14
			Metal Welding and Metal Work Technology										17	1	18										18
		Industrial Technology	Installation and Maintenance										87	11	98	79	4	83							181
			Production Industry														1	1							1
		Computer Technology	Computer Software										12	1	13										13
		Electric	Industrial Measurement Tools										9		9	13		13							22
			Electric Control										101	17	118	128	15	143							261
		Power Electric	Electrical Mechanical Tools													1		1							1
		Electric and Electronics	Computer Technique							3		3													3
			Power Electric							4		4													4
		Mechatronics	Mechatronics	12	2	14										22	1	23							37
		Mechatronics and Robots	Mechatronics and Robots										16	7	23										23
		Metallurgy	Metal Welding							1		1													1
		Electronics	Industrial Electronics										22	10	32	45	8	53							85
40	Tungsong Technical College	Construction	Construction							1		1													1
			Construction Technology													3		3							3
		Mechanical Engineer	Automobile Body and Color Repairing Technique													5		5							5
			Automotive Technology													28		28							28
			Automobile							13		13													13
		Construction Technician	Construction	43	5	48	18	6	24	21	3	24	14	2	16	11	3	14							126
		Power Electric Technician	Power Electric	129	4	133	80	3	83	66	1	67													283
		Automotive Technician	Automobile Body and Color				20		20	20		20													40
			Automobile	211		211	199		199	224		224													634
		Electronics Technician	Electronics	44	4	48	47	2	49	27	1	28													125
		Mechanical Technology	Automobile Body and Color Repairing Technique										7		7	17		17							24
			Automotive Technology										63		63	82		82							145
		Rubber Products	Rubber production							1	1	2													2
		Electric	Electric Control										43	1	44	28		28							72

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Power Electric	Electrical Mechanical Tools													4		4							4
		Electric and Electronics	Power Electric							2		2													2
			Electronics							4		4													4
		Electronics	Industrial Electronics										22	5	27	38		38							65
		Rubber Industry	Rubber Industry							9	8	17													17
41	Thanyaburi Technical College	Construction	Construction							17	1	18													18
			Construction Technology													63		63							63
		Mechanical Engineer	Automotive Technology													4		4							4
			Automobile							7		7													7
		Construction Technician	Construction	83	11	94	84	10	94	143	7	150	111	14	125	86	5	91							554
		Power Electric Technician	Power Electric	89	7	96	59	1	60	62	5	67													223
		Automotive Technician	Automobile	109		109	111	2	113	71		71													293
		Electronics Technician	Electronics	49	8	57	53	10	63	42	3	45													165
		Mechanical Technology	Automotive Technology										51	1	52	53		53							105
		Electric	Cooler and Air-condition													9		9							9
			Power Electric										59	4	63	64	1	65							128
			Electric Control										25	1	26	20	3	23							49
		Power Electric	Electrical Mechanical Tools													2		2							2
			Electricity Installation													1		1							1
		Electric and Electronics	Power Electric							9		9													9
			Electronics							4		4													4
		Electronics	Industrial Electronics										41	7	48	47	4	51							99
42	Nakorn Khon Kaen Technical College	Mechanical Engineer	Automotive Technology													2		2							2
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
		Machine Tools Technology	Mechanical Tools	39		39	29		29	32	2	34													102
		Power Electric Technician	Power Electric	42		42	12		12	62		62													116
		Automotive Technician	Automobile	44		44	44	1	45	49		49													138
		Electronics Technician	Electronics	8	6	14	8	1	9	16	2	18													41
		Mechanical Technology	Automobile Body and Color Repairing Technique										3		3										3
			Automotive Technology										22		22	16		16							38
		Industrial Technology	Production Industry										18		18										18
		Electric	Power Electric													33		33							33
			Electric Control										39	2	41										41
		Power Electric	Electrical Mechanical Tools													7		7							7
		Electric and Electronics	Power Electric							2		2													2
			Electronics							1		1													1
		Electronics	Industrial Electronics										6	3	9										9
43	Nakorn Nayok Technical College	Construction	Construction							6		6													6
		Mechanical Engineer	Automotive Technology													7		7							7
			Automobile							17		17													17
		Mechanical Tools and Maintenance	Mechanical Tools							10		10													10
		Machine Tools Technology	Mechanical Tools	87	1	88	55	3	58	64	1	65													211
		Construction Technician	Construction	25	20	45	23	5	28	20	3	23	16	4	20	12	2	14							130
		Metal Welding Technician	Structure	41	1	42	13		13	27		27													82
		Power Electric Technician	Power Electric	80	6	86	52	4	56	67	1	68													210
		Automotive Technician	Automobile	125		125	78		78	69		69													272
		Electronics Technician	Electronics	59	25	84	52	21	73	29	7	36													193
		Production Technology	Mechanical Tools										36	1	37	48		48							85
			Auto-part Production										15		15										15
		Mechanical Technology	Automotive Technology										54		54	56		56							110
		Metal Technology	Metal Welding Technology													62		62							62
			Metal Welding and Metal Work Technology										27		27										27
		Electronics Technology	Electronics Technology																20		20	11	1	12	32
		Electric	Power Electric										38	4	42	47		47							89
			Electric Control										33		33	39		39							72
		Power Electric	Electrical Mechanical Tools													4		4							4
			Electricity Installation													2		2							2
		Electric and Electronics	Computer Technique							2	1	3													3
			Power Electric							6		6													6
			Electronics							7	3	10													10
		Metallurgy	Metal Welding							5		5													5
		Electronics	Computer Technique													21	5	26							26
			Industrial Electronics										35	8	43	50	3	53							96
44	Nakhon Pathom Technical	Construction	Construction							3		3													3
			Construction Technology													7		7							7
			Architecture								2	2													2
		Mechanical Engineer	Automotive Technology													6		6							6
			Automobile							12		12													12
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
			Industrial Machine Maintenance							8		8													8
		Machine Tools Technology	Mechanical Tools	81	6	87	55	3	58	47		47													192
		Construction Technician	Construction	33	13	46	21	5	26	32	2	34				8	1	9							115
		Metal Welding Technician	Structure	45	1	46	29	2	31	17		17													94
		Maintenance Technician	Industrial Maintenance	37	11	48	26	2	28	39	1	40													116
		Power Electric Technician	Power Electric	108	18	126	84	8	92	108	8	116													334
		Automotive Technician	Automobile	128		128	93		93	112		112													333
		Electronics Technician	Electronics	58	23	81	34	14	48	54	7	61													190

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
	College	Production Technology	Mechanical Tools										9		9	24		24							33
		Mechanical Technology	Automotive Technology										65	1	66	20		20							86
		Metal Technology	Metal Welding inspection										26	1	27										27
			Industrial Welding Technology													28	1	29							29
		Industrial Technology	Installation and Maintenance													15		15							15
		Telecommunication Technology	Network Technology										22	3	25										25
		Electric	Power Electric										52	4	56	73	3	76							132
			Electric Control										31	6	37	13	1	14							51
		Power Electric	Electrical Mechanical Tools													4		4							4
			Electricity Installation													4		4							4
		Electric and Electronics	Power Electric							3		3													3
			Electronics							2		2													2
		Metallurgy	Metal Welding							3		3													3
		Architecture	Architecture	25	18	43	16	10	26	14	15	29													98
		Electronics	Industrial Electronics													19		19							19
45	Nakorn Panom Technical College	Mechanical Engineer	Automotive Technology													2		2							2
			Automobile							16		16													16
		Power Electric Technician	Power Electric	73	2	75	14		14	6		6													95
		Automotive Technician	Automobile	185	1	186	38	1	39	11		11													236
		Electronics Technician	Electronics	119	8	127	40	5	45	1		1													173
		Mechanical Technology	Automotive Technology										37		37	2		2							39
		Electric	Power Electric										38		38										38
		Power Electric	Electrical Mechanical Tools										1		1										1
		Electric and Electronics	Power Electric							2		2													2
			Electronics							9		9													9
		Electronics	Computer Technique													3		3							3
			Industrial Electronics										27	2	29										29
46	Nakorn Ratchasima Technical College	Construction	Construction							20	1	21													21
			Construction Technology													10		10							10
			Architecture							2		2													2
		Machine Tools Design	Machine Tools Design										45	16	61										61
			Production Design													47	13	60							60
		Mechanical Engineer	Automotive Technology													8		8							8
			Automobile							29		29													29
		Mechanical Tools and Maintenance	Machine Tools Design							13	1	14													14
			Mechanical Tools							31		31													31
		Machine Tools Technology	Mechanical Tools	194	10	204	161	2	163	167	1	168													535
		Construction Technician	Construction	104	27	131	56	11	67	62	8	70	74	12	86	45	8	53							407
		Machine Tools Design	Machine Tools Design	90	20	110	64	9	73	57	7	64													247
		Metal Welding Technician	Products	137	11	148	60	7	67	84	2	86													301
		Power Electric Technician	Power Electric	191	20	211	153	11	164	131	2	133													508
		Automotive Technician	Automobile	213	8	221	169		169	144	1	145													535
		Electronics Technician	Electronics	153	49	202	123	25	148	95	14	109													459
		Production Technology	Mechanical Tools										190	4	194	182	3	185							379
			Plastic Tools and Die													10		10							10
			Metal Tools and Die										9		9	12		12							21
		Mechanical Technology	Automotive Technology										246		246	149		149							395
		Metal Technology	Metal Welding inspection										68	2	70										70
			Industrial Welding Technology													105	8	113							113
			Metal Welding and Metal Work Technology										32		32										32
		Industrial Technology	Production Industry										73	9	82	69	3	72							154
		Computer Technology	Computer Hardware										30	7	37										37
		Telecommunication Technology	Communication and Networking													40	7	47							47
		Electric Technology	Electric Technology																21	2	23	16		16	39
		Automobile Technology	Automobile Technology																13		13	11	1	12	25
		Electric	Cooler and Air-condition										76	1	77	42	2	44							121
			Power Electric										113	4	117	111	9	120							237
			Electric Control										101	4	105	74	8	82							187
		Power Electric	Electrical Mechanical Tools													9		9							9
			Cooler and Air-condition													3		3							3
			Electricity Installation													3		3							3
		Electric and Electronics	Power Electric							17		17													17
			Mechatronics							1		1													1
			Electronics							12	1	13													13
		Mechatronics	Mechatronics	100	18	118	58		58	38	3	41				108	7	115							332
		Mechatronics and Robots	Mechatronics and Robots										108	6	114										114
		Civil Engineer	Civil Engineer										75	18	93	86	12	98							191
		Metallurgy	Metal Welding							22	1	23													23
		Architecture	Architecture	19	23	42	12	10	22	15	8	23													87
		Electronics	Computer Technique													7		7							7
			Telecommunication System													8	2	10							10
			Industrial Electronics										138	36	174	95	86	181							355
		Construction	Construction Technology													4		4							4
		Mechanical Engineer	Automotive Technology													11		11							11
			Automobile							7		7													7
		Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
		Machine Tools Technology	Mechanical Tools	115		115	104		104	126		126													345
		Construction Technician	Construction	129	9	138	73	4	77	65	4	69	48	3	51	53	1	54							389
		Metal Welding Technician	Products	49		49	39		39	22		22													110

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
47	Nakhon Si Thammarat Technical College	power Electric Technician	Power Electric	237	7	244	166		166	156	2	158													568
		Automotive Technician	Automobile Body and Color	23		23	18		18	20		20													61
			Automobile	250		250	190	1	191	155		155													596
		Electronics Technician	Electronics	141	14	155	144	13	157	147	14	161													473
		Production Technology	Mechanical Tools										31		31	36		36							67
			Metal Tools and Die										12		12	33		33							45
		Mechanical Technology	Automobile Body and Color Repairing Technique										24		24										24
			Automotive Technology										112		112	119		119							231
		Metal Technology	Metal Welding Technology													21		21							21
			Metal Welding and Metal Work Technology										17		17										17
		Computer Technology	Computer Hardware										14	1	15										15
		Electric Technology	Electric Technology																			30	2	32	32
		Rubber Technology	Rubber Technology										1	7	8	15	5	20							28
		Rubber and Polymer Technology	Rubber and Polymer Technology													3		3							3
		Automotive Technology	Automobile Technology																14		14	14		14	28
		Rubber Products	Products							2		2													2
		Electric	Industrial Measurement Tools										20		20	19		19							39
			Power Electric										37		37	32	1	33							70
			Electric Control										74	6	80	75	2	77							157
		Power Electric	Electrical Mechanical Tools													12		12							12
			Industrial Measurement Tools													3		3							3
		Electric and Electronics	Power Electric							4		4													4
			Electronics							1		1													1
		Mechatronics	Mechatronics				10		10	23		23													33
		Mechatronics and Robots	Mechatronics and Robots										18		18										18
		Civil	Civil Engineer	85	23	108	91	13	104	69	12	81	45	5	50	52	5	57							400
		Metallurgy	Metal Welding							9		9													9
		Electronics	Computer Technique													15		15							15
			Telecommunication System													1		1							1
			Industrial Electronics										99	7	106	84	13	97							203
		Rubber Industry	Rubber Industry	16	2	18	5	2	7	10	6	16													41
48	Nakornsawan Technical College	Construction	Construction							1		1													1
			Construction Technology													14		14							14
			Architecture							2		2													2
			Survey							1		1													1
		Mechanical Engineer	Automotive Technology													16		16							16
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							2		2													2
		Machine Tools Technology	Mechanical Tools	162	3	165	93		93	109	1	110													368
		Construction Technician	Construction	65	9	74	27	8	35	40	3	43	61	9	70	62	3	65							287
		Metal Welding Technician	Structure	31	1	32	24	1	25	30		30													87
		Power Electric Technician	Power Electric	163	9	172	114	10	124	95	3	98													394
		Automotive Technician	Automobile	186	1	187	188	1	189	161		161													537
		Electronics Technology	Electronics	114	14	128	90	8	98	85	5	90													316
		Production Technology	Mechanical Tools										87	4	91	100	1	101							192
			Metal Tools and Die													4		4							4
		Mechanical Technology	Automotive Technology										196		196	143		143							339
		Metal Technology	Metal Welding inspection										19		19										19
			Metal Welding Technology													33	1	34							34
			Metal Welding and Metal Work Technology										7		7										7
		Architecture Technology	Architecture Technology										8	2	10	9	3	12							22
		Industrial Technology	Production Industry										122	1	123	130		130							253
		Construction Technology	Construction Technology																17	1	18				18
		Electric Technology	Electric Technology																17	1	18	13		13	31
		Automotive Technology	Automobile Technology																20		20	18		18	38
		Electric	Power Electric										83	4	87	80	1	81							168
			Electric Control										82	5	87	76	7	83							170
		Power Electric	Electrical Mechanical Tools													10	1	11							11
			Electricity Installation													26		26							26
		Electric and Electronics	Power Electric							2		2													2
			Mechatronics							2		2													2
			Electronics							3		3													3
		Mechatronics	Mechatronics	46	3	49	19		19	17	1	18				25	1	26							112
		Mechatronics and Robots	Mechatronics and Robots										20		20										20
		Civil	Civil Engineer	99	37	136	57	15	72	67	5	72	134	27	161	112	21	133							574
		Architecture	Architecture	14	27	41	13	17	30	15	10	25													96
		survey	Survey	18	4	22	20	4	24	12	4	16	38	5	43	44	7	51							156
		Electronics	Computer Technique													6		6							6
			Industrial Electronics										95	13	108	119	9	128							236
	Nonthaburi	Mechanical Engineer	Automotive Technology													8		8							8
			Automobile							20		20													20
		Metal Welding Technician	Products	10		10	7		7	3		3													20
		Maintenance Technician	Industrial Maintenance	24	1	25	17		17																42
		Power Electric Technician	Power Electric	68	5	73	33	4	37	39	1	40													150
		Automotive Technician	Automobile	129	3	132	78	2	80	65		65													277
		Electronics Technician	Electronics	11		11	4		4	16		16													31

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
49	Nonthaburi Technical College	Mechanical Technology	Automotive Technology										35		35	49		49							84
		Metal Technology	Metal Welding inspection										1		1										1
			Metal Welding Technology													1		1							1
			Pressure Tank and Pipe Welding Technology										8		8										8
		Electric	Electricity in Big Buildings										22		22	28	1	29							51
			Power Electric										15	1	16	12		12							28
		Power Electric	Technician in Big Building													6		6							6
			Electricity Installation													3		3							3
		Electric and Electronics	Power Electric							18		18													18
			Electronics							3		3													3
		Metallurgy	Metal Welding							3		3													3
		Electronics	Industrial Electronics										7	1	8	8		8							16
50	Nangrong Technical College	Mechanical Engineer	Automotive Technology													20		20							20
			Automobile							11		11													11
		Mechanical Tools and Maintenance	Mechanical Tools							10		10													10
		Machine Tools Technology	Mechanical Tools	132	2	134	111	6	117	63		63													314
		Metal Welding Technician	Products	26	1	27	21	1	22	28		28													77
		Power Electric Technician	Power Electric	92		92	68	1	69	49	1	50													211
		Automotive Technician	Automobile	160	8	168	153	2	155	108	2	110													433
		Electronics Technician	Electronics	33	2	35	27	5	32	16	4	20													87
		Production Technology	Plastic Tools and Die										64	2	66	71		71							137
		Mechanical Technology	Automotive Technology										76	1	77	86	3	89							166
		Metal Technology	Metal Welding inspection										7		7										7
			Metal Welding Technology										1		1	43		43							44
		Electric	Power Electric										81	1	82	51		51							133
		Power Electric	Electricity Installation													18		18							18
		Electric and Electronics	Power Electric							9		9													9
			Electronics							3		3													3
		Electronics	Industrial Electronics										6	4	10	25	1	26							36
51	Nan Technical College	Construction	Construction							33	2	35													35
			Construction Technology													35	1	36							36
		Mechanical Engineer	Automotive Technology													58		58							58
			Automobile							46		46													46
		Mechanical Tools and Maintenance	Mechanical Tools							40		40													40
		Machine Tools Technology	Mechanical Tools	57	1	58	53	2	55	77		77													190
		Construction Technician	Construction	74	11	85	45	3	48	49	14	63	72	3	75	67	2	69							340
		Metal Welding Technician	Products	25		25	9		9	37	1	38													72
		Power Electric Technician	Power Electric	85	3	88	61		61	116	3	119													268
		Automotive Technician	Automobile	98	1	99	78	1	79	102		102													280
		Electronics Technician	Electronics	33	4	37	22		22	30	9	39													98
		Production Technology	Mechanical Tools										83		83	105	2	107							190
		Computer Technology	Computer Technique	12	2	14	3		3																17
		Mechanical Technology	Automotive Technology										106		106	91		91							197
		Metal Technology	Industrial Welding Technology													28		28							28
			Metal Welding and Metal Work Technology										12		12										12
		Electric Technology	Electric Technology																24	1	25	29		29	54
		Electric	Power Electric													23		23							23
			Electric Control										100	5	105	64	3	67							172
		Power Electric	Electrical Mechanical Tools													20		20							20
			Electricity Installation													40		40							40
		Electric and Electronics	Computer Technique							13	2	15													15
			Power Electric							26		26													26
			Electronics							19	1	20													20
		Metallurgy	Metal Welding							30		30													30
		Electronics	Computer Technique													9	2	11							11
			Industrial Electronics										11		11	28	4	32							43
52	Namphong Technical College	Construction	Construction							3		3													3
		Mechanical Engineer	Automotive Technology													26		26							26
			Automobile							40		40													40
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	47	7	54	47	7	54	50	2	52													160
		Construction Technician	Construction				19	2	21	15		15													36
		Metal Welding Technician	Structure	9		9	10		10	15		15													34
		Power Electric Technician	Power Electric	39	4	43	55	1	56	51	6	57													156
		Automotive Technician	Automobile	61		61	47		47	68		68													176
		Electronics Technician	Electronics	12	5	17	25	7	32	14	7	21													70
		Mechanical Technology	Automotive Technology										17		17	25		25							42
		Metal Technology	Metal Welding Technology													21		21							21
			Metal Welding and Metal Work Technology										2		2										2
		Industrial Technology	Installation and Maintenance													5	1	6							6
			Industrial Technology													16		16							16
			Production Industry										37	2	39										39
		Electric	Power Electric										44	1	45	55		55							100
		Power Electric	Electricity Installation													22		22							22
		Electric and Electronics	Power Electric							14		14													14
			Electronics							15		15													15
		Civil Engineer	Civil Engineer	5	9	14							13	1	14	19	4	23							51
		Metallurgy	Metal Welding							7		7													7

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Telecommunication System													6	1	7							7
			Industrial Electronics										5	6	11	25		25							36
53	Baankhai Technical College	Construction	Construction							10	1	11													11
			Construction Technology													24	4	28							28
		Mechanical Engineer	Shipbuilding Mechanical Technique													3		3							3
			Automotive Technology										5		5	22		22							27
			Automobile							13		13													13
		Mechanical Tools and Maintenance	Industrial Machine Maintenance							40	1	41													41
		Machine Tools Technology	Mechanical Tools	73	6	79	133	1	134	141	1	142													355
			Auto-part Production	42	3	45	34	3	37																82
		Construction Technician	Construction	22	5	27	18	6	24	18	4	22	31	3	34	31	4	35							142
		Maintenance Technician	Industrial Maintenance	37	3	40	40	4	44	63	2	65													149
		Automotive Technician	Automobile	92	2	94	55		55	83		83													232
		Electronics Technician	Electronics	57	18	75	34	21	55	73	24	97													227
		Production Technology	Auto-part Production													2		2							2
			Metal Tools and Die										32	1	33	66		66							99
		Mechanical Technology	Shipbuilding Mechanical Technique										30		30	30		30							60
			Automotive Technology										36		36	30		30							66
		Industrial Technology	Production Industry										68	12	80	138	19	157							237
		Electric and Electronics	Electronics							17	1	18													18
			Mechatronics and Robots													3		3							3
		Electronics	Industrial Electronics										49	9	58	58	6	64							122
54	Baanpang Technical College	Construction	Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													17		17							17
		Machine Tools Technology	Mechanical Tools	25	4	29																			29
		Construction Technician	Construction	8	10	18	5	1	6	14	2	16	10	2	12	3		3							55
		Power Electric Technician	Power Electric	28	3	31	17		17	17		17													65
		Automotive Technician	Automobile	29		29	28		28	10		10													67
		Electronics Technician	Electronics	6	3	9	22	8	30	12		12													51
		Production Technology	Mechanical Tools										13		13										13
		Mechanical Technology	Automotive Technology										14		14										14
		Electric	Power Electric										21	2	23	15		15							38
		Power Electric	Electricity Installation													3		3							3
		Electronics	Industrial Electronics										11		11	18		18							29
55	Bungkan Technical College	Construction	Construction Technology													3		3							3
		Mechanical Engineer	Automotive Technology													9		9							9
			Automobile							1		1													1
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	37	1	38	26	2	28	30	2	32													98
		Construction Technician	Construction				4		4	10	3	13													17
		Power Electric Technician	Power Electric	31		31	21	3	24	26		26													81
		Automotive Technician	Automobile	71	1	72	51	2	53	48		48													173
		Electronics Technician	Electronics	20	3	23	21	3	24	15	3	18													65
		Production Technology	Mechanical Tools										12		12	14	2	16							28
		Mechanical Technology	Automotive Technology										40		40	16		16							56
		Electric Technology	Electric Technology																5		5	11		11	16
		Automotive Technology	Automobile Technology																			17		17	17
		Electric	Power Electric										40		40										40
			Electric Control													40		40							40
		Power Electric	Electrical Mechanical Tools													7		7							7
		Electric and Electronics	Power Electric							1		1													1
			Electronics							2		2													2
		Civil Engineer	Civil Engineer	18	1	19							12	2	14	23	5	28							61
		Electronics	Industrial Electronics										13	1	14	17		17							31
56	Buriram Technical College	Construction	Construction							1		1													1
			Construction Technology													13	4	17							17
			Civil Engineer							2		2													2
		Mechanical Engineer	Automotive Technology													12		12							12
			Automobile							5		5													5
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	133	9	142	142	1	143	86		86													371
		Construction Technician	Construction	52	17	69	53	9	62	16	10	26	39	6	45	22	3	25							227
		Metal Welding Technician	Structure	99	1	100	72		72	39		39													211
		Power Electric Technician	Power Electric	181	7	188	168	7	175	101	3	104													467
		Automotive Technician	Automobile	265	5	270	223	4	227	137	1	138													635
		Electronics Technician	Electronics	125	43	168	118	16	134	89	14	103													405
		Production Technology	Mechanical Tools										92	1	93	164	5	169							262
		Mechanical Technology	Automotive Technology										109	1	110	132	1	133							243
		Metal Technology	Metal Welding Technology													73	4	77							77
			Metal Welding and Metal Work Technology										63		63										63
		Architecture Technology	Architecture Technology										25	13	38	17	19	36							74
		Computer Technology	Computer Hardware										27	7	34										34

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
	College	Telecommunication Technology	Communication Information System and Network Technology										18		18										18
			Communication Information System and Network													32		32							32
		Electric Technology	Electric Technology																7		7	9		9	16
		Automotive Technology	Automobile Technology																13	1	14	13		13	27
		Electronics Technology	Electronics Technology																15	2	17	15	2	17	34
		Electric	Industrial Measurement Tools										80	6	86	61		61							147
			Power Electric										20		20										20
			Electric Control										31		31	31	2	33							64
		Power Electric	Electrical Mechanical Tools													3		3							3
			Industrial Measurement Tools													31	1	32							32
			Electricity Installation													5		5							5
		Electric and Electronics	Power Electric							10		10													10
			Electronics							2		2													2
		Civil Engineer	Civil Engineer	52	25	77	43	22	65	28	8	36	65	10	75	66	25	91							344
		Metallurgy	Metal Welding							3		3													3
		Architecture	Architecture	23	29	52	9	21	30	13	14	27													109
		Electronics	Telecommunication System													3		3							3
			Industrial Electronics										65	7	72	86	16	102							174
57	Burapha Prachin Technical College	Mechanical Engineer	Industrial Mechanical Technology													4		4							4
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Industrial Machine Maintenance							1		1													1
		Maintenance Technician	Industrial Maintenance	29		29	16		16	10		10													55
		Power Electric Technician	Power Electric	40		40	18		18	16		16													74
		Automotive Technician	Automobile	45	5	50	30	2	32	31	1	32													114
		Electronics Technician	Electronics				9	1	10	2		2													12
		Mechanical Technology	Industrial Mechanical Technology										20		20	44	1	45							65
		Industrial Technology	Installation and Maintenance										9	1	10	47	4	51							61
		Electric	Power Electric										27		27	57	4	61							88
		Power Electric	Electricity Installation													3		3							3
		Mechatronics	Mechatronics	17	15	32	17	4	21	16	2	18				2		2							73
		Mechatronics and Robots	Mechatronics and Robots										19	6	25	20	9	29							54
		Electronics	Industrial Electronics										1		1	9	4	13							14
58	Pathumthani Technical College	Construction	Construction							2		2													2
			Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													12		12							12
			Automobile							4		4													4
		Mechanical Tools and Maintenance	Mechanical Tools					1	1	11	2	13													14
		Measurement and Control Tools	Measurement and Control Technology										9	1	10	14		14							24
		Machine Tools Technology	Mechanical Tools	115	14	129	68	4	72	90	4	94													295
		Construction Technician	Construction	29	12	41	24	5	29	25	5	30	8	1	9	22	4	26							135
		Metal Welding Technician	Structure	31	1	32	12	1	13	20		20													65
		Power Electric Technician	Power Electric	139	34	173	72	17	89	92	9	101													363
		Automotive Technician	Mechanical Engineer								1	1													1
			Automobile	159	5	164	97	2	99	106		106													369
		Electronics Technician	Electronics	25	19	44	18	14	32	17	7	24													100
		Production Technology	Mechanical Tools													23		23							23
			Plastic Tools and Die										63	1	64	32	1	33							97
		Mechanical Technology	Automotive Technology										84	4	88	44	2	46							134
		Metal Technology	Metal Welding Technology													2		2							2
			Metal Welding and Metal Work Technology										14	1	15	15		15							30
		Tools and Die Technology	Tools and Die Technology																18	2	20	25		25	45
		Electronics Technology	Electronics Technology																17	3	20	21	3	24	44
		Electric	Electric Control										85	15	100	55	9	64							164
		Power Electric	Electricity Installation													8	2	10							10
		Electric and Electronics	Power Electric							2		2													2
			Electronics							1		1													1
		Metallurgy	Metal Welding							5		5													5
		Electronics	Computer Technique													3	6	9							9
			Industrial Electronics										30	7	37	12	1	13							50
59	Prachuap Khiri Khan Technical College	Construction	Construction							7	3	10													10
			Construction Technology													14	6	20							20
		Mechanical Engineer	Automotive Technology													10		10							10
			Automobile							37		37													37
		Mechanical Tools and Maintenance	Mechanical Tools							26	1	27													27
		Machine Tools Technology	Mechanical Tools	59	4	63	44		44	25	2	27													134
		Construction Technician	Construction	34	24	58	29	8	37	27	3	30	14	5	19	20	4	24							168
		Metal Welding Technician	Structure	29	2	31	17	2	19	3		3													53
		Power Electric Technician	Power Electric	77	8	85	67	3	70	36	4	40													195
		Automotive Technician	Automobile	120	3	123	62		62	74		74													259
		Electronics Technician	Electronics	45	16	61	36	5	41	42	2	44													146
		Production Technology	Mechanical Tools										33	2	35	28		28							63
			Metal Tools and Die													3		3							3
		Mechanical Technology	Automotive Technology										62	1	63	34	1	35							98
		Metal Technology	Metal Welding Technology													7		7							7

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
			Metal Welding and Metal Work Technology										7		7										7
		Automotive Technology	Automobile Technology																21		21	18		18	39
		Electric	Power Electric										46	2	48	61	1	62							110
		Power Electric	Electrical Mechanical Tools													5		5							5
			Electricity Installation													6		6							6
		Electric and Electronics	Power Electric							13	1	14													14
			Electronics							15		15													15
		Metallurgy	Metal Welding							6		6													6
		Electronics	Industrial Electronics										23	3	26	29	8	37							63
60	Prachinburi Technical College	Construction	Construction							2	2	4													4
			Construction Technology													3		3							3
		Mechanical Engineer	Industrial Mechanical Technology													77	3	80							80
			Automotive Technology													26		26							26
			Automobile							13		13													13
		Mechanical Tools and Maintenance	Mechanical Tools							4		4													4
			Industrial Machine Maintenance							2		2													2
			Metal Tools and Die							1		1													1
		Machine Tools Technology	Mechanical Tools	132	4	136	72	3	75	47		47													258
			Metal Tools and Die	22		22	9	1	10	20		20													52
		Construction Technician	Construction	41	14	55	27	14	41	44	5	49	31	5	36	23	5	28							209
		Metal Welding Technician	Products	15		15	1		1	9		9													25
		Maintenance Technician	Industrial Maintenance	41	1	42	20	3	23	35	1	36													101
		Power Electric Technician	Power Electric	155	6	161	87	4	91	91	1	92													344
		Automotive Technician	Automobile	172	4	176	119	2	121	112		112													409
		Electronics Technician	Electronics	76	12	88	72	8	80	53	9	62													230
		Production Technology	Mechanical Tools										79	1	80	109	3	112							192
			Metal Tools and Die										15		15	17		17							32
		Mechanical Technology	Industrial Mechanical Technology										78	1	79										79
			Automotive Technology										30		30										30
		Metal Technology	Metal Welding Technology													10		10							10
		Industrial Technology	Installation and										16		16	20		20							36
			Production Industry										6		6	9		9							15
		Electric Technology	Electric Technology																27	1	28	23		23	51
		Electric	Power Electric										120	7	127	62	1	63							190
			Electric Control										16		16	40		40							56
		Power Electric	Electrical Mechanical Tools													1		1							1
			Electricity Installation													9		9							9
		Electric and Electronics	Power Electric							8		8													8
			Electronics							14	2	16													16
		Metallurgy	Metal Welding							5		5													5
		Electronics	Computer Technique													5	2	7							7
			Industrial Electronics										82	9	91	72	7	79							170
61	Pakthongchai Technical College	Mechanical Engineer	Automotive Technology													10		10							10
			Automobile							1		1													1
		Mechanical Tools and Maintenance	Mechanical Tools							15		15													15
		Machine Tools Technology	Mechanical Tools	109	19	128	66	10	76	91	1	92													296
		Construction Technician	Construction	8	1	9	7	4	11	8		8	2		2	4		4							34
		Maintenance Technician	Industrial Maintenance							6		6													6
		Power Electric Technician	Power Electric	30		30	34		34	40		40													104
		Automotive Technician	Automobile	67	2	69	63	5	68	66	2	68													205
		Electronics Technician	Electronics	14	6	20	19	7	26	14	2	16													62
		Production Technology	Mechanical Tools										66	8	74	64	9	73							147
		Mechanical Technology	Automotive Technology										12		12	31	2	33							45
		Industrial Technology	Installation and Maintenance													1		1							1
		Electric	Power Electric										13	1	14	5		5							19
		Power Electric	Electricity Installation													5	1	6							6
		Electric and Electronics	Power Electric							3		3													3
			Electronics							2	3	5													5
		Electronics	Industrial Electronics										7		7	10	1	11							18
62	Pattani Technical College	Mechanical Engineer	Automotive Technology													11		11							11
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	24	1	25	13		13	13		13													51
		Construction Technician	Construction	32	7	39	12		12	32	1	33													84
		Metal Welding Technician	Products	11		11	1		1	9		9													21
		Power Electric Technician	Power Electric	85	4	89	43	1	44	60		60													193
		Automotive Technician	Automobile	78		78	46	1	47	55		55													180
		Electronics Technician	Electronics	30	1	31	23		23	28	7	35													89
		Production Technology	Mechanical Tools										12		12	12		12							24
		Computer Technique	Computer Technique	7		7																			7
		Mechanical Technology	Automotive Technology										91		91	54		54							145
		Metal Technology	Metal Welding inspection										10		10	13		13							23
			Metal Welding Technology													10		10							10
		Electric Technology	Electric Technology																25		25	15		15	40
		Automobile Technology	Automobile Technology																13		13				13
		Electric	Power Electric										123		123	60		60							183
		Power Electric	Electrical Mechanical Tools													7		7							7
		Civil Engineer	Civil Engineer										89	3	92	24	2	26							118

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Industrial Electronics										12		12	3		3							15
63	Papayom Technical College	Construction	Construction							1		1													1
			Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													1		1							1
			Automobile							2		2													2
		Construction Technician	Construction	9		9	7	1	8	8		8	6		6	13		13							44
		Metal Welding Technician	Structure	8		8	8		8	18		18													34
		Power Electric Technician	Power Electric	17		17	17		17	23		23													57
		Automotive Technician	Automobile	66		66	38		38	65	1	66													170
		Computer Technique	Computer Technique	6	1	7	3		3																10
		Mechanical Technology	Automotive Technology										25		25	28	1	29							54
		Metal Technology	Industrial Welding Technology													10		10							10
			Metal Welding and Metal Work Technology										6		6										6
		Electric	Power Electric										13		13	11		11							24
		Electric and Electronics	Power Electric							3		3													3
64	Ayutthaya Technical College	Construction	Construction							2		2													2
			Construction Technology													3	3	6							6
		Machine Tools Design	Machine Tools Design										8	2	10										10
			Production Design													8	5	13							13
		Mechanical Engineer	Automotive Technology													12		12							12
			Automobile							4		4													4
		Mechanical Tools and Maintenance	Machine Tools Design							3	2	5													5
			Mechanical Tools							2		2													2
			Industrial Machine Maintenance							9		9													9
		Machine Tools Technology	Mechanical Tools	154	8	162	127	2	129	90	6	96													387
		Construction Technician	Construction	36	11	47	15	8	23	44	13	57	18	6	24	16	1	17							168
		Machine Tools Design	Machine Tools Design	24	18	42	9	8	17	21	13	34													93
		Metal Welding Technician	Products	55	2	57	11		11	23	1	24													92
		Maintenance Technician	Industrial Maintenance	118	9	127	66	4	70	108	5	113													310
		Power Electric Technician	Power Electric	118	36	154	131	12	143	112	11	123													420
		Automotive Technician	Automobile	161	7	168	134	1	135	134	2	136													439
		Electronics Technician	Electronics	119	37	156	91	22	113	62	17	79													348
		Production Technology	Mechanical Tools										49	3	52	89	4	93							145
		Mechanical Technology	Automotive Technology										92	1	93	76	1	77							170
		Metal Technology	Industrial Welding Technology													18		18							18
			Metal Welding and Metal Work Technology										1		1										1
			Metal Welding and Metal Work Technology										7		7										7
		Industrial Technology	Installation and Maintenance										91	4	95	135	1	136							231
		Electronics	Electronics Technology																21	2	23	9	2	11	34
		Electric	Power Electric										132	7	139	116	7	123							262
		Power Electric	Electrical Mechanical Tools													3		3							3
			Electricity Installation													5		5							5
		Electric and Electronics	Computer Technique							1	1	2													2
			Power Electric							3		3													3
			Electronics							3		3													3
		Metallurgy	Metal Welding							1		1													1
		Electronics	Computer Technique													1	1	2							2
			Telecommunication System													2		2							2
			Industrial Electronics										50	9	59	72	12	84							143
65	Payao Technical College	Construction	Construction							5		5													5
			Construction Technology										30	4	34	73	4	77							111
		Mechanical Engineer	Automotive Technology													53		53							53
			Automobile							17		17													17
		Mechanical Tools and Maintenance	Mechanical Tools							9		9													9
		Machine Tools Technology	Mechanical Tools	53	2	55	34		34	62		62													151
		Construction Technician	Construction	39	11	50	47	8	55	43	4	47													152
		Metal Welding Technician	Structure	9		9	51		51	39		39													99
		Power Electric Technician	Power Electric	63	4	67	74	2	76	74		74													217
		Automotive Technician	Automobile	139	1	140	108		108	118		118													366
		Electronics Technician	Electronics	30	2	32	22	3	25	40	2	42													99
		Production Technology	Mechanical Tools										71	1	72	105		105							177
		Mechanical Technology	Automotive Technology										100	1	101	80		80							181
		Metal Technology	Metal Welding Technology										5	1	6	13		13							19
			Metal Welding and Metal Work Technology										4		4										4
		Industrial Technology	Production Industry										9		9										9
		Electric Technology	Electric Technology																20	2	22				22
		Automobile Technology	Automobile Technology																13		13	12		12	25
		Power Electric	Electrical Mechanical Tools										78	3	81	112	5	117							198
		Electric and Electronics	Power Electric							9		9													9
			Electronics							4	2	6													6
		Metallurgy	Metal Welding							5		5													5
		Electronics	Computer Technique													1		1							1
			Industrial Electronics										18	1	19	35	2	37							56
		Construction	Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													7		7							7
			Automobile							11		11													11

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
66	Phang Nga Technical College	Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
		Machine Tools Technology	Mechanical Tools	3		3	12		12	6		6													21
		Construction Technician	Construction	33	3	36	28	4	32	14		14	7		7	11		11							100
		Metal Welding Technician	Products	5		5	5		5	5		5													15
		Power Electric Technician	Power Electric	47	1	48	25		25	31		31													104
		Automotive Technician	Automobile	127		127	89		89	63		63													279
		Electronics Technician	Electronics	20		20	34	2	36	26	1	27													83
		Mechanical Technology	Automotive Technology										22		22	29		29							51
		Electric	Power Electric										14		14	25		25							39
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Electronics							2		2													2
		Electronics	Industrial Electronics										15	1	16	18		18							34
67	Pattaya Technical College	Mechanical Engineer	Mechanical Engineer							2		2													2
			Automotive Technology													31		31							31
			Automobile							37	2	39													39
		Mechanical Tools and Maintenance	Mechanical Tools							19		19													19
		Machine Tools Technology	Mechanical Tools	105	1	106	54	2	56	40	2	42													204
		Metal Welding Technician	Structure	32	3	35	14		14	20	4	24													73
		Power Electric Technician	Power Electric	85	5	90	50	2	52	53	2	55													197
		Automotive Technician	Automobile	125	1	126	85	1	86	80	1	81													293
		Electronics Technician	Electronics	42	15	57	31	9	40	30		30													127
		Computer Technique	Computer Technique	48	7	55	30	5	35	29	2	31													121
		Mechanical Technology	Automotive Technology										46		46	49	2	51							97
		Metal Technology	Metal Welding Technology													1		1							1
			Industrial Welding Technology													3		3							3
			Metal Welding and Metal Work Technology										12	1	13										13
		Industrial Technology	Industrial Technology													9	2	11							11
			Production Industry										35	6	41	46	9	55							96
		Computer Technology	Computer Hardware										13	3	16										16
		Electric	Power Electric										25	2	27	38	7	45							72
		Power Electric	Electrical Mechanical Tools													8		8							8
			Electricity Installation													54	1	55							55
		Electric and Electronics	Computer Technique							8	1	9													9
			Power Electric							19		19													19
			Electronics							32		32													32
		Metallurgy	Metal Welding							9		9													9
		Electronics	Industrial Electronics										20	2	22	28	3	31							53
68	Patthalung Technical College	Construction	Construction							16		16													16
			Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													18		18							18
			Automobile							20		20													20
		Mechanical Tools and Maintenance	Mechanical Tools							18		18													18
		Machine Tools Technology	Mechanical Tools	61		61	53	1	54	39		39													154
		Construction Technician	Construction	41	3	44	31	2	33	41	6	47	14	2	16	26		26							166
		Metal Welding Technician	Structure	26		26	13		13	11		11													50
			Products				4		4	1		1													5
		Power Electric Technician	Power Electric	121	2	123	66	5	71	73	1	74													268
		Automotive Technician	Automobile	174		174	105		105	143		143													422
		Electronics Technician	Electronics	27	1	28	32	4	36	53	4	57													121
		Production Technology	Mechanical Tools										50		50	69		69							119
			Metal Tools and Die													4		4							4
		Computer Technique	Computer Technique	35	8	43	30	6	36																79
		Mechanical Technology	Automotive Technology										71		71	44		44							115
		Metal Technology	Industrial Welding Technology													32		32							32
			Metal Welding and Metal Work Technology										37		37										37
		Construction Technology	Construction Technology																31		31				31
		Computer Technology	Computer Hardware										25	8	33										33
		Telecommunication Technology	Telecommunication System Technology										16	1	17										17
		Electric	Power Electric										74	1	75	44		44							119
		Power Electric	Electrical Mechanical Tools													1		1							1
			Electricity Installation													11		11							11
		Electric and Electronics	Computer Technique							37	9	46													46
			Power Electric							12		12													12
			Electronics							13	1	14													14
		Civil Engineer	Civil Engineer	26	8	34	13	2	15	16	1	17	16	1	17	29		29							112
		Metallurgy	Metal Welding							8		8													8
		Electronics	Telecommunication System													13	2	15							15
			Industrial Electronics													22	1	23							23
		Construction	Construction							3		3													3
			Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													13		13							13
			Automobile							17		17													17
		Mechanical Tools and Maintenance	Mechanical Tools							9		9													9
			Metal Tools and Die							2		2													2
		Machine Tools Technology	Mechanical Tools	40		40	25		25	20		20													85
			Metal Tools and Die	39	1	40	31		31	37		37													108
		Construction Technician	Construction	50	14	64	27	7	34	41	5	46													144
		Metal Welding Technician	Products	36		36	27		27	30		30													93

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
69	Pichit Technical College	Power Electric Technician	Power Electric	123	4	127	85		85	73	4	77													289
		Automotive Technician	Automobile	117	2	119	73		73	90		90													282
		Electronics Technician	Electronics	66	8	74	43	5	48	48	3	51													173
		Production Technology	Mechanical Tools										50		50	34		34							84
			Metal Tools and Die										13		13	31		31							44
		Mechanical Technology	Automotive Technology										81	1	82	89		89							171
		Metal Technology	Metal Welding Technology													14		14							14
			Metal Welding and Metal Work Technology										6		6										6
		Electric	Power Electric										74	4	78	32	1	33							111
			Electric Control										20		20	49	1	50							70
		Power Electric	Electricity Installation													32		32							32
		Electric and Electronics	Power Electric							11		11													11
			Electronics							3	1	4													4
		Civil Engineer	Civil Engineer										52	6	58	40	5	45							103
		Metallurgy	Metal Welding							8		8													8
		Electronics	Computer Technique													12		12							12
			Industrial Electronics										27	7	34	38	5	43							77
70	Pibulmansaharn Technical College	Mechanical Engineer	Automotive Technology													5		5							5
			Automobile							9		9													9
		Machine Tools Technology	Mechanical Tools	44		44	20		20																64
		Metal Welding Technician	Structure				6		6																6
		Power Electric Technician	Power Electric	57		57	45		45	30		30													132
		Automotive Technician	Automobile	85	4	89	66	3	69	54		54													212
		Electronics Technician	Electronics	34	1	35	34	1	35	21	4	25													95
		Computer Technique	Computer Technique	7		7	13	12	25																32
		Mechanical Technology	Automotive Technology										36		36	26		26							62
		Electric	Power Electric										36	1	37	27		27							64
		Power Electric	Electricity Installation													3		3							3
		Electric and Electronics	Computer Technique							6	1	7													7
			Power Electric							6		6													6
			Electronics							11	4	15													15
		Electronics	Computer Technique													2	1	3							3
			Industrial Electronics										9	4	13	11	1	12							25
71	Pimai Technical College	Mechanical Engineer	Automotive Technology													1		1							1
			Automobile							16		16													16
		Mechanical Tools and Maintenance	Mechanical Tools							4		4													4
			Industrial Machine Maintenance							13		13													13
		Machine Tools Technology	Mechanical Tools	93		93	75		75	39		39													207
		Maintenance Technician	Industrial Maintenance	48		48	39		39	22		22													109
		Power Electric Technician	Power Electric	80	6	86	68	3	71	59	1	60													217
		Automotive Technician	Automobile	105	1	106	85		85	89		89													280
		Electronics Technician	Electronics	44	32	76	45	17	62	37	3	40													178
		Production Technology	Mechanical Tools										17	3	20										20
		Mechanical Technology	Automotive Technology										62		62	59		59							121
		Industrial Technology	Installation and Maintenance										25		25	14		14							39
		Electric	Power Electric										66	3	69	67		67							136
		Power Electric	Electricity Installation													4		4							4
		Electric and Electronics	Power Electric							15		15													15
			Electronics							7		7													7
		Electronics	Computer Technique													1		1							1
			Industrial Electronics										50	9	59	42	11	53							112
72	Phitsanulok Technical College	Construction	Construction							21	4	25													25
			Construction Technology													14	2	16							16
			Architecture							16	4	20													20
			Survey							14	2	16													16
		Mechanical Engineer	Automotive Technology													69	1	70							70
			Automobile							58		58													58
		Mechanical Tools and Maintenance	Mechanical Tools							59		59													59
			Industrial Machine Maintenance							18		18													18
		Machine Tools Technology	Mechanical Tools	119	4	123	93		93	104		104													320
		Construction Technician	Construction	41	6	47	41	6	47	59		59	63	8	71	44	5	49							273
		Metal Welding Technician	Products	32	1	33	35		35	48	1	49													117
		Maintenance Technician	Industrial Maintenance	23	2	25	19		19	38	1	39													83
		Power Electric Technician	Power Electric	174	10	184	149	3	152	135	4	139													475
		Automotive Technician	Automobile	171		171	167	1	168	158	1	159													498
		Electronics Technician	Electronics	72	5	77	81	3	84	86	2	88													249
		Production Technology	Mechanical Tools										91	3	94	112	5	117							211
			Plastic Tools and Die										28		28	37	1	38							66
			Metal Tools and Die										32		32	39		39							71
		Mechanical Technology	Automotive Technology										169	1	170	169		169							339
		Energy Technology	Industrial Energy Maintenance Technology										7	1	8	16		16							24
		Metal Technology	Metal Welding Technology													68		68							68
			Pressure Tank and Pipe Welding Technology										65	2	67										67
		Architecture Technology	Architecture Technology										56	16	72	42	19	61							133
		Industrial Technology	Installation and Maintenance										53	5	58	54	3	57							115
		Computer Technology	Computer Hardware										26	4	30										30
		Telecommunication Technology	Telecommunication System Technology										18		18										18

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
			Radio Communication System													30		30							30
		Tools and Die Technology	Tools and Die Technology																11		11	4		4	15
		Architecture Technology	Architecture Technology																11	2	13				13
		Electric	Power Electric										139	5	144	124	4	128							272
			Electric Control										45		45	30	2	32							77
		Power Electric	Electrical Mechanical Tools													13		13							13
			Electricity Installation													43	1	44							44
		Electric and Electronics	Power Electric							53	2	55													55
			Electronics							40	1	41													41
		Civil Engineer	Civil Engineer	19	2	21							27	1	28	35	2	37							86
		Metallurgy	Metal Welding							31		31													31
		Architecture	Architecture	21	18	39	27	19	46	27	24	51													136
		Survey	Survey	25	14	39	21	8	29	55	11	66	72	22	94	75	15	90							318
		Electronics	Computer Technique													7	2	9							9
			Industrial Electronics										43	2	45	44	4	48							93
		Construction	Construction Technology													1		1							1
			Civil Engineer							1		1													1
		Mechanical Engineer	Automotive Technology													9		9							9
		Machine Tools Technology	Mechanical Tools	86	2	88	23		23	6		6													117
		Construction Technician	Construction	82	7	89	27	4	31	1		1	40	2	42										163
		Metal Welding Technician	Products	17		17	10		10	4		4													31
		Maintenance Technician	Industrial Maintenance	18	1	19	7		7	4		4													30
		Power Electric Technician	Power Electric	264	4	268	71	1	72	16		16													356
		Automotive Technician	Automobile	212		212	56		56	8		8													276
		Electronics Technician	Electronics	111	5	116	46		46	5		5													167
		Production Technology	Mechanical Tools										43		43	1		1							44
73	Petchaburi Technical College	Computer Technique	Computer Technique	16	2	18																			18
		Mechanical Technology	Automotive Technology										128	2	130										130
		Metal Technology	Metal Welding Technology										4		4	1		1							5
			Metal Welding and Metal Work Technology										3		3										3
		Industrial Technology	Installation and Maintenance										11		11										11
		Computer Technology	Computer Hardware										7	1	8										8
		Electric Technology	Electric Technology																24		24	16		16	40
		Automobile Technology	Automobile Technology																12		12				12
		Electronics Technology	Electronics Technology																21	1	22				22
		Electric	Power Electric										113	4	117										117
		Power Electric	Electricity Installation													2		2							2
		Electric and Electronics	Power Electric							8		8													8
			Electronics							1		1													1
		Metallurgy	Metal Welding							1		1													1
		Electronics	Industrial Electronics										67	2	69	1		1							70
		Construction	Construction							5		5													5
			Construction Technology													29	2	31							31
			Architecture							1	2	3													3
		Mechanical Engineer	Automotive Technology													23	1	24							24
			Automobile							25		25													25
		Mechanical Tools and Maintenance	Mechanical Tools							20		20													20
		Machine Tools Technology	Mechanical Tools	143	1	144	83	2	85	107		107													336
		Construction Technician	Construction	114	33	147	24	6	30	67	15	82	78	7	85	64	12	76							420
		Metal Welding Technician	Structure	53		53	32		32	33		33													118
		Power Electric Technician	Power Electric	135	16	151	73	4	77	71	2	73													301
		Automotive Technician	Automobile	227	5	232	129		129	162	1	163													524
		Electronics Technician	Electronics	34	21	55	28	7	35	46	2	48													138
		Production Technology	Mechanical Tools										118	5	123	171	7	178							301
74	Petchaboon Technical College	Computer Technique	Computer Technique	23	2	25	7	7	14																39
		Mechanical Technology	Automotive Technology										182		182	167	2	169							351
		Metal Technology	Industrial Welding Technology										2		2	45		45							47
			Metal Welding and Metal Work Technology										17		17										17
		Architecture Technology	Architecture Technology										6	10	16	8	10	18							34
		Electric Technology	Electric Technology																22		22	22		22	44
		Electric	Power Electric										183	19	202	151	11	162							364
		Power Electric	Electricity Installation													22		22							22
		Electric and Electronics	Computer Technique							1		1													1
			Power Electric							15		15													15
			Electronics							4		4													4
		Metallurgy	Metal Welding							11		11													11
		Architecture	Architecture	14	22	36	10	25	35	16	17	33													104
		Electronics	Telecommunication System													28	2	30							30
			Industrial Electronics										49	9	58	37	7	44							102
		Construction	Construction							1		1													1
			Construction Technology													22	3	25							25
			Architecture							1	1	2													2
			Survey							1		1													1
		Mechanical Engineer	Mechanical Engineer							2		2													2
			Industrial Mechanical Technology													1		1							1
			Automotive Technology													44		44							44
			Automobile							1		1													1

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
75	Phrae Technical College	Mechanical Tools and Maintenance	Mechanical Tools							4		4													4
			Industrial Machine Maintenance							2		2													2
			Metal Tools and Die							2		2													2
		Machine Tools Technology	Mechanical Tools	86		86	74		74	81		81													241
			Metal Tools and Die	13		13	23		23	25	2	27													63
		Construction Technician	Construction	73	10	83	49	4	53	54	4	58	76	16	92	75	15	90							376
		Metal Welding Technician	Structure				14	1	15	21		21													36
		Maintenance Technician	Industrial Maintenance				15		15	31		31													46
		Power Electric Technician	Power Electric	133	4	137	128	3	131	109		109													377
		Automotive Technician	Mechanical Engineer	42	1	43	35		35	11		11													89
			Automobile	121		121	95		95	113		113													329
		Electronics Technician	Electronics	26	6	32	32	4	36	49	5	54													122
		Production Technology	Mechanical Tools										102		102	147		147							249
			Metal Tools and Die										21	1	22	15	2	17							39
		Computer Technology	Computer Technique	49	18	67	42	9	51	39	9	48													166
		Mechanical Technology	Industrial Mechanical Technology										60	1	61	22		22							83
			Automotive Technology										136		136	139		139							275
		Metal Technology	Metal Welding Technology													30	1	31							31
			Metal Welding and Metal Work Technology										24	3	27										27
		Industrial Technology	Production Industry										20		20	26		26							46
		Computer Technology	Computer Software										47	3	50										50
		Tools and Die Technology	Tools and Die Technology																17		17	15		15	32
		Automotive Technology	Automobile Technology																23		23	22		22	45
		Electronics Technology	Electronics Technology																17		17	12		12	29
		Electric	Power Electric										152	4	156	122		122							278
		Power Electric	Electricity Installation													39	1	40							40
		Electric and Electronics	Computer Technique							6		6													6
			Power Electric							3		3													3
			Electronics								1	1													1
		Metallurgy	Metal Welding							2		2													2
		architecture	Architecture	6	9	15	18	11	29	10	12	22													66
		survey	Survey	33	3	36	23	4	27	23	3	26	7	1	8	10		10							107
		Electronics	Computer Technique													13	17	30							30
			Industrial Electronics										71	16	87	70	14	84							171
76	Photharam Technical College	Mechanical Engineer	Automotive Technology													1		1							1
			Automobile							1		1													1
		Metal Welding Technician	Structure	44		44	10		10	11		11													65
		Power Electric Technician	Power Electric	56	1	57	59	1	60	38	1	39													156
		Automotive Technician	Automobile	117		117	105	1	106	104		104													327
		Electronics Technician	Electronics	22	7	29	32	3	35	22	3	25													89
		Mechanical Technology	Automotive Technology										25		25	27		27							52
		Metal Technology	Metal Welding Technology													12		12							12
		Electric	Power Electric										46		46	18		18							64
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Power Electric	18	1	19																			19
		Electronics	Industrial Electronics										17	1	18	28	1	29							47
77	Phuket Technical College	Construction	Construction							1	1	2													2
			Construction Technology													1		1							1
			Construction Control Technology													5		5							5
			Architecture								1	1													1
		shipbuilding	Ship Maintenance							1		1													1
		Mechanical Engineer	Automotive Technology													20		20							20
			Automobile							10	1	11													11
		Mechanical Tools and Maintenance	Mechanical Tools							6		6													6
		Machine Tools Technology	Mechanical Tools	44		44	13	1	14	19	1	20													78
		Construction Technician	Construction	75	4	79	38	9	47	30	6	36	14	2	16	27	6	33							211
		Metal Welding Technician	Structure	17		17	8		8	15		15													40
		shipbuilding Technician	Ship Maintenance	24		24	6		6	10	1	11													41
		Power Electric Technician	Power Electric	85	5	90	39		39	66		66													195
		Automotive Technician	Automobile	138	2	140	62		62	90	1	91													293
		Electronics Technician	Electronics	81	1	82	38	1	39	43	3	46													167
		Production Technology	Mechanical Tools										3		3	8	2	10							13
		Mechanical Technology	Automotive Technology										64	1	65	53	1	54							119
		Metal Technology	Industrial Welding Technology										1		1	11		11							12
			Metal Welding and Metal Work Technology										1		1										1
		Electric	Cooler and Air-condition										13		13	11		11							24
			Power Electric										18		18	27	4	31							49
		Power Electric	Cooler and Air-condition													9		9							9
			Electricity Installation													4		4							4
		Electric and Electronics	Power Electric							12		12													12
			Electronics							3		3													3
		Metallurgy	Metal Welding							7		7													7
		Architecture	Architecture	20	10	30	11	6	17	18	1	19													66
		Electronics	Computer Technique													14		14							14
			Telecommunication System													33		33							33
			Image and Sound System										10		10										10
			Industrial Electronics										13		13										13
		Construction	Construction							1		1													1

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
78	Muaklek Technical College	Mechanical Engineer	Industrial Mechanical Technology													11		11							11
			Automotive Technology													38		38							38
			Automobile							2		2													2
		Mechanical Tools and Maintenance	Industrial Machine Maintenance							3		3													3
		Construction Technician	Construction	15	9	24	5	1	6	5		5													35
		Maintenance Technician	Industrial Maintenance	45	2	47	37		37	25		25													109
		Power Electric Technician	Power Electric	57	6	63	28	1	29	41		41													133
		Automotive Technician	Automobile	96		96	47		47	40		40													183
		Electronics Technician	Electronics	22	11	33	10	6	16	7	8	15													64
		Production Technology	Mechanical Tools										11	1	12	10		10							22
		Mechanical Technology	Industrial Mechanical Technology										5		5										5
			Automobile Body and Color Repairing Technique										9		9										9
			Automotive Technology										13		13	1		1							14
		Electric	Power Electric										27	2	29	33	1	34							63
		Power Electric	Electricity Installation													5		5							5
		Electric and Electronics	Power Electric							2		2													2
			Electronics							2		2													2
		Civil Engineer	Civil Engineer										11	2	13	19	3	22							35
		Electronics	Computer Technique													2		2							2
			Industrial Electronics													11	2	13							13
79	Mahasarakham Technical College	Construction	Construction		1	1				5		5													6
			Construction Technology													6		6							6
			Civil Engineer							4		4													4
		Mechanical Engineer	Mechanical Engineer							7		7													7
			Industrial Mechanical Technology													25		25							25
			Automotive Technology													21		21							21
			Automobile							13		13													13
		Mechanical Tools and Maintenance	Mechanical Tools							32		32													32
			Industrial Machine Maintenance							16	1	17													17
		Machine Tools Technology	Mechanical Tools	89	2	91	92		92	84	1	85													268
		Construction Technician	Construction	36	2	38	36	3	39	31	4	35	24		24	20		20							156
		Metal Welding Technician	Products	29	1	30	18	8	26	28		28													84
		Maintenance Technician	Industrial Maintenance	45	3	48	50	2	52	70	1	71													171
		Power Electric Technician	Power Electric	73	1	74	79	4	83	73	2	75													232
		Automotive Technician	Mechanical Engineer	73		73	70		70	72		72													215
			Automobile	97		97	83		83	116		116													296
		Electronics Technician	Electronics	55	9	64	77	8	85	89	15	104													253
		Production Technology	Mechanical Tools										98		98	103		103							201
			Plastic Tools and Die										81		81	105		105							186
		Computer Technology	Computer Technique	30	15	45	44	23	67	20	4	24													136
		Mechanical Technology	Industrial Mechanical Technology										66		66	67		67							133
			Automotive Technology										83		83	85		85							168
		Energy Technology	Energy Management Technology													4		4							4
		Metal Technology	Metal Welding Technology													6	1	7							7
			Industrial Welding Technology													31	1	32							32
			Metal Welding and Metal Work Technology										35	3	38										38
		Industrial Technology	Installation and Maintenance										92	1	93	134	7	141							234
		Computer Technology	Computer Hardware										35	5	40										40
		Electric Technology	Electric Technology																23	1	24	16		16	40
		Tools and Die Technology	Tools and Die Technology																15		15	22		22	37
		Automotive Technology	Automobile Technology																25		25	8		8	33
		Electronics Technology	Electronics Technology																12		12	22	1	23	35
		Electric	Power Electric										183	8	191	156	3	159							350
		Power Electric	Industrial Measurement Tools													7		7							7
			Electricity Installation													55		55							55
		Electric and Electronics	Computer Technique							7	6	13													13
			Power Electric							19		19													19
			Electronics							16	1	17													17
		Civil	Civil Engineer	22	3	25	22	4	26	21	4	25	48	2	50	44	5	49							175
		Metallurgy	Metal Welding							3		3													3
		survey	Survey							1		1													1
		Electronics	Industrial Electronics										86	8	94	120	9	129							223
80	Mapthaput Technical College	Construction	Fire Prevention													3		3							3
		Mechanical Engineer	Automotive Technology													4		4							4
			Automobile							1		1													1
		Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
			Industrial Machine Maintenance							3		3													3
		Machine Tools Technology	Mechanical Tools	64	3	67	51	1	52	22	1	23													142
		Metal Welding Technician	Structure	23		23	20		20																43
		Maintenance Technician	Industrial Maintenance	50	2	52	28	1	29	38		38													119
		Power Electric Technician	Power Electric	36	3	39	19		19	23		23													81
		Automotive Technician	Automobile	35	2	37	14		14	16		16													67
		Electronics Technician	Electronics	12	11	23	11		11	8	2	10													44
		Production Technology	Mechanical Tools										73		73	59	3	62							135
			Production Technology													3		3							3

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Mechanical Technology	Automotive Technology										21	1	22	9		9							31
		Industrial Technology	Installation and Maintenance										9		9	26		26							35
		Petrochemical	Petrochemical										39		39	38		38							77
		Electric	Electric Control										47	1	48	35	1	36							84
		Power Electric	Electrical Mechanical Tools													5		5							5
		Electric and Electronics	Power Electric							2		2													2
			Electronics							1		1													1
		Electronics	Industrial Electronics													8		8							8
		Construction	Construction							1		1													1
			Construction Technology													2		2							2
		Tools and Die	Tools and Die								2	2	18	31	49	15	20	35							86
		Mechanical Tools and Maintenance	Industrial Machine Maintenance							5		5													5
		Machine Tools Technology	Mechanical Tools	112	3	115	70	2	72	56	1	57													244
		Construction Technician	Construction	59	20	79	37	9	46	36	10	46	23	5	28	25	2	27							226
		Tools and Die Technology	Tools and Die Technology	27	38	65	16	28	44	24	26	50													159
		Power Electric Technician	Power Electric	190	10	200	99	10	109	101	4	105													414
		Electronics Technician	Electronics	136	12	148	74	15	89	55	8	63													300
81	Minburi Technical College	Industrial Technology	Production Industry										38	2	40	32		32							72
		Construction Technology	Construction Technology																18	3	21				21
		Electric Technology	Electric Technology																25		25	17	1	18	43
		Electronics Technology	Electronics Technology																18		18	14	1	15	33
		Electric	Electric Control										168	4	172	88	1	89							261
		Power Electric	Electricity Installation													7		7							7
		Electric and Electronics	Power Electric							4		4													4
			Mechatronics							1		1													1
			Electronics							3		3													3
		Mechatronics	Mechatronics	42	5	47	37	2	39	37	3	40				36	7	43							169
		Mechatronics and Robots	Mechatronics and Robots										32	3	35										35
		Electronics	Computer Technique													4		4							4
			Industrial Electronics										59	10	69	62	10	72							141
		Construction	Construction							3		3													3
		Mechanical Engineer	Automotive Technology													12		12							12
			Automobile							15		15													15
		Construction technician	Construction	14	5	19	8		8	7	3	10		1	1	2	3	5							43
		Power Electric Technician	Power Electric	35	4	39	30	4	34	29		29													102
		Automotive Technician	Automobile	99		99	66		66	54		54													219
82	Maewong Technical College	Electronics Technician	Electronics	16	10	26	11	2	13	29	2	31													70
		Mechanical Technology	Automotive Technology										45		45	13		13							58
		Electric	Power Electric										22	2	24	19	1	20							44
		Power Electric	Electricity Installation													3		3							3
		Electric and Electronics	Power Electric							7		7													7
			Electronics							6		6													6
		Electronics	Computer Technique													1	1	2							2
			Industrial Electronics										4	3	7	5		5							12
		Mechanical Engineer	Automotive Technology													23	1	24							24
			Automobile							41		41													41
		Mechanical Tools and Maintenance	Mechanical Tools							8		8													8
		Machine Tools Technology	Mechanical Tools	37	2	39	30		30	35	2	37													106
		Metal Welding Technician	Products							35		35													35
		Maintenance Technician	Industrial Maintenance				8		8																8
		Power Electric Technician	Power Electric	84	1	85	67		67	81	1	82													234
83	Maesod Technical College	Automotive Technician	Automobile	188	2	190	134		134	157		157													481
		Electronics Technician	Electronics	38		38	32		32	48	5	53													123
		Mechanical Technology	Automotive Technology										64	1	65	36		36							101
		Industrial Technology	Installation and Maintenance										5		5	22		22							27
		Electric	Power Electric										58	1	59	42		42							101
		Power Electric	Electricity Installation													35		35							35
		Electric and Electronics	Power Electric							19		19													19
			Electronics							18	2	20													20
		Metallurgy	Metal Welding							35		35													35
		Construction	Construction							4		4													4
			Civil Engineer							10		10													10
			Architecture							8	2	10													10
		Mechanical Engineer	Mechanical Engineer							8		8													8
			Industrial Mechanical Technology													11		11							11
			Automotive Technology													24		24							24
			Automobile							35		35													35
		Mechanical Tools and Maintenance	Mechanical Tools							23	1	24													24
		Machine Tools Technology	Mechanical Tools	97		97	84		84	66	1	67													248
		Construction Technician	Construction	20	1	21	10		10	11		11	6		6	8		8							56
		Metal Welding Technician	Structure	18		18	9		9	17		17													44
		Power Electric Technician	Power Electric	96	3	99	102	1	103	91	2	93													295
		Automotive Technician	Mechanical Engineer				23		23	17		17													40
			Automobile	188	1	189	176	2	178	151		151													518
		Electronics Technician	Electronics	61	10	71	51	3	54	49	1	50													175
		Production Technology	Mechanical Tools										60	1	61	70	1	71							132
			Metal Tools and Die										17		17	32		32							49
84	Yasothorn Technical College	Computer Technology	Computer Technique	45	14	59	27	6	33	41	5	46													138

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Mechanical Technology	Industrial Mechanical Technology										45		45	33		33							78
			Automotive Technology										107		107	94		94							201
		Metal Technology	Metal Welding Technology													7		7							7
			Metal Welding and Metal Work Technology										4		4										4
		Architecture Technology	Architecture Technology										2	1	3	9	3	12							15
		Computer Technology	Computer Hardware										19	1	20										20
		Electric Technology	Electric Technology																7		7	34		34	41
		Automotive Technology	Automobile Technology																7		7	5		5	12
		Electric	Electric Control										138	6	144	91	2	93							237
		Power Electric	Electricity Installation													25		25							25
		Electric and Electronics	Computer Technique							34	2	36													36
			Power Electric							18		18													18
			Electronics							24	1	25													25
		Civil Engineer	Civil Engineer	21	7	28	30	3	33	26	3	29	33	5	38	48	3	51							179
		Metallurgy	Metal Welding							3		3													3
		Architecture	Architecture	9	4	13	9	8	17	9	6	15													45
		Electronics	Industrial Electronics										43	5	48	76	4	80							128
		Mechanical Engineer	Automotive Technology													17		17							17
			Automobile							2		2													2
		Mechanical Tools and Maintenance	Mechanical Tools							2		2													2
		Machine Tools Technology	Mechanical Tools	18	1	19	12		12	8		8													39
		Construction Technician	Construction	40	3	43	25	3	28	21		21													92
		Metal Welding Technician	Products	17		17	9		9	10		10													36
		Power Electric Technician	Power Electric	78	2	80	61	3	64	52	1	53													197
		Automotive Technology	Automobile	115		115	113		113	96		96													324
		Electronics Technology	Electronics	49	4	53	33		33	17	1	18													104
		Production Technology	Mechanical Tools										24		24	16		16							40
		Mechanical Technology	Automotive Technology										106		106	124		124							230
		Metal Technology	Industrial Welding Technology													4		4							4
85	Yala Technical College		Metal Welding and Metal Work Technology										21		21	7		7							28
		Architecture Technology	Architecture Technology										27	6	33	30	9	39							72
		Telecommunication Technology	Telecommunication System Technology										28	2	30	25	3	28							58
		Rubber and Polymer Technology	Rubber and Polymer Technology										3	5	8		3	3							11
		Automotive Technology	Automobile Technology																28		28	14		14	42
		Electric	Power Electric										61	1	62	54	1	55							117
			Electric Control										19	3	22	34	1	35							57
		Power Electric	Electrical Mechanical Tools													2		2							2
			Electricity Installation													14		14							14
		Electric and Electronics	Power Electric							3		3													3
			Electronics							4		4													4
		Civil Engineer	Civil Engineer										68	4	72	63	2	65							137
		Architecture	Architecture	19	10	29	8	2	10	7	6	13													52
		Electronics	Computer Technique													7		7							7
			Telecommunication System													1		1							1
		Rubber Industry	Rubber Industry	1	3	4	1	4	5	1	3	4													13
		Construction	Construction							1		1													1
			Architecture							3		3													3
		Mechanical Engineer	Automobile Body and Color							1		1													1
			Automotive Technology										1		1	10		10							11
			Automobile							2		2													2
		Mechanical Tools and Maintenance	Mechanical Tools	1		1				5		5													6
			Metal Tools and Die							5		5													5
		Machine Tools Technology	Mechanical Tools	142		142	134	1	135	131		131													408
			Auto-part Production	31		31	23		23	21		21													75
			Metal Tools and Die	34	3	37	25		25	22	1	23													85
		Construction Technician	Construction	79	31	110	84	15	99	52	13	65													274
		Metal Welding Technician	Structure	20		20	37		37	24		24													81
		Maintenance Technician	Industrial Maintenance	64	3	67	66	4	70	59		59													196
		Power Electric Technician	Power Electric	169	7	176	145	5	150	119	4	123													449
		Automotive Technician	Automobile Body and Color	23		23	30		30	31		31													84
			Automobile	180		180	159	2	161	149		149													490
		Electronics Technician	Electronics	127	33	160	132	18	150	104	18	122													432
		Production Technology	Mechanical Tools										150	2	152	151	1	152							304
			Metal Tools and Die										30	1	31	16		16							47
86	Roi-et Technical College	Mechanical Technology	Automobile Body and Color Repairing Technique										10		10										10
			Automotive Technology										140	1	141	108		108							249
		Metal Technology	Metal Welding Technology													38		38							38
			Metal Welding and Metal Work Technology										20		20										20
		Architecture Technology	Architecture Technology										23	15	38	13	6	19							57
		Industrial Technology	Installation and Maintenance										70	4	74	78		78							152
		Electric Technology	Electric Technology																16		16	13	1	14	30
		Tools and Die Technology	Tools and Die Technology																12		12				12
		Electronics Technology	Electronics Technology																13	1	14	10	1	11	25
		Electric	Electric Control										167	3	170	119	5	124							294
		Power Electric	Electrical Mechanical Tools													9		9							9

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
			Cooler and Air-condition													1		1							1
		Electric and Electronics	Power Electric	1		1				3		3													4
			Electronics							3		3													3
		Civil	Civil Engineer										103	24	127	106	21	127							254
		Metallurgy	Metal Welding							1		1													1
		Architecture	Architecture	13	26	39	20	34	54	40	31	71													164
		Electronics	Computer Technique										69	17	86	53	16	69							155
			Telecommunication System										31	1	32	48	4	52							84
		Construction	Construction				1		1																1
			Construction Technology													11		11							11
		Mechanical Engineer	Automotive Technology													16		16							16
			Automobile				1		1	3		3													4
		Mechanical Tools and Maintenance	Mechanical Tools	5		5	1		1																6
		Machine Tools Technology	Mechanical Tools	11	1	12	7		7	19		19													38
		Construction Technician	Construction	40	1	41	27	7	34	24		24	21	3	24										123
		Metal Welding Technician	Products	19		19																			19
87	Ranong Technical College	Power Electric Technician	Power Electric	38		38	32	1	33	42		42													113
		Automotive Technician	Automobile	88	1	89	56		56	25		25													170
		Electronics Technician	Electronics	24	2	26	32	4	36	28	3	31													93
		Mechanical Technology	Automotive Technology										49	2	51										51
		Electric	Power Electric										2		2	11		11							13
		Power Electric	Electricity Installation													6		6							6
		Electric and Electronics	Power Electric					2	2	1		1													3
		Architecture	Architecture	6	8	14	7	6	13	7	2	9													36
		Electronics	Computer Technique													5		5							5
			Industrial Electronics										12	2	14	14	2	16							30
		Construction	Construction							6	2	8													8
			Construction Technology													20	7	27							27
		Industrial chemical	Industrial chemical													12	68	80							80
		Mechanical Engineer	Automotive Technology													31		31							31
			Automobile							29		29													29
		Mechanical Tools and Maintenance	Mechanical Tools							11	1	12													12
		Measurement and Control Tools	Measurement and Control Tools										31	4	35	36	6	42							77
		Machine Tools Technology	Mechanical Tools	138	5	143	111	2	113	116	4	120													376
		Construction Technician	Construction	63	36	99	37	8	45	38	18	56	60	18	78	35	13	48							326
		Metal Welding Technician	Structure	122		122	57		57	76		76													255
		Power Electric Technician	Power Electric	152	29	181	88	15	103	123	13	136													420
		Automotive Technician	Automobile	176	3	179	123	1	124	95		95													398
		Electronics Technician	Electronics	118	40	158	102	26	128	107	24	131													417
88	Rayong Technical College	Production Technology	Mechanical Tools										99	1	100	87	3	90							190
		Mechanical Technology	Automotive Technology										54		54	66		66							120
		Metal Technology	Industrial Welding Technology													20		20							20
			Metal Technology													55	2	57							57
			Metal Welding and Metal Work Technology										92		92										92
		Electric Technology	Electric Technology																			21		21	21
		Rubber Technology	Rubber Technology										25	25	50	25	24	49							99
		automotive Technology	Automobile Technology																21	2	23				23
		petrochemical	petrochemical										67	31	98	63	30	93							191
		Electric	Power Electric										84	9	93	85	3	88							181
		Power Electric	Electricity Installation													9		9							9
		Electric and Electronics	Power Electric							11	1	12													12
			Electronics							16	4	20													20
		Metallurgy	Metal Welding							16		16													16
		Electronics	Industrial Electronics										39	9	48	44	12	56							104
		Construction	Construction							7		7													7
			Construction Technology													6	3	9							9
			Architecture								1	1													1
		Machine Tools Design	Machine Tools Design										7	3	10										10
			Production Design													18	5	23							23
		Mechanical Engineer	Automotive Technology													8		8							8
			Automobile							3		3													3
		mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		machine Tools Technology	Mechanical Tools	112	4	116	81	5	86	50		50													252
		Construction Technician	Construction	57	21	78	14	13	27	51	10	61	28	8	36	26	3	29							231
		Machine Tools Design	Machine Tools Design	8	8	16	12	4	16	6	3	9													41
		Metal Welding Technician	Structure	21		21	15	1	16	21		21													58
		Power Electric Technician	Power Electric	204	34	238	104	17	121	71	3	74													433
		Automotive Technician	Automobile	213	6	219	147	3	150	118	1	119													488
		Electronics Technician	Electronics	96	24	120	71	16	87	61	9	70													277
		Production Technology	Mechanical Tools										57	3	60	45		45							105
			Plastic Tools and Die										17	2	19	24	1	25							44
			Metal Tools and Die										12		12	19		19							31
89	Ratchaburi Technical College	Mechanical Technology	Automotive Technology										138		138	98		98							236
		Metal Technology	Metal Welding inspection										19		19										19
			Metal Welding Technology										1		1	45		45							46
			Metal Welding and Metal Work Technology										13		13										13
		Architecture Technology	Architecture Technology										9	15	24	18	12	30							54

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Industrial Technology	Installation and Maintenance										21		21	24	1	25							46
		Computer Technology	Computer Hardware										14	2	16										16
		Telecommunication Technology	Telecommunication System Technology										17		17										17
		Electric	Power Electric										136	12	148	73	4	77							225
			Electric Control										39		39	33	2	35							74
		Power Electric	Electrical Mechanical Tools													2		2							2
			Electricity Installation													14		14							14
		Electric and Electronics	Power Electric							1		1													1
			Electronics							1		1													1
		Metallurgy	Metal Welding							1		1													1
		Architecture	Architecture	21	22	43	10	17	27	6	11	17													87
		Electronics	Computer Technique													3	2	5							5
			Telecommunication System													1		1							1
			Image and Sound System													38	8	46							46
			Industrial Electronics										33	2	35	51	9	60							95
		Mechanical Engineer	Automotive Technology													73		73							73
			Automobile				2		2	23		23													25
		Mechanical Tools and Maintenance	Mechanical Tools							5	1	6													6
		Metal Welding Technician	Bus/Coach Building Industry				1		1																1
		Power Electric Technician	Power Electric	48	5	53	41	4	45	25		25													123
		Automotive Technician	Automobile	105	2	107	44		44	33	1	34													185
90	the second Ratchaburi Technical College	Electronics Technician	Electronics	18	13	31	18	4	22	8		8													61
		Mechanical Technology	Automotive Technology										66		66										66
		Electric	Power Electric										64	2	66										66
		Power Electric	Electricity Installation													45	5	50							50
		Electric and Electronics	Power Electric							1		1													1
			Electronics							2	1	3													3
		Metallurgy	Bus/Coach Building Industry							1		1													1
		Electronics	Industrial Electronics										3	2	5	11	3	14							19
		Mechanical Engineer	Automotive Technology													16		16							16
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools								1	1													1
		Machine Tools Technology	Mechanical Tools	16	4	20	15	1	16	7		7													43
		Construction Technician	Construction	41	6	47	14	2	16	17		17	27	1	28	32	1	33							141
		Metal Welding Technician	Products	9	1	10	4		4	6		6													20
		Power Electric Technician	Power Electric	25	2	27	14	2	16	18	2	20													63
		Automotive Technician	Automobile	62	1	63	51	4	55	27	3	30													148
91	Ratchasittharam Technical College	Electronics Technician	Electronics	11	4	15	7	3	10	8	2	10													35
		Mechanical Technology	Automotive Technology										7		7	21		21							28
		Architecture Technology	Architecture Technology										47	5	52	94	18	112							164
		Industrial Technology	Production Industry													27	4	31							31
		Architecture Technology	Architecture Technology																17	6	23	26	7	33	56
		Electric	Power Electric										39	1	40	19	1	20							60
		Electric and Electronics	Power Electric							1		1													1
		Mechatronics	Mechatronics				7	1	8	5		5													13
		Metallurgy	Metal Welding							1		1													1
		Architecture	Architecture	16	11	27	18	5	23	4	8	12													62
		Electronics	Industrial Electronics										3		3	4		4							7
		Construction	Construction							8		8													8
			Construction Technology													8	2	10							10
		Mechanical Engineer	Automotive Technology													48		48							48
			Automobile							11		11													11
		Mechanical Tools and Maintenance	Mechanical Tools							8		8													8
		machine Tools Technology	Mechanical Tools	192	1	193	99	1	100	114	1	115													408
		Construction Technician	Construction	88	26	114	44	20	64	58	13	71	66	24	90	32	15	47							386
		Metal Welding Technician	Products	108	1	109	46		46	38		38													193
		Power Electric Technician	Power Electric	172	28	200	117	22	139	119	14	133													472
		Automotive Technician	Automobile	195	2	197	131	1	132	141	1	142													471
		Electronics Technician	Electronics	87	36	123	75	28	103	76	29	105													331
		Production Technology	Mechanical Tools										131		131	72		72							203
			Plastic Tools and Die													13		13							13
			Metal Tools and Die										15	1	16	14		14							30
92	Lopburi Technical College	Computer Technology	Computer Technique	22	8	30																			30
		Mechanical Technology	Automotive Technology										165	2	167	132	1	133							300
		Metal Technology	Metal Welding Technology													30		30							30
			Metal Welding and Metal Work Technology										10		10										10
		Industrial Technology	Installation and Maintenance										151	2	153	148	2	150							303
		Construction Technology	Construction Technology																8		8	17	3	20	28
		Computer Technology	Computer Software										16	21	37	21	25	46							83
		Electric Technology	Electric Technology																17	1	18				18
		Automotive Technology	Automobile Technology																19		19				19
		Electric	Electric Control										179	20	199	173	22	195							394
		Power Electric	Electrical Mechanical Tools													39	2	41							41

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electric and Electronics	Power Electric							7	1	8													8
		Metallurgy	Metal Welding							5		5													5
		Architecture	Architecture	12	29	41	9	24	33	3	13	16													90
		Electronics	Industrial Electronics										89	21	110	91	15	106							216
93	The second Lopburi Technical College	Construction	Construction							1		1													1
			Construction Technology													5		5							5
		Mechanical Engineer	Automotive Technology													1		1							1
		Construction Technician	Construction	6	1	7	6	2	8	3		3	21	3	24	27	5	32							74
		Power Electric Technician	Power Electric	16	1	17	19		19	14	1	15													51
		Automotive Technician	Automobile	25	1	26	13		13	4		4													43
		Electronics Technician	Electronics	2	1	3	2	1	3	2		2													8
		Mechanical Technology	Automotive Technology										9	1	10	13		13							23
		Electric	Power Electric										56	1	57	27		27							84
		Power Electric	Electrical Mechanical Tools													6	1	7							7
94	Lampang Technical College	Construction	Construction							20	1	21													21
			Construction Technology													29	4	33							33
		Mechanical Engineer	Automotive Technology													33		33							33
			Automobile							29		29													29
		Mechanical Tools and Maintenance	Mechanical Tools							16		16													16
		Machine Tools Technology	Mechanical Tools	187	7	194	160	2	162	173		173													529
		Construction Technician	Construction	63	33	96	57	25	82	124	15	139	117	31	148	73	13	86							551
		Metal Welding Technician	Structure	97		97	77		77	76		76													250
		Power Electric Technician	Power Electric	206	38	244	186	30	216	192	8	200													660
		Automotive Technician	Automobile	242	1	243	161		161	190		190													594
		electronics Technician	Electronics	150	22	172	114	20	134	144	24	168													474
		Production Technology	Mechanical Tools										159	1	160	147		147							307
		Mechanical Technology	Automotive Technology										265	2	267	275	1	276							543
		Metal Technology	Metal Welding inspection										128		128										128
			Metal Welding Technology													112	2	114							114
		Construction Technology	Construction Technology																			25	3	28	28
		Computer Technology	Computer Hardware										80	25	105										105
		Electric Technology	Electric Technology																			15	1	16	16
		Electric	Power Electric										134	21	155	121	13	134							289
			Electric Control										93	5	98	94	3	97							195
		Power Electric	Electrical Mechanical Tools													4		4							4
			Electricity Installation													16		16							16
		Electric and Electronics	Power Electric							4		4													4
			Mechatronics							4		4													4
			Electronics							20	1	21													21
		Mechatronics	Mechatronics	37	7	44	28	9	37	29	4	33				89	14	103							217
		Mechatronics and Robots	Mechatronics and Robots										70	13	83										83
		Civil	Civil Engineer	64	35	99	44	13	57				70	26	96	74	16	90							342
		Metallurgy	Metal Welding							34		34													34
		Electronics	Computer Technique													39	1	40							40
			Telecommunication System													40	3	43							43
			Industrial Electronics										70	15	85	37	9	46							131
95	Lampoon Technical College	Construction	Construction							1		1													1
		Mechanical Engineer	Automotive Technology													2		2							2
		Machine Tools Technology	Mechanical Tools	93	1	94	58	1	59	89	2	91													244
		Construction Technician	Construction	36	7	43	28	1	29	26	3	29	18	2	20	33	2	35							156
		Metal Welding Technician	Products							20		20													20
		Power Electric Technician	Power Electric	78	5	83	88	4	92	89	4	93													268
		Automotive Technician	Automobile	133		133	72		72	88		88													293
		Electronics Technician	Electronics	50	7	57	43	2	45	54	6	60													162
		Production Technology	Mechanical Tools										37		37	62		62							99
		Computer Technology	Computer Technique	26	1	27	16	1	17																44
		Mechanical Technology	Automotive Technology										89		89	65		65							154
		Metal Technology	Industrial Welding Technology													5		5							5
			Metal Welding and Metal Work Technology										17		17										17
		Industrial Technology	Production Industry										64	7	71	19		19							90
		Telecommunication Technology	Telephone System										16		16	40		40							56
		Electrics Technology	Electric Technology																21	1	22				22
		Electronics Technology	Electronics Technology																14		14	18	1	19	33
		Electric	Cooler and Air-condition										74	11	85	53	1	54							139
			Maintenance and Sale System of Electric Equipment										8		8										8
			Power Electric										30	1	31	36	5	41							72
			Electric Control										10	2	12	35	1	36							48
		Power Electric	Electrical Mechanical Tools										1		1	14		14							15
			Electricity Installation													5		5							5
		Electric and Electronics	Power Electric							2		2													2
		Metallurgy	Metal Welding							1		1													1

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Industrial Electronics										25	2	27	40	6	46							73
96	Loei Technical College	Construction	Construction							39	2	41													41
			Construction Technology											1	1	33	4	37							38
			Civil Engineer							35	8	43													43
			Architecture							4	11	15													15
		Mechanical Engineer	Automotive Technology										1		1	97	1	98							99
			Automobile							64		64													64
		Mechanical Tools and Maintenance	Mechanical Tools							44	2	46													46
		Machine Tools Technology	Mechanical Tools	157	2	159	122	1	123	150		150													432
		Construction Technician	Construction	24	4	28	20	2	22	25	1	26	19	3	22	13	4	17							115
		Metal Welding Technician	Products	20		20	23		23	21		21													64
		Power Electric Technician	Power Electric	151	7	158	114	1	115	101		101													374
		Automotive Technician	Automobile	155		155	117	1	118	176		176													449
		Electronics Technician	Electronics	32	5	37	34	7	41	46	8	54													132
		Production Technology	Mechanical Tools										121	2	123	193	2	195							318
		Computer Technology	Computer Technique	27	6	33	25	3	28																61
		Mechanical Technology	Automotive Technology										129		129	123		123							252
		Metal Technology	Industrial Welding Technology													36		36							36
			Metal Welding and Metal Work Technology										29	2	31										31
		Construction Technology	Construction Technology																6		6	26	2	28	34
		Computer Technology	Computer Hardware										31	9	40										40
		Electric Technology	Electric Technology																6	1	7	18		18	25
		Automotive Technology	Automobile Technology																20	1	21				21
		Electric	Power Electric										79	1	80	73	4	77							157
			Electric Control										66	2	68	55	1	56							124
		Power Electric	Electrical Mechanical Tools													62		62							62
			Electricity Installation													74		74							74
		Electric and Electronics	Computer Technique				3		3	57	17	74													77
			Telecommunication							10	4	14													14
			Power Electric							56	3	59													59
			Electronics							23	2	25													25
		Civil	Civil Engineer	41	25	66	28	17	45	34	14	48	11	2	13	16	3	19							191
		Metallurgy	Metal Welding							26		26													26
		Architecture	Architecture	13	12	25	6	15	21	8	8	16													62
		Electronics	Computer Technique													99	16	115							115
			Telecommunication System													1		1							1
			Industrial Electronics										17	1	18	24	1	25							43
97	Wapi Pathum Technical College	Mechanical Engineer	Automotive Technology													15		15							15
			Automobile							11		11													11
		Machine Tools Technology	Mechanical Tools	77		77	12		12																89
		Metal Welding Technician	Structure	14		14	18		18																32
			Products	9		9				12		12													21
		Power Electric Technician	Power Electric	83	3	86	36		36	17		17													139
		Automotive Technician	Automobile	170		170	72		72	32		32													274
		Electronics Technician	Electronics	54	17	71	30	8	38	7		7													116
		Production Technology	Mechanical Tools										57	1	58										58
		Mechanical Technology	Automotive Technology										64		64	2		2							66
		Metal Technology	Metal Welding inspection										12		12										12
		Electric	Power Electric										73	4	77										77
		Power Electric	Electrical Mechanical Tools													4		4							4
			Electricity Installation													12	1	13							13
		Electric and Electronics	Power Electric							4		4													4
			Electronics							3		3													3
		Metallurgy	Metal Welding							1		1													1
		Electronics	Industrial Electronics										45	19	64	9	4	13							77
98	Wiang Pa Pao Technical College	Mechanical Engineer	Automotive Technology													3		3							3
			Automobile							4		4													4
		Power Electric Technician	Power Electric	76	1	77	27	1	28	24		24													129
		Automotive Technician	Automobile	47		47	85	1	86	66		66													199
		Electronics Technician	Electronics	37	6	43	20	3	23	14		14													80
		Mechanical Technology	Automotive Technology										22		22	23		23							45
		Industry Technology	Industrial Technology										1		1	7		7							8
		Electric	Power Electric										9	2	11	17	2	19							30
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Power Electric							6		6													6
			Electronics							1		1													1
		Construction	Construction							32		32													32
		Mechanical Engineer	Automobile							56		56													56
		mechanical Tools and Maintenance	Mechanical Tools							24	1	25													25
		machine Tools Technology	Mechanical Tools	46	1	47	68		68	64	1	65													180
			Metal Tools and Die	44		44																			44
		Construction Technician	Construction	59	8	67	49	3	52	55	6	61	51	4	55	52	3	55							290
		Metal Welding Technician	Structure	32	1	33																			33
			Products				41	1	42	32		32													74
		Power Electric Technician	Power Electric	99	5	104	112	2	114	108	1	109													327
		Automotive Technician	Automobile	186		186	137	3	140	161		161													487
		Electronics Technician	Electronics	95	12	107	82	9	91	68	3	71													269

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
99	Srisaket Technical College	Production Technology	Mechanical Tools										139	1	140	172	3	175							315
			Metal Tools and Die										29		29										29
		Computer Technology	Computer Technique	18	3	21																			21
		Mechanical Technology	Automotive Technology										182		182	167	1	168							350
		Metal Technology	Metal Welding inspection													32		32							32
			Metal Welding and Metal Work Technology										28		28										28
		Architecture Technology	Architecture Technology										23	14	37	20	12	32							69
		Computer Technology	Computer Multimedia										12	7	19										19
		Electric Technology	Electric Technology																			7		7	7
		Rubber Technology	Rubber Technology										13	6	19	17	7	24							43
		Electronics Technology	Electronics Technology																			7		7	7
		Electric	Power Electric										102	2	104										104
			Electric Control										65	3	68	203	5	208							276
		Electric and Electronics	Power Electric							63	2	65													65
		Civil	Civil Engineer	67	21	88	49	8	57	30	4	34	91	22	113	151	13	164							456
		Metallurgy	Metal Welding							3		3													3
		Architecture	Architecture	31	31	62	22	24	46	12	14	26													134
		Electronics	Industrial Electronics										86	10	96	82	6	88							184
100	Sakonnakorn Technical College	Construction	Construction							19	1	20													20
			Construction Technology													5	1	6							6
			Civil Engineer							23	5	28													28
		Mechanical Engineer	Automotive Technology										7		7	34		34							41
			Automobile				1		1	44		44													45
		Mechanical Tools and Maintenance	Mechanical Tools	1		1				18		18													19
		Machine Tools Technology	Mechanical Tools	265	2	267	70		70	40		40													377
		Construction Technician	Construction	39	4	43	22	4	26	10		10	43	6	49										128
		Metal Welding Technician	Structure				21		21																21
			Products	69		69				5		5													74
		Power Electric Technician	Power Electric	281	13	294	93	1	94	11	2	13													401
		Automotive Technician	Automobile	328	1	329	104		104	24		24													457
		Electronics Technician	Electronics	144	29	173	75	10	85	14		14													272
		Production Technology	Mechanical Tools										159	6	165	31	1	32							197
			Metal Tools and Die										14		14										14
		Mechanical Technology	Automotive Technology										280		280										280
		Metal Technology	Metal Welding inspection										27		27										27
		Industrial Technology	Installation and Maintenance										108	10	118	13		13							131
		Construction Technology	Construction Technology																			10		10	10
		Electric Technology	Electric Technology																7		7	12		12	19
		Electric	Power Electric										274	8	282	1		1							283
		Power Electric	Cooler and Air-condition													1		1							1
			Electricity Installation										1		1	65	1	66							67
		Electric and Electronics	Power Electric				1		1	43		43													44
			Electronics							33	6	39													39
		Civil Engineer	Civil Engineer	142	73	215	49	11	60	8	4	12	209	47	256	37	2	39							582
		Metallurgy	Metal Welding							11		11													11
		Electronics	Industrial Electronics										186	18	204	30	4	34							238
101	Satul Technical College	Construction	Construction							6		6													6
			Construction Technology													1		1							1
		Mechanical Engineer	Mechanical Engineer							11		11													11
			Shipbuilding Mechanical Technique(commerce)													7		7							7
			Automotive Technology													18		18							18
			Automobile							7		7													7
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	21		21	2		2	5		5													28
		Construction Technician	Construction	21	1	22	9	1	10	9	1	10	6	1	7										49
		Metal Welding Technician	Structure	8		8	2		2	3		3													13
		Power Electric Technician	Power Electric	45		45	24		24	29		29													98
		Automotive Technician	Mechanical Engineer	46		46	36		36	23		23													105
			Automobile	81		81	49		49	59		59													189
		Electronics Technician	Electronics	39	6	45	16	5	21	18	3	21													87
		Mechanical Technology	Shipbuilding Mechanical Technique										38		38										38
			Shipbuilding Mechanical Technique													10		10							10
			Automotive Technology										24		24	14		14							38
		Computer Technology	Computer Software										7	1	8										8
		Telecommunication Technology	Telecommunication System Technology										4	1	5										5
		Electric	Power Electric										32		32	38		38							70
		Power Electric	Electricity Installation													13		13							13
		Electric and Electronics	Power Electric							4		4													4
			Electronics							5		5													5
		Metallurgy	Metal Welding							5		5													5
		Electronics	Telecommunication System													2		2							2
		Construction	Construction Control Technology													1		1							1
		Machine Tools Design	Machine Tools Design										9	7	16										16
			Production Design													2	2	4							4
		Mechanical Engineer	Automotive Technology													80	3	83							83
			Automobile							8		8													8
		Mechanical Tools and Maintenance	Mechanical Tools							4		4													4
			Tannery Industry							1		1													1
		Machine Tools Technology	Mechanical Tools	114	5	119	69	4	73	84	6	90													282
			Plastic Tools and Die	36	19	55	16	1	17	11	1	12													84
			Metal Tools and Die	51	1	52	3		3	18	1	19													74

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
102	Samutprakarn Technical College	Construction Technician	Construction	72	9	81	16	6	22	15	8	23	17	2	19	7	1	8							153
		Machine Tools Design	Machine Tools Design	23	17	40	8	9	17	14	8	22													79
		Metal Welding Technician	Structure	38		38	12		12	16		16													66
		Maintenance Technician	Industrial Maintenance	63		63	21		21	16		16													100
		Power Electric Technician	Power Electric	125	7	132	80	8	88	86	13	99													319
		Automotive Technician	Automobile	244	9	253	89	3	92	116	2	118													463
		Aircraft Technician	Aircraft Technician										13	5	18										18
		Electronics Technician	Electronics	94	24	118	38	16	54	37	6	43													215
		Production Technology	Mechanical Tools										19	1	20	76	4	80							100
			Plastic Tools and Die										23	2	25	13	1	14							39
			Metal Tools and Die										8	1	9	14		14							23
		Mechanical Technology	Rail Mechanical Technology										18		18										18
			Automotive Technology										110	7	117	85	6	91							208
		Metal Technology	Metal Welding Technology													23		23							23
			Metal Welding and Metal Work Technology										10		10										10
		Industry Technology	Production Industry										26		26	36	2	38							64
		Automotive Technology	Automobile Technology																24		24				24
		Electric	Power Electric										45	7	52	49	4	53							105
		Power Electric	Electrical Mechanical Tools													2		2							2
			Electricity Installation													30	1	31							31
		Electric and Electronics	Power Electric							3		3													3
			Electronics							6		6													6
		Electronics	Computer Technique													2		2							2
			Industrial Electronics										38	5	43	41	1	42							85
		Tannery Industry	Tannery Industry	4	6	10	4	3	7	1	9	10													27
103	Samutsongkram Technical College	Construction	Construction Technology													2		2							2
		machinery Design	Machine Tools Design										19	15	34										34
			Production Design													24	11	35							35
		Mechanical Engineer	Automotive Technology													2		2							2
			Automobile							4		4													4
		Machine Tools Technology	Mechanical Tools	22		22	26		26	17		17													65
			Auto-part Production	19	1	20	9		9	5		5													34
			Plastic Tools and Die	16	4	20	15	1	16	20		20													56
			Metal Tools and Die	20		20	17		17	14		14													51
		Construction Technician	Construction	32	8	40	13	10	23	20	4	24	12		12	14	1	15							114
		Machine Tools Design	Machine Tools Design	13	24	37	7	5	12	17	12	29													78
		Metal Welding Technician	Structure	28	1	29	8		8	15		15													52
		Power Electric Technician	Power Electric	74	10	84	45	4	49	60	2	62													195
		Automotive Technician	Automobile	95	6	101	76		76	67	1	68													245
		Electronics Technician	Electronics	33	4	37	30	1	31	29	6	35													103
		Production Technology	Mechanical Tools										30	7	37	32	10	42							79
			Metal Tools and Die													2		2							2
		Computer Technology	Computer Technique	22	7	29	11	1	12																41
		Mechanical Technology	Automotive Technology										36	1	37	36		36							73
		Computer Technology	Computer Hardware										8	1	9	13	1	14							23
		Tools and Die Technology	Tools and Die Technology																17		17	33		33	50
		Electric	Industrial Measurement Tools										35	2	37	31		31							68
		Electric and Electronics	Power Electric							1		1													1
		Electronics	Industrial Electronics										10	2	12	18	1	19							31
104	Samutsakorn Technical College	Construction	Construction							1		1													1
			Construction Technology													3		3							3
		Mechanical Engineer	Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							4		4													4
		Machine Tools Technology	Mechanical Tools	158	2	160	100	3	103	120		120													383
		Construction Technician	Construction	75	12	87	32	5	37	79	6	85	8		8	23	4	27							244
		Metal Welding Technician	Structure	126	3	129	52	1	53	43		43													225
		Power Electric Technician	Power Electric	95	2	97	82	4	86	80		80													263
		Automotive Technician	Mechanical Engineer				11	1	12	12		12													24
			Automobile	161	6	167	125	4	129	146		146													442
		Electronics Technician	Electronics	78	7	85	50	10	60	50	14	64													209
		Production Technology	Mechanical Tools										50		50	57		57							107
		Computer Technology	Computer Technique	36	5	41	30	1	31																72
		Mechanical Technology	Industrial Mechanical Technology										20		20	21		21							41
			Automotive Technology										23		23	11	1	12							35
		Metal Technology	Metal Welding Technology													29		29							29
			Metal Welding and Metal Work Technology										14		14										14
		Architecture Technology	Architecture Technology													4	1	5							5
		Computer Technology	Computer Network										14	5	19										19
		Telecommunication Technology	Telecommunication System Technology										16	1	17										17
		Telecommunication	Telecommunication							4		4													4
		Electric	Cooler and Air-condition													18		18							18
			Power Electric										29		29	11		11							40
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Computer Technique							2		2													2
			Electronics							3		3													3
		Architecture	Architecture	17	17	34	5	10	15	6	3	9													58

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Computer Technique													23	3	26							26
			Telecommunication System													33	4	37							37
105	Srakaew Technical College	Construction	Construction	1	2	3				1		1													4
			Construction Technology													1		1							1
		Mechanical Engineer	Industrial Mechanical Technology													9		9							9
			Automotive Technology													1		1							1
			Automobile	1		1				4		4													5
		Construction Technician	Construction	51	12	63	38	6	44	30	1	31	32	5	37	17	2	19							194
		Metal Welding Technician	Structure				22		22	29		29													51
			Products	49		49																			49
		Power Electric Technician	Power Electric	156	17	173	136	9	145	107	2	109													427
		Automotive Technician	Automobile	130	1	131	128	3	131	137		137													399
		Electronics Technician	Electronics	84	21	105	57	16	73	78	8	86													264
		Computer Technology	Computer Technique	15	9	24	13	3	16																40
		Mechanical Technology	Industrial Mechanical Technology										14		14										14
			Automotive Technology										108		108	71		71							179
		Metal Technology	Metal Welding inspection										16		16	5		5							21
			Metal Welding Technology													1		1							1
		Electric	Power Electric										200	2	202	100	7	107							309
		Power Electric	Electricity Installation													5		5							5
		Electric and Electronics	Power Electric							4		4													4
		Electronics	Industrial Electronics										54	8	62	40	5	45							107
106	Saraburi Technical College	Construction	Construction	1		1				2		2													3
			Construction Technology													7		7							7
		Mechanical Engineer	Automobile Body and Color							2		2													2
			Automotive Technology													5		5							5
			Automobile							11		11													11
		Mechanical Tools and Maintenance	Mechanical Tools							2		2													2
			Industrial Machine Maintenance							1		1													1
		Machine Tools Technology	Mechanical Tools	148	13	161	105	5	110	94	3	97													368
		Construction Technology	Construction	89	26	115	31	16	47	43	9	52	74	18	92	24	15	39							345
		Metal Welding Technician	Structure	97	1	98	72	1	73	80		80													251
		Maintenance Technician	Industrial Maintenance	86	5	91	34	1	35	30		30													156
		Power Electric Technician	Power Electric	141	18	159	142	11	153	124	6	130													442
		Automotive Technician	Automobile	154	1	155	102	1	103	134		134													392
		Electronics Technician	Electronics	97	45	142	73	24	97	75	12	87													326
		Production Technology	Mechanical Tools										94	2	96	77	1	78							174
		Mechanical Technology	Industrial Mechanical Technology										20		20										20
			Automotive Technology										48		48	63		63							111
		Metal Technology	Metal Welding inspection										41		41										41
			Metal Welding Technology													41		41							41
			Industrial Welding Technology													23		23							23
			Metal Welding and Metal Work Technology										17		17										17
		Industrial Technology	Installation and Maintenance										52	5	57	37	1	38							95
			Production Industry										93	1	94	48		48							142
		Construction Technology	Construction Technology																25	6	31	38		38	69
		Electric Technology	Electric Technology																24		24	29		29	53
		Automotive Technology	Automobile Technology																			21		21	21
		Electronics Technology	Electronics Technology																11		11	17	2	19	30
		Electric	Maintenance and Sale System of Electric Equipment										27		27	13	3	16							43
			Power Electric										100	1	101	21	5	26							127
			Electric Control													69	8	77							77
		Power Electric	Electrical Mechanical Tools													5		5							5
			Electricity Installation													2		2							2
		Electric and Electronics	Power Electric							2		2													2
			Mechatronics							1		1													1
			Electronics							1		1													1
		Mechatronics	Mechatronics	45	12	57	26	9	35	22	5	27				24	9	33							152
		Mechatronics and Robots	Mechatronics and Robots										37	9	46										46
		Metallurgy	Metal Welding							2		2													2
		Electronics	Computer Technique													2	4	6							6
			Industrial Electronics										87	22	109	75	21	96							205
107	Song Khwae Technical College	Mechanical Engineer	Automotive Technology													4		4							4
			Automobile							2		2													2
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	24		24	17		17	13		13													54
		Power Electric Technician	Power Electric	30	2	32	17		17	29	1	30													79
		Automotive Technician	Automobile Body and Color							1		1													1
			Automobile	53		53	74		74	32		32													159
		Electronics Technician	Electronics	13		13	4		4	5		5													22
		Production Technology	Mechanical Tools										6		6	2		2							8
		Mechanical Technology	Automotive Technology										56	4	60	23		23							83
		Electric	Power Electric										23		23	19		19							42
		Power Electric	Electricity Installation													2		2							2
		Electric and Electronics	Power Electric							3		3													3

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Computer Technique													1		1							1
			Industrial Electronics										4	1	5										5
108	Sattaheap Technical College	Construction	Construction							6		6													6
			Construction Technology													4		4							4
			Construction Control Technology													17	1	18							18
		Machine Tools Design	Machine Tools Design										23	14	37										37
			Production Design													27	11	38							38
		Mechanical Engineer	Agricultural Machinery							4		4													4
			Mechanical Engineer							1		1													1
			Mechanical Technology													2		2							2
			Shipbuilding Mechanical Technique													3		3							3
			Industrial Mechanical Technology													7		7							7
			Automotive Technology													24	1	25							25
			Automobile							7		7													7
		Mechanical Tools and Maintenance	Machine Tools Design							3		3													3
			Mechanical Tools							4		4													4
		Measurement and Control Tools	Measurement and Control Tools										64	29	93	67	23	90							183
		Machine Tools Technology	Mechanical Tools	154	14	168	113	15	128	125	2	127													423
			Auto-part Production	35	3	38	26	1	27	24	2	26													91
		Construction Technician	Construction	35	17	52	31	21	52	25	15	40	18	7	25	16	9	25							194
		Machine Tools Design	Machine Tools Design	27	22	49	24	36	60	16	16	32													141
		Metal Welding Technician	Structure	44	2	46	22		22	33	1	34													102
			Products				13	1	14																14
		Power Electric Technician	Power Electric	139	19	158	164	18	182	142	8	150													490
		Automotive Technician	Mechanical Engineer				19		19	5		5													24
			Mechanical Engineer				34	2	36	36	2	38													74
			Automobile	158	2	160	139	3	142	90	2	92													394
		Aircraft Technician	Aircraft Technician										19	1	20										20
		Electronics Technician	Electronics	78	18	96	92	12	104	91	14	105													305
		Production Technology	Mechanical Tools										37	3	40	103	4	107							147
			Plastic Tools and Die										13	6	19	49	1	50							69
			Metal Tools and Die										50	3	53	29	4	33							86
		Computer Technology	Computer Technique	42	8	50	29	6	35																85
		Mechanical Technology	Mechanical Technology(agriculture)										18		18	12		12							30
			Rail Mechanical Technology										9	9	18										18
			Shipbuilding Mechanical Technique										9	1	10	9		9							19
			Industrial Mechanical Technology										26		26	25	2	27							53
			Automotive Technology										33		33	113		113							146
		Metal Technology	Metal Welding Technology													9		9							9
			Industrial Welding Technology													45		45							45
			Metal Welding and Metal Work Technology										58	8	66	20		20							86
		Computer Technology	Computer Network										15	1	16										16
		Electric	Industrial Measurement Tools										6		6	11		11							17
			Power Electric										20		20	81	1	82							102
			Electric Control										85	8	93	74	7	81							174
		Power Electric	Electrical Mechanical Tools													6		6							6
			Electricity Installation													13		13							13
		Electric and Electronics	Computer Technique							20	1	21													21
			Power Electric							4		4													4
			Electronics							5		5													5
		Mechatronics	Mechatronics	70	14	84	43	16	59	24	6	30				25	4	29							202
		Mechatronics and Robots	Mechatronics and Robots										22	4	26										26
		Electronics	Computer Technique													2		2							2
			Image and Sound System										12		12	20	2	22							34
			Industrial Electronics										42	3	45	39	3	42							87
109	Sankhamphang Technical College	Construction	Construction							7		7													7
			Construction Technology													6		6							6
		Mechanical Engineer	Automobile							1		1													1
		Construction Technician	Construction	41	5	46	25	1	26	6	1	7													79
		Metal Welding Technician	Products	32		32	13		13																45
		Power Electric Technician	Power Electric	55	1	56	19		19	3		3													78
		Automotive Technician	Automobile	96		96	52		52	6		6													154
		Electronics Technician	Electronics	12	7	19	11		11																30
		Electric and Electronics	Power Electric							2		2													2
			Electronics							10		10													10
110	Saraphi Technical College	Mechanical Engineer	Automotive Technology													25		25							25
			Automobile							48		48													48
		Metal Welding Technician	Products	19		19	30		30																49
		Power Electric Technician	Power Electric	21		21	23	1	24	26	1	27													72
		Automotive Technician	Automobile	48	2	50	63		63	94		94													207
		Electronics Technician	Electronics	19	6	25	10		10	17		17													52
		Mechanical Technology	Automotive Technology										60		60	41		41							101
		Industrial Technology	Installation and Maintenance													5	1	6							6
		Electric	Power Electric										27	1	28	27		27							55
		Power Electric	Electricity Installation													38		38							38
		Electric and Electronics	Power Electric							18		18													18
			Electronics							19	2	21													21
		Electronics	Computer Technique													3		3							3
			Industrial Electronics										11		11	9		9							20
		Mechanical Engineer	Automobile							1		1													1

No.	Technical College	Subject	Course	BWC 1 Male	BWC 1 Female	BWC 1 Total	BWC 2 Male	BWC 2 Female	BWC 2 Total	BWC 3 Male	BWC 3 Female	BWC 3 Total	BWS 1 Male	BWS 1 Female	BWS 1 Total	BWS 2 Male	BWS 2 Female	BWS 2 Total	BA 1 Male	BA 1 Female	BA 1 Total	BA 2 Male	BA 2 Female	BA 2 Total	Total
111	Singburi Technical College	Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	78	1	79	55	1	56	68	1	69													204
		Construction Technician	Construction	31	14	45	25	4	29	34	1	35				10	1	11							120
		Metal Welding Technician	Structure	21		21	7		7	8		8													36
		Maintenance Technician	Industrial Maintenance	24	1	25	10		10	16		16													51
		Power Electric Technician	Power Electric	77	6	83	54	6	60	63		63													206
		Automotive Technician	Automobile	84	2	86	60		60	55		55													201
		Electronics Technician	Electronics	32	5	37	23	3	26	33	3	36													99
		Production Technology	Mechanical Tools										22		22	34		34							56
			Metal Tools and Die										20	1	21	15		15							36
		Computer Technique	Computer Technique	17	4	21	16	2	18	9	5	14													53
		Mechanical Technology	Automotive Technology										51		51	31		31							82
		Metal Technology	Metal Welding Technology													8	1	9							9
			Metal Welding and Metal Work Technology										4		4										4
		Industrial Technology	Production Industry										6		6	10		10							16
		Computer Technology	Computer Software										20	2	22										22
		Electric	Power Electric										56		56	44	1	45							101
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Computer Technique							1		1													1
		Mechatronics	Mechatronics	21		21	9	3	12	7	1	8				15		15							56
		Mechatronics and Robots	Mechatronics and Robots										12		12										12
		Civil Engineer	Civil Engineer										40	6	46	14	1	15							61
		Electronics	Industrial Electronics										16	4	20	8	5	13							33
112	Singburi Technical College 2	Mechanical Engineer	Automotive Technology													5		5							5
		Construction Technician	Construction	5	1	6	5		5	1	2	3													14
		Power Electric Technician	Power Electric	21	5	26	12	3	15	13	2	15													56
		Automotive Technician	Automobile	40	1	41	19		19	23		23													83
		Electronics Technician	Electronics	5	3	8	5		5	13		13													26
		Mechanical Technology	Industrial Mechanical Technology													10		10							10
			Automotive Technology										27		27	9		9							36
		Electric	Power Electric										50	7	57	17	1	18							75
		Civil Engineer	Civil Engineer										27	8	35	2		2							37
		Electronics	Industrial Electronics										4		4	5	2	7							11
113	Sichon Technical College	Mechanical Engineer	Automotive Technology													1		1							1
			Automobile							1		1													1
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Machine Tools Technology	Mechanical Tools	35		35	12		12	13		13													60
		Construction Technician	Construction	21		21	15		15	6	1	7				9		9							52
		Metal Welding Technician	Products	26		26	14		14	7		7													47
		Power Electric Technician	Power Electric	46	2	48	26		26	34	1	35													109
		Automotive Technician	Automobile	87		87	45		45	63		63													195
		Electronics Technician	Electronics	23	7	30	11	1	12	6	2	8													50
		Production Technology	Mechanical Tools										10		10	14		14							24
		Mechanical Technology	Automotive Technology										37		37	42		42							79
		Metal Technology	Industrial Welding Technology													4		4							4
			Metal Welding and Metal Work Technology										6		6										6
		Electric	Power Electric										15		15	19		19							34
		Power Electric	Electricity Installation													1		1							1
		Electric and Electronics	Power Electric							2		2													2
		Electronics	Industrial Electronics										9	1	10	12		12							22
114	Sukhothai Technical College	Construction	Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													24		24							24
			Automobile							4		4													4
		Mechanical Tools and Maintenance	Mechanical Tools							6		6													6
		Machine Tools Technology	Mechanical Tools	116	1	117	94		94	83	1	84													295
		Construction Technician	Construction	42	3	45	22	2	24	36	3	39	42	7	49	27	4	31							188
		Metal Welding Technician	Products	8		8	9		9	6		6													23
		Power Electric Technician	Power Electric	117	3	120	102	2	104	97		97													321
		Automotive Technician	Automobile	166	1	167	115	1	116	121		121													404
		Electronics Technician	Electronics	62	4	66	53	2	55	58	4	62													183
		Production Technology	Mechanical Tools										77	2	79	85		85							164
		Mechanical Technology	Automotive Technology										79		79	77		77							156
		Metal Technology	Metal Welding and Metal Work Technology										10		10										10
		Computer Technology	Computer Hardware										15	1	16										16
		Automobile Technology	Automobile Technology																6		6				6
		Electric	Cooler and Air-condition										20		20	20		20							40
			Power Electric										101	1	102	58		58							160
		Power Electric	Electricity Installation													13		13							13
		Electric and	Power Electric							6		6													6

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Electronics							3		3													3
		Metallurgy	Metal Welding							2		2													2
		Electronics	Computer Technique													2		2							2
			Industrial Electronics										38	2	40	61	3	64							104
115	Suphanburi Technical College	Construction	Construction							2	2	4													4
		Mechanical Engineer	Automotive Technology													16		16							16
			Automobile							11		11													11
		Mechanical Tools and Maintenance	Mechanical Tools							5		5													5
			Industrial Machine Maintenance							4		4													4
			Metal Tools and Die							3		3													3
		Machine Tools Technology	Mechanical Tools	123		123	72	1	73	78	1	79													275
			Metal Tools and Die	29	2	31	11	1	12	18		18													61
		Construction Technician	Construction	65	10	75	44	5	49	35	5	40													164
		Metal Welding Technician	Products	35		35	34		34	29		29													98
		Maintenance Technician	Industrial Maintenance	56	3	59	35		35	39		39													133
		Power Electric Technician	Power Electric	168	18	186	99	6	105	69	5	74													365
		Automotive Technician	Automobile Body and Color	12		12				8		8													20
			Automobile	176	1	177	172	2	174	154		154													505
		Electronics Technician	Electronics	75	14	89	61	3	64	82	4	86													239
		Production Technology	Mechanical Tools										58	4	62	40	2	42							104
			Auto-part Production										23		23										23
			Metal Tools and Die										36	7	43	48	4	52							95
		Mechanical Technology	Automotive Technology										161	3	164	192		192							356
		Metal Technology	Metal Welding inspection										13		13										13
			Industrial Welding Technology													26	1	27							27
		Industrial Technology	Installation and Maintenance										31		31	31	1	32							63
		Computer Technology	Computer Hardware										11	7	18										18
		Automobile Technology	Automobile Technology																19	1	20	30		30	50
		Electric	Maintenance and Sale System of Electric Equipment													20		20							20
			Power Electric										146	14	160	100	3	103							263
		Power Electric	Electricity Installation													5		5							5
		Electric and Electronics	Power Electric							6		6													6
			Electronics							13		13													13
		Civil Engineer	Civil Engineer	23	12	35	19	8	27	12	3	15	62	11	73	49	15	64							214
		Metallurgy	Metal Welding							6		6													6
		Electronics	Computer Technique													6	3	9							9
			Industrial Electronics										52	7	59	58	3	61							120
116	Suranaree Technical College	Construction	Construction							8		8													8
			Furniture and Interior Design							5		5													5
		Mechanical Engineer	Automotive Technology													16		16							16
			Automobile							50		50													50
		Mechanical Tools and Maintenance	Mechanical Tools							27		27													27
		Machine Tools Technology	Mechanical Tools	138	4	142	101	12	113	92	1	93													348
		Construction Technician	Construction	10	1	11							5		5	10	2	12							28
		Metal Welding Technician	Structure	11		11	1		1	20		20													32
		Power Electric Technician	Power Electric	41	4	45	31	2	33	32		32													110
		Automotive Technician	Automobile	114	2	116	87	3	90	66		66													272
		Electronics Technician	Electronics	15	3	18	12	8	20	14		14													52
		Science-based Industry Technician	Construction				4	1	5	7	7	14													19
			Automatic Machines	29	27	56	16	7	23	8	7	15													94
			Mechanical Tools				4	5	9																9
		Production Technology	Mechanical Tools										22		22	38	3	41							63
			Auto-part Production										42		42	61	7	68							110
		Mechanical Technology	Automotive Technology										24		24	27		27							51
		Metal Technology	Metal Welding and Metal Work Technology										10		10										10
		Electric	Power Electric										22		22	15		15							37
		Power Electric	Electricity Installation													22		22							22
		Electric and Electronics	Power Electric							29		29													29
			Electronics							4		4													4
		Metallurgy	Metal Welding							15		15													15
		Electronics	Industrial Electronics										15	3	18	15	1	16							34
117	Suratthani Technical College	Construction	Construction	122	5	127				8		8													135
			Construction Technology													3		3							3
			Architecture							1		1													1
		Mechanical Engineer	Automotive Technology										144		144	24		24							168
			Automobile	258		258	2		2	14		14													274
		Mechanical Tools and Maintenance	Mechanical Tools	131		131	1		1	9		9													141
			Metal Tools and Die	21		21				4		4													25
		Machine Tools Technology	Mechanical Tools				54		54	43		43													97
			Metal Tools and Die				8		8	11		11													19
		Construction Technician	Construction				59	3	62	66		66	45		45	38	1	39							212
		Metal Welding Technician	Structure	46		46	16		16	33		33													95
		Power Electric Technician	Power Electric	193	5	198	135	1	136	117	1	118													452
		Automotive Technician	Automobile	4		4	186	1	187	170		170													361
		Electronics Technician	Electronics	120	11	131	83	3	86	109	4	113													330
		Production Technology	Mechanical Tools										19		19	25		25							44
			Metal Tools and Die										14		14										14
		Mechanical Technology	Automotive Technology													102		102							102
		Metal Technology	Metal Welding inspection										11		11	19		19							30
			Industrial Welding Technology													5		5							5
		Architecture Technology	Architecture Technology													12	3	15							15

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electric Technology	Electric Technology																18	1	19	63	1	64	83
		Rubber Industry	Rubber Industry																21	3	24	17	11	28	52
		Rubber and Polymer Technology	Rubber and Polymer Industry										15	6	21	23	6	29							50
		Automobile Technology	Automobile Technology																40		40	54		54	94
		Electronics Technology	Electronics Technology																23	2	25	51	4	55	80
		Electric	Power Electric										67	2	69	48	2	50							119
			Electric Control										18		18	17		17							35
		Power Electric	Electrical Mechanical Tools													1		1							1
			Electricity Installation													5	1	6							6
		Electric and Electronics	Power Electric							11		11													11
			Electronics							10		10													10
		Metallurgy	Metal Welding							8		8													8
		Architecture	Architecture	52	26	78	31	14	45	32	24	56													179
		Electronics	Telecommunication System													1		1							1
			Industrial Electronics										34	2	36	60	3	63							99
		Rubber Industry	Rubber Industry	11	2	13	9	1	10	17	5	22													45
118	Surin Technical College	Construction	Construction							1	1	2													2
			Construction Technology													7		7							7
			Civil Engineer							2	1	3													3
		Mechanical Engineer	Automotive Technology													69		69							69
			Automobile							7		7													7
		Mechanical Tools and Maintenance	Mechanical Tools							10		10													10
		Machine Tools Technology	Mechanical Tools	259	8	267	153	2	155	179	1	180													602
			Metal Tools and Die	74	3	77	30		30																107
		Construction Technician	Construction	87	8	95	54	6	60	51		51	50	4	54	45	1	46							306
		Metal Welding Technician	Structure	65		65	38		38	44	2	46													149
		Power Electric Technician	Power Electric	178	7	185	121	2	123	119	5	124													432
		Automotive Technician	Automobile	221		221	155		155	158		158													534
		Electronics Technician	Electronics	127	10	137	57	2	59	95	7	102													298
		Production Technology	Mechanical Tools										120	3	123	128	4	132							255
			Plastic Tools and Die										164	5	169	212	2	214							383
			Metal Tools and Die										65	1	66	71		71							137
		Computer Technology	Computer Technique	48	17	65	31	5	36																101
		Mechanical Technology	Automotive Technology										165	2	167	116		116							283
		Metal Technology	Industrial Welding Technology										1		1	30		30							31
			Metal Welding and Metal Work Technology										36		36										36
		Computer Technology	Computer Multimedia										16	2	18										18
		Electric Technology	Electric Technology																25		25	39		39	64
		Tools and Die Technology	Tools and Die Technology																16		16				16
		Electronics Technology	Electronics Technology																19		19				19
		Electric	Cooler and Air-condition										14		14										14
			Power Electric										188	1	189	102	2	104							293
		Power Electric	Electricity Installation													66	2	68							68
		Electric and Electronics	Power Electric							6		6													6
			Electronics							8	1	9													9
		Civil Engineer	Civil Engineer	106	26	132	48	18	66	61	18	79	87	17	104	82	14	96							477
		Metallurgy	Metal Welding							10		10													10
		survey	Survey	62	29	91	37	9	46	50	14	64	63	22	85	65	14	79							365
		Electronics	Telecommunication System													2		2							2
			Industrial Electronics										75	5	80	101	9	110							190
119	Suwannaphum Technical College	Construction	Construction							3		3													3
			Construction Technology													1		1							1
		Mechanical Engineer	Automotive Technology													5		5							5
			Automobile							2		2													2
		Machine Tools Technology	Mechanical Tools	55	5	60	52	5	57	59	1	60													177
		Construction Technician	Construction	12	5	17	7	3	10	7	4	11													38
		Metal Welding Technician	Structure				6		6	1		1													7
		Power Electric Technician	Power Electric	19	1	20	36	1	37	38	1	39													96
		Automotive Technician	Automobile	59	2	61	60	1	61	53		53													175
		Electronics Technician	Electronics	30	9	39	25	2	27	23	1	24													90
		Production Technology	Mechanical Tools										40		40	28	6	34							74
			Production Technology													3		3							3
		Mechanical Technology	Automotive Technology										20		20	38		38							58
		Electric	Power Electric										14	1	15										15
			Electric Control													28		28							28
		Power Electric	Electrical Mechanical Tools													7	1	8							8
		Electric and Electronics	Power Electric							1		1													1
			Electronics								1	1													1
		Civil Engineer	Civil Engineer										11	3	14	14	6	20							34
		Electronics	Telecommunication System													4		4							4
			Industrial Electronics										15	2	17	9	2	11							28
		Construction	Construction							2		2													2
			Construction Technology													28	4	32							32
		Mechanical Engineer	Industrial Mechanical Technology													20		20							20
			Automotive Technology													31		31							31
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							3		3													3
		Machine Tools Technology	Mechanical Tools	230	4	234	80	2	82	25		25													341

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
120	Nongkhai Technical College	Construction Technician	Construction	92	11	103	20	2	22	10	4	14	68	8	76										215
		Metal Welding Technician	Structure	31		31	16		16	12		12													59
		Power Electric Technician	Power Electric	142	6	148	47	4	51	17	3	20													219
		Automotive Technician	Automobile	316	5	321	92		92	39		39													452
		Electronics Technician	Electronics	109	51	160	41	19	60	11	3	14													234
		Production Technology	Mechanical Tools										109	1	110	32		32							142
			Plastic Tools and Die										68		68	22		22							90
			Metal Tools and Die										14		14										14
		Computer Technology	Computer Technique	33	10	43																			43
		Mechanical Technology	Industrial Mechanical Technology										88		88										88
			Automotive Technology										113		113										113
		Metal Technology	Industrial Welding Technology													12		12							12
			Metal Welding and Metal Work Technology										14		14										14
		Architecture Technology	Architecture Technology										41	32	73	6	14	20							93
		Construction Technology	Construction Technology																24	5	29				29
		Computer Technology	Computer Hardware										37	11	48										48
		Electric Technology	Electric Technology																24	1	25	6	1	7	32
		Tools and Die Technology	Tools and Die Technology																14		14				14
		Automotive Technology	Automobile Technology																26		26	14	1	15	41
		Electronics Technology	Electronics Technology																36	8	44				44
		Electric	Cooler and Air-condition										26		26										26
			Power Electric										156	4	160										160
		Power Electric	Electrical Mechanical Tools													36		36							36
			Cooler and Air-condition													12		12							12
		Electric and Electronics	Power Electric							1		1													1
		Mechatronics	Mechatronics	11	4	15																			15
		Mechatronics and Robots	Mechatronics and Robots										13	2	15										15
		Architecture	Architecture	24	17	41	7	6	13	3	4	7													61
		Electronics	Computer Technique													12	2	14							14
			Industrial Electronics										102	38	140	19	4	23							163
121	Nongbualamphu Technical College	Construction	Construction							6	1	7													7
			Construction Technology													14	1	15							15
		Mechanical Engineer	Automotive Technology													25		25							25
			Automobile							23		23													23
		Mechanical Tools and Maintenance	Mechanical Tools	17		17				7		7													24
		Machine Tools Technology	Mechanical Tools	97	3	100	117	3	120	145		145													365
		Construction Technician	Construction	28	13	41	31	14	45	39	2	41	33	6	39	38	4	42							208
		Metal Welding Technician	Structure	11		11	18		18	22		22													51
		Power Electric Technician	Power Electric	55	6	61	77	1	78	69	2	71													210
		Automotive Technician	Automobile	73		73	112	2	114	145		145													332
		Electronics Technician	Electronics	32	10	42	27	6	33	36	4	40													115
		Production Technology	Mechanical Tools										46	1	47	69		69							116
		Mechanical Technology	Automotive Technology										45		45	51		51							96
		Metal Technology	Metal Welding Technology													6		6							6
			Metal Welding and Metal Work Technology										7	3	10										10
		Electric Technology	Electric Technology																18		18	24		24	42
		Electric	Power Electric										29		29	66		66							95
			Electric Control										23		23										23
		Power Electric	Electricity Installation													16		16							16
		Electric and Electronics	Power Electric							9		9													9
			Electronics							8	3	11													11
		Metallurgy	Metal Welding							2		2													2
		Electronics	Industrial Electronics										21	5	26	29	1	30							56
122	Luangphorkhoon Praisutho Technical College	Construction	Construction							4	3	7													7
			Construction Technology													2	1	3							3
			Architecture							2	1	3													3
		Mechanical Engineer	Industrial Mechanical Technology													10		10							10
			Automotive Technology													19		19							19
			Automobile							43		43													43
		Mechanical Tools and Maintenance	Mechanical Tools							57		57													57
		Machine Tools Technology	Mechanical Tools	82	4	86	103	1	104	142		142													332
		Construction Technician	Construction	6	2	8	2	1	3	11	2	13	3	3	6	2		2							32
		Metal Welding Technician	Products	6		6	9		9	17	1	18													33
		Power Electric Technician	Power Electric	73	1	74	66	3	69	56	3	59													202
		Automotive Technician	Automobile	93		93	85		85	121		121													299
		Electronics Technician	Electronics	25	8	33	34	2	36	68	4	72													141
		Production Technology	Mechanical Tools										67		67	115	1	116							183
		Mechanical Technology	Industrial Mechanical Technology										29		29	27		27							56
			Automotive Technology										27		27	17		17							44
		Metal Technology	Industrial Welding Technology													2		2							2
			Metal Welding and Metal Work Technology										6		6	9		9							15

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electric Technology	Electric Technology																			22		22	22
		Automotive Technology	Automobile Technology																			1		1	1
		Electric	Power Electric										29	1	30	22	1	23							53
			Electric Control										26	1	27	22		22							49
		Power Electric	Electrical Mechanical Tools													7		7							7
			Electricity Installation													12		12							12
		Electric and Electronics	Power Electric							11		11													11
			Electronics							4	2	6													6
		Metallurgy	Metal Welding							1		1													1
		Architecture	Architecture	1	5	6	9	4	13	5		5													24
		Electronics	Computer Technique													5	1	6							6
			Industrial Electronics										22		22	38		38							60
123	Huathaphan Technical College	Mechanical Engineer	Automotive Technology													3		3							3
			Automobile							16		16													16
		Power Electric Technician	Power Electric	42	2	44	60	1	61	46	2	48													153
		Automotive Technician	Automobile	66	1	67	69		69	78		78													214
		Electronics Technician	Electronics	24	5	29	34	9	43	21	1	22													94
		Mechanical Technology	Automotive Technology										30		30	21		21							51
		Electric	Power Electric										16	1	17	8	1	9							26
		Power Electric	Electrical Mechanical Tools													6		6							6
		Electric and Electronics	Power Electric							13		13													13
			Electronics							1		1													1
		Electronics	Industrial Electronics										17	2	19	14		14							33
124	Hat Yai Technical College	Construction	Construction							1		1													1
			Furniture and Interior Design							3		3													3
			Construction Technology													13		13							13
			Civil Engineer							1		1													1
			Architecture							1	1	2													2
			Survey							3		3													3
		Mechanical Engineer	Automotive Technology													34		34							34
			Automobile							3		3													3
		Mechanical Tools and Maintenance	Mechanical Tools							1		1													1
		Measurement and Control Tools	Petroleum Technology										14		14	24	1	25							39
			Petroleum Drilling Technology										18	1	19	25	3	28							47
		Machine Tools Technology	Mechanical Tools	187	2	189	106		106	103		103													398
		Construction	Construction	84	2	86	67	9	76	46	8	54	55	7	62	56	6	62							340
		Furniture and Interior Design Technician	Furniture and Interior Design	42	20	62	13	18	31	19	18	37													130
		Metal Welding Technician	Products	183		183	75		75	84	1	85													343
		Power Electric Technician	Power Electric	228	9	237	187	13	200	175	10	185													622
		Automotive Technician	Automobile	241		241	154		154	145		145													540
		Electronics Technician	Electronics	192	30	222	138	32	170	128	20	148													540
		Production Technology	Mechanical Tools										74	1	75	70		70							145
		Mechanical Technology	Automotive Technology										190	2	192	157		157							349
		Energy Technology	Energy Management Technology										16	3	19										19
		Metal Technology	Metal Welding Technology													106	1	107							107
			Metal Welding and Metal Work Technology										102	3	105										105
		Computer Technology	Computer network										26	1	27										27
		Telecommunication Technology	Telecommunication System Technology										36	2	38										38
		Electric Technology	Electric Technology																24	3	27	21	2	23	50
		Electric	Cooler and Air-condition										39		39	25		25							64
			Maintenance and Sale System of Electric Equipment										16		16	10		10							26
			Power Electric										84		84	66		66							150
			Electric Control										58	1	59	55	3	58							117
		Power Electric	Electrical Mechanical Tools													6		6							6
			Cooler and Air-condition													5		5							5
			Electricity Installation													9	1	10							10
		Electric and Electronics	Power Electric							4		4													4
			Electronics							4		4													4
		Civil Engineer	Civil Engineer	84	13	97	50	12	62	52	11	63	32	6	38	35	12	47							307
		Metallurgy	Metal Welding							18		18													18
		Architecture	Architecture	65	50	115	25	35	60	36	22	58													233
		survey	Survey	69	25	94	24	18	42	32	16	48	34	14	48	15	8	23							255
		Electronics	Computer Technique													30	1	31							31
			Telecommunication System													32	1	33							33
			Industrial Electronics										37	3	40	28	5	33							73
		Furniture and Interior Design Industry	Interior Design										22	10	32										32
		Construction	Construction							1		1													1
			Construction Technology													2		2							2
			Architecture							2	2	4													4
		Mechanical Engineer	Automotive Technology													4		4							4
			Automobile							10		10													10
		Mechanical Tools and Maintenance	Mechanical Tools							9		9													9
			Plastic Tools and Die							2		2													2
		Machine Tools Technology	Mechanical Tools	77	9	86	81	5	86	53	2	55													227
			Plastic Tools and Die	36	1	37	17		17	15		15													69
		Construction Technician	Construction	27	5	32	23	4	27	14	4	18	14	1	15	6	2	8							100
		Metal Welding Technician	Structure	51	1	52	19	2	21	9		9													82
		Power Electric Technician	Power Electric	127	12	139	81	8	89	74	4	78													306

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
125	Angthong Technical College	Automotive Technician	Automobile	87		87	54		54	42		42													183
		Electronics Technician	Electronics	45	4	49	34	12	46	27	13	40													135
		Production Technology	Mechanical Tools										75	1	76	111	1	112							188
			Plastic Tools and Die										14		14	26		26							40
		Mechanical Technology	Automotive Technology										44		44	35		35							79
		Metal Technology	Metal Welding Technology													14		14							14
			Metal Welding and Metal Work Technology										9		9										9
		Electric	Electric Control										58	6	64	46	2	48							112
		Power Electric	Electrical Mechanical Tools													6		6							6
		Electric and Electronics	Power Electric							7	2	9													9
			Electronics							6	1	7													7
		Metallurgy	Metal Welding							4		4													4
		Architecture	Architecture	9	7	16	4	9	13	1	5	6													35
		Electronics	Industrial Electronics										27	5	32	27	4	31							63
126	Amnartcharoen Technical College	Construction	Construction							28	2	30													30
		Mechanical Engineer	Automotive Technology										58		58	111	3	114							172
			Automobile							120		120													120
		Mechanical Tools and Maintenance	Mechanical Tools							70		70													70
		Machine Tools Technology	Mechanical Tools	91	1	92	76	3	79	60	2	62													233
		Construction Technician	Construction	19	2	21	14	2	16	20	9	29													66
		Metal Welding Technician	Structure	24	2	26	21	2	23	44	1	45													94
		Power Electric Technician	Power Electric	78	3	81	62		62	80		80													223
		Automotive Technician	Automobile	95		95	91	3	94	113		113													302
		Electronics Technician	Electronics	24	1	25	38	8	46	75	5	80													151
		Production Technology	Mechanical Tools										44	4	48	80		80							128
		Computer Technology	Computer Technique	15	3	18	12	5	17																35
		Metal Technology	Welding Work inspection										17	3	20										20
			Metal Welding													42	7	49							49
		Electronics Technology	Electronics Technology																14		14	17		17	31
		Power Electric	Electricity Installation										67	2	69	146		146							215
		Electric and Electronics	Computer Technique							11	7	18													18
			Power Electric							66		66													66
			Mechatronics							2		2													2
			Electronics							71	3	74													74
		Civil Engineer	Civil Engineer										28	3	31	55	10	65							96
		Metallurgy	Metal Welding							41		41													41
		Architecture	Architecture	5	9	14	2	5	7																21
		Electronics	Computer Technique													8		8							8
			Industrial Electronics										19	1	20	99	6	105							125
127	Udonthani Technical College	Construction	Construction							5	1	6													6
			Construction Technology													67	5	72							72
			Civil Engineer							8	2	10													10
			Architecture							2	3	5													5
		Mechanical Engineer	Automotive Technology													86		86							86
			Automobile							26		26													26
		Mechanical Tools and Maintenance	Machine Tools Design							1		1													1
			Mechanical Tools							21		21													21
		Machine Tools Technology	Mechanical Tools	141	4	145	98	2	100	95		95													340
		Construction Technician	Construction	42	3	45	25		25	14	3	17	27	4	31	25	1	26							144
		Machine Tools Design	Machine Tools Design							2		2													2
		Metal Welding Technician	Structure	14		14				12		12													26
			Products				14		14																14
		Maintenance Technician	Industrial Maintenance	9	4	13	13	6	19	15		15													47
		Power Electric Technician	Power Electric	156	11	167	110	3	113	100	3	103													383
		Automotive Technician	Automobile	206		206	120		120	134		134													460
		Electronics Technician	Electronics	101	28	129	72	11	83	71	7	78													290
		Production Technology	Mechanical Tools										130	2	132	206	3	209							341
		Mechanical Technology	Automotive Technology										160		160	162		162							322
		Metal Technology	Metal Welding										25		25	39	1	40							65
		Architecture Technology	Architecture Technology										10	15	25	24	14	38							63
		Industrial Technology	installation and Maintenance										43		43	63	1	64							107
			logistic Industry										1		1	37	7	44							45
			Production Industry										20	3	23	57	7	64							87
		Computer Technology	Computer Hardware										12		12										12
		telecommunication Technology	Telecommunication Technology										16	5	21										21
		Electric Technology	Electric Technology																4		4	7		7	11
		Tools and Die Technology	Tools and Die Technology																12		12	11		11	23
		Automotive Technology	Automotive Technology																22		22	32		32	54
		Electronics Technology	Electronics Technology																5		5	22		22	27
		Electric	Cooler and Air-condition										7		7										7
			Power Electric										171	2	173										173
			Electric Control										48		48										48
		Power Electric	Electrical Mechanical Tools										2		2	78	2	80							82
			Cooler and Air-condition													11		11							11
			Electricity Installation										6		6	115		115							121
		Electric and Electronics	Power Electric							19		19													19
			Electronics							22	2	24													24
		Civil Engineer	Civil Engineer	48	14	62	29	9	38	26	7	33	60	10	70	62	12	74							277
		Metallurgy	Metal Welding							14		14													14
		Architecture	Architecture	21	20	41	21	15	36	11	6	17													94

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
		Electronics	Computer Technique													40	9	49							49
			Telecommunication System										1		1	19	3	22							23
			Industrial Electronics										69	12	81	107	10	117							198
128	Uttraradit Technical College	Construction	Construction							5		5													5
		Mechanical Engineer	Automotive Technology													3		3							3
			Automobile							15		15													15
		Mechanical Tools and Maintenance	Mechanical Tools							5		5													5
		Machine Tools Technology	Mechanical Tools	142	1	143	93	2	95	89		89													327
		Construction Technician	Construction	47	13	60	32	8	40	62	9	71	10		10	38	4	42							223
		Metal Welding Technician	Products	41		41	38		38	49		49													128
		Power Electric Technician	Power Electric	183	12	195	112		112	125	1	126													433
		Automotive Technician	Automobile	192	1	193	120		120	162		162													475
		Electronics Technician	Electronics	54	8	62	46	6	52	31	1	32													146
		Production Technology	Mechanical Tools										93	9	102	100	1	101							203
			Metal Tools and Die										35		35	40		40							75
		Mechanical Technology	Automotive Technology										131	1	132	152	1	153							285
		Metal Technology	Metal Welding													27		27							27
		Electronics Technology	Electronics Technology																19	3	22				22
		Electric	Power Electric										179	7	186	149	3	152							338
		Power Electric	Electricity Installation													2		2							2
		Electric and Electronics	Power Electric							7		7													7
			Electronics							6		6													6
		Civil Engineer	Civil Engineer										26	3	29										29
		Electronics	Computer Technique										10	7	17	18	4	22							39
			Industrial Electronics										41	1	42	31	5	36							78
129	Motor Industrial Technical College	Mechanical Engineer	Automotive Technology													10		10							10
		Production Technology	Mechanical Tools										84	4	88	98	7	105							193
		Mechanical Technology	Automobile Body and Color										27	1	28	41		41							69
			Automotive Technology										165		165	147		147							312
		Metal Technology	Metal Welding and Metal Work Technology										27		27										27
		Industrial Technology	Production Industry										91	11	102	55	3	58							160
		Automotive Technology	Automotive Technology																34		34	10		10	44
		Mechatronics	Mechatronics													28	10	38							38
		Mechatronics and Robots	Mechatronics and Robots										12	8	20										20
		Electronics	Industrial Electronics										20	3	23	31	4	35							58
130	Uthaithani Technical College	Construction	Construction							4		4													4
			Construction Technology													4		4							4
		Mechanical Engineer	Automotive Technology													4		4							4
			Automobile							9		9													9
		Machine Tools Technology	Mechanical Tools	85	3	88	52	1	53	58		58													199
		Construction Technician	Construction	59	6	65	34	3	37	42	5	47	18	5	23	28	2	30							202
		Metal Welding Technician	Structure	26		26	9		9	8		8													43
		Power Electric Technician	Power Electric	75	7	82	55	4	59	62	3	65													206
		Automotive Technician	Automobile	108	3	111	79		79	77		77													267
		Electronics Technician	Electronics	48	7	55	48	9	57	38	6	44													156
		Production Technology	Mechanical Tools										15		15	39		39							54
		Mechanical Technology	Automotive Technology										60		60	89	1	90							150
		Metal Technology	Welding technique for Industry													14		14							14
			Metal Structure Welding Technology										5		5										5
		Computer Technology	Computer Hardware										23	22	45										45
		Automotive Technology	Automotive Technology																13		13				13
		Electronics Technology	Industrial Electronics																11	4	15				15
		Electric	Power Electric										81	2	83	59	1	60							143
		Power Electric	Electricity Installation													2		2							2
		Electric and Electronics	Power Electric							1		1													1
		Electronics	Computer Technique													42	4	46							46
			Telecommunication System													16		16							16
			Industrial Electronics										24	1	25										25
		Construction	Construction							13	2	15													15
			Construction Technology													20	5	25							25
			Civil Engineer							40	9	49													49
			Architecture							22	11	33													33
		Mechanical Engineer	Automotive Technology													81		81							81
			Automobile							76		76													76
		Mechanical Tools and Maintenance	Mechanical Tools							48	1	49													49
		Machine Tools Technology	Mechanical Tools	188	3	191	165	2	167	112		112													470
		Construction Technician	Construction	21	1	22	21	2	23	41	3	44	36	1	37	42	6	48							174
		Metal Welding Technician	Products	21		21	24		24	37		37													82
		Power Electric Technician	Power Electric	178	5	183	153	1	154	162	3	165													502
		Automotive Technician	Automobile	276	3	279	251		251	279	1	280													810
		Electronics Technician	Electronics	96	8	104	89	10	99	97	12	109													312
		Production Technology	Mechanical Tools										240	8	248	276	4	280							528
			Metal Tools and Die										31		31	19		19							50
		Computer Technology	Computer Technique	104	17	121	87	14	101	63	20	83													305

No.	Technical College	Subject	Course	BWC 1			BWC 2			BWC 3			BWS 1			BWS 2			BA 1			BA 2			Total
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
131	Ubonratchathani Technical College	Mechanical Technology	Automotive Technology										372		372	280		280							652
		Metal Technology	Welding Work inspection										29		29										29
			Metal Welding													62		62							62
		Architecture Technology	Architecture Technology										10	1	11	12	5	17							28
		Computer Technology	Computer Software													26	11	37							37
			Multimedia													18	5	23							23
			Computer network													6	10	16							16
			Computer Hardware													7	2	9							9
		Telecommunication Technology	Telecommunication System										17	6	23										23
			radio communication System										8		8	21	11	32							40
		automotive Technology	Automotive Technology																			75	1	76	76
		Telecommunication	Telecommunication	3		3	14	4	18	10	1	11													32
		Electric	Power Electric										287	9	296	278	7	285							581
		Power Electric	Electrical Mechanical Tools													29	2	31							31
			Electricity Installation													25		25							25
		Electric and Electronics	Computer Technique							25	7	32													32
			Telecommunication							14	2	16													16
			Power Electric							35	2	37													37
			Electronics							46	5	51													51
		Civil Engineer	Civil Engineer	49	13	62	59	8	67	52	9	61	141	12	153	144	21	165							508
		Metallurgy	Metal Welding							30		30													30
		Architecture	Architecture	12	9	21	23	6	29	14	7	21													71
		Electronics	Computer Technique													2		2							2
			Industrial Electronics										125	14	139	191	15	206							345

Source http://datacenter.vec.go.th

ANNEX 8-1

Data Summary of Company Survey

Note: Response percentages may not add up to 100% due to rounding.
"n" means that the number of valid responses

Q1: Attribution of respondents

Q1.1: Type of companies responded

Table 1 Type of companies responded

	Japanese Companies		Thai Companies		No. of Respondents	
	Res. Count	%	Res. Count	%	Res. Count	%
Maker	41	57.7%	46	74.2%	87	65.4%
Primary Supplier	17	23.9%	7	11.3%	24	18.0%
Secondary Supplier	8	11.3%	1	1.6%	9	6.8%
Tertiary Supplier	1	1.4%	1	1.6%	2	1.5%
Others	4	5.6%	7	11.3%	11	8.3%
Total	71	100.0%	62	100.0%	133	100.0%

Q1.2: Number of employees

Table 2 Number of employees at the responded companies

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Less than 20	5	7.0%	2	3.2%	7	5.3%
20-100 persons	8	11.3%	11	17.7%	19	14.3%
100-300 persons	17	23.9%	12	19.4%	29	21.8%
300-1,000 persons	20	28.2%	17	27.4%	37	27.8%
1,000-10,000 persons	20	28.2%	15	24.2%	35	26.3%
More than 10,000 persons	1	1.4%	5	8.1%	6	4.5%
Total	71	-	62	-	133	100.0%

Q 2.1: Number of Thai technical employees who graduated from University

Table 3 Number of technical employees who graduated from University

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Less than 5 persons	15	30.6%	6	12.5%	21	21.6%
5 - 20 persons	17	34.7%	8	16.7%	25	25.8%
20 - 100 persons	8	16.3%	17	35.4%	25	25.8%
100 - 200 persons	2	4.1%	4	8.3%	6	6.2%

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
200 - 500 persons	4	8.2%	10	20.8%	14	14.4%
More than 500 persons	3	6.1%	3	6.3%	6	6.2%
Total	71	100.0%	62	100.0%	133	100.0%
NA	22	-	14	-	36	-

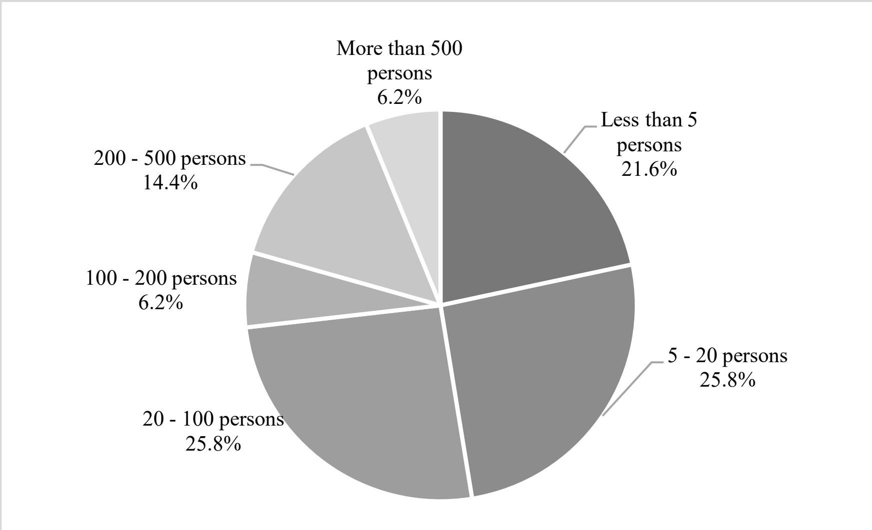


Figure 1 Number of technical employees who graduated from University

Q2.2: Number of technical employees who newly graduated from university last year

Table 4 Number of technical employees who newly graduated from university last year

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
0 persons	23	46.9%	9	20.0%	32	34.0%
1-4 persons	16	32.7%	9	20.0%	25	26.6%
5-9 persons	2	4.1%	4	8.9%	6	6.4%
10-19 persons	3	6.1%	8	17.8%	11	11.7%
20 – 29 persons	0	0.0%	6	13.3%	6	6.4%
30 – 39 persons	1	2.0%	2	4.4%	3	3.2%
40 – 49 persons	1	2.0%	2	4.4%	3	3.2%
50 – 99 persons	0	0.0%	1	2.2%	1	1.1%
More than 100 persons	3	6.1%	4	8.9%	7	7.4%
Total	71	100.0%	62	100.0%	133	100.0%
NA	22		17		39	-

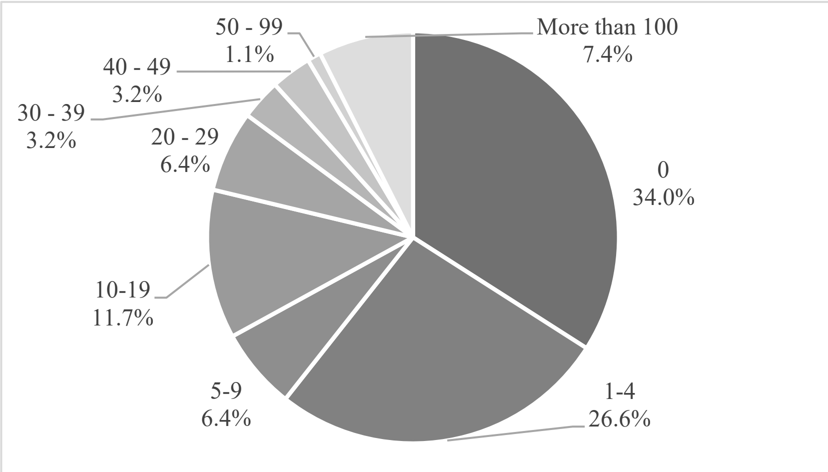


Figure 2 Number of technical employees who newly graduated from university

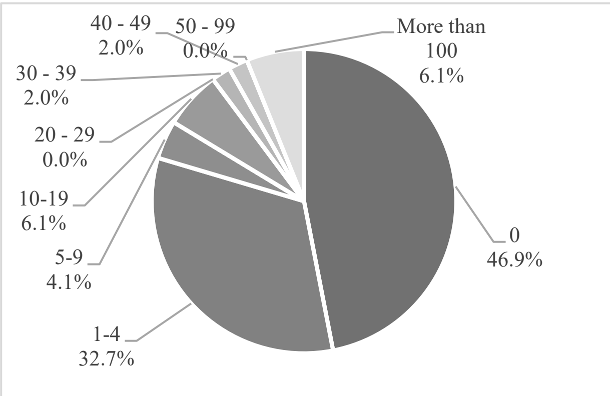


Figure 3 Number of technical employees who newly graduated from university (Japanese companies)

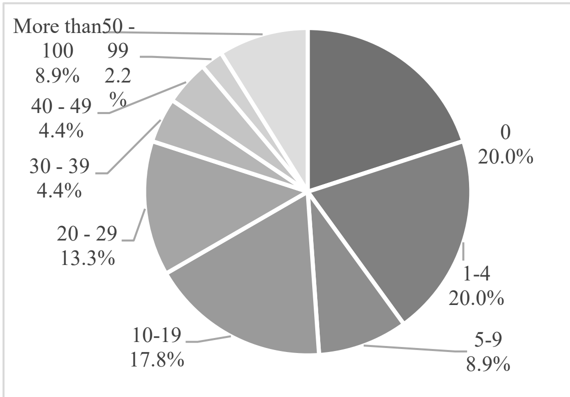


Figure 4 Number of technical employees who newly graduated from university (Thai companies)

Q2.3: Universities which a company employed from in the last three years.

Burapha University (39.5%), Kasetsart University (39.5%) and King Mongkut's Institute of Technology Ladkrabang (39.5%) are the top three universities which the Japanese companies responded to the survey employed more number of technical graduates from. On the other hand, Thai companies which responded to the survey tend to employee more number of technical graduates from King Mongkut's Institute of Technology Ladkrabang (66.7%), King Mongkut's University of Technology North Bangkok (78.6%) and King Mongkut's University of Technology Thonburi (71.4%). In total, more than 50% of the responded companies employed the graduates from King Mongkut's University of Technology North Bangkok (57.5%) followed by King Mongkut's Institute of Technology Ladkrabang (53.8%).

Table 5 Universities which a company employed from in the last three years.

Name of university	% of responses of Japanese Com.	% of responses of Thai Com.	% of responses (Total)
Burapha University	39.5%	45.2%	42.5%
Chiang Mai University	21.1%	28.6%	25.0%
Chulalongkorn University	28.9%	42.9%	36.3%

Name of university	% of responses of Japanese Com.	% of responses of Thai Com.	% of responses (Total)
Kasetsart University	39.5%	61.9%	51.3%
Khon Kaen University	23.7%	57.1%	41.3%
King Mongkut's Institute of Technology Ladkrabang	39.5%	66.7%	53.8%
King Mongkut's University of Technology North Bangkok	34.2%	78.6%	57.5%
King Mongkut's University of Technology Thonburi	28.9%	71.4%	51.3%
Mahidol University	15.8%	28.6%	22.5%
Pathumwan Institute of Technology	0.0%	-	0.0%
Rajabhat Universities	7.9%	19.0%	13.8%
Rajamangala University of Technology Isan	13.2%	4.8%	8.8%
Rajamangala University of Technology Krungthep	5.3%	7.1%	6.3%
Rajamangala University of Technology Lanna	5.3%	11.9%	8.8%
Rajamangala University of Technology Phra Nakhon	7.9%	2.4%	5.0%
Rajamangala University of Technology Rattanakosin	7.9%	0.0%	3.8%
Rajamangala University of Technology Srivijaya	2.6%	2.4%	2.5%
Rajamangala University of Technology Suvarnabhumi	5.3%	4.8%	5.0%
Rajamangala University of Technology Tawan-ok	2.6%	38.1%	21.3%
Rajamangala University of Technology Thanyaburi	13.2%	26.2%	20.0%
Suranaree University of Technology	21.1%	45.2%	33.8%
Thammasat University	18.4%	11.9%	15.0%
TNI	10.5%	23.8%	17.5%
Private university	23.7%	9.5%	16.3%
University in Japan	2.6%	2.4%	2.5%
University in Europe or U.S.A.	2.6%	2.4%	2.5%
University in Southeast Asia	0.0%	0.0%	0.0%
University in East Asia (e.g. China, South Korea)	2.6%	14.3%	8.8%
Others *	7.9%	16.7%	12.5%
Total No. of respondents	38	42	80

Q2.4: Engineers allocation who graduated from university at responded companies

Table 6 Engineers allocation who graduated from university at responded companies (Japanese and Thai) Part 1:

	100	90	80	70	60	50	40	30	20	10	0	Total	%
Design/R&D	1	1	3	4	4	13	0	7	8	7	6	54	65.1%
Production	9	2	7	5	4	9	6	13	6	3	3	67	80.7%
Sales	1	0	0	0	1	5	1	4	4	11	12	39	47.0%
O&M	5	1	1	0	0	5	0	3	18	14	8	55	66.3%
Others	1	0	0	0	0	1	2	2	8	9	9	32	38.6%

	100	90	80	70	60	50	40	30	20	10	0	Total	%
Total responses	17	4	11	9	9	33	9	29	44	44	38	83	100.0%
NA	-	-	-	-	-	-	-	-	-	-	-	50	-

Table 7 Engineers allocation who graduated from university at responded companies (Japanese and Thai)

	50% and more		Less than 50%		0%		Total	
	Res. Count	%	Res. Count	%	Res. Count	%	Res. Count	%
Design/R&D	26	48.1%	22	40.7%	6	11.1%	54	100.0%
Production	36	53.7%	28	41.8%	3	4.5%	67	100.0%
Sales	7	17.9%	20	51.3%	12	30.8%	39	100.0%
O&M	12	21.8%	35	63.6%	8	14.5%	55	100.0%
Others	2	6.3%	21	65.6%	9	28.1%	32	100.0%
Total responses	-	-	-	-	-	-	83	-
NA	-	-	-	-	-	-	50	-

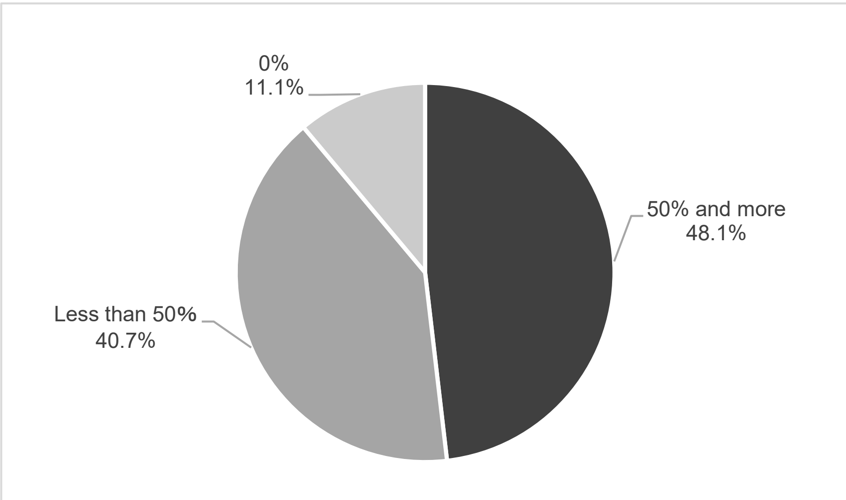


Figure 5 Engineers allocation at Design/R&D departments at the responded companies (Japanese + Thai)

Q2.5 Your company's priority/criteria in recruitment

Japanese Companies (12 respondents):

- None（7）
- No criteria
- Thai engineering graduates meet certain standards, so we don't need to set a priority.
- We don't recruit university graduates on a regular basis.
- We look at applicants' practical knowledge as well as theory.
- Because of our past relationships, we prioritize some university graduates.
- We don't give a priority to any universities.

Thai Companies (22 respondents):

- Not one university in particular
- All universities with chemical engineer knowledge and expertise
- Government university

- Not one university in particular, because all candidates has to join CWIE project first before they are selected to work for our company
- Not one university in particular
- Lanna University because they have been trained at our company and already understand the nature of our work
- Employees are accepted according to job description and market direction.
- Government university, because their student passed entrance exam and possess engineer knowledge on satisfying level
- Mahidol University
- Not specify but will consider each person’s experience, attitude and perspective, and their dedication to work. But most of our employees are from King Mongkut University (KMITL, KMUTT, KMUTNB)
- KMUTT
- TNI
- KMUTNB
- All universities
- Not one university in particular. Depend on capability of each person
- King Mungkut University (KMITL, KMUTT, KMUTNB) and Chulalongkorn University
- All universities, because each university has different teaching style and it reflects on their student’s attitude and behavior.
- King Mongkut University because they provide courses and projects and match the need of our production department
- Not one university in particular.
- Not one university in particular. Depend on qualification of each person
- Not one university in particular. But apart from knowledge that is necessary to work, we will also consider English communication ability of each person

Q3.1: Number of Thai technical employees who graduated from TC

About 30% of the total responded companies employed 0-5 TC graduates and 25% of them employed 20-100 TC graduates. Among Japanese companies, about the half percentage of them employed less than 5 TC graduates, followed by “5-20 persons.” On the other hand, 33% of Thai companies responded employed “20-100 TC persons”, followed by “5-20 TC persons”.

Table 8 Number of Thai technical employees who graduated from TC

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Less than 5 persons	20	48.8%	3	8.3%	23	29.9%
5 - 20 persons	9	22.0%	7	19.4%	16	20.8%
20 - 100 persons	7	17.1%	12	33.3%	19	24.7%
100 - 200 persons	3	7.3%	5	13.9%	8	10.4%
200 - 500 persons	1	2.4%	5	13.9%	6	7.8%
More than 500 persons	1	2.4%	4	11.1%	5	6.5%
Total	41	100.0%	36	100.0%	77	100.0%
NA	30	-	26	-	56	-

Q3.2: The number of technical employees who newly graduated from TC last year

Table 9 The number of technical employees who newly graduated from TC last year

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
0	25	61.0%	4	11.1%	29	37.7%
1-4	10	24.4%	7	19.4%	17	22.1%
5-9	0	0.0%	5	13.9%	5	6.5%
10-19	2	4.9%	11	30.6%	13	16.9%
20 – 29	3	7.3%	2	5.6%	5	6.5%
30 – 39	0	0.0%	3	8.3%	3	3.9%
40 – 49	0	0.0%	1	2.8%	1	1.3%
More than 50	1	2.4%	3	8.3%	4	5.2%
Total	41	100.0%	36	100.0%	77	100.0%
NA	30	-	26	-	56	-

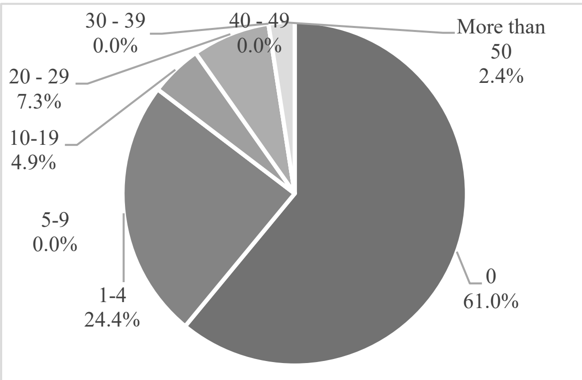


Figure 6 The number of technical employees who newly graduated from TC last year (Japanese Companies)

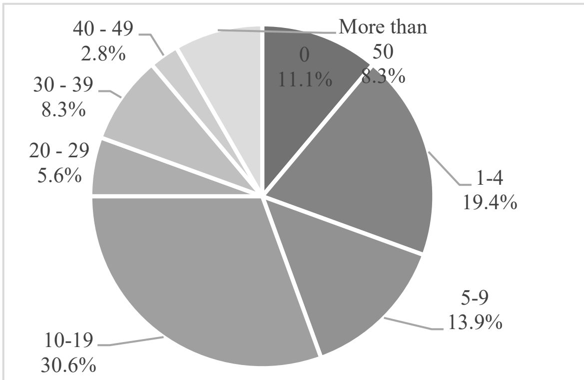


Figure 7 The number of technical employees who newly graduated from TC last year (Thai Companies)

Q3.3: Allocation of TC graduates at responded companies

	Design/R&D		Production		Sales		O&M		Others		Total	NA
	Res. Count	%	Res. Count	%	Res. Count	%	Res. Count	%	Res. Count	%		
100%	1	4.2%	8	16.7%	0	0.0%	6	13.3%	1	5.0%		
90%	0	0.0%	4	8.3%	0	0.0%	1	2.2%	0	0.0%		
80%	0	0.0%	8	16.7%	0	0.0%	5	11.1%	0	0.0%		
70%	1	4.2%	5	10.4%	0	0.0%	0	0.0%	0	0.0%		
60%	1	4.2%	2	4.2%	0	0.0%	1	2.2%	0	0.0%		
50%	2	8.3%	8	16.7%	0	0.0%	6	13.3%	1	5.0%	60	73
40%	1	4.2%	1	2.1%	1	8.3%	3	6.7%	0	0.0%		
30%	0	0.0%	4	8.3%	1	8.3%	5	11.1%	2	10.0%		
20%	5	20.8%	6	12.5%	0	0.0%	4	8.9%	1	5.0%		
10%	8	33.3%	1	2.1%	3	25.0%	10	22.2%	9	45.0%		
0%	5	20.8%	1	2.1%	7	58.3%	4	8.9%	6	30.0%		

Total respondents	24	100.0 %	48	100.0 %	12	100.0 %	45	100.0 %	20	100.0 %		

Table 10 Allocation of TC graduates at responded companies (total respondents of each categories/total respondents)

	Res. Count	%
Design/R&D	24	40.0%
Production	48	80.0%
Sales	12	20.0%
O&M	45	75.0%
Others	20	33.3%
Total responses	60	100.0%
NA	73	-

Q3.4: Recruitment of TC graduates

At both Japanese and Thai companies responded to the survey, about 70-80 % of them utilize TC graduates as technicians at their companies. At Japanese companies, 32.3% of them utilized TC graduates as engineers; on the other hand, only 2.9% of Thai companies utilize TC graduate as engineers.

Table 11 Recruitment and allocation of employees who graduated from TC (multiple choices)

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Recruited as an engineer	10	32.3%	1	2.9%	11	16.9%
Recruited as a technician	22	71.0%	28	82.4%	50	76.9%
Recruited as a worker	7	22.6%	8	23.5%	15	23.1%
Recruited TC graduates as an engineer who has special skills	8	25.8%	5	14.7%	13	20.0%
Others	1	3.2%	3	8.8%	4	6.2%
Total	31		34		65	
NA	40		28			

Q3.5 Companies opinions about dual system

Table 12 Companies opinions about dual system

	Japanese companies		Thai companies		Total	
	Rating Ave.	Res. Count	Rating Ave.	Res. Count	Rating Ave.	Res. Count
Quality of students	2.67	3	2.90	20	2.9	23
Willingness of students	3.00	3	2.90	20	2.9	23
Importance of dual system to company	2.50	2	3.00	20	3.0	22
Benefit of finding good students through dual system	2.67	3	3.00	20	3.0	23

	Japanese companies		Thai companies		Total	
	Rating Ave.	Res. Count	Rating Ave.	Res. Count	Rating Ave.	Res. Count
Possibility of expanding dual system	3.00	3	3.00	20	3.0	23

*Average is calculated on the scale of 1 to 4: very high=4, high to some extent=3, not so high=2, low=1".

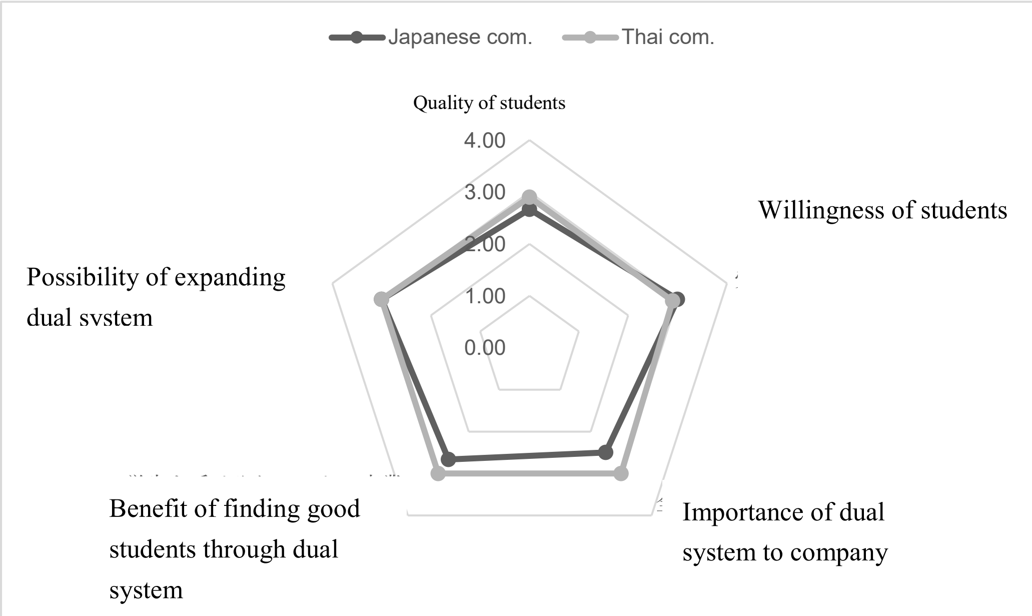


Figure 8 Companies opinions about dual system (n=23)

Design and R&D Engineers

Q4.1 (1): Companies' opinion about the number of Design/R&D engineers

39.5 of responded Japanese companies think that the number of engineers is slightly less than their expectation. 33.6% of responded Thai companies think that the number of engineers are sufficient to some extent; however, 30.6% of them think that it is less than expected as Japanese companies think.

Table 13 Companies' opinion about the number Design/R&D engineer

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Response Count	%
Sufficient	1	2.6%	3	8.3%	4	5.4%
Sufficient to some extent	8	21.1%	12	33.3%	20	27.0%
Not so sufficient	15	39.5%	11	30.6%	26	35.1%
Insufficient	5	13.2%	4	11.1%	9	12.2%
Do not need it	9	23.7%	6	16.7%	15	20.3%
Total	38	100.0%	36	100.0%	74	100.0%
NA	33	-	26	-	59	-
	2.17		2.47		2.32	

Average is calculated on the scale of 1 to 4: Sufficient=4, Sufficient to some extent=3, Not so sufficient=2, insufficient=1".
Rating Average is divided by the total number of "Sufficient", "Sufficient to some extent", "Not so sufficient", and "insufficient".

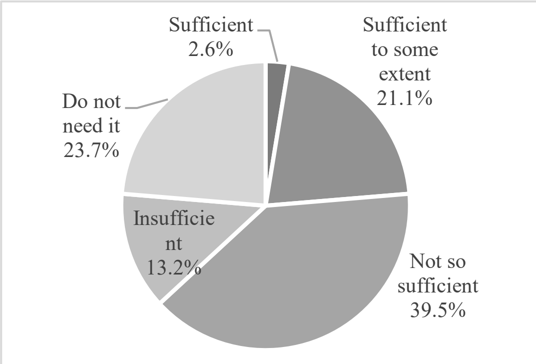


Figure 9 Japanese companies' opinions about the number of design/R&D engineers

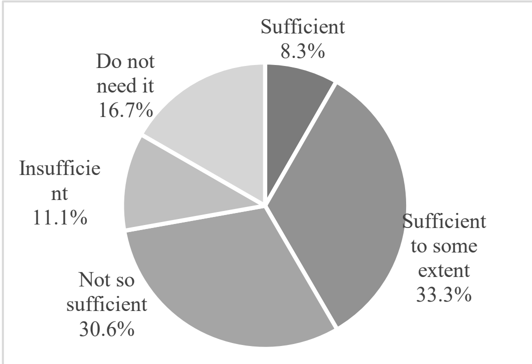


Figure 10 Thai companies' opinions about the number of design/R&D engineers

Q4.1 (2): Companies' satisfaction level with quality and skill level of design or R&D engineers

Table 14 Companies' satisfaction level with quality and skill level of design or R&D engineers

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Satisfied very much	0	0.0%	1	2.9%	1	1.5%
Satisfied to some extent	8	24.2%	24	68.6%	32	47.1%
Not so satisfied	16	48.5%	5	14.3%	21	30.9%
Unsatisfied	4	12.1%	0	0.0%	4	5.9%
Do not need it	4	12.1%	5	14.3%	9	13.2%
Other	1	3.0%	0	0.0%	1	1.5%
Total	33	100.0%	35	100.0%	68	100.0%
NA	38	-	27	-	65	-
Rating Ave.	2.07		2.87		2.47	

Average is calculated on the scale of 1 to 4: Satisfied very much=4, Satisfied to some extent=3, Not so satisfied=2, unsatisfied=1".
Rating Average is divided by the total number of "Satisfied very much", "Satisfied to some extent", "Not so satisfied", and "unsatisfied".

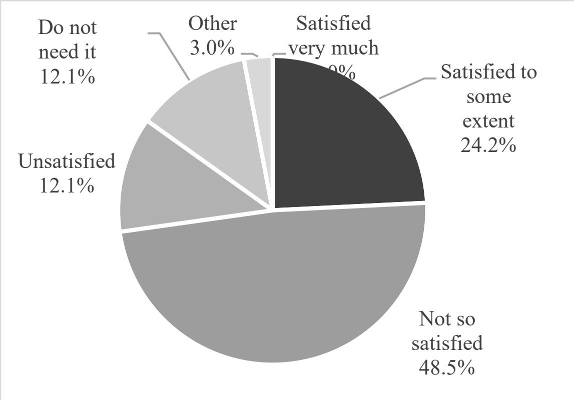


Figure 11 Quality and skill level of design or R&D engineers at <u>Japanese</u> companies

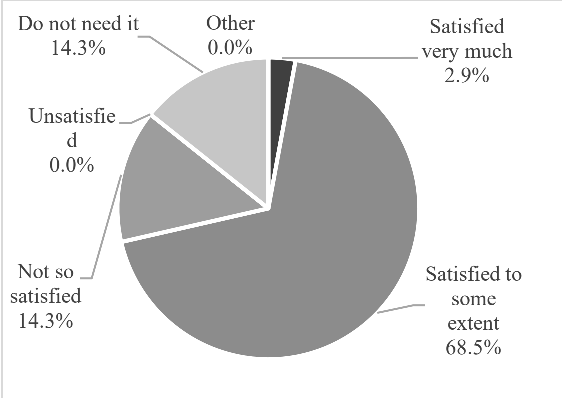


Figure 12 Quality and skill level of design or R&D engineers at <u>Thai</u> companies

Q4.1 (3): Type of engineers the companies look for (in short supply)

<Japanese Companies> n=20

Knowledge

- Have mathematical capacity more than Japanese high school graduates（2）
- Those who can apply their knowledge
- Those who have practical knowledge

Technical Skills

- An engineer who can use 3D CAD and also act as sale engineer
- An engineer who can do both software development and mechanical control
- An engineer who can do CAD design（2）
- An engineer who can do product design
- Product design and production management are in short supply.
- Metal engineering
- Equipment design and product design are in short supply.
- The engineers who can understand specific technologies of the company
- Chemical engineers
- Mold and die specialist
- Those who can do structural design of prefabricated structures.

English

- Communication ability in English
- Those who have knowledge on control and able to communicate in English

Management and Problem Solving

- We are in short supply of project managers.
- The engineers who can proactively look for problems and solutions are very hard to find. They tend to be passive, waiting for instructions.
- We need the type of engineers who do not wait for instructions and set a goal themselves.（2）
- We need Thai engineers who have a quality of Japanese engineers in engineering knowledge, insights, judgment and planning.

Others

- Education program seems very different from that of Japan.

- Thai engineers' knowledge in thermodynamics and material mechanics, which is essential for DD engineers, is too general (2)
- Engineering majors are homogeneous. More specialization desired.
- Thai engineers prefer to sit at their desk and not so much interested in doing trial on the site.

<Thai Companies> n=17

Knowledge
- Engineers who can adapt both science and engineering knowledge into work, e.g. those in Sputtering, Photo-electronic field (with photo-lithography process knowledge)

Technical Skills
- Production design, to produce new products
- Design or R&D (4) (one mentioned in the field of electric and electronics)
- Air conditioning
- Mechanical engineer for power plant engineering & design
- Industrial piping system design of several types e.g. fire hydrant system, stream system
- Programmers
- Microelectronics /PCB / embedded software, and product testing (for new products, e.g. IoT, medical device, smart products) etc.)
- Metal stamping tool and die design
- 3D design (2)
- Jig design

English
- None

Management and Problem Solving
- Engineers with management skill or production development skill
- Engineers who are up-to-date with limitation in terms of current principle and regulations

Others
- Not enough engineers in needed field because they change their job very often
- Engineers who can be self-developed

Q4.1 (4): Problems or difficulties resulting from lack of competent engineers

<Japanese Companies> n=19
Have to ask support from HQs in Japan
- Minor problems happening to production process cannot be solved locally. We need to request the headquarters to help.
- The DD section in the headquarters have to continue to support DD work in Thailand (2).
- We still have to rely on other companies and the headquarters for designing.

Causing delay of schedule or work progress by shortage of engineers
- The time from new product development to actually production is long in Thailand.
- Delays in project implementation and trouble shooting
- The possibility of causing problem to future operation plan
- Technology transfer from Japan to Thailand is slow.
- Delay in DD work
- Unable to produce new products in Thailand
- Overall management
- Unable to increase production

- D.D. work requires too much time to comply with clients' request or deadline.
- Delay in solving problems in production

Human Resources

- Cannot transfer responsibilities to Thai engineers.
- Cannot produce competent engineers after years of operation in Thailand
- Lots of time needed to train engineers, but many of them quit.
- Too much burden on the Japanese engineers
- Leads to shortage of manpower

Others

- Unable to solve problems in compliance with instructions from the headquarters (their knowledge is limited.)

<Thai Companies> n=16

Work attitudes or capacity

- Only work on the task assigned (do not engage in other development)
- Cannot finish the work as assigned
- They work slowly and inefficient
- Production development is slow

Technical Skills

- Presentation skill, English communication
- The company is unable to do product design work. Can only do product installation and it is such a lost opportunity
- Product design and development promotion services, and product testing services expansion

Causing delay of schedule or work progress

- Unable to response to market's need in time
- Technology development knowledge
- Lack of product variation to meet the customers' need. Product quality is not good enough
- The company's development plan got delayed

Human Resources

- It takes time to train staff who are not graduated from engineering field to work because they need to learn basics and build skills
- Unable to understand the design/plan
- They quit the job for a new company that pays better
- Newly graduates do not have enough experience and unable to meet the need of the company

Others

- Thailand is an agrarian country

Production Engineers

Q4.2 (1): Companies' opinions about the number of engineers at production department

In total, more than half of the companies responded to the survey satisfied the number of engineers in production departments (60.3%). When looking at companies in two countries, the Japanese companies tends to feel lack of number of production engineers more than Thai companies, showing that 37.1% of responded Japanese companies think the number of production engineers is "slightly insufficient", whereas 15.2% of responded Thai companies think so.

Table 15 Companies' opinions about the number of engineers at production department

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Sufficient	3	8.6%	5	15.2%	8	11.8%
Sufficient to some extent	15	42.9%	18	54.5%	33	48.5%
Slightly insufficient	13	37.1%	5	15.2%	18	26.5%
Insufficient	3	8.6%	1	3.0%	4	5.9%
Others	1	2.9%	4	12.1%	5	7.4%
Total	35	100.0%	33	100.0%	68	100.0%
NA	36	-	29	-	65	-
Rating Ave.	2.46		2.58		2.51	

Average is calculated on the scale of 1 to 4: Sufficient=4, Sufficient to some extent=3, Not so sufficient=2, insufficient=1".

Rating Average is divided by the total number of "Sufficient", "Sufficient to some extent", "Not so sufficient", and "insufficient".

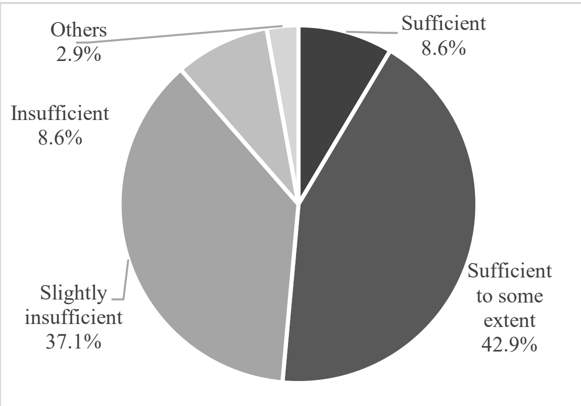


Figure 13 Japanese companies opinions about the number of production engineers

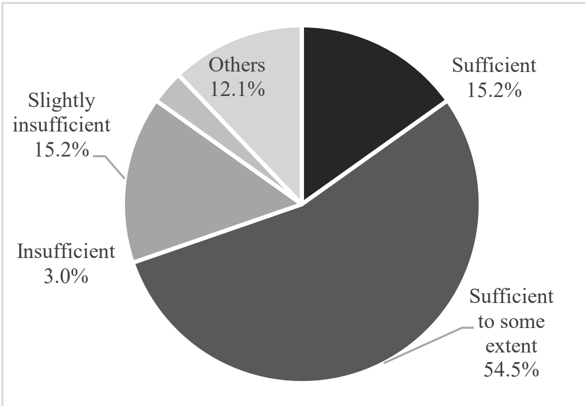


Figure 14 Thai companies opinions about the number of production engineers

Q4.2 (2) Companies' satisfaction level with quality and skill level of production engineers

In total, among the companies responded to the survey, 60.6% of them satisfied the quality and skill level of production engineers at their own companies. When comparing their responses separately in two countries, 55.9% of responded Japanese companies are not so much satisfied or satisfied with their skill level, whereas only 12.5% of Thai companies are not so much satisfied with their level.

Table 16 Companies' satisfaction level with quality and skill level of production engineers

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Satisfied very much	1	2.9%	4	12.5%	5	7.6%
Satisfied to some extent	14	41.2%	21	65.6%	35	53.0%
Not so satisfied	15	44.1%	4	12.5%	19	28.8%
Unsatisfied	4	11.8%	0	0.0%	4	6.1%
Others	0	0.0%	3	9.4%	3	4.5%
Total	34	100.0%	32	100.0%	66	100.0%

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
NA	37	-	30	-	67	-
Rating Ave.	2.35		3.00		2.65	

Average is calculated on the scale of 1 to 4: Satisfied very much=4, Satisfied to some extent=3, Not so satisfied=2, unsatisfied=1".
Rating Average is divided by the total number of "Satisfied very much", "Satisfied to some extent", "Not so satisfied", and "unsatisfied".

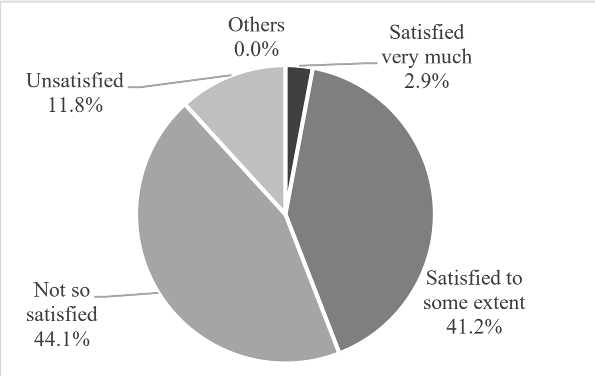


Figure 15 Satisfaction level of <u>Japanese</u> companies with quality and skill level of production engineers

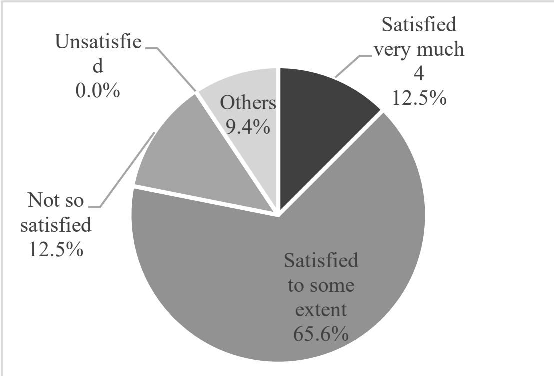


Figure 16 Satisfaction level of <u>Thai</u> companies with quality and skill level of production engineers

Q4.2 (3) Type of engineers the companies look for.

<Japanese Companies> n=15

Basic knowledge

- Basic mathematics is very weak.
- Their mathematics capacity is limited. I hope they are able to understand high school mathematics in Japan
- Limited kowledge

English

- English communication skills

Problem Solving

- They seem not to know the process of problem solving. So, they react only problems happen or wait for Japanese engineers to give instructions.
- Very few can try to find solutions themselves.
- Logical thinking needs to be strengthened.
- Few can contribute to productivity improvement.

Technical Skills

- The engineers who have knowledge in metallurgy, material engineering and able to do heat treatment.
- Limited availability of production and manufacturing engineers.
- Shortage of engineers who know molding machines and mold & die technologies.
- Thai engineers are not so familiar with programming of mounter and AOI setting

Management

- Shortage of managers of chemical plants.

- Generally speaking, many seminar engineers in automotive industry but not so many in chemical engineering.
- Engineers with leadership

Others
- Difficult to attract talents in the suburb.
- Engineers with Japanese language proficiency

<Thai Companies> n=11

Problem Solving
- Need engineers who understand a variety of production process and who can analyze problems from real causes

Technical Skills
- Have experience in designing and developing automation machines
- Lean Process
- Lacking chemical engineers
- Electric engineers
- Engineers in automation system development and tool & die design
- Production engineer. Right now we cannot balance the production line
- Engineers with knowledge and understanding on chemical and polymer
- Engineers with molding, plating, e-coating, soldering skills and knowledge on APQP,PPAP,SPC,MSA,SIX SIGMA
- Mechanical and industrial engineers

Q4.2 (4) Problems or difficulties resulting from lack of competent engineers

<Japanese companies> n=16
Have to ask support from HQs in Japan
- Unable to solve problems and end up asking for help to the headquarters.
- Ask help to the headquarters very often (2)
- Few are multitasking, so work has been divided for each engineer. This is time-consuming.

Causing delay of schedule or work progress
- Breakdown of machinery due to poor maintenance
- Unable to predict production plan
- Stop the operation of molding machines
- Responsibility tends to disproportionally given to a few engineers who are competent.

Human Resources
- Long time required to train engineers
- Increase of burden on Japanese engineers
- Long time required until they can be trained to work in a position
- Shortage of manpower
- Cannot vision a future operation as we do not have Thai managers.

Others
- Those companies that do not do mass production have more problem because engineers don't contribute production efficiency or productivity enhancement.
- Productivity enhancement does not progress in the factory.
- KAIZEN has not progress.
- Weak leadership

<Thai companies> n=12

Causing delay of schedule or work progress

- Delay in productivity development technology
- Conceal losses
- Delay in production so cannot meet the need of sales department. As a result, loss of profit
- Delay in work plan
- Lost opportunity in production process improvement, effectiveness
- Lost of time. Work is unprofitable
- Unable to support production process to meet the need and unable to solve problems effectively
- Delay in production process improvement and the increase of productivity is not as high as planned

Human Resources

- Might have to rely on foreign experts
- No successor
- Lack of continuity in transferring techniques and skills that require specific knowledge and understanding

<u>Technicians</u>

Q4.3 (1): Companies' opinion about number of technicians

Table 17 Companies' opinions about the number of technicians

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Sufficient	4	11.1%	11	32.4%	15	21.4%
Sufficient to some extent	18	50.0%	20	58.8%	38	54.3%
Slightly insufficient	11	30.6%	4	11.8%	15	21.4%
Insufficient	2	5.6%	0	0.0%	2	2.9%
Other	1	2.8%	0	0.0%	1	1.4%
Total	36	100.0%	34	100.0%	70	100.0%
NA	35	-	28	-	63	-
Rating Ave.	2.69		3.29		2.99	

Average is calculated on the scale of 1 to 4: Sufficient=4, Sufficient to some extent=3, Not so sufficient=2, insufficient=1".
Rating Average is divided by the total number of "Sufficient", "Sufficient to some extent", "Not so sufficient", and "insufficient".

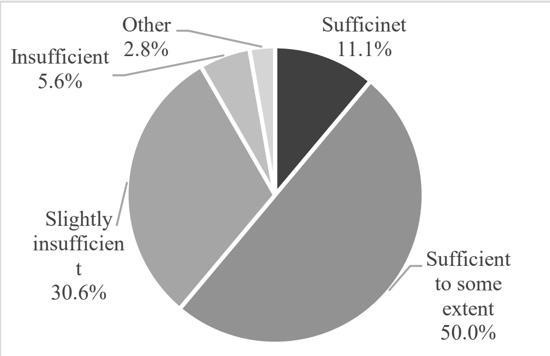


Figure 17 <u>Japanese</u> companies' opinions about the number of technicians

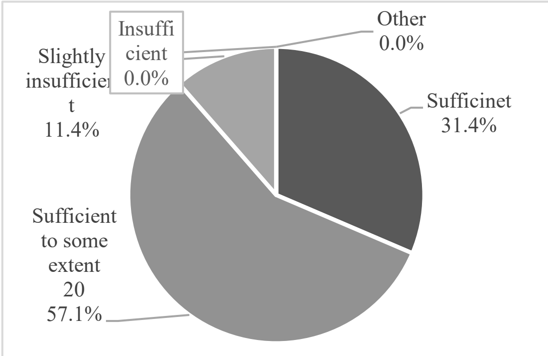


Figure 18 <u>Thai</u> companies' opinion about the number of technicians

Q4.3 (2) Companies' satisfaction level with quality and skill level of technicians

Table 18 Companies' opinion about quality and skill level of technician

	Japanese Companies		Thai Companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Satisfied very much	0	0.0%	5	14.7%	5	7.2%
Satisfied to some extent	16	45.7%	23	67.6%	39	56.5%
Not so satisfied	12	34.3%	6	17.6%	18	26.1%
Unsatisfied	5	14.3%	0	0.0%	5	7.2%
Other	2	5.7%	0	0.0%	2	2.9%
Total	35	100.0%	34	100.0%	69	100.0%
NA	36	-	28	-	64	-
Rating Ave.	2.33		2.97		2.66	

Average is calculated on the scale of 1 to 4: Satisfied very much=4, Satisfied to some extent=3, Not so satisfied=2, unsatisfied=1".
Rating Average is divided by the total number of "Satisfied very much", "Satisfied to some extent", "Not so satisfied", and "unsatisfied".

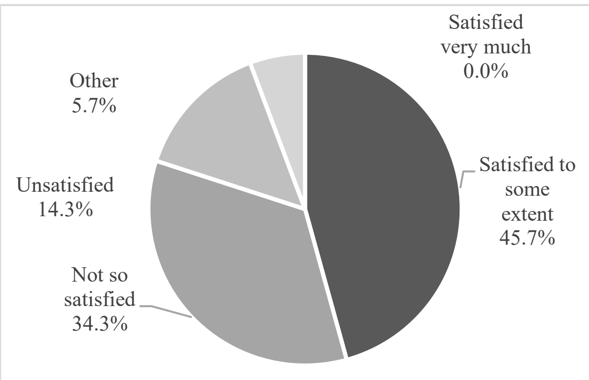


Figure 19 Satisfaction level of <u>Japanese</u> companies with quality and skill level of technicians

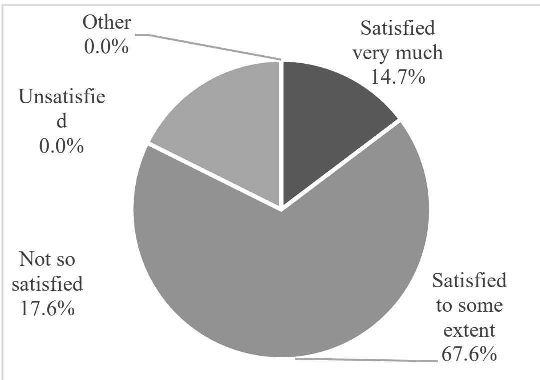


Figure 20 Satisfaction level of <u>Thai</u> companies with quality and skill level of technicians

Q4.3 (3) Type of technicians the companies look for.

<Japanese Companies> n=13

- The technicians who can do O&M of electric system
- Those who can prevent problems caused by poor maintenance
- Technicians who can take care of production system
- The turnover is too high. We always train new people.
- The technicians who can do preventive maintenance
- Not enough technicians who can stay long enough to receive knowledge and know-how of production
- CAD/CAM operators
- Mold & die technicians (2)
- Technology transfer is too difficult due to a very high turnover rate.
- New graduates are not ready technically.
- Those who can do process management and quality control
- Those who have managerial capacity
  Electric and electronic technicians

<Thai companies> n=7

- Higher certificate graduates (BWS) have less skills than before
- Needs expert who is highly skillful in chemical industry
- Need one who can solve problems when they fact them and who is able to report problems and causes effectively
- Power electric
- Productivity process control
- Technicians with management skills

Q4.3 (4) Problems or difficulties resulting from lack of competent technicians

<Japanese Companies> n=11

- We contract out O&M because the company cannot do it itself.
- Unable to increase production
- Delay in standardization of production activities
- Increased risk of stopping of molding machines
- Unable to transfer technology SOPs cannot be fully applied
- Work does not progress during the absence of Japanese staff
- Takes too much time for staff training
- Cannot meet the deadlines. The quality of the products is low.
- Not enough staff who can act as a manager
- Time loss due to system/facility breakdown

<Thai companies> n=10

- Delay in production process due to the lack of certain practical skills and problem solving skills while working
- Presentation skill and English communication
- Have to rely on foreign experts
- Must train them for a few year
- When problems occur and customers are aware of them
- Not enough employee in terms of quantity
- Problem solving in delay of productivity line

- Unable to solve problems when they occur
- Have to learn the same thing over and over again. Not enthusiastic in learning new knowledge and unable to work without mentor

Q5: Knowledge or skills which university or TC should teach students who can pursue their work appropriately at their workplace after graduation.

Three top priorities that Japanese companies think university or TC should teach students are as below:

1) Attitude to works and discipline (22 respondents, 61.6%)
2) Research and problem identification (18, 50.0%)
3) Management skills (management of team or department) (17, 47.2%)
3) Experience and know-how of problem-solving (17, 47.2%)

Three top priorities that Thai companies think university or TC should teach students are:

1) Communication skills (24 respondents, 72.7%)
2) Management skills (management of team or department) (19, 57.6%)
2) Engineering knowledge (19, 57.6%)

From the results, the Japanese companies responded to the survey tend to put priorities on discipline, management skills, or analytical/problem-solving skills more than technical knowledge or skills. Thai companies responded to the survey also put priorities on communication or management skills as well as knowledge about engineering.

Table 19 Knowledge or skills which university or TC should teach students

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Basic knowledge of math and science	16	44.4%	11	33.3%	27	39.1%
Engineering knowledge	8	22.2%	19	57.6%	27	39.1%
Knowledge of production technology, system and machine	16	44.4%	17	51.5%	33	47.8%
Knowledge of design and development	10	27.8%	11	33.3%	21	30.4%
Management skills (management of team or department)	17	47.2%	19	57.6%	36	52.2%
Communication skills	16	44.4%	24	72.7%	40	58.0%
IT knowledge	3	8.3%	4	12.1%	7	10.1%
Research and problem identification	18	50.0%	18	54.5%	36	52.2%
Experience and know-how of problem-solving	17	47.2%	17	51.5%	34	49.3%
Attitude to works and discipline	22	61.1%	18	54.5%	40	58.0%
Method of corporate management /production management	5	13.9%	9	27.3%	14	20.3%
Others	1	2.8%	2	6.1%	3	4.3%
Total	36	100.0%	33	100.0%	69	100.0%
NA	35	-	29	-	64	-

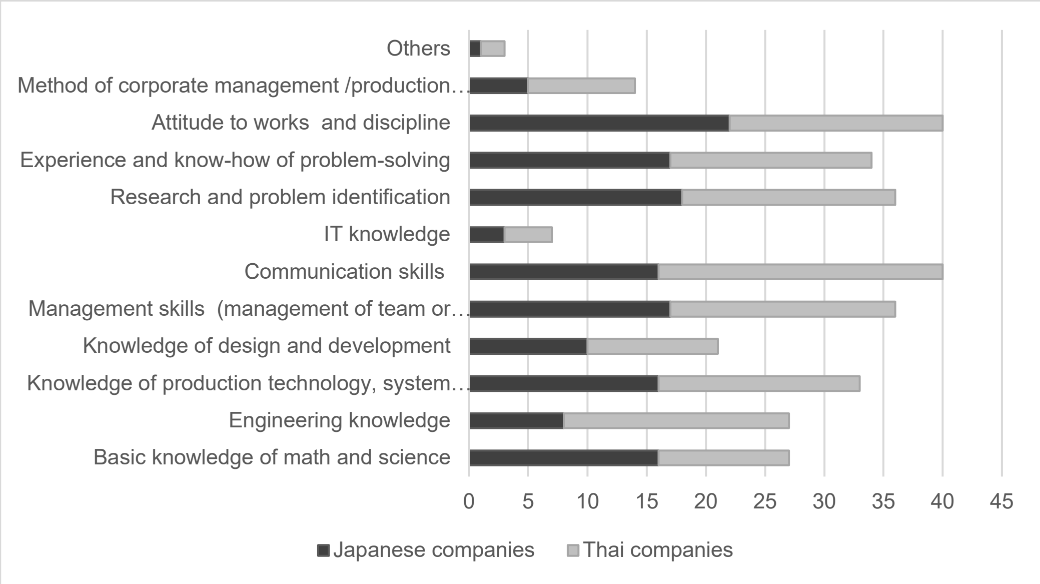


Figure 21 Knowledge or skills which technical staff of companies should acquires through education at university or TC.

Q6.1: What measures are taken to compensate the lack of capacities of the engineers or technicians employed. (Multiple choices)

Table 20 Measures are taken to compensate the lack of capacities of the engineers or technicians employed

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Training in company (in Thailand)	28	80.0%	31	91.2%	59	85.5%
Training in company (in Japan)	18	51.4%	16	47.1%	34	49.3%
Training in third countries	0	0.0%	7	20.6%	7	10.1%
External training (public institutes)	9	25.7%	16	47.1%	25	36.2%
External training (private organization)	13	37.1%	18	52.9%	31	44.9%
External training (private enterprise)	6	17.1%	19	55.9%	25	36.2%
External training (higher educational institutes)	1	2.9%	8	23.5%	9	13.0%
Individual guidance such as mentor	2	5.7%	28	82.4%	30	43.5%
Invite Japanese engineers	23	65.7%	15	44.1%	38	55.1%
Invite engineers from third countries	2	5.7%	4	11.8%	6	8.7%
No special training	1	2.9%	0	0.0%	1	1.4%
Others	2	5.7%	3	8.8%	5	7.2%
Total	35	100.0%	34	100.0%	69	100.0 %
NA	36		28		64	

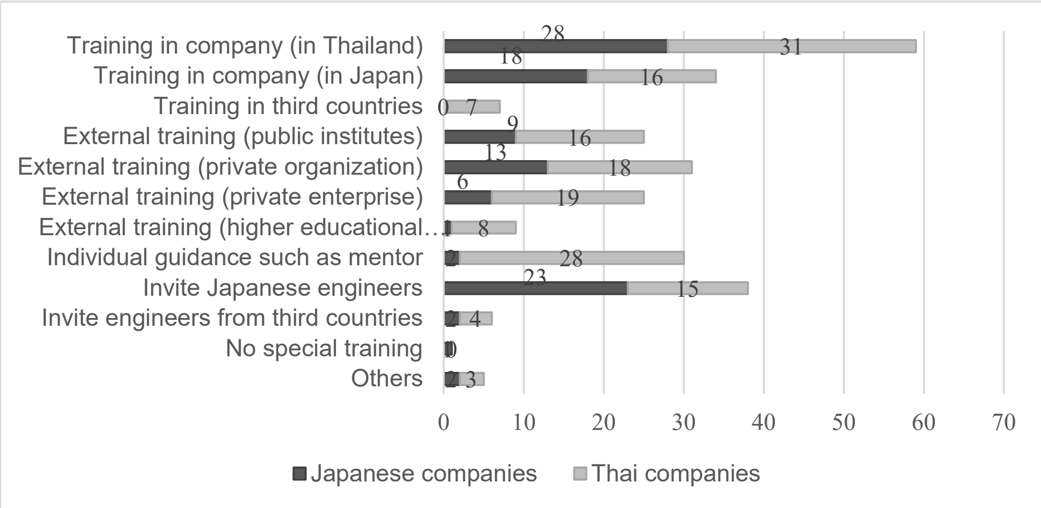


Figure 22 Measures are taken to compensate the lack of capacities of the engineers or technicians employed

Q6.2 Whether the measures taken at Q6.1 become a big burden for your companies.

65% of responded Japanese companies and 45.5% of Thai companies think it is burden of taking some measures to compensate the lack of capacities of the engineers or technicians. When looking at 51.5% of responded Thai companies which think it is not a big burden to do it, Japanese companies feel more burdens of doing it at their own companies.

Table 21 Whether the measures taken become a big burden for a company

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Become a big burden	5	14.3%	1	3.0%	6	8.8%
Become a big burden to some extent	23	65.7%	15	45.5%	38	55.9%
Not a big burden	7	20.0%	17	51.5%	24	35.3%
Total	35	100.0%	33	100.0%	68	100.0%
NA	36	-	29	-	65	-

Q7.1: Support provided to universities or TCs in Thailand in the last three years (Multiple choices)

Table 22 Support provided to universities or TCs in Thailand in the last three years

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Joint research	1	4.5%	7	22.6%	8	15.1%
Contract-out of research	1	4.5%	6	19.4%	7	13.2%
Accepting internship students (less	5	22.7%	1	3.2%	6	11.3%

than 1 month)						
Accepting internship students (more than 1 month)	13	59.1%	16	51.6%	29	54.7%
Accepting internship students (more than 6 month)	3	13.6%	4	12.9%	7	13.2%
Joint class	0	0.0%	8	25.8%	8	15.1%
Dispatch of staff as a lecturer	3	13.6%	2	6.5%	5	9.4%
Endowed chair	2	9.1%	3	9.7%	5	9.4%
Sending engineers to graduate program	1	4.5%	6	19.4%	7	13.2%
Provision of scholarship to students	5	22.7%	13	41.9%	18	34.0%
Advisor to university	1	4.5%	3	9.7%	4	7.5%
Transfer of staff to university	0	0.0%	0	0.0%	0	0.0%
Contribution for facility improvement	2	9.1%	0	0.0%	2	3.8%
Donation of equipment	0	0.0%	2	6.5%	2	3.8%
Sponsorship for student activities	2	9.1%	4	12.9%	6	11.3%
Financial/technical support	1	4.5%	9	29.0%	10	18.9%
Others	2	9.1%	7	22.6%	9	17.0%
Total	22	100.0%	31	100.0%	53	100.0%
NA	49	-	31	-	80	-

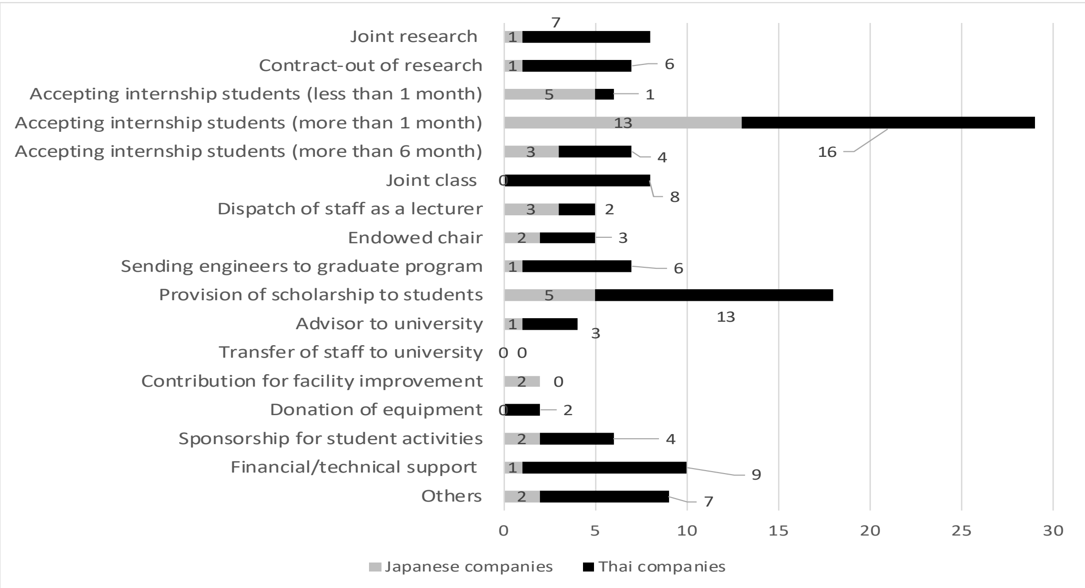


Figure 23 Support provided to universities or TCs in Thailand in the last three years

Q7.2: Support which can be provided to universities or TCs in Thailand in the future (Multiple choices)

Table 23 Support which can be provided to universities or TCs in Thailand in the future

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Joint research	4	16.7%	11	33.3%	15	26.3%

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Contract-out of research	1	4.2%	6	18.2%	7	12.3%
Accepting internship students (less than 1 month)	7	29.2%	1	3.0%	8	14.0%
Accepting internship students (more than 1 month)	14	58.3%	13	39.4%	27	47.4%
Accepting internship students (more than 6 month)	9	37.5%	11	33.3%	20	35.1%
Joint class	2	8.3%	11	33.3%	13	22.8%
Dispatch of staff as a lecturer	3	12.5%	4	12.1%	7	12.3%
Endowed chair	1	4.2%	7	21.2%	8	14.0%
Sending engineers to graduate program	2	8.3%	7	21.2%	9	15.8%
Provision of scholarship to students	3	12.5%	10	30.3%	13	22.8%
Advisor to university	3	12.5%	7	21.2%	10	17.5%
Transfer of staff to university	0	0.0%	2	6.1%	2	3.5%
Contribution for facility improvement	1	4.2%	2	6.1%	3	5.3%
Donation of equipment	1	4.2%	6	18.2%	7	12.3%
Sponsorship for student activities	1	4.2%	4	12.1%	5	8.8%
Financial/technical support	3	12.5%	9	27.3%	12	21.1%
Others	1	4.2%	1	3.0%	2	3.5%
Total	24	100.0%	33	100.0 %	57	100.0%
NA	47	-	29	-	76	-

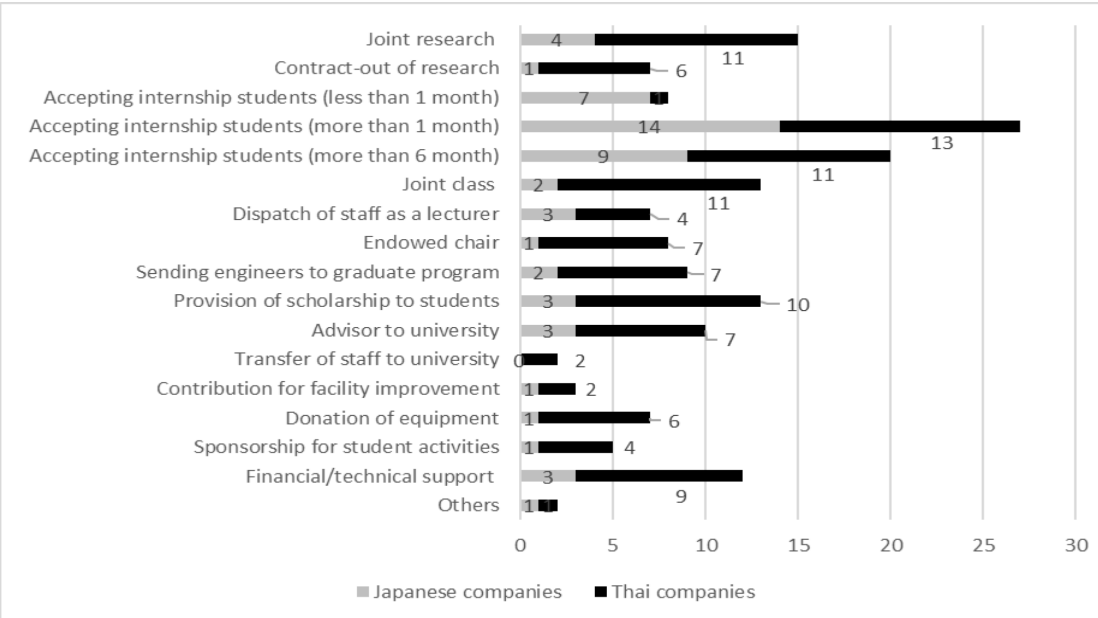


Figure 24 Support which can be provided to universities or TCs in Thailand in the future

Q8.1: Skills qualification which can be advantage of recruits of engineers or technicians and promotion/salary increase at your company (Multiple choices)

Table 24 Skills qualification that private companies recognize it as advantage

	Japanese com.		Thai com.		Total	
	Rating Ave.	Res. Count	Rating Ave	Res. Count	Rating Ave	Res. Count
APEC engineer	1.50	26	1.26	27	1.38	53
Registered engineer by COE	1.76	25	1.55	29	1.65	54
Language certificate	2.00	29	1.88	33	1.94	62
TPQI qualifications	1.48	25	1.46	28	1.47	53
Bachelor's degree	1.63	24	2.12	33	1.91	57
Master degree	1.60	25	1.61	28	1.60	53
Ph.D.	1.60	25	1.48	25	1.54	50
Other public certificates	1.71	28	1.47	30	1.59	58
Other private certificates	1.65	26	1.44	27	1.55	53
Total responses		34		34		68
NA		37		28		65

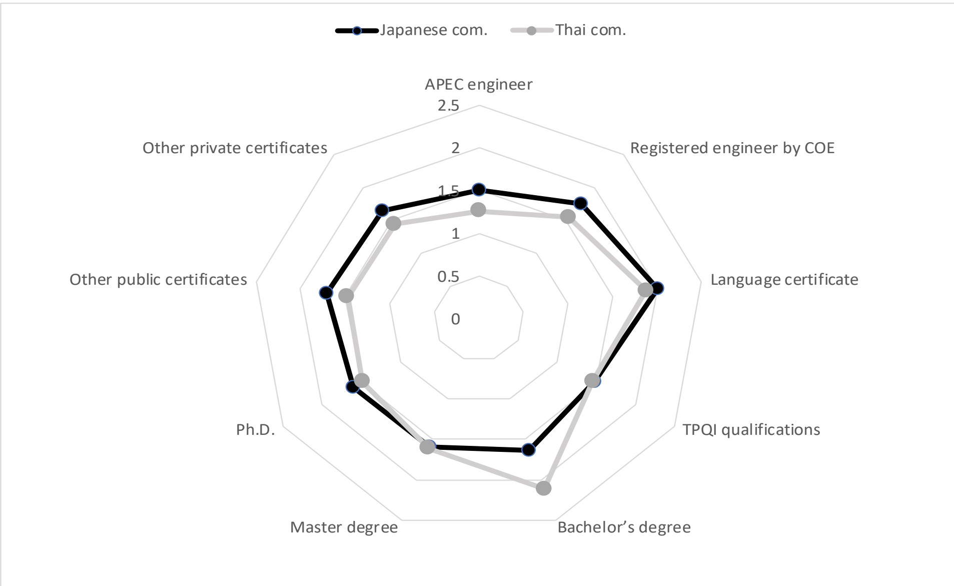


Figure 25 Skills qualification that private companies recognize it as advantage

Q8.2 Skills qualification that companies promote

<Japanese Companies>

Table 25 Skills qualification that Japanese companies promote

	Res. Count	%
APEC engineer	2	9.1%
Registered engineer by COE	7	31.8%

	Res. Count	%
Language certificate	14	63.6%
TPQI qualifications	1	4.5%
Bachelor's degree	5	22.7%
Master degree	3	13.6%
Ph.D.	3	13.6%
Other public certificates	6	27.3%
Other private certificates	2	9.1%
Company's qualifications	3	13.6%
Total responses		
NA		

<Thai Companies>

Table 26 Skills qualification that Thai companies promote

	Rating Ave.	Res. Count
APEC Engineer License	1.33	18
License for Professional Engineer	1.71	24
English Language proficiency certificate (Engli	1.96	27
Certificate from TPQI	1.43	21
Bachalor degree	2.14	22
Master degree	1.50	20
Doctor degree	1.47	19
License or certificate from government agencies	1.74	23
License or certificate from private agencies	1.70	20
Total responses	-	30
NA	-	32

Q9: Diploma or Master course for Monozukuri

Table 27 Companies' interest in diploma or master course for Monozukuri (Multiple choices)

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Would consider the recruitment of graduates of a MONOZUKURI program	16	57.1%	17	51.5%	33	54.1%
Would consider support (financial or sending staff to a program)	11	39.3%	6	18.2%	17	27.9%
Would encourage the staff to study at a MONOZUKURI program	4	14.3%	10	30.3%	14	23.0%
Others	2	7.1%	7	21.2%	9	14.8%
Total	28	100.0%	33	100.0%	61	100.0%
NA	43	-	29	-	72	-

Q10: Companies' interest in employing more number of TC graduates if the capacity of TCs is enhanced.

Table 28 Companies' interest in employing more number of TC graduates (Multiple choices)

	Japanese companies		Thai companies		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
It is possible to recruit TC graduates as engineers if their competencies are high.	20	60.6 %	8	23.5 %	28	41.8 %
Company regulations or labor administration rules stipulated that engineers must have degrees from universities	2	6.1%	1	2.9%	3	4.5%
Even if their competencies are high, TC graduates will be recruited as technicians, but not engineers.	7	21.2 %	10	29.4 %	17	25.4 %
We have little interest in recruiting TC graduates since the target of engineering positions are university graduates	2	6.1%	7	20.6 %	9	13.4 %
Not interested in recruiting TC graduates because there is not much need to utilize technicians	1	3.0%	2	5.9%	3	4.5%
Others (specify)	3	9.1%	8	23.5 %	11	16.4 %
Total	33	-	34	-	67	-
NA	38	-	28	-	66	-

Q11: Skills, knowledge, equipment or machines that students should acquire or know how to use it.

<Japanese companies> n=11

- Solid knowledge in basic math, physics and natural sciences
- First of all basic mathematical knowledge, then ability to apply such knowledge and analytical skill to solve problems
- NC and machining
- CAD operation (3)
- PLC and robotics
- Basic knowledge in engineering and math and science
- Logical thinking
- Basic knowledge is enough for O&M of machinery. Analytical knowledge, management capacity and breath of vision are more important.

<Thai companies> n=30

- Those who can adapt to technology
- Understanding of English language, because most of data engineer has to input is in English
- Knowledge on equipment and machinery, according to their study background

- English language communication and presentation. Those who can work with foreigners and are technology literate in, e.g. 3D printer and AR usage. Those who are creative and innovative
- Computer skills, e.g. computer programming
- PLC or basic machinery programming
- Robot
- Chemical industry
- 3D design
  - Computer/program
- Product testing and measurement
- Those with knowledge on technique and skills on the use of equipment for installation and service
- Automation and industrial robotic
- Those who are applicable and innovative
- Presentation of problem solving method that is understandable, fast and accurate
- Design and highly accurate tool and die production skill
- Computer
- Automation technique
- 3D design
- Automatic control system
- Understanding computer programming, e.g. calculation computer software
- Usage of technology to analyst problems that occur in production process. Usage of technology to work for people
- Embeded Program, Robotic, Advance CNC, Advance PLC, Wireless Technology
- Work planning and processing
- Knowledge on industrial robotic arms and add-on automation
- IT and machinery
- IT and measurement tools
- Knowledge on how to adapt computer programs to work better

Q12: Other comments

<Japanese Companies>   n=13

- Universities should demand that basic education curriculums be improved.
- Turnover of staff is too high. School education can probably do something about it.
- Difficult to utilize staff
- Need more proactive attitude to search for solutions
- The demand for industrial robots will be increased in Thailand. Universities and technical colleges should focus more on robotics and programming.
- Need to produce more students who have a strong orientation toward technologies
- Need more English proficiency
- Need more engineers who can act independently
- Our company needs only industry-ready staff. New graduates are not ready.
- In order to improve higher education, basic education should be improved first. Hope that Thailand can improve basic education to foster a strong sense of responsibility, discipline and basic mathematical knowledge

- Some university graduates are not different from technical college graduates.
- The quality of teachers needs to be improved.

<Thai Companies> n=24

- Do not focus much on lecture, but focus on practice or presentation
- According to the law, some engineers/technicians need a certain kind of work certificate so they should hold necessary certificate too
- Wish that institute focuses more on practical subject and teach students how to use equipment and machine as well as to analysis problems
- Institution needs to cooperate closely with company and has policy that promote the cooperation, e.g. having people from industry sector to teach students
- Curriculum of each school plays a big part in how students think
- Institution has to meet with companies and work with them, be a supplier of labor to factory such as Toyota college
- Focus on training students to have responsibility. Talented students are easy to find, but responsible and dedicated students are hard to find
- Improve capacity of professor, update textbook, analysis data center
- Improve skills on analysis, presentation, business competency and continue self-development
- Improve skills on English communication, work attitude (to be more patient at work)
- Increase courses on practical skills and knowledge, and perspective development. Encourage students to have new idea that would help them to save time when working. Improve presentation skill
- Focus more on drawing and reading pattern
- Please let us know the result of this survey **
- Focus more on practical subject. Work more with companies
- Focus more on practical subject. Have students work at a company for 1 year
- Improve skill on how to handle equipment and controlling programs
- Wish that students will have a chance to work in a company and have a chance to do some experiments so they can also adjust easily to working in a company (when they have to work)
- Institutions should study market needs to see what position is lacking and produce worker accordingly. Graduates should be able to work efficiently or able to learn how to work right away after graduation
- Focus on knowledge on innovation, R&D more than job routine
- Train students in teamwork and how to follow rules and regulations.
- An important skill that all students need is English language. And they should be patient, responsible and honest.
- Institutions should have courses that match with actual work in industry sector. Graduates should be able to work immediately after got accepted in a company
- Focus on academic. No need to divide engineer course into several sub-course. Encourage students to have responsibility so they can work more efficiently
- Promote English language education and improve analysis skills of students

Note: Some questions are cited from Chiba University "Study report on the way to develop science and technology human resources" Ministry of Education, Culture, Sports, Science and Technology, 2015.

ANNEX 8 - 2

Data Summary of Survey for College/University

Q2-1: What % of your students become engineers after graduation?

(1) Central Government

Percentage	Res. Counts	%
80%	3	13.6%
61%	1	4.5%
60%	1	4.5%
50%	7	31.8%
30%	4	18.2%
15%	1	4.5%
10%	2	9.1%
0%	3	13.6%
Total	22	100.0%
NA	103	-

(2) Tuition Fees

Percentage	Res. Counts	%
20%	3	10.3%
35%	1	3.4%
39%	1	3.4%
40%	3	10.3%
45%	1	3.4%
50%	6	20.7%
70%	1	3.4%
80%	2	6.9%
90%	2	6.9%
100%	9	31.0%
Total	29	100.0%
NA	96	-

(3) Private Sector

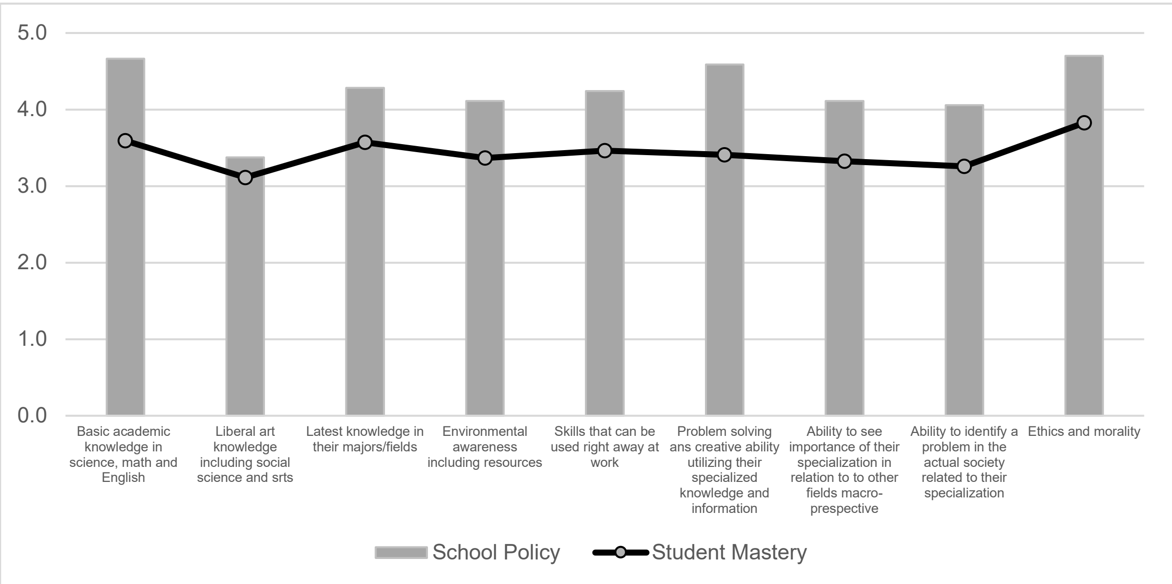
Percentage	Res. Counts	%
0%	3	27.3%
5%	2	18.2%
10%	2	18.2%
20%	2	18.2%
Total	11	100.0%
NA	114	-

(4) Others

Percentage	Res. Counts	%
0	2	25.0%
5	2	25.0%
10	1	12.5%
30	1	12.5%
Total	8	100.0%
NA	119	-

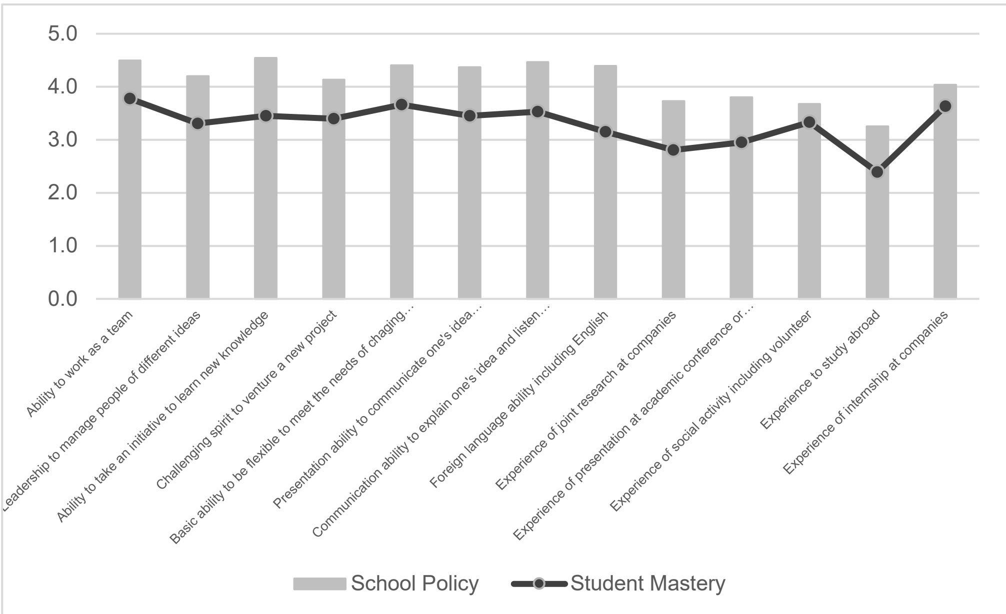
Q3. In your school, what do you think important knowledge and skills? Do you think your students have acquired those knowledge and skills?

	School Policy		Student Mastery	
	Rating Ave.	Res. Counts	Rating Ave.	Res. Counts
Basic academic knowledge in science, math and English	4.7	107	3.6	98
Liberal art knowledge including social science and arts	3.4	107	3.1	98
Latest knowledge in their majors/fields	4.3	106	3.6	98
Environmental awareness including resources	4.1	107	3.4	98
Skills that can be used right away at work	4.2	107	3.5	97
Problem solving and creative ability utilizing their specialized knowledge and information	4.6	107	3.4	98
Ability to see importance of their specialization in relation to other fields macro-perspective	4.1	107	3.3	98
Ability to identify a problem in the actual society related to their specialization	4.1	107	3.3	97
Ethics and morality	4.7	107	3.8	98



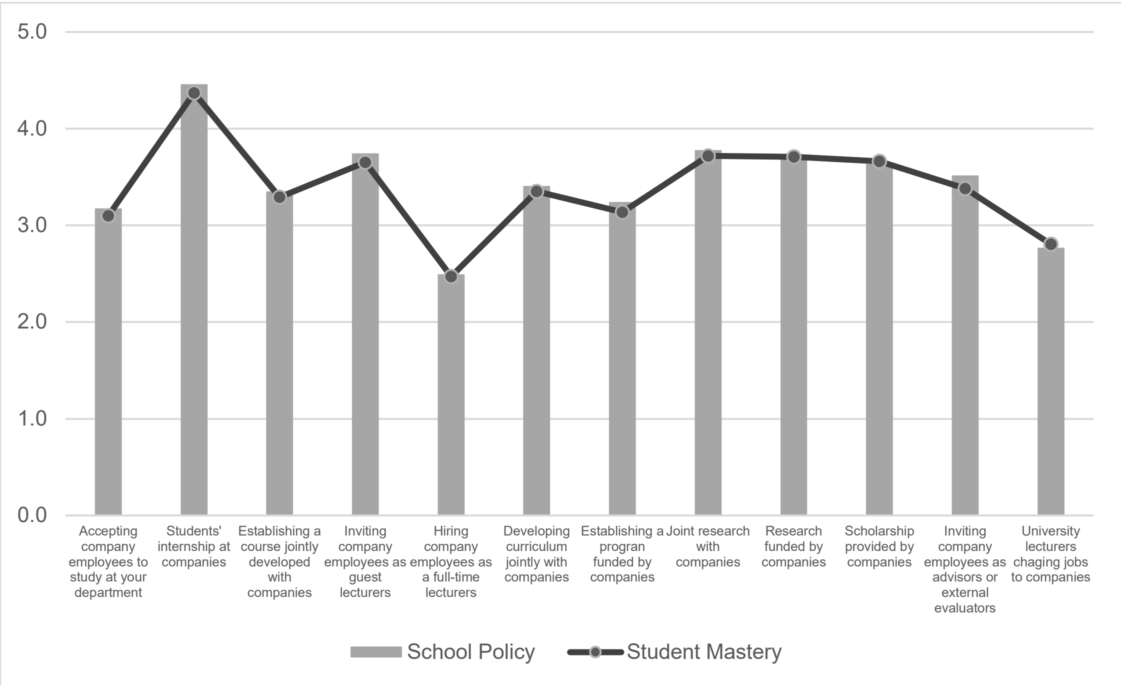
Q4. In your school, what do you think important knowledge and skills? Do you think your students have acquired those knowledge and skills?

	School Policy		Student Mastery	
	Rating Ave.	Res. Counts	Rating Ave.	Res. Counts
Ability to work as a team	4.5	107	3.8	98
Leadership to manage people of different ideas	4.2	106	3.3	98
Ability to take an initiative to learn new knowledge	4.5	107	3.4	98
Challenging spirit to venture a new project	4.1	106	3.4	98
Basic ability to be flexible to meet the needs of changing society	4.4	107	3.7	98
Presentation ability to communicate one's idea appropriately	4.4	106	3.4	98
Communication ability to explain one's idea and listen to others	4.5	107	3.5	98
Foreign language ability including English	4.4	107	3.2	98
Experience of joint research at companies	3.7	107	2.8	98
Experience of presentation at academic conference or oral presentation	3.8	107	2.9	97
Experience of social activity including volunteer	3.7	107	3.3	97
Experience to study abroad	3.3	107	2.4	97
Experience of internship at companies	4.0	107	3.6	96



Q5: University-Industry Linkage

	School Policy		Student Mastery	
	Rating Ave.	Res. Counts	Rating Ave.	Res. Counts
Accepting company employees to study at your department	3.2	91	3.1	89
Students' internship at companies	4.5	91	4.4	89
Establishing a course jointly developed with companies	3.4	91	3.3	89
Inviting company employees as guest lecturers	3.7	90	3.7	89
Hiring company employees as a full-time lecturer	2.5	91	2.5	89
Developing curriculum jointly with companies	3.4	91	3.4	88
Establishing a program funded by companies	3.2	91	3.1	89
Joint research with companies	3.8	90	3.7	89
Research funded by companies	3.7	90	3.7	89
Scholarship provided by companies	3.6	91	3.7	89
Inviting company employees as advisors or external evaluators	3.5	91	3.4	89
University lecturers changing jobs to companies	2.8	91	2.8	88



Q6: What do you think the most important abilities are in order for Thai industry to develop? Please rank top 3.

Top priorities are:

First priorities		Second priorities		Third priorities	
Responsibility	22.5%	Problem-solving ability	20.2%	Teamwork	22.2%
Problem-solving ability	15.7%	Communication	14.6%	Responsibility	17.8%
Conformity and flexibility	11.2%	Teamwork	13.5%	English language	13.3%
Basic knowledge	11.2%	—		Problem-solving ability	13.3%

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
English language	6	6.7%	10	11.2%	12	13.3%
Communication	2	2.2%	13	14.6%	9	10.0%
Conformity and flexibility	10	11.2%	8	9.0%	7	7.8%
Teamwork	5	5.6%	12	13.5%	20	22.2%
Leadership	1	1.1%	2	2.2%	0	0.0%
Responsibility	20	22.5%	8	9.0%	16	17.8%
Challenging spirit	1	1.1%	1	1.1%	1	1.1%
Taking an initiative	10	11.2%	2	2.2%	5	5.6%
Problem-solving ability	14	15.7%	18	20.2%	12	13.3%
Morality	6	6.7%	2	2.2%	3	3.3%
Basic knowledge	10	11.2%	10	11.2%	3	3.3%
Advanced knowledge in specialization	4	4.5%	3	3.4%	1	1.1%
Thai identity	0	0.0%	0	0.0%	1	1.1%
Others	0	0.0%	0	0.0%	0	0.0%
Total responses	89	-	89	-	90	-
NA	36	-	36	-	35	-

Q7: There is a project idea to establish a MONOZUKURI (focusing only on engineering, manufacturing and craftsmanship – not MOT/MBA) certificate/diploma/bachelor/master program at a Thai university.

Q7.1 (1) Does your university/faculty/department have a similar program?

	Res. Count	%
Yes	23	26.1%
No	42	47.7%
Don't know	23	26.1%
Total responses	88	100.0%
NA	37	-

(2) If the answer is yes, please describe the program(s), difficulties/challenges and possible areas for cooperation with JICA

(n=19)

- Several courses in BA level are tied with Council of Engineer and others organizations. So the content is old and out-of-date. There are too much lectures more than necessary and they cannot answer some industry needs. Some lecturers do not have experience with industry sector. Also it is difficult to accept BWC and BWS students to study BA due to complication of credit transferring. We have tried before but both sides (university and TC) cannot agree on terms. For MA and Ph.D. level, the university does not own high-technology research equipment and the number of students in this level is decreasing. Diploma course is not so popular.
- lack of modern equipment to improve students' skill
- lack of modern equipment to teach practical subject
- Department of Skill Development is under Ministry of Labor so they have small involvement in skill development of students. Cooperation between Ministries has budget problem so cooperation is very difficult. JICA can support this part so students in higher education level can improve their industry-related skills
- technology transfer
- The question is not clear. Should give example of what happen in Japan and (I) might be able to answer this question more. Like example on qualifications of Monozukuri students
- focus on production, practice and experiment
- There are difficulties in focusing on Hands-on education; 1. Students will have less time studying at university, 2. Lack of entrepreneur who have understanding in education and capacity to teach students
- n/a
- Our university has policy to produce graduates who have both practical and theoretical skills. Challenges, however, are to follow that policy within limited time and equipment
- We have mini-Project course for students before they can do their Senior Project. JICA can support Monozukuri at school during this mini-Project period
- We train students to be experts in academic and practice but equipment and teaching tools are still not enough
- "New production technology (10-20 years from now)

- Frontier technology"
- Development of equipment to be up-to-date and exchange of new technology
- project
- The program aims to produce practical engineers and also accepts BWC and BWS students to study BA but not enough up-to-date equipment, tool and teaching materials
- bring in industrial needs into account and design/produce products that the industry needs. The difficulty is customers' need changes all the time and their needs vary
- create curriculum with practical content, focusing on actual practice in company, e.g. installation and maintenance of cooling system and air-conditioning
- create high-quality products or services with technology

Q7.2 (1) Does your university have a plan or vision to establish a similar program?

	Res. Count	%
Yes	28	31.8%
No	17	19.3%
Don't know	43	48.9%
Total responses	88	100.0%
NA	37	-

(2) If your answer is yes, please describe the plan or vision, main progress to realize the plan, foreseen difficulties/challenges and possible areas for cooperation with JICA.

(n=21)

- due to competition, the university tries to open new courses that are needed by industry sector but have to get approval from OHEC. Also if there are new courses, lecturers will have to teach more classes. JICA can however support the university with this new courses
- wish that graduates from engineering faculty are equipped with academic and practical skills that meet the industry's needs (labor-wise)
- industrial robot
- our faculty has a plan to establish a course (continuous course) for BWS students of some major. But it's still in information gathering process
- Already have similar program (engineering faculty)
- Thammasart has established Sirindhorn International Institute of Technology, with cooperation from Federal of Thai Industry and Keidanren of Japan since 1992
- help university to connect to industry (that have connection with JICA) and foreign experts
- problem is the curriculum is controlled by related organizations
- there is an attempt to link project of 4th year student to industry section

- n/a
- Students are now studying a subject that is similar to Monozukuri
- students are now studying a subject that is similar to Monozukuri
- Same as 7.1
- improve curriculum to focus more on innovation and being a maker
- Long-term cooperation and partner-basis cooperation
- the program sounds good, can strengthen engineering background of students
- focus on graduates with practical skill
- is about to establish EIDI center to answer industry's needs
- have no experience. But if the training about the subject is organized, (I) will be pleased to join
- the university produce practical graduates and want to establish a professional skill testing unit
- has a project to bring alumni with experience in working in engineering field to co-teach with lecturers. But no new curriculum or program is established. However, it is not easy to find alumni with lot of experience. JICA can help sending expert to co-teach. But there might be language problem

Q8: JICA plans to enhance the capacities of technical colleges (engineering departments) under OVEC.

Q8.1: Does your university/faculty/department accept technical college graduates from the 3rd year as transferred students?

	Res. Count	%
Yes	15	18.3%
No	50	61.0%
Don't know	17	20.7%
Total responses	82	100.0%
NA	43	-

If the answer is yes, please provide the information.

a. The number of students accepted for 2015/2016 by the department (n=14)

Respondent's Number	No. of students accepted
1	30
2	none
3	12
4	none
5	200
6	500
7	22
8	30

Respondent's Number	No. of students accepted
9	60
10	10
11	0
12	4
13	15
14	50

b. The degree(s) these students would receive on graduation (n=15)

Degree	Res. count
BA of Engineer	15

c. Your observation about the weaknesses of these students (Please describe.). (n=15)

- Only 5 subjects can be transferred (credits)
- not enough basic knowledge esp. math and english
- not enough science and english knowledge
- English and math
- English and math
- not enough basic knowledge, english
- Cannot think, analyst, solve problems and self-studying
- Their basic mathematic knowledge is low Their English ability is very low
- academic knowledge
- math and calculation
- calculation skills
- Personally, (I) think all students can be improved
- Not enough mathematic foundation
- TC students and general track students do not have equal knowledge

Q 8.2: Does your university have a plan to accept technical college graduates from the 3rd year as transferred students? If the answer is yes, please describe the plan and reasons.

	Res. Count	%
Yes	17	21.3%
No	41	51.3%
Don't know	22	27.5%
Total responses	80	100.0%
NA	45	-

If the answer is yes, please describe the plan and reasons.
(n=13)

- Students can transfer credit but not all credits can be transferred. If they have study for 3 years they will have to study too hard (even during summer holiday) because there are lots of subjects to cover. They cannot study deeply because not enough time
- Specialty in practical skills that are important to working in company
- Already accept
- There is a plan to do so but have no idea when
- BA education is a 4 year program and accepts students from highschool of general track or vocational track (BWC) only. Students who transfer credit will start from 1st year
- Some credits can be transferred
- Some credits can be transferred but the rest TC students have to acquire at university level
- TC students (technicians) will have a chance to develop as engineers
- Now preparing continuous course/program that BWC students can continue their study and get BA degree
- Already accept
- TC students (technicians) will have a chance to gain more knowledge as engineers do
- TC students are good at practical subjects. If they can study more theory at university level, they can be more capable

Q8.3: If your university has no plan to accept technical college graduates from the 3rd year as transferred students, please describe the reasons for not taking any from technical colleges.
(n=29)

- Used to accept TC students to study in electric, mechanical and civil engineering course but a lot of them fail due to low score in mathematic. For chenical major, it is impossible because TC does not provide chemical subject
- different educational background
- No policy, subjects/class are not the same
- University's policy. However, there are plan in the future
- No clear policy
- only accept students who pass exam
- depends on policy of the university and the Dean
- depends on policy of the university, the University Council and the Dean
- The courses of general and vocational track are different. No policy. No appropriate programs for TC students
- According to university's policy, only graduates from highschool are accepted
- University's policy

- General and vocational systems are two separate systems so the criterias to accept students are different. Some Rajamangala university accept BWS students so it also depends on policy of each institution
- BWS students can enter the univesrity but not all credits can be transferred. They have to finished all required credit (sometime have to study 3 years)
- Both groups of students have not been studying the same course in highschool (general and vocational track) so credit cannot be directly transferred. However, we have a plan to accept BWS student to study from 1st year
- For Chemical engineering course, students will start their major from 2nd year. If TC students enter from 3rd year onward, they will lack knowledge/background on chemical engineering and cannot continue their study
- Only accept highschool students from general track
- not Chulalongkorn's policy
- According to university's policy, only graduates from high school are accepted
- Don't know
- COE is the main organization that control the production of engineers. TC students, therefore, need to study all courses that are specified/approved by COE
- Course for university students is different/not for TC students. Combining these 2 groups of students together in the same class might have problems in teaching
- Used to accept but was not successful
- There is a curriculum for BW students but it requires 3 years of studying
- framework and outcome of university and council of engineers of some subjects are not matched
- academic result of both groups of student is different. Difference outcome. No guarantee from OHEC and not acceptable by COE
- OHEC's framework
- Not enough basic knowledge
- University's policy

ANNEX 8-3

Data Summary of Online Survey for University Students

Respondents' Grade

	Res. Count	%
1st year student	48	16.2%
2nd year student	68	22.9%
3rd year student	85	28.6%
4th year student	78	26.3%
Others	18	6.1%
Total	297	100.0%

Others: Master students, Ph.D. students, or 5th year students

Respondents' Majors

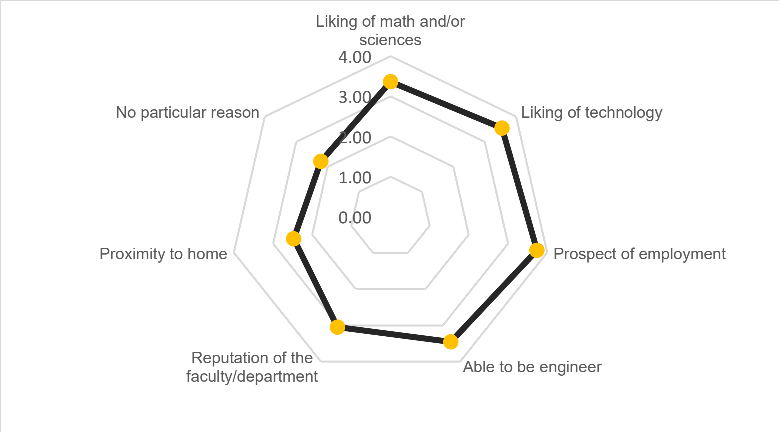
	Res. Count	%
Mechanical and production	55	18.5%
Electric and electronics	128	43.1%
Chemical	5	1.7%
Material	0	0.0%
Computer, information and communication	15	5.1%
Environment	2	0.7%
Energy	25	8.4%
Others	67	22.6%
	297	100.0%

Q1: What were the main reasons for having chosen engineering?

	Rating Ave.	Res. Count
Liking of math and/or sciences	3.36	285
Liking of technology	3.55	284
Prospect of employment	3.74	285
Able to be engineer	3.46	285
Reputation of the faculty/department	3.05	285
Proximity to home	2.47	285
No particular reason	2.22	268
Others		16
NA		12

*Others: liking of new innovation, because it is fun, because it is widely acceptable, engineering basic knowledge can be adapted/used to create useful innovation, want to create something new, can supervise and work at the same time.

(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

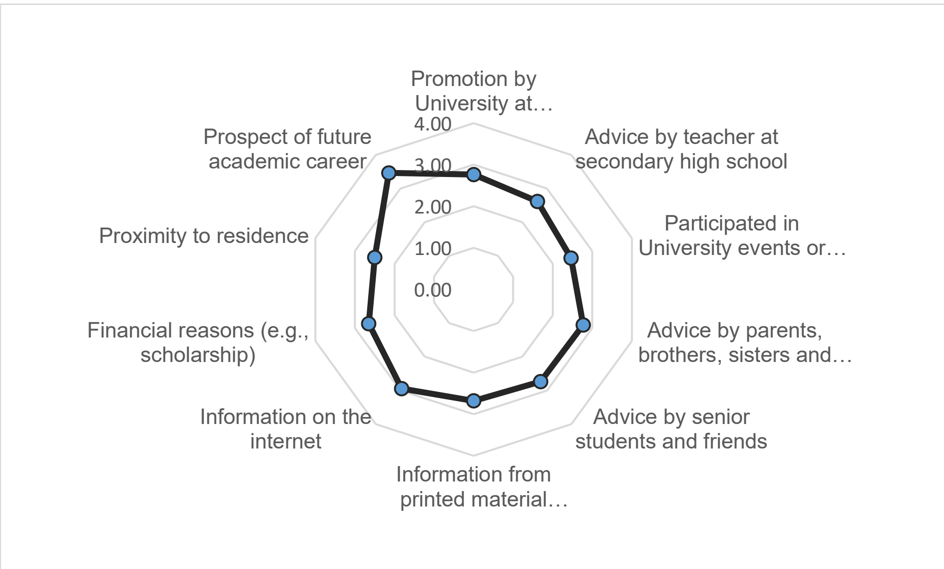


(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

Q2: What affected your decision to go to your university? Please choose the appropriate answer.

	Rating Ave.	Res. Count
Promotion by University at secondary high school	2.76	285
Advice by teacher at secondary high school	2.61	285
Participated in University events or visit to University	2.46	285
Advice by parents, brothers, sisters and relatives	2.77	285
Advice by senior students and friends	2.74	285
Information from printed material (newspaper, magazine)	2.68	284
Information on the internet	2.94	284
Financial reasons (e.g., scholarship)	2.65	285
Proximity to residence	2.50	284
Prospect of future academic career	3.47	283
Others	-	11
Total Respondents	-	285
NA	-	12

(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

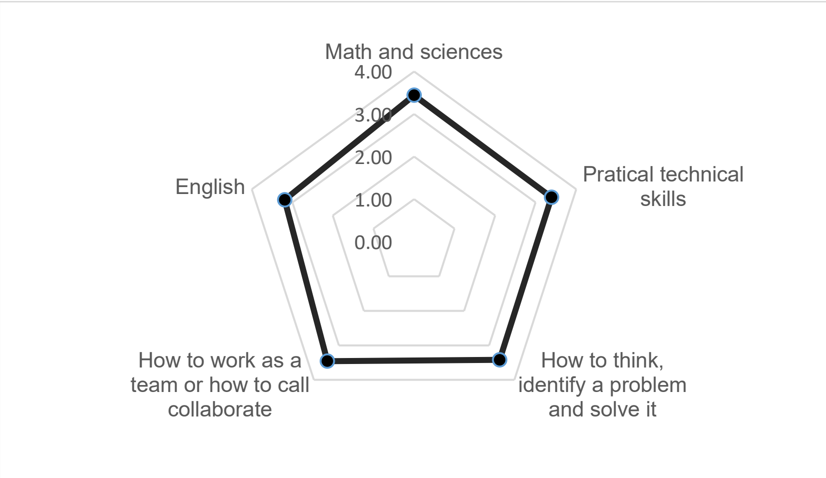


(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

Q3: What do you think about the curriculum? Please choose the appropriate answer.

	Rating Average	Res. Count
Math and sciences	3.44	285
Practical technical skills	3.39	285
How to think, identify a problem and solve it	3.42	285
How to work as a team or how to call collaborate	3.46	285
English	3.19	285
Total responses	-	285
NA	-	12

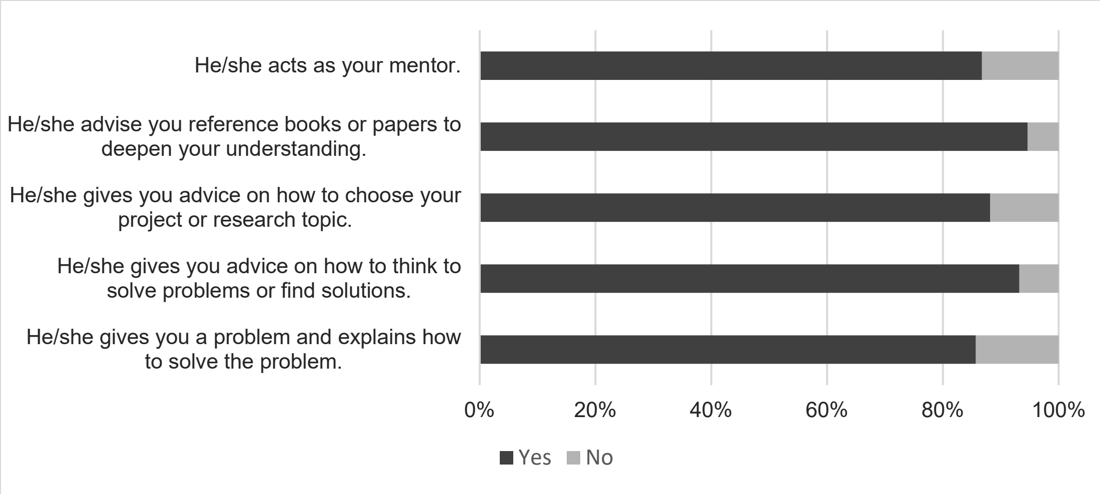
(Average is calculated on the scale of 1 to 4: Agree=4, Agree to extent=3, Not agree much=2, and Not agree at all=1".)



(Average is calculated on the scale of 1 to 4: Agree=4, Agree to extent=3, Not agree much=2, and Not agree at all=1".)

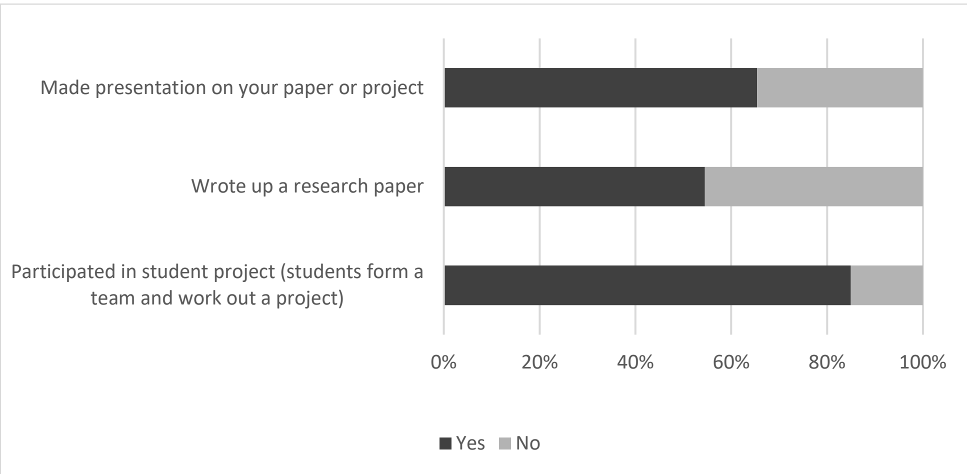
Q4: What is your teacher's teaching style? Please choose the appropriate answer.

	Yes		No		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
He/she gives you a problem and explains how to solve the problem.	240	85.7%	40	14.3%	280	100.0%
He/she gives you advice on how to think to solve problems or find solutions.	261	93.2%	19	6.8%	280	100.0%
He/she gives you advice on how to choose your project or research topic.	247	88.2%	33	11.8%	280	100.0%
He/she advise you reference books or papers to deepen your understanding.	265	94.6%	15	5.4%	280	100.0%
He/she acts as your mentor.	242	86.7%	37	13.3%	279	100.0%
Total responses	-	-	-	-	280	-
NA	-	-	-	-	17	-



Q5: Please choose the things you have done.

	Yes		No		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Participated in student project (students form a team and work out a project)	237	84.9%	42	15.1%	279	100.0%
Wrote up a research paper	152	54.5%	127	45.5%	279	100.0%
Made presentation on your paper or project	183	65.4%	97	34.6%	280	100.0%
Total responses	-	-	-	-	280	-
NA	-	-	-	-	17	-

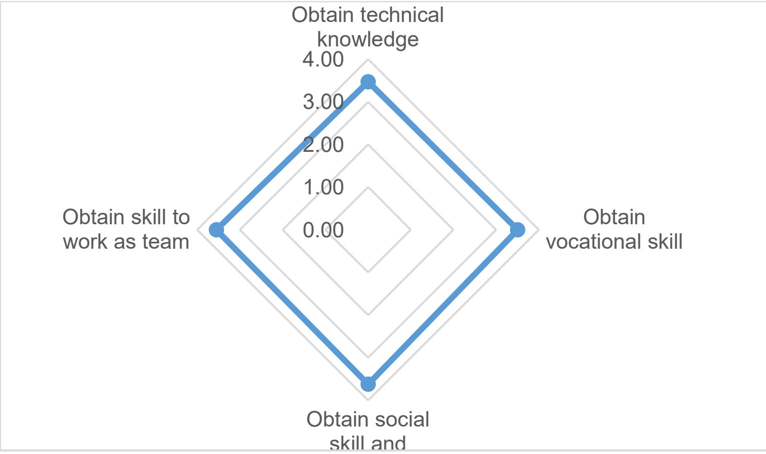


Q6: Please choose the appropriate answer about work experience at school

Answer Options	Rating Ave.	Res. Count
Obtain technical knowledge	3.47	249
Obtain vocational skill	3.51	249
Obtain social skill and discipline	3.62	249

Answer Options	Rating Ave.	Res. Count
Obtain skill to work as team	3.55	248
Total responses	-	249
NA	-	48

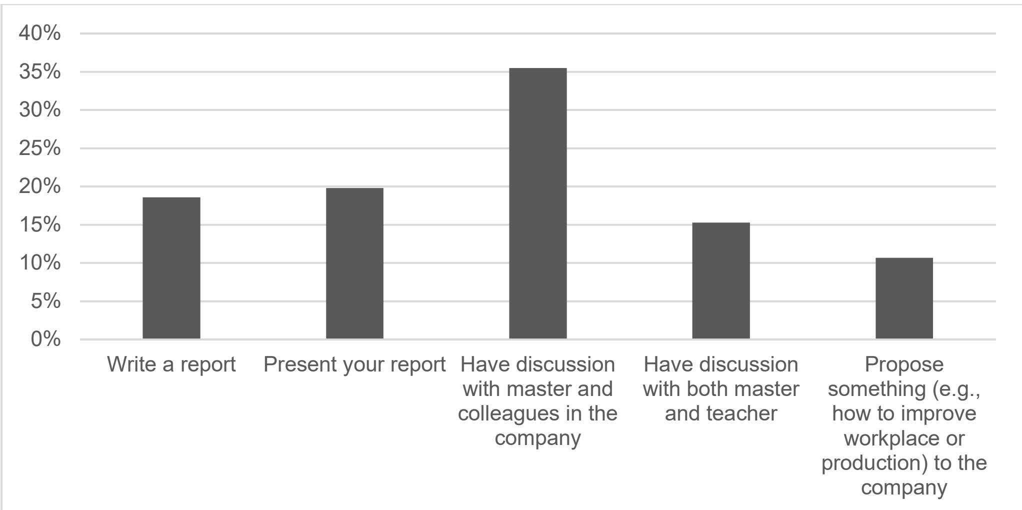
(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and Irreverent=1".)



(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and Irreverent=1".)

Q7: Internship program, you have chance to: (multiple choice)

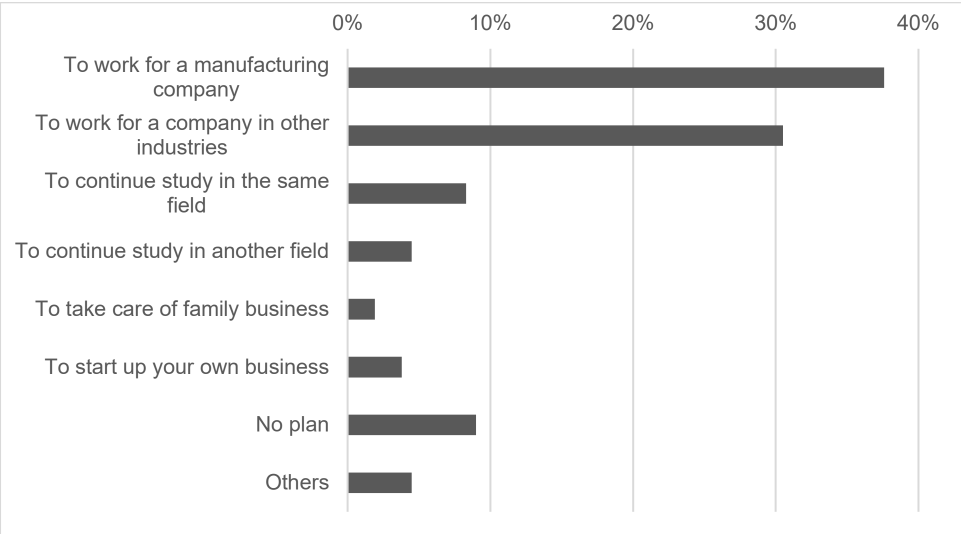
	Response Count	%
Write a report	45	18.6%
Present your report	48	19.8%
Have discussion with master and colleagues in the company	86	35.5%
Have discussion with both master and teacher	37	15.3%
Propose something (e.g., how to improve workplace or production) to the company	26	10.7%
Total	242	-
NA	55	-



Q8: After graduation, what do you plan to do?

	Res. Count	%
To work for a manufacturing company	100	37.6%
To work for a company in other industries	81	30.5%
To continue study in the same field	22	8.3%
To continue study in another field	12	4.5%
To take care of family business	5	1.9%
To start up your own business	10	3.8%
No plan	24	9.0%
Others	12	4.5%
Total	266	-
NA	31	-

*Others: Freelance, continue studying in international business, educational job Freelance, continue studying in international business, educational job

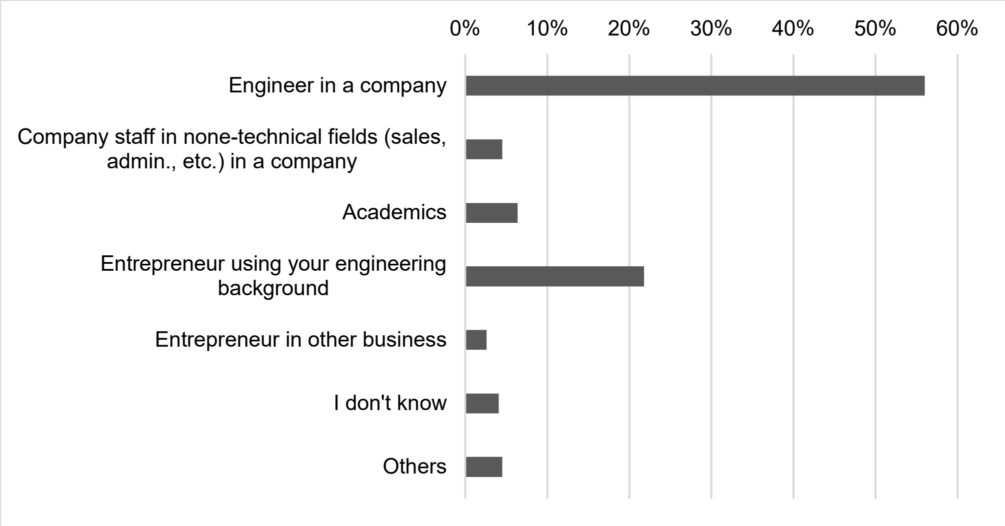


*Others: Freelance, continue studying in international business, educational job Freelance, continue studying in international business, educational job

Q9: What would you like to be in near future?

	Res. Count	%
Engineer in a company	149	56.0%
Company staff in none-technical fields (sales, admin., etc.) in a company	12	4.5%
Academics	17	6.4%
Entrepreneur using your engineering background	58	21.8%
Entrepreneur in other business	7	2.6%
I don't know	11	4.1%
Others	12	4.5%
Total responses	266	-
NA	31	-

Others: Study Ph.D., establish a farm with energy conservative idea, freelance, soilder (engineering soilder)

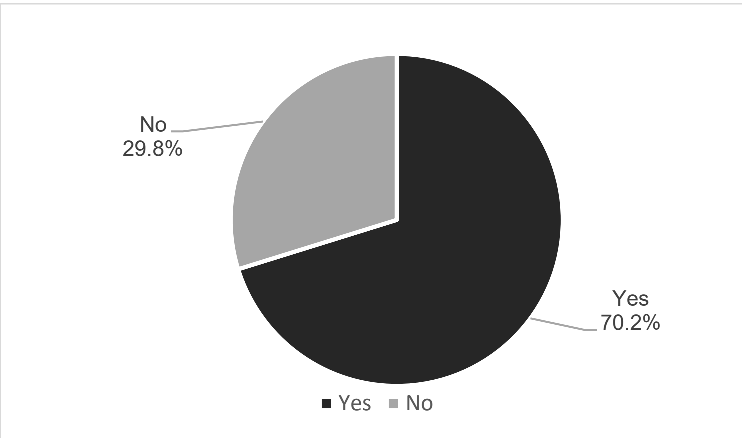


Others: Study Ph.D., establish a farm with energy conservative idea, freelance, soilder (engineering soilder)

Q10: Questions regarding career development. Please answer yes or no.)

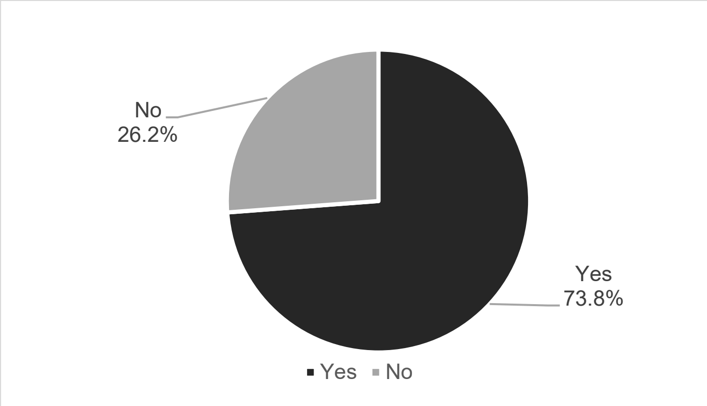
a. Do you have a role model (anybody whom you wish to be like in the future)?

	Res. Count	%
Yes	186	70.2%
No	79	29.8%
Total	265	-
NA	32	-



b. Do you have any information about career path of such a role model or any other person who become a model in your field of study?

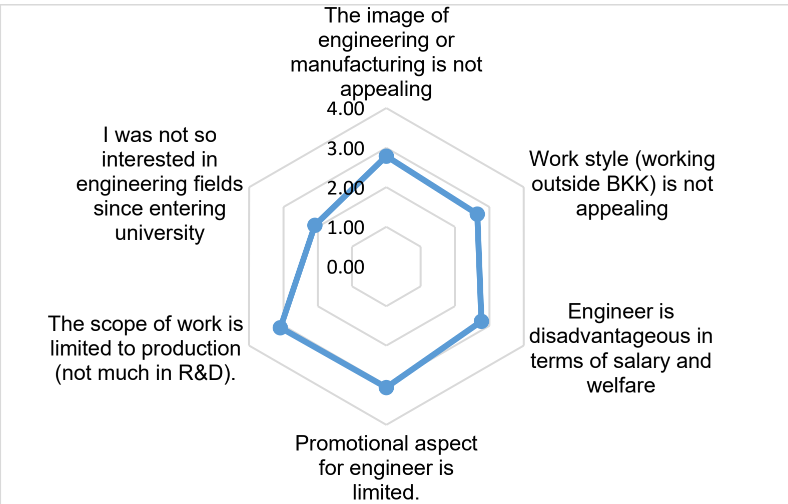
	Res. Count	%
Yes	194	73.8%
No	69	26.2%
Total	263	-
NA	34	-



Q11: It is known in Thailand that there is a tendency for engineers not to work as engineer as their career (They may change jobs and move to management rather than engineering and in the end very few people remain as engineer.) Please choose the appropriate answer to fit your feeling.

	Rating Ave.	Res. Count
The image of engineering or manufacturing is not appealing	2.79	266
Work style (working outside BKK) is not appealing	2.65	265
Engineer is disadvantageous in terms of salary and welfare	2.77	264
Promotional aspect for engineer is limited.	3.06	266
The scope of work is limited to production (not much in R&D).	3.09	265
I was not so interested in engineering fields since entering university	2.09	266
Others	-	7
Total	-	266
NA	-	31

*Others: gender limitation (some positions are only for male or female)
(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and Irreverent=1".)



(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and Irreverent=1".)

ANNEX 8-4

Data Summary of Survey for TC

1. What % of new entrants (BWS) to industry-related program at your college comes from the same school (BWC)?

	Res. Count	%
0-10 %	0	0.0%
11-30 %	2	2.7%
31-50 %	13	17.3%
51-70 %	19	25.3%
71-100 %	41	54.7%
Total responses	75	100.0%
NA	9	-

Q2: What % of students in industry-related program (BWS) commute from their home?

	Res. Count	%
0-10 %	1	1.4%
11-30 %	3	4.2%
31-50 %	8	11.3%
51-70 %	21	29.6%
71-100 %	38	53.5%
Total	71	100.0%
NA	13	-

Q3: What % of students in industry-related programs (BWS) is female?

	Res. Count	%
0-10 %	56	73.7%
11-30 %	16	21.1%
31-50 %	2	2.6%
51-70 %	2	2.6%
71-100 %	0	0.0%
Total	76	100.0%
NA	8	-

Q4: Do you have any mature/returning students (BWS)?

	Res. Count	%
Yes	61	82.4%
No	13	17.6%
Total	74	100.0%
NA	10	-

Q4.1. If yes, what % of them?

	Res. Count	%
0-10 %	49	76.6%
11-30 %	12	18.8%
31-50 %	2	3.1%
51-70 %	1	1.6%
71-100 %	0	0.0%
Total	64	100.0%
NA	20	-

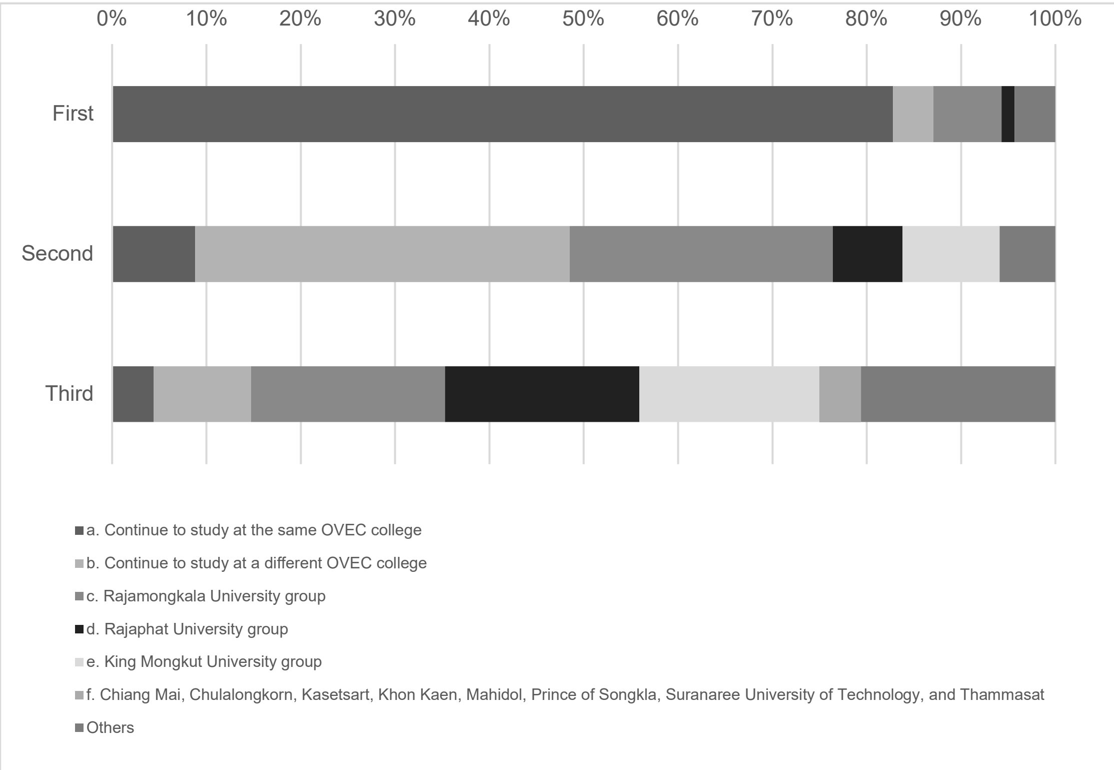
Q5: What % of graduates continue to study at higher level? (This is a question for BWC.)

	Res. Count	%
0-10 %	0	0.0%
11-30 %	3	4.2%
31-50 %	6	8.5%
51-70 %	28	39.4%
71-100 %	34	47.9%
Total	71	100.0%
NA	13	-

Q 5.1: Among them, which universities group is the top destination? Please choose top 3.

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
a. Continue to study at the same OVEC college	57	82.6%	6	8.8%	3	4.4%
b. Continue to study at a different OVEC college	3	4.3%	27	39.7%	7	10.3%

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
c. Rajamongkala University group	5	7.2%	19	27.9%	14	20.6%
d. Rajaphat University group	1	1.4%	5	7.4%	14	20.6%
e. King Mongkut University group	0	0.0%	7	10.3%	13	19.1%
f. Chiang Mai, Chulalongkorn, Kasetsart, Khon Kaen, Mahidol, Prince of Songkla, Suranaree University of Technology, and Thammasat	0	0.0%	0	0.0%	3	4.4%
Others	3	4.3%	4	5.9%	14	20.6%
Total responses	69	100.0 %	68	100.0%	68	100.0 %
NA	15	-	16	-	16	-



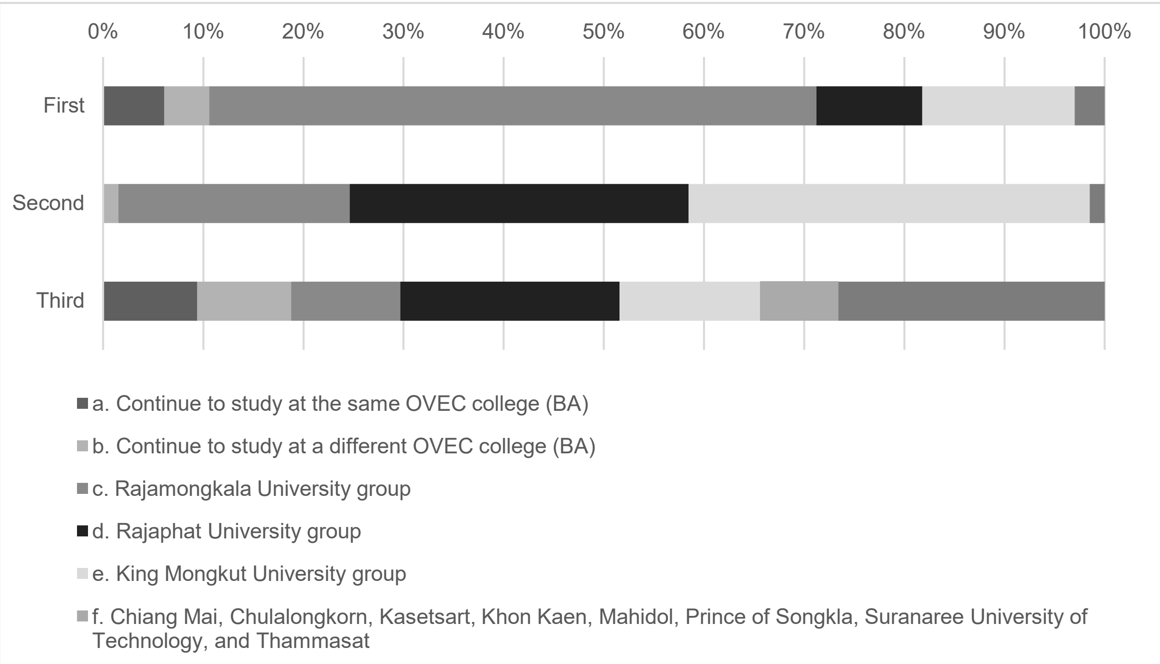
Q6: What % of graduates (BWS) continue to study at higher level? (This is a question for BWS).

	Res. Count	%
0-10 %	3	4.1%
11-30 %	20	27.4%
31-50 %	21	28.8%
51-70 %	22	30.1%
71-100%	7	9.6%

	Res. Count	%
Total responses	73	100.0%
NA	11	-

Q6.1: Among them, which university group is the top destination? Please choose top 3.

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
a. Continue to study at the same OVEC college (BA)	4	6.1%	0	0.0%	6	9.4%
b. Continue to study at a different OVEC college (BA)	3	4.5%	1	1.5%	6	9.4%
c. Rajamongkala University group	40	60.6%	15	23.1%	7	10.9%
d. Rajaphat University group	7	10.6%	22	33.8%	14	21.9%
e. King Mongkut University group	10	15.2%	26	40.0%	9	14.1%
f. Chiang Mai, Chulalongkorn, Kasetsart, Khon Kaen, Mahidol, Prince of Songkla, Suranaree University of Technology, and Thammasat	0	0.0%	0	0.0%	5	7.8%
Others	2	3.0%	1	1.5%	17	26.6%
Total responses	66	100.0 %	65	100.0 %	64	100.0 %
NA	18	-	19	-	20	-



Q7: What percent of BWS students graduate? (# of graduates/# of entrants).

	Res. Count	%
0-10%	0	0.0%
11-30%	2	2.9%
31-50%	2	2.9%
51-70%	16	23.2%
71-100%	49	71.0%
Total responses	69	100.0%
NA	15	-

Q8: Do you have any extra-curricular activities (e.g. science club, robot club) to promote developing practical engineers?

	Res. Count	%
Yes	63	86.3%
No	10	13.7%
Total responses	73	100.0%
NA	11	-

Q9: Do you have any academic support system when students struggle with the study?

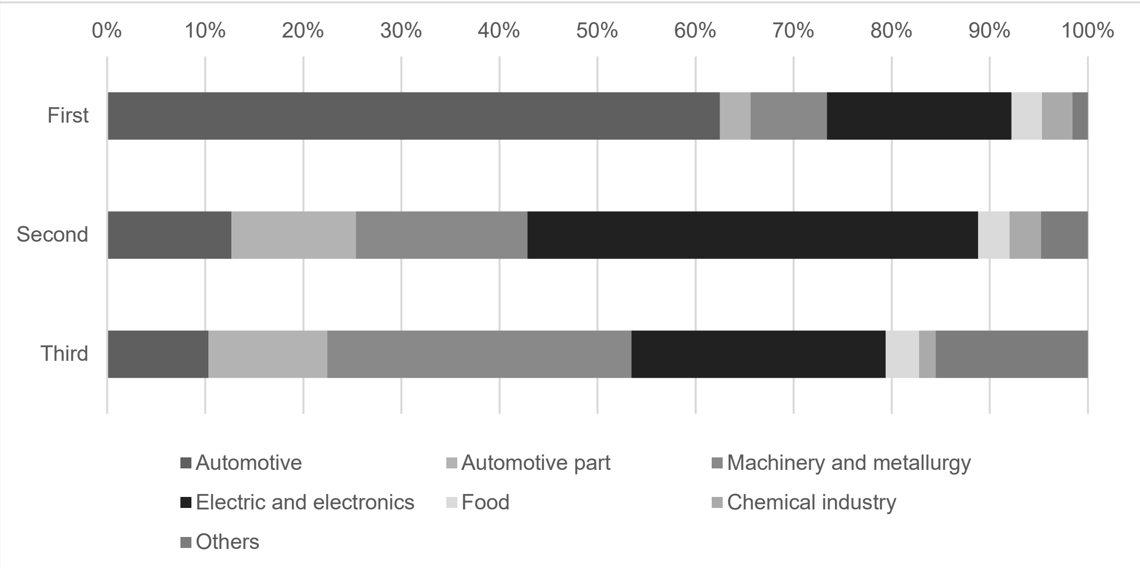
	Res. Count	%
Yes	68	93.2%
No	5	6.8%
Total responses	73	100.0%
NA	11	-

Q10: Approximately how many companies come to your school to recruit students in industry program per year?

	Res. Count	%
None	6	8.2%
1-5 companies/year	26	35.6%
6-10 companies/year	14	19.2%
10-20 companies/year	16	21.9%
more than 20 companies/year	11	15.1%
Total responses	73	100.0%
NA	11	-

Q10.1: Please name the top three industries of those companies. (e.g. automotive and parts, food-related, electronics, machinery, digital, chemical, petrochemical)

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
Automotive	40	62.5%	8	12.7%	6	10.3%
Automotive part	2	3.1%	8	12.7%	7	12.1%
Machinery and metallurgy	5	7.8%	11	17.5%	18	31.0%
Electric and electronics	12	18.8%	29	46.0%	15	25.9%
Food	2	3.1%	2	3.2%	2	3.4%
Chemical industry	2	3.1%	2	3.2%	1	1.7%
Others	1	1.6%	3	4.8%	9	15.5%
Total responses	64	100.0%	63	100.0%	58	100.0%
NA	20	-	21	-	26	-

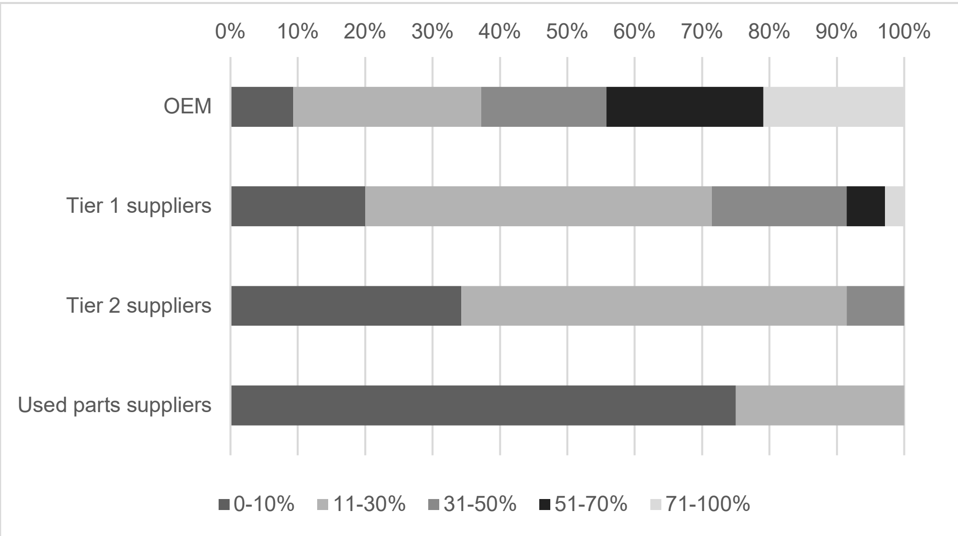


Q10.2: What type of companies are they? Please indicate the percentage of the type of companies. (Total of 100%) or ranking is fine.

	OEM*		Tier 1 suppliers		Tier 2 suppliers		Used parts suppliers	
	Res. Count	%	Res. Count	%	Res. Count	%	Res. Count	%
0-10%	4	9.3%	7	20.0%	12	34.3%	24	75.0%
11-30%	12	27.9%	18	51.4%	20	57.1%	8	25.0%
31-50%	8	18.6%	7	20.0%	3	8.6%	0	0.0%

	OEM*		Tier 1 suppliers		Tier 2 suppliers		Used parts suppliers	
	Res. Count	%	Res. Count	%	Res. Count	%	Res. Count	%
51-70%	10	23.3%	2	5.7%	0	0.0%	0	0.0%
71-100%	9	20.9%	1	2.9%	0	0.0%	0	0.0%
Total responses	43	100.0%	35	100.0%	35	100.0%	32	100.0%
NA	41	-	49	-	49	-	52	-

OEM: (Original Equipment Manufacturers)



OEM: (Original Equipment Manufacturers)

Q11: Do you think Japanese "Kosen" model of 5-year program is applicable to your school?

	Res. Count	%
Yes	49	72.1%
No	2	2.9%
Not sure	17	25.0%
Total responses	68	100.0%
NA	16	-

Q12: What % of teachers is government-employed (versus contracted teachers)?

	Res. Count	%
0-10 %	3	4.5%
11-30 %	13	19.4%
31-50 %	20	29.9%

51-70 %	19	28.4%
71-100 %	12	17.9%
Total responses	67	100.0%
NA	17	-

Q13: What % of teachers has experience working in industry?

	Res. Count	%
0-10 %	22	34.4%
11-30 %	13	20.3%
31-50 %	13	20.3%
51-70 %	11	17.2%
71-100 %	5	7.8%
Total responses	64	100.0%
NA	20	-

Q14: Do you think you have enough qualified teachers in all subjects?

	Res. Count	%
Yes	33	51.6%
No	25	39.1%
Not sure	6	9.4%
Total responses	64	100.0%
NA	20	-

Q15: Among teachers, which universities group they graduated? Please choose top 3.

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
a. Technical colleges	5	8.3%	2	3.3%	4	6.7%
b. Rajamongkala University group	20	33.3%	27	45.0%	6	10.0%
c. Rajaphat University group	7	11.7%	8	13.3%	23	38.3%
d. King Mongkut University group	25	41.7%	14	23.3%	14	23.3%
e. Chiang Mai, Chulalongkorn, Kasetsart, Khon Kaen, Mahidol, Prince of Songkla, Suranaree University of Technology, and Thammasat	1	1.7%	6	10.0%	8	13.3%
Others	2	3.3%	3	5.0%	5	8.3%
Total responses	60	100.0%	60	100.0%	60	100.0%
NA	24	-	24	-	24	-

Q16: What percent of school budget is spent for teacher training?

	Res. Count	%
0-10 %	13	20.3%
11-30 %	25	39.1%
31-50 %	15	23.4%
51-70 %	11	17.2%
71-100 %	0	0.0%
Total responses	64	100.0%
NA	20	-

Q17: What are the main areas of training? Please choose top 3.

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
a. Industry/technical skills and knowledge	35	55.6%	11	17.7%	11	18.0%
b. Basic subjects (math, science, English)	2	3.2%	7	11.3%	6	9.8%
c. Pedagogy/Teaching methods (PBL, active-learning)/Curriculum development	17	27.0%	20	32.3%	15	24.6%
d. 21st century skills (critical thinking, creativity, communication, collaboration)	1	1.6%	4	6.5%	6	9.8%
e. Development of teaching materials (hands-on experiment materials)	7	11.1%	19	30.6%	16	26.2%
Others	1	1.6%	1	1.6%	7	11.5%
Total responses	63	100.0%	62	100.0 %	61	100.0%
NA	21	-	22	-	23	-

Q18: What are the sources of training? Please indicate the top 3.

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
Internal (within school)	16	25.0%	25	40.3%	12	19.4 %
OVEC	43	67.2%	20	32.3%	2	3.2%
Universities	0	0.0%	3	4.8%	13	21.0 %

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
International organizations	0	0.0%	1	1.6%	1	1.6%
Companies in the related industries	4	6.3%	11	17.7%	23	37.1 %
Others	1	1.6%	2	3.2%	11	17.7 %
Total responses	64	100.0%	62	100.0%	62	100.0 %
NA	20	-	22	-	22	-

Q19: Does your school provide the budget for teachers to develop their own teaching materials (hands-on experiment materials)?

	Res. Count	%
Yes	44	69.8%
No	3	4.8%
Application-basis	16	25.4%
Total responses	63	100.0%
NA	21	-

Q20: What percent of the school budget is spent for teaching materials (hands-on experiment materials)?

	Res. Count	%
0-10 %	16	25.4%
11-30 %	23	36.5%
31-50 %	13	20.6%
51-70 %	11	17.5%
71-100 %	0	0.0%
Total responses	63	100.0%
NA	21	-

Q21: What percent of the school budget is spent for equipment and facilities?

	Res. Count	%
0-10 %	15	21.7%
11-30 %	19	27.5%
31-50 %	25	36.2%
51-70 %	7	10.1%

71-100 %	3	4.3%
Total responses	69	100.0%
NA	15	-

Q22: What percent of equipment and facilities is donated/funded by private sector/industry?

	Res. Count	%
0-10 %	39	57.4%
11-30 %	18	26.5%
31-50 %	6	8.8%
51-70 %	5	7.4%
71-100 %	0	0.0%
Total responses	68	100.0%
NA	16	-

LINKAGE TO INDUSTRY

Q24: Do you send students for internship at companies?

	Res. Count	%
Yes	61	98.4%
No	1	1.6%
Total responses	62	100.0%
NA	22	-

Q24.1: If yes, what % of students?

	Res. Count	%
0-10 %	1	1.7%
11-30 %	4	6.9%
31-50 %	7	12.1%
51-70 %	6	10.3%
71-100 %	40	69.0%
Total responses	58	100.0%
NA	26	-

Q25: Do you send teachers for training at companies?

	Res. Count	%
Yes	59	95.2%
No	3	4.8%
Total responses	62	100.0%
NA	22	-

Q25.1: If yes, what % of teachers?

	Res. Count	%
0-10 %	25	43.9%
11-30 %	13	22.8%
31-50 %	9	15.8%
51-70 %	7	12.3%
71-100 %	3	5.3%
Total responses	57	100.0%
NA	27	-

Q26: Do you have a course funded by companies?

	Res. Count	%
Yes	22	36.7%
No	38	63.3%
Total responses	60	100.0%
NA	24	-

Q26.1: If yes, how many courses?

	Res. Count	%
1	2	8.7%
2	4	17.4%
3-5	6	26.1%
more than 5	4	17.4%
more than 10	7	30.4%
Total responses	23	100.0%
NA	61	-

Q27: Do you invite company employees as teachers?

	Res. Count	%
Yes	42	67.7%
No	20	32.3%
Total responses	62	100.0%
NA	22	-

Q27.1: If yes, how many employees per year?

	Res. Count	%
1	3	7.1%
2	2	4.8%
3-5	16	38.1%
more than 5	13	31.0%
more than 10	8	19.0%
Total responses	42	100.0%
NA	42	-

Q28: Do you develop curriculum with companies of related-industries?

	Res. Count	%
Yes	51	82.3%
No	11	17.7%
Total responses	62	100.0%
NA	22	-

Q28.1: If yes, how many times do you get together per year?

	Res. Count	%
1	23	46.9%
2	14	28.6%
3-5	9	18.4%
more than 5	3	6.1%
more than 10	0	0.0%
Total responses	49	100.0%
NA	35	-

Q29: Do you do joint research with companies?

	Res. Count	%
Yes	24	39.3%
No	37	60.7%
Total responses	61	100.0%
NA	23	-

Q29.1: If yes, how many cases do you have currently?

	Res. Count	%
1	11	44.0%
2	9	36.0%
3-5	5	20.0%
more than 5	0	0.0%
more than 10	0	0.0%
Total responses	25	100.0%
NA	59	-

Q30: Do you provide consulting and testing services to companies?

	Res. Count	%
Yes	47	78.3%
No	13	21.7%
Total responses	60	100.0%
NA	24	-

Q30.1: If yes, how many cases do you provide per year?

	Res. Count	%
1	9	19.1%
2	11	23.4%
3-5	15	31.9%
more than 5	6	12.8%
more than 10	6	12.8%
Total responses	47	100.0%
NA	37	-

Q31: Do you have scholarships for students funded by companies?

	Res. Count	%
Yes	57	93.4%
No	4	6.6%
Total responses	61	100.0%
NA	23	-

Q31.1: If yes, how many companies offer scholarship per year?

	Res. Count	%
1	3	5.3%
2	12	21.1%
3-5	16	28.1%
more than 5	14	24.6%
more than 10	12	21.1%
Total responses	57	100.0%
NA	27	-

Q31.2: If yes, how many scholarships are offered per year?

	Number of Scholarships	%
0 - 10	21	46.7%
11 - 30	13	28.9%
31 - 50	2	4.4%
51 - 70	3	6.7%
71 - 100	3	6.7%
More than 100	3	6.7%
Total responses	45	100.0%
NA	12	-

Q32: What percent of budget comes from private sector at your school?

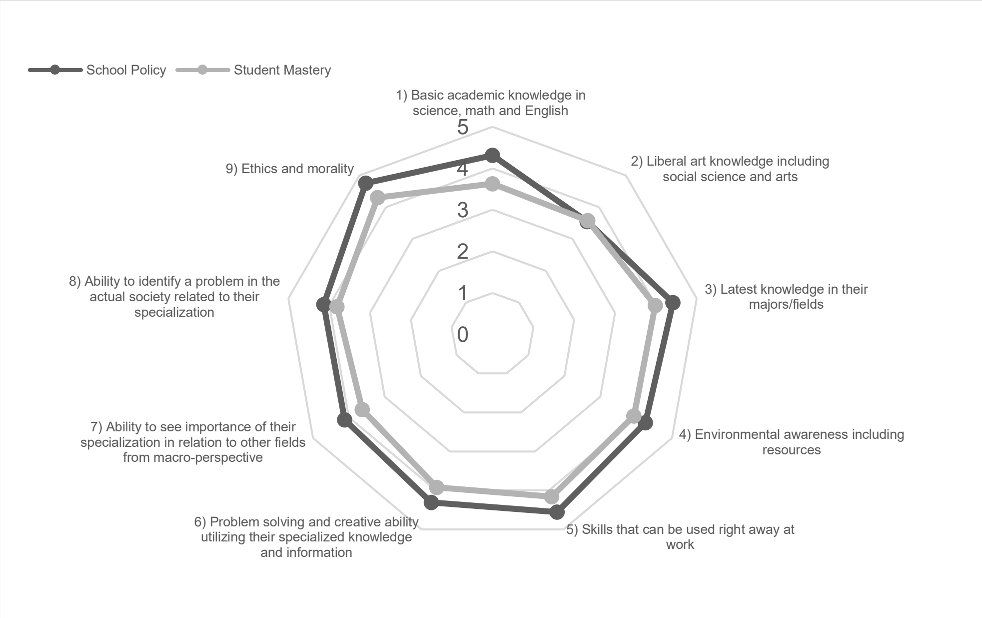
	Res. Count	%
0-10%	36	75.0%
11-30%	8	16.7%
31-50%	3	6.3%
51-70%	1	2.1%

70-100%	0	0.0%
Total responses	48	100.0%
NA	36	-

Q33: In your school, what do you think important knowledge and skills? Do you think your students have acquired those knowledge and skills?

	School Policy		Student Mastery	
	Rating Ave.	Res. Count	Rating Ave.	Res. Count
1) Basic academic knowledge in science, math and English	4.31	61	3.63	62
2) Liberal art knowledge including social science and arts	3.55	62	3.58	62
3) Latest knowledge in their majors/fields	4.42	62	3.98	62
4) Environmental awareness including resources	4.26	62	3.93	61
5) Skills that can be used right away at work	4.56	61	4.16	62
6) Problem solving and creative ability utilizing their specialized knowledge and information	4.31	62	3.92	62
7) Ability to see importance of their specialization in relation to other fields from macro-perspective	4.11	62	3.63	62
8) Ability to identify a problem in the actual society related to their specialization	4.13	60	3.81	62
9) Ethics and morality	4.76	62	4.31	62
Total responses	-	62	-	62
NA	-	22	-	22

(Average is calculated on the scale of 1 to 4: Very important=5, Important=4, Cannot say which=3, Not so important=2, and not important=1”.)



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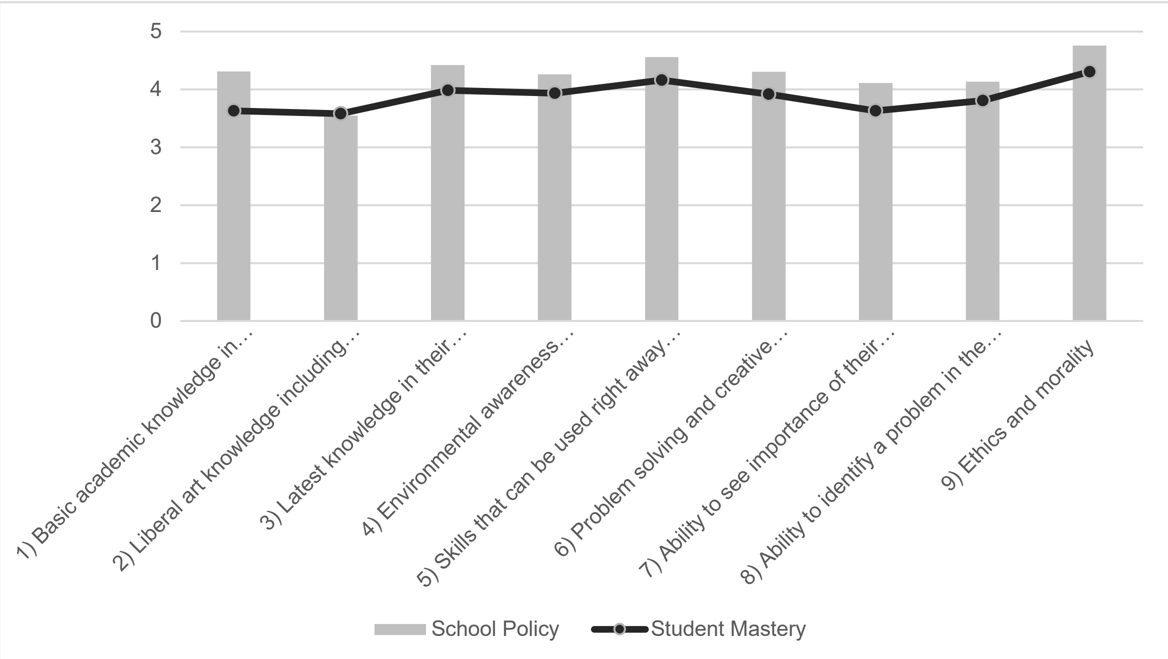
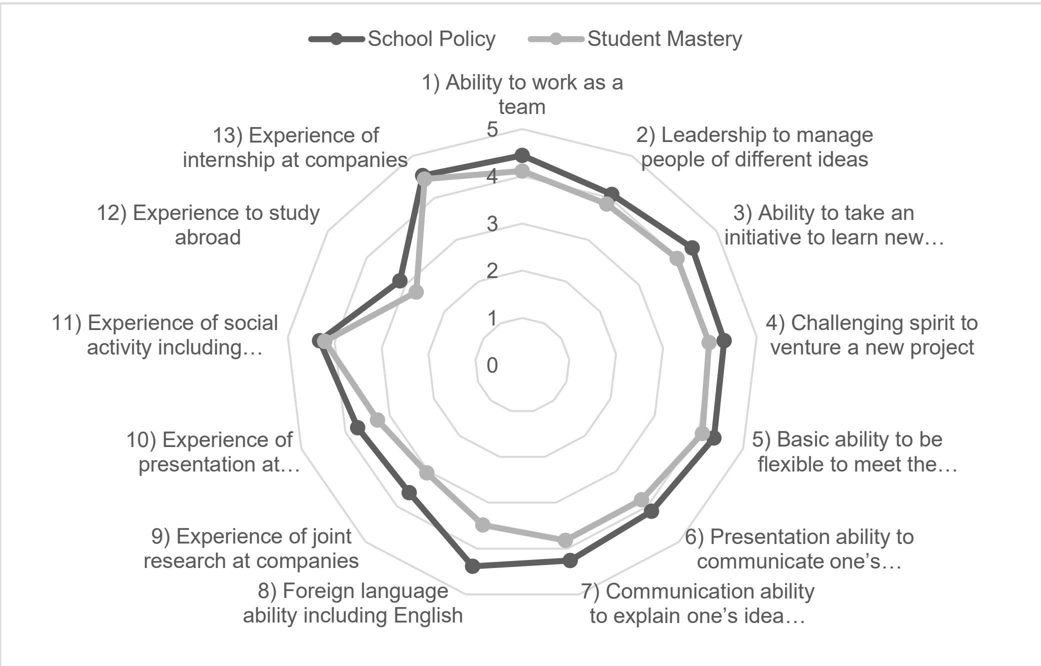


Q34: In your school, what do you think important knowledge and skills? Do you think your students have acquired those knowledge and skills?

	School Policy		Student Mastery	
	Rating Ave.	Res. Count	Rating Ave.	Res. Count
1) Ability to work as a team	4.44	61	4.11	62
2) Leadership to manage people of different ideas	4.08	61	3.85	62
3) Ability to take an initiative to learn new knowledge	4.37	62	3.98	61

	School Policy		Student Mastery	
	Rating Ave.	Res. Count	Rating Ave.	Res. Count
4) Challenging spirit to venture a new project	4.31	62	3.98	62
5) Basic ability to be flexible to meet the needs of changing society	4.34	62	4.08	62
6) Presentation ability to communicate one's idea appropriately	4.13	62	3.81	62
7) Communication ability to explain one's idea and listen to others	4.26	62	3.82	62
8) Foreign language ability including English	4.39	62	3.48	62
9) Experience of joint research at companies	3.61	61	3.05	62
10) Experience of presentation at academic conference or oral presentation	3.73	62	3.27	62
11) Experience of social activity including volunteer	4.32	62	4.21	62
12) Experience to study abroad	3.15	62	2.73	62
13) Experience of internship at companies	4.53	62	4.45	62
Total responses	-	62	-	62
NA	-	22	-	22

(Average is calculated on the scale of 1 to 4: Very important=5, Important=4, Cannot say which=3, Not so important=2, and not important=1".)



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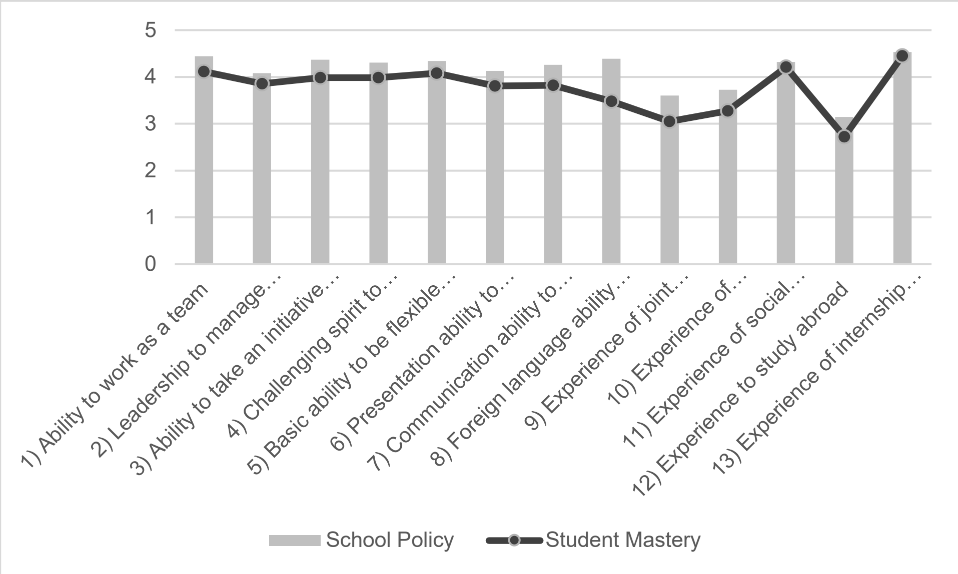


(Average is calculated on the scale of 1 to 4: Very important=5, Important=4, Cannot say which=3, Not so important=2, and not important=1".)

FOR DUAL SYSTEM

Q1: What % of new entrants (BWS) to industry-related program at your college comes from the same school (BWC)?

	Res. Count	%
0-10 %	2	3.4%
11-30 %	6	10.3%
31-50 %	11	19.0%
51-70 %	12	20.7%
71-100 %	27	46.6%
Total responses	58	100.0%
NA	26	-

Q2: What % of students in industry-related program commute from their home?

	Res. Count	%
0-10 %	5	9.3%
11-30 %	2	3.7%
31-50 %	8	14.8%
51-70 %	13	24.1%
71-100 %	26	48.1%
Total responses	54	100.0%

	Res. Count	%
NA	30	-

Q3: What % of students in industry-related programs is female?

	Res. Count	%
0-10 %	50	80.6%
11-30 %	6	9.7%
31-50 %	3	4.8%
51-70 %	1	1.6%
71-100 %	2	3.2%
Total responses	62	100.0%
NA	22	-

Q4:

	Res. Count	%
Yes	32	51.6%
No	30	48.4%
Total responses	62	100.0%
NA	22	-

Q4.1: If yes, what % of them?

	Res. Count	%
0-10 %	26	76.5%
11-30 %	4	11.8%
31-50 %	1	2.9%
51-70 %	1	2.9%
71-100 %	2	5.9%
Total responses	34	100.0%
NA	50	-

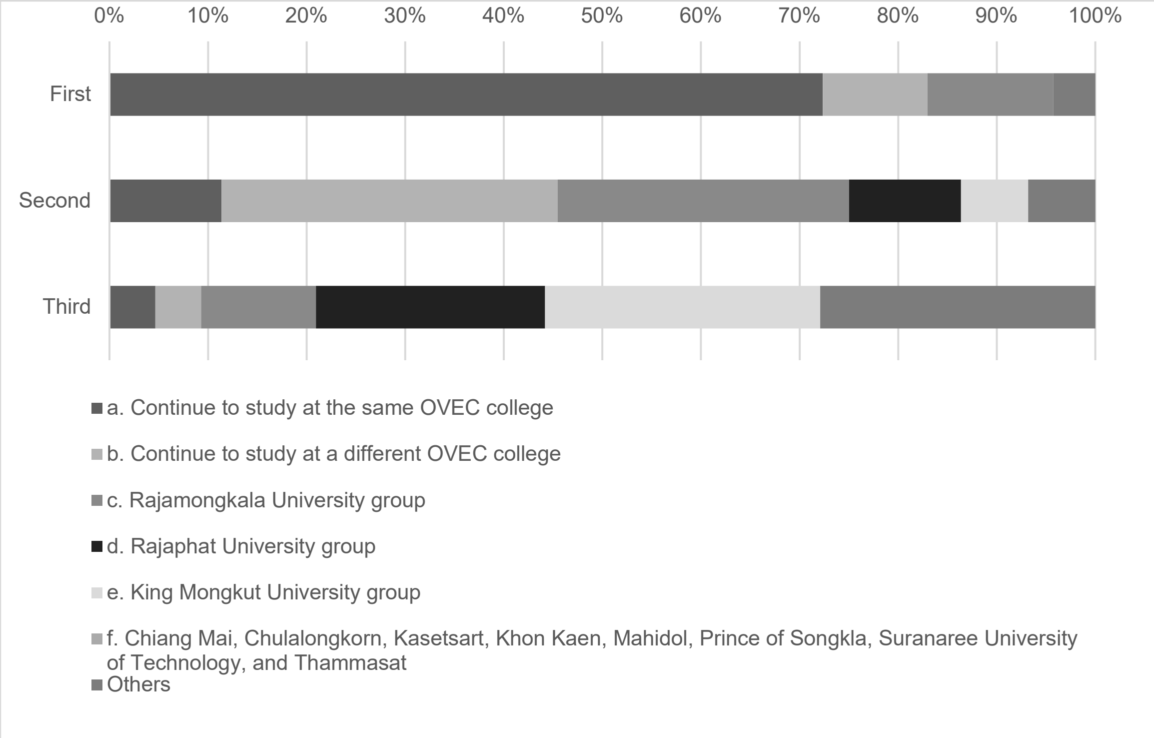
Q5: This is a question for BWC in dual system. What % of graduates continue to study at higher level?

	Res. Count	%
0-10 %	9	16.4%
11-30 %	9	16.4%

	Res. Count	%
31-50 %	11	20.0%
51-70 %	12	21.8%
71-100 %	14	25.5%
Total responses	55	100.0%
NA	29	-

Q5.1: Among them, which universities group is the top destination? Please choose top 3

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
a. Continue to study at the same OVEC college	34	72.3%	5	11.4%	2	4.7%
b. Continue to study at a different OVEC college	5	10.6%	15	34.1%	2	4.7%
c. Rajamongkala University group	6	12.8%	13	29.5%	5	11.6%
d. Rajaphat University group	0	0.0%	5	11.4%	10	23.3%
e. King Mongkut University group	0	0.0%	3	6.8%	12	27.9%
f. Chiang Mai, Chulalongkorn, Kasetsart, Khon Kaen, Mahidol, Prince of Songkla, Suranaree University of Technology, and Thammasat	0	0.0%	0	0.0%	0	0.0%
Others	2	4.3%	3	6.8%	12	27.9%
Total responses	47	100.0%	44	100.0% -	43	100.0%
NA	37	-	40	-	41	-



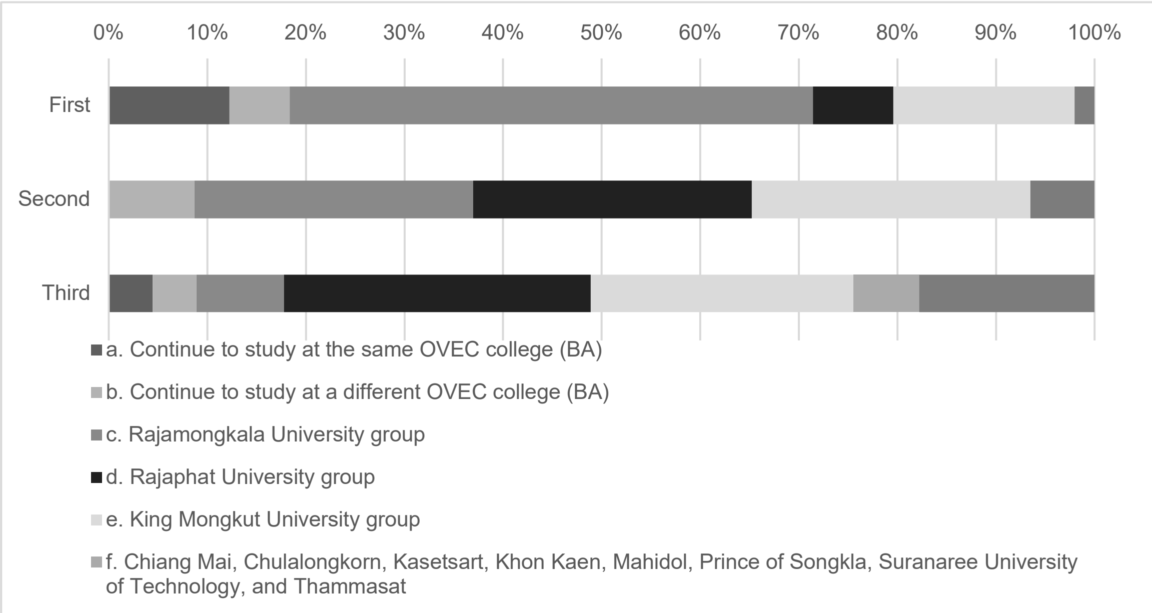
Q6: This is a question for BWS in dual system. What % of your graduates (BWS) continue to study at higher level?

	Res. Count	%
0-10 %	19	32.8%
11-30 %	18	31.0%
31-50 %	12	20.7%
51-70 %	7	12.1%
71-100%	2	3.4%
Total responses	58	100.0%
NA	26	-

Q6.1: Among them, which universities group is the top destination? Please choose top 3

	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
a. Continue to study at the same OVEC college (BA)	6	12.2%	0	0.0%	2	4.4%
b. Continue to study at a different OVEC college (BA)	3	6.1%	4	8.7%	2	4.4%
c. Rajamongkala University group	26	53.1%	13	28.3%	4	8.9%
d. Rajaphat University group	4	8.2%	13	28.3%	14	31.1%

e. King Mongkut University group	9	18.4%	13	28.3%	12	26.7%
f. Chiang Mai, Chulalongkorn, Kasetsart, Khon Kaen, Mahidol, Prince of Songkla, Suranaree University of Technology, and Thammasat	0	0.0%	0	0.0%	3	6.7%
Others	1	2.0%	3	6.5%	8	17.8%
Total responses	49	100.0%	46	100.0%	45	100.0 %
NA	35	-	38	-	39	-



Q7. What percent of BWS students graduate?

	Res. Count	%
0-10%	2	4.0%
11-30%	3	6.0%
31-50%	5	10.0%
51-70%	7	14.0%
71-100%	33	66.0%
Total responses	50	100.0%
NA	34	-

Q8: Do you encourage your students to obtain professional certificates (e.g. Welding)

	Res. Count	%
Yes	46	76.7%

No	14	23.3%
Total responses	60	100.0%
NA	24	-

Q8.1: If yes, what % of students obtain such certificates?

	Res. Count	%
0-10 %	8	18.2%
11-30 %	11	25.0%
31-50 %	5	11.4%
51-70 %	7	15.9%
71-100%	13	29.5%
Total responses	44	100.0%
NA	40	-

Q9: Do you have any extra-curricular activities (e.g. science club, robot club) to promote developing practical engineers?

	Res. Count	%
Yes	46	74.2%
No	16	25.8%
Total responses	62	100.0%
NA	22	-

Q10: Do you have any academic support system when students struggle with the study?

	Res. Count	%
Yes	51	82.3%
No	11	17.7%
Total responses	62	100.0%
NA	22	-

Q11: Approximately how many companies collaborate in dual system?

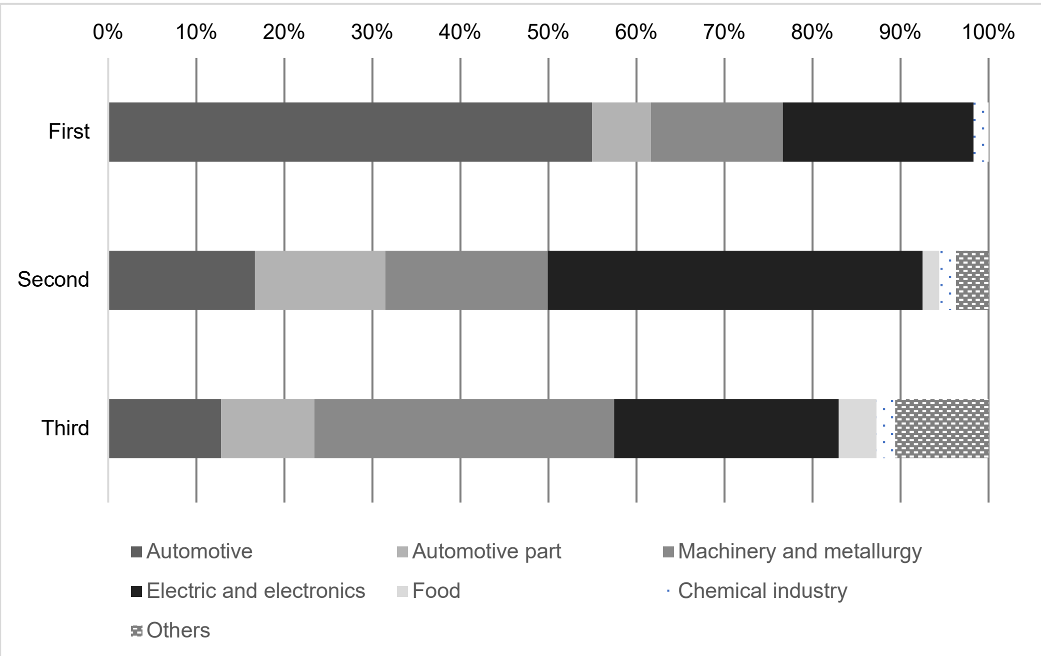
	Res. Count	%
1-5	12	20.0%
6-10	17	28.3%
10-20	17	28.3%
More than 20	11	18.3%

	Res. Count	%
more than 50	1	1.7%
Others	2	3.3%
Total responses	60	100.0%
NA	24	-

Others: No official cooperation but students apply to be trained on their own/by themselves.

Q11.1. Please name the top three industries of those companies. (e.g. Automotive, food, electronics)

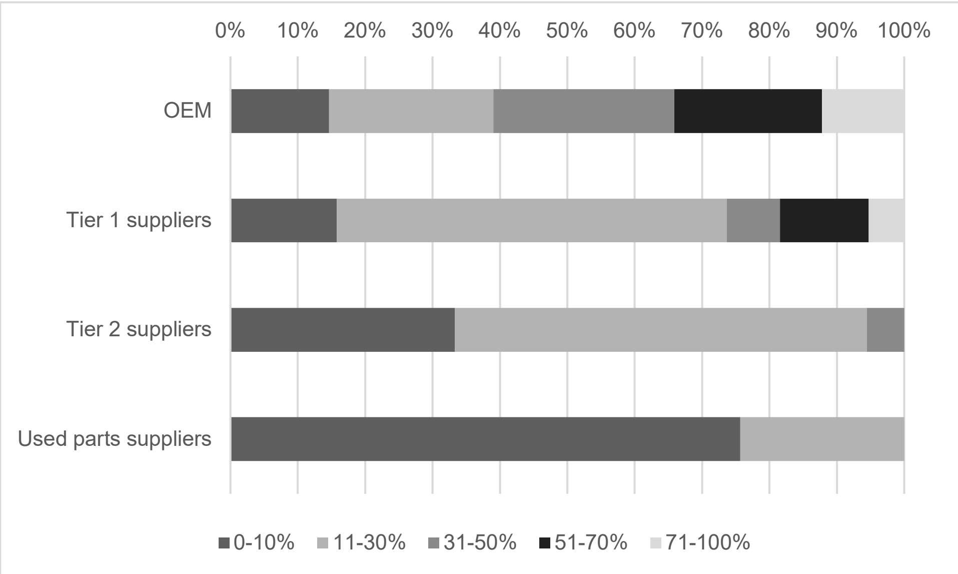
	First		Second		Third	
	Res. Count	%	Res. Count	%	Res. Count	%
Automotive	33	55.0%	9	16.7%	6	12.8%
Automotive part	4	6.7%	8	14.8%	5	10.6%
Machinery and metallurgy	9	15.0%	10	18.5%	16	34.0%
Electric and electronics	13	21.7%	23	42.6%	12	25.5%
Food	0	0.0%	1	1.9%	2	4.3%
Chemical industry	1	1.7%	1	1.9%	1	2.1%
Others	0	0.0%	2	3.7%	5	10.6%
Total responses	60	100.0%	54	100.0%	47	100.0%
NA	24	-	30	-	37	-



Q11.2: What type of companies are they? Please indicate the percentage of the type of companies. (Total of 100%) or ranking is fine.

	OEM		Tier 1 suppliers		Tier 2 suppliers		Used parts suppliers	
	Res. Count	%	Res. Count	%	Res. Count	%	Res. Count	%
0-10%	6	14.6%	6	15.8%	12	33.3%	28	75.7%
11-30%	10	24.4%	22	57.9%	22	61.1%	9	24.3%
31-50%	11	26.8%	3	7.9%	2	5.6%	0	0.0%
51-70%	9	22.0%	5	13.2%	0	0.0%	0	0.0%
71-100%	5	12.2%	2	5.3%	0	0.0%	0	0.0%
Total responses	41	100.0 %	38	100.0%	36	100.0%	37	100.0%
NA	43		46		48		47	

OEM: (Original Equipment Manufacturers)



OEM: (Original Equipment Manufacturers)

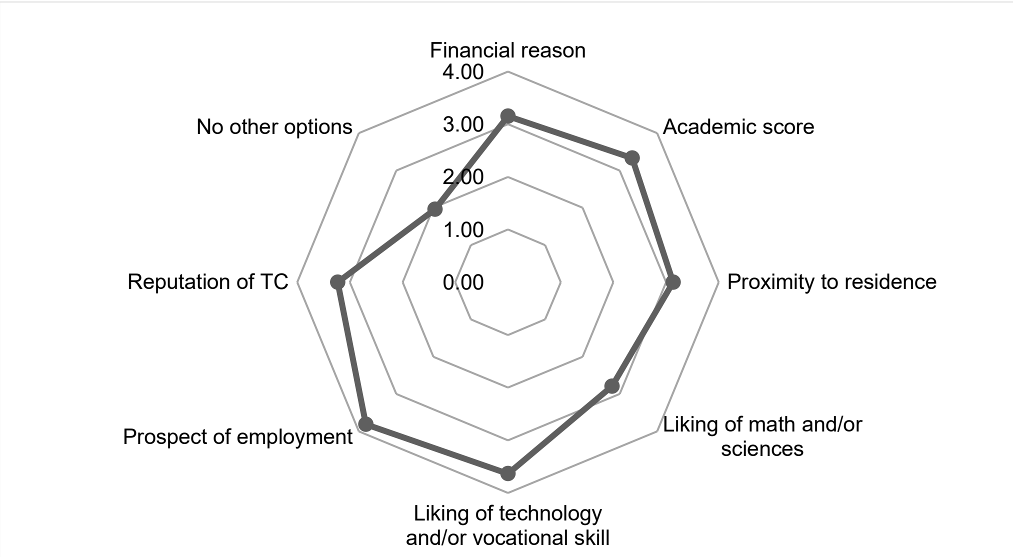
ANNEX 8-5

Data Summary of Online Survey for TC Students

Q1: What were the main reasons for having chosen TC (certificate)?

	Rating Ave.	Res. Count
Financial reason	3.15	574
Academic score	3.33	575
Proximity to residence	3.13	574
Liking of math and/or sciences	2.79	575
Liking of technology and/or vocational skill	3.64	576
Prospect of employment	3.82	574
Reputation of TC	3.23	573
No other options	1.96	567
Total responses	-	577
NA		13

(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

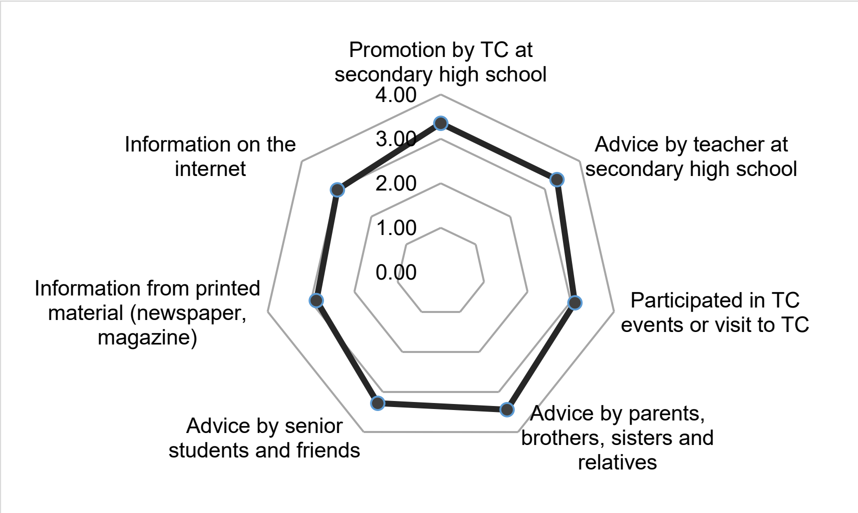


(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

Q2: What affected your decision to go to TC (Certificate)?

	Rating Ave.	Res. Count
Promotion by TC at secondary high school	3.35	579
Advice by teacher at secondary high school	3.34	577
Participated in TC events or visit to TC	3.10	577
Advice by parents, brothers, sisters and relatives	3.44	577
Advice by senior students and friends	3.27	579
Information from printed material (newspaper, magazine)	2.87	577
Information on the internet	2.98	579
Total responses		580
NA		10

(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

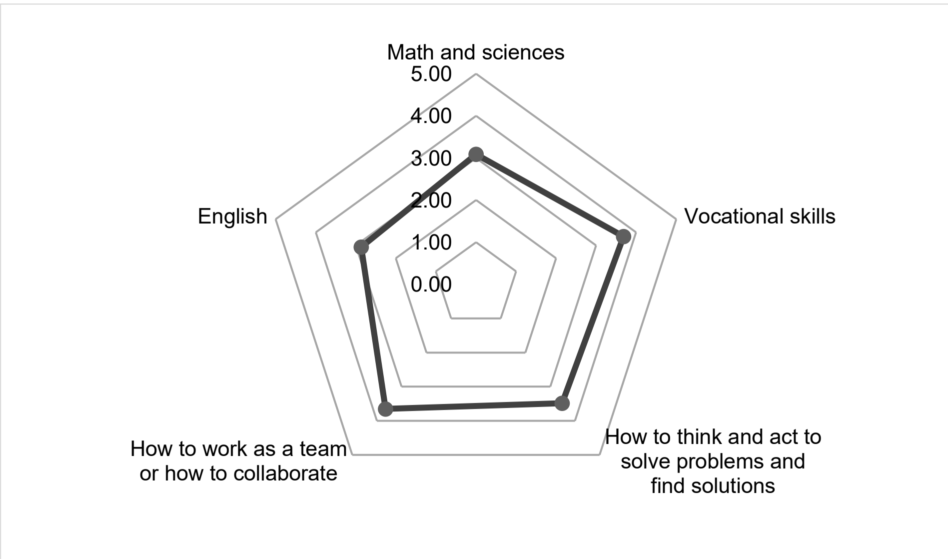


(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and irreverent=1".)

Q3: What do you think about the curriculum?

	Rating Ave.	Res. Count
Math and sciences	3.09	580
Vocational skills	3.68	579
How to think and act to solve problems and find solutions	3.48	580
How to work as a team or how to collaborate	3.65	579
English	2.86	579
Total responses	-	581
NA	-	9

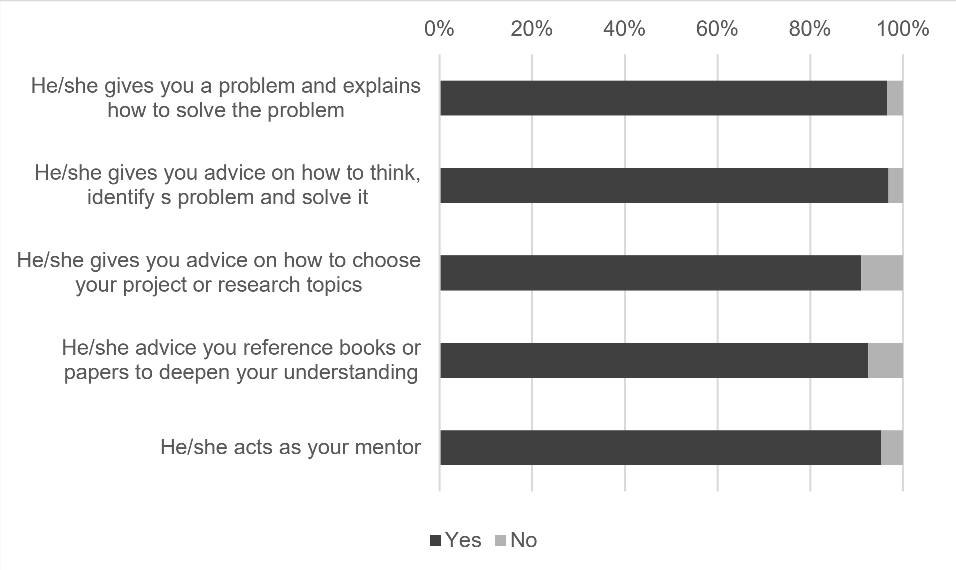
(Average is calculated on the scale of 1 to 4: Agree=4, Agree to extent=3, Not agree much=2, and Not agree at all=1".)



(Average is calculated on the scale of 1 to 4: Agree=4, Agree to extent=3, Not agree much=2, and Not agree at all=1".)

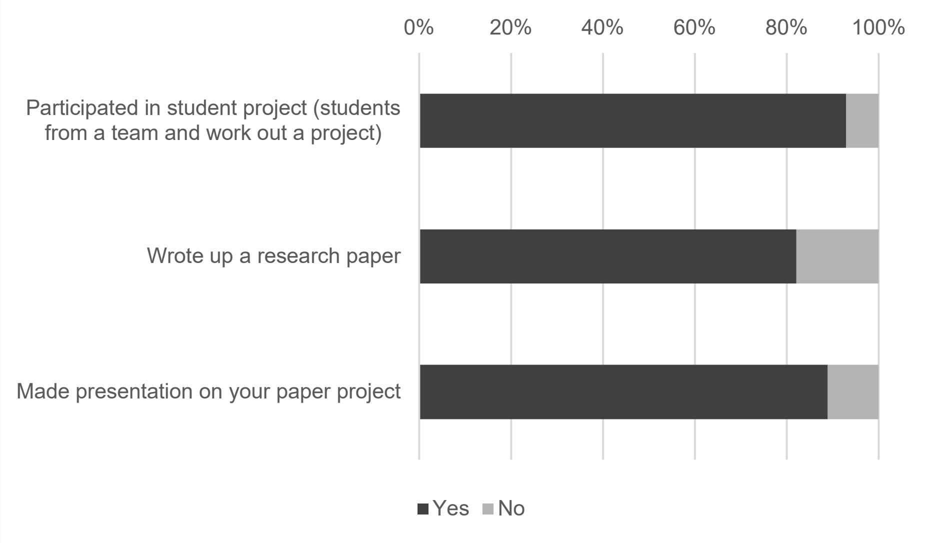
Q4: What is your teacher's teaching style?

	Yes		No		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
He/she gives you a problem and explains how to solve the problem	557	96.5%	20	3.5%	577	100.0%
He/she gives you advice on how to think, identify s problem and solve it	559	96.9%	18	3.1%	577	100.0%
He/she gives you advice on how to choose your project or research topics	526	91.0%	52	9.0%	578	100.0%
He/she advice you reference books or papers to deepen your understanding	534	92.5%	43	7.5%	577	100.0%
He/she acts as your mentor	550	95.3%	27	4.7%	577	100.0%
Total responses	-	-	-	-	579	-
NA	-	-	-	-	11	-



Q5: Please choose the things you have done.

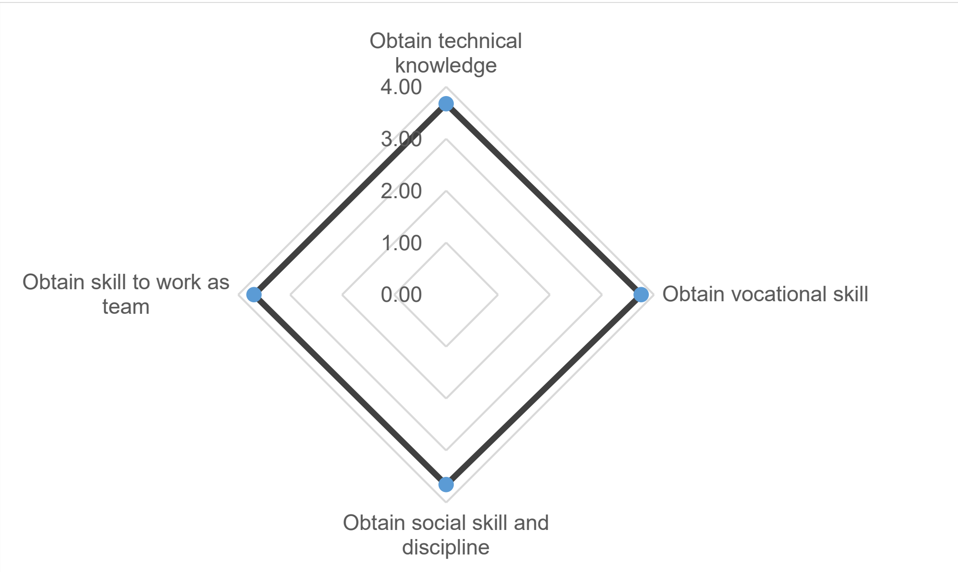
	Yes		No		Total	
	Res. Count	%	Res. Count	%	Res. Count	%
Participated in student project (students from a team and work out a project)	534	92.9%	41	7.1%	575	100.0%
Wrote up a research paper	472	82.1%	103	17.9%	575	100.0%
Made presentation on your paper project	513	88.9%	64	11.1%	577	100.0%
Total responses	-	-	-	-	579	-
NA	-	-	-	-	11	-



Q6: Please choose the appropriate answer about work experience at school

Answer Options	Rating Ave.	Res. Count
Obtain technical knowledge	3.67	551
Obtain vocational skill	3.76	551
Obtain social skill and discipline	3.66	553
Obtain skill to work as team	3.70	547
Total responses	-	553
NA	-	37

(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and Irreverent=1".)

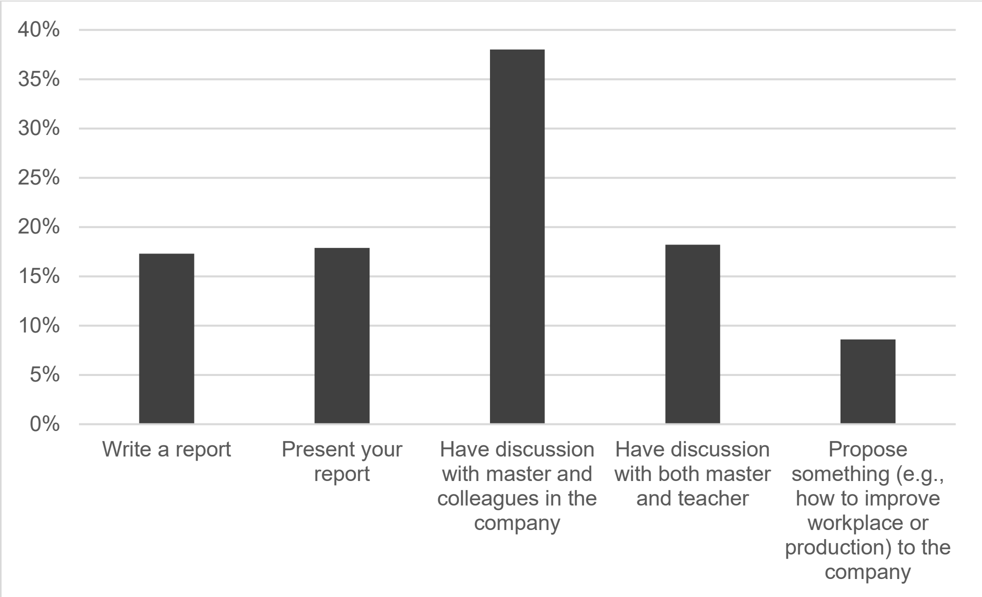


(Average is calculated on the scale of 1 to 4: Very much=4, To some extent=3, Not so much=2, and Irreverent=1".)

Q7: In dual system, you have chance to:

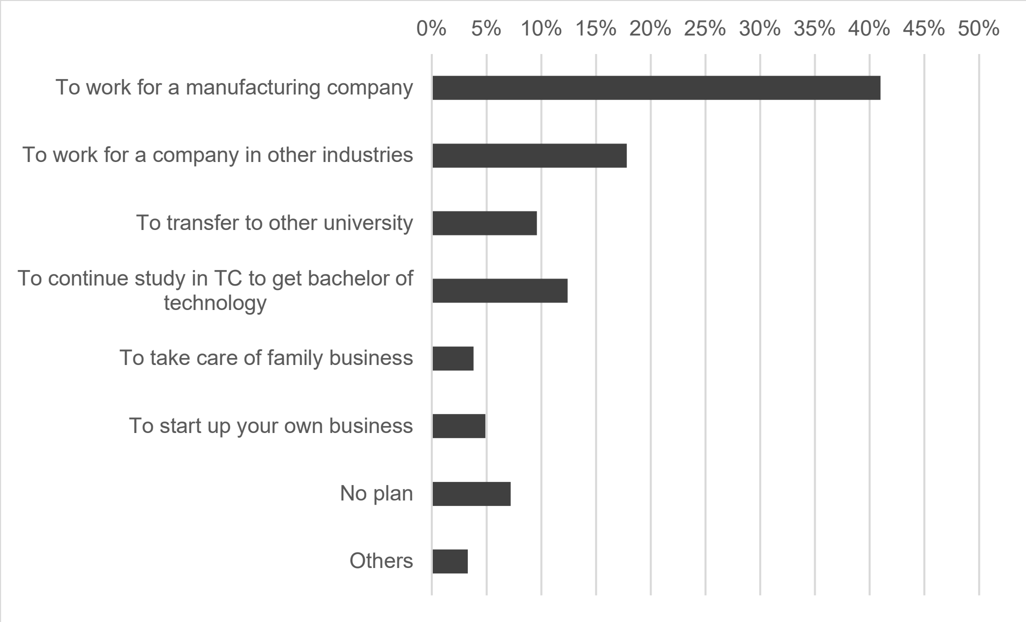
	Res. Count	%
Write a report	95	17.3%
Present your report	98	17.9%
Have discussion with master and colleagues in the company	208	38.0%

	Res. Count	%
Have discussion with both master and teacher	100	18.2%
Propose something (e.g., how to improve workplace or production) to the company	47	8.6%
Total responses	548	100.0%
NA	42	-



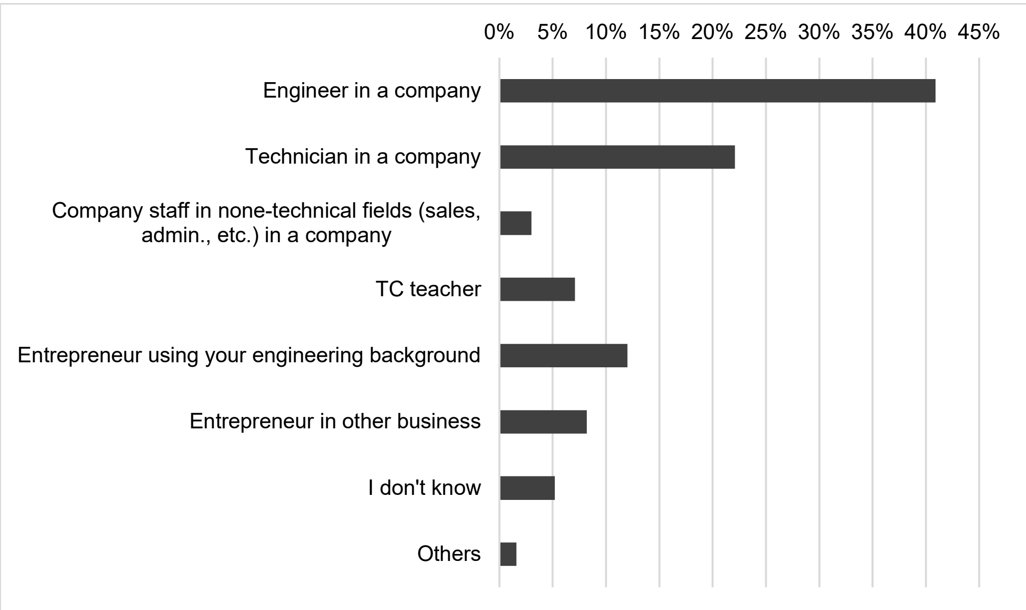
Q8: After graduation, what do you plan to do?

	Res. Count	%
To work for a manufacturing company	235	41.0%
To work for a company in other industries	102	17.8%
To transfer to other university	55	9.6%
To continue study in TC to get bachelor of technology	71	12.4%
To take care of family business	22	3.8%
To start up your own business	28	4.9%
No plan	41	7.2%
Others	19	3.3%
Total responses	573	100.0%
NA	17	-



Q9: What would you like to be in near future?

	Res. Count	%
Engineer in a company	235	40.9%
Technician in a company	127	22.1%
Company staff in none-technical fields (sales, admin., etc.) in a company	17	3.0%
TC teacher	41	7.1%
Entrepreneur using your engineering background	69	12.0%
Entrepreneur in other business	47	8.2%
I don't know	30	5.2%
Others	9	1.6%
Total responses	575	-
NA	15	-



ANNEX 9

Annex 9: Type of Work Integrated Learning by OHEC

Type of WIL	Definition
Pre-course Experience	Students will learn about nature of job they are interested in before choosing to study in each field
Sandwich Course	Students both study in class and work in a company. Academic knowledge learnt in class will be consistent with professional knowledge. Studying subjects will range from general courses to specific courses that provide students with specific knowledge that can be utilized at the workplace. Students can attend class and work at a company for a short period or for a whole semester
Cooperative Education	Cooperative education allows students to study and work systematically. Students will study at school and be trained at a company. The position they work for will be consistent with their major subject at school. They will learn from experience at work in principle, or from some special projects
Job Shadowing	Students will learn from work experience through observing their model/idol. They will work under extra guidance from the said model/idol
Joint Industry	Joint Industry is a joint cooperation between educational institutes and entrepreneurs/organizations both in public and private sectors to produce graduates with quality and professionalism in order to meet the need from the labor market. They will work in accordance with the signed MOU/agreement and be consistent with professional standards
New Traineeship	Students will work in the field that they have studied at school. They will use knowledge gained from classes and adapt them at work. The focus will be given to basic training and the duration will be less than 2 months
Practicum	Practicum is a professional training of students that is approved by a company. Students will be taken care of by their mentor continuously so that they will gain knowledge and understanding of the nature of their job like a professional. They will also have an advisor who is a teacher at their school. The duration can be fixed by hour or week.
Fieldwork	Students will learn from working at a company in a real situation by using knowledge gained at a certain level to work in their field of expertise. They will be guided by their company and teacher
Post-course Internship	Students will work in their field of expertise at a company. Focus will be given to project-based job or jobs that fit with their expertise. The duration will be no less than 4 months

(Example) Research and Innovation Services of King Mongkut's Institute of Technology Ladkrabang

The below table shows the number of cases and examples of the work that the Faculty of Engineering were implemented in the fiscal year of 2016 through the Research and Innovation Service Office. The area of work is classified by four main sections under the Research and Innovation Services Office.

Area of work	No. of cases (or budget)	Examples of topic/area & companies (relevant departments e.g. electronics, electrical, mechanic, mechatronics, automation)
Academic services	45 cases (Note: 12 cases for Civil Engineering Department, 9 cases for Computer Engineering Department, 3 cases for Instrumentation and Control Engineering Department, 9 cases for Electrical Engineering Department, 5 cases for Food Engineering; 1 case for Industrial Engineering Department, 4 Telecommunications Engineering Department; and 2 Building Engineering Department)	• **Electrical Engineering Department** worked with only one company (Samart Telecom Public Co.,Ltd.) about the planning on the infrastructure on technology, information and communication. Others are government agencies including Office of the Cane and Sugar Board, National Institute of Metrology, Chumporn Local Administrative Promotion Office, Ministry of Natural Resources and Environment, Bangkok Mass Transit Authority, Office of the Welfare Promotion Commission for Teachers and Educational Personnel, and Thai Bar Association. • **Instrumentation and Control Engineering Department** did not work with any company. It worked with government agencies including Bangkok Mass Transit Authority and Department of Empowerment of People with Disabilities. • **Industrial Engineering Department** worked with a company (Scan Inter Public Co.,Ltd.) about tanks for natural gas (known as CNG IV).
Research with external partners	18 cases (2 cases for Mechanic Engineering Department, 2 cases for Electrical Engineering Department, 6 cases for Food Engineering Department, 6 cases for Computer Engineering Department, 1 case for Civil Engineering Department, and 1 case for Telecommunications Engineering Department)	• **Mechanical Engineering Department** worked with one company (Rayong Engineering and Maintenance Co.,Ltd) about the Study and Research of Application of Porous Burner and Staging Burner. It also worked with a government agency (National Science Technology and Innovation Party Office) about the research on rail transportation engineering) • **Electrical Engineering Department** did not work with any companies**.** It worked with a government agency(Regional Electrical Authority) about electric bus for the low-carbon society.

Public-private policy support	3 cases (3 cases for Food Engineering Department)	No relevant department
Intellectual property	1 (1 case for Food Engineering Department)	No relevant department

ANNEX 10

Annex 10: Results of surveys to universities and technical colleges on equipment

Survey results for basic equipment (universities)

* Noting that the average response percentage and the average response count are given under each table. The equipment that receives response below the average response count is in red color (if the color can be seen).

หน่วยปฏิบัติการกลศาสตร์ของไหล (Fluid Mechanics Lab)		
Answer Options	**Response Percent**	**Response Count**
ความสูญเสียในระบบท่อ วาล์วและข้อต่อ (Losses in Piping, Valves, and Fittings)	75.0%	12
การไหลและความเสียดทานในท่อ (Flow and Friction in Pipe)	68.8%	11
ชุดฝึกทฤษฎีของ Bernoulli (Bernoulli's Theorem Apparatus)	62.5%	10
ชุดฝึกทดลองระบบไฮดรอลิกส์ (Hydraulic Training System)	62.5%	10
ชุดฝึกทดลองระบบนิวเมติกส์ (Pneumatic Training System)	62.5%	10
ชุดทดสอบการต่อปั๊มแบบขนาดและแบบอนุกรม (Series and Parallel Pump Test Set)	56.3%	9
ชุดทดสอบปั๊มหลายแบบ (Multi-Pump Test Set)	37.5%	6
ชุดทดสอบเครื่องกังหันแบบฟรานซิส และแบบเพลตัน (Pelton & Francis Turbine Sets)	25.0%	4
ชุดทดลองการไหลแบบอัดตัวได้ (Compressible Flow Experiment Set)	18.8%	3
ชุดฝึกเครื่องกังหันแบบ Kaplan (Kaplan Turbine Trainer)	0.0%	0
answered question	***16***	**16**
skipped question	***26***	**26**

Average Response Percent 49.6% Average Response Count 8

หน่วยปฏิบัติการยานยนต์ (Automotive Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกการถอดประกอบเครื่องยนต์ (Engine Assembly Training)	75.0%	9
ชุดระบบส่งกำลังแบบธรรมดา (Manual Transmission Set)	58.3%	7
เครื่องยนต์ผ่าซีก (Sectioned Engine)	58.3%	7
ชุดฝึกทดลองระบบไฟฟ้ารถยนต์ (Automotive Electrical Circuit Training)	50.0%	6
ชุดระบบพวงมาลัยรถยนต์ (Automotive Steering System)	50.0%	6
ระบบเบรครถยนต์แบบดิสและแบบดรัม (Drum/Disc Brakes System)	50.0%	6
ชุดทดสอบสมรรถนะเครื่องยนต์ (Engine Test Bed)	50.0%	6
ชุดส่วนประกอบเพลาหลังรถยนต์ (Real Axle Assembly)	50.0%	6
ชุดระบบส่งกำลังแบบอัตโนมัติ (Automatic Transmission Set)	41.7%	5
เครื่องทดสอบหัวฉีดเชื้อเพลิง (Fuel Injector Tester)	33.3%	4
ระบบช่วงล่างรถยนต์ (Vehicle Suspension)	33.3%	4
ระบบเบรคแบบ ABS (Anti-Lock Braking (ABS) System)	25.0%	3
ชุดฝึกการควบคุมการทำงานของเครื่องยนต์ (Engine Management Training)	25.0%	3
ชุดตั้งศูนย์รถยนต์ (Wheel Alignment System)	8.3%	1
ชุดถ่วงล้อรถยนต์ (Wheel Balancer)	8.3%	1
ชุดฝึกระบบทำความร้อนความเย็นในรถยนต์ (Automotive Heating and Cooling Training)	0.0%	0
ชุดอุปกรณ์ฟอกไอเสียแบบเร่งปฏิกิริยา (Exhaust Gas Catalytic Converter)	0.0%	0
answered question	***12***	**12**
skipped question	***30***	**30**

Average Response Percent 36.3% Average Response Count 4

หน่วยปฏิบัติการอุณหพลศาสตร์และการถ่ายเทความร้อน (Thermodynamics & Heat Transfer Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดทดลองการปรับอากาศ (Air Conditioning Unit)	63.2%	12
ชุดทดสอบการนำความร้อน (Heat Conduction Set)	52.6%	10
ชุดทดสอบการพาความร้อน (Free & Forced Heat Convection Set)	42.1%	8
ชุดทดลองการทำความเย็น (Refrigeration Unit)	42.1%	8
ชุดฝึกเครื่องแลกเปลี่ยนความร้อน (Heat Exchanger Trainer)	36.8%	7
ชุดทดสอบการแผ่รังสี (Heat Radiation Set)	26.3%	5
ชุดหอทำความเย็น (Cooling Tower Unit)	15.8%	3
ชุดกังหันแก๊ส (Gas Turbine Unit)	15.8%	3
ชุดทดลองระบบจ่ายลม (Air Duct Systems)	5.3%	1
ชุดการก่อสภาพของของไหลและการถ่ายเทความร้อน (Fluidisation and Heat Transfer)	5.3%	1
ชุดปั๊มความร้อน (Heat Pump Unit)	5.3%	1
ชุดทดลองความบกพร่องของระบบไฟฟ้าในระบบทำความเย็น (Electrical Faults in Air Conditioning Systems)	0.0%	0
answered question	***19***	**19**
skipped question	***23***	**23**

Average Response Percent 25.9% Average Response Count 5

หน่วยปฏิบัติการพลศาสตร์และจลนศาสตร์ (Kinematics and Dynamics Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดทดสอบการสั่นสะเทือน (Vibration Testing System)	64.3%	9
ไจโรสโคป (Gyroscope)	42.9%	6
ชุดฝึกระบบควบคุมแบบป้อนกลับ (Feedback Control Training System)	35.7%	5
เครื่องสมดุลอเนกประสงค์ (Universal Balancing Machine)	35.7%	5
ชุดฝึก Micro Controller (Micro Controller Training Set)	28.6%	4
ชุดฝึกการประกอบระบบส่งกำลังด้วยเฟือง สายพานและโซ่ (Gear Assembly Trainer)	21.4%	3
ชุดฝึกการตั้งศูนย์ของระบบส่งกำลัง (Aligment of Drives, Shafts and Gears Trainer)	7.1%	1
โปรแกรมจำลองการทำงานของระบบพลศาสตร์ (Dynamics System Simulation Software)	7.1%	1
answered question	***14***	**14**
skipped question	***28***	**28**

Average Response Percent 30.4% Average Response Count 4

หน่วยปฏิบัติการทดสอบวัสดุ (Material Testing Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องทดสอบแรงดึงอเนกประสงค์ (Tensile Testing or Universal Testing Machine)	75.0%	12
เครื่องทดสอบความแข็งของวัสดุแบบ Brinell Rockwell และ Vickers (Brinell, Rockwell and Vickers Hardness Test)	68.8%	11
เครื่องทดสอบแรงบิด (Torsion Test Machine)	62.5%	10
เครื่องวัดความล้า (Fatigue Testing Machine)	37.5%	6
เครื่องทดสอบด้วยการกระแทกแบบทิ้งน้ำหนักแนวดิ่ง (Drop Weight Impact Testing Machine)	25.0%	4
เครื่องทดสอบด้วยการกระแทกแบบอเนกประสงค์ (Universal Impact Testing Machince)	25.0%	4
เครื่องทดสอบการคืบ (Creep Testing Machine)	12.5%	2

answered question	***16***	**16**
skipped question	***26***	**26**

Average Response Percent 43.8% Average Response Count 7

หน่วยปฏิบัติการการวัด (Measurement Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องมือวัดค่าความร้อน (Bomb Calorimeter)	63.6%	14
ออสซิลโลสโคป (Oscilloscope)	59.1%	13
เครื่องมือวัดความเร็วลม (Anemometer)	50.0%	11
เครื่องมือวัดความเข้มแสง (Lux Meter)	50.0%	11
ชุดฝึกการวัดอุณหภูมิ (Temperature Measurement Set)	45.5%	10
เครื่องมือวัดความชื้น (Humidity Measurement Set)	40.9%	9
เครื่องมือวัดและวิเคราะห์กำลังไฟฟ้า (Power Meter and Analyzer)	40.9%	9
เครื่องวัดความหนืดของน้ำมัน (Viscometer)	40.9%	9
ชุดฝึกการวัดการไหลของอากาศ (Air Flow Measurement Set)	31.8%	7
ชุดฝึกการวัดการไหลของของไหล (Fluid Flow Measurement Set)	31.8%	7
เครึ่งมือวิเคราห์ไอเสียและเขม่า (Exhaust Gas Analyzer & Smoke Detector)	27.3%	6
ชุดฝึกการวัดความดัน (Pressure Measurement Set)	22.7%	5
เครื่องมือวัดค่าความร้อนของไอเสีย (Exhaust Gas Calorimeter)	13.6%	3
เครื่องมือวัดเสียง (Sound Measurement)	13.6%	3
ชุดฝึกการวัดด้วย Strain Guage (Strain Guage Training System)	13.6%	3
answered question	***22***	**22**
skipped question	***20***	**20**

Average Response Percent 36.4% Average Response Count 8

หน่วยปฏิบัติการเครื่องจักรกลและการขึ้นรูป (Machining and Fabrication Laboratory)		
Answer Options	**Response Percent**	**Response Count**
เครื่องกลึงขนาดเล็ก (Lathe Machines (Small Size))	82.4%	14
ชุดเครื่องกลึง CNC (Computer Numerical Control (CNC) Machining Center)	76.5%	13
เครื่องเชื่อมแบบ TIG (Welding Maching (TIG))	58.8%	10
ชุดเครื่องมือพื้นฐานสำหรับงานช่างกลโรงงาน (General Machining Equipment)	52.9%	9
เครื่องกัดแบบอเนกประสงค์ (Universial Milling Machine)	47.1%	8
ชุดโปรแกรมเพื่อการวิเคราะห์ Finite Element (Software Package for Finite Element Analysis)	41.2%	7
เครื่องตัดแบบ Wire Cut (Wire Cut Machine)	41.2%	7
เครื่องเชื่อมแบบ MIG/MAG (Welding Machine (MIG/MAG))	35.3%	6
โปรแกรมจำลองการทำงานของเครื่อง CNC (Computer Simulation Program for CNC)	29.4%	5
เครื่องกลึงขนาดใหญ่ (Lathe Machines (Large Size))	23.5%	4
เครื่องตัดแบบพลาสม่า (Plasma Cutter)	17.6%	3
เครื่องเชื่อมแบบ MMA (Welding Maching (MMA))	17.6%	3
เครื่องปั๊มขึ้นรูประบบไฮดรอลิกส์ (Hydraulic Compressor Machine)	11.8%	2
ชุดตรวจสอบรอยเชื่อม (Weld Inspection Sets)	11.8%	2
answered question	***17***	**17**
skipped question	***25***	**25**

Average Response Percent 39.1% Average Response Count 7

หน่วยปฏิบัติการวงจรไฟฟ้า (Electrical Circuits Lab)		
Answer Options	**Response Percent**	**Response Count**
ดิจิตอลมัลติมิเตอร์ (Digital Multimeter)	96.0%	24
เครื่องจ่ายแรงดันไฟฟ้ากระแสตรง (DC Power Supply)	88.0%	22
ชุดฝึกวงจรไฟฟ้ากระแสตรง / กระแสสลับ (Training System for DC / AC Electric Circuits)	80.0%	20
เครื่องกำเนิดสัญญาณฟังก์ชั่น (Arbitrary Function Generator)	80.0%	20
อนาล็อคมัลติมิเตอร์ (Analog Multimeter)	80.0%	20
แคล้มป์มิเตอร์ (DC Clamp Meter)	76.0%	19
ออสซิลโลสโคปแบบอนาล็อค (Analog Oscilloscope)	76.0%	19
เครื่องจ่ายแรงดันไฟฟ้ากระแสสลับ (AC Power Supply)	72.0%	18
เครื่องปรับแรงดันไฟ AC (AC Slide Regulator)	64.0%	16
ออสซิลโลสโคปแบบพกพา (Handheld oscilloscopes)	32.0%	8
answered question	***25***	**25**
skipped question	***17***	**17**

Average Response Percent 74.4% Average Response Count 19

หน่วยปฏิบัติการอิเล็กทรอนิคส์ (Electronics Lab)		
Answer Options	**Response Percent**	**Response Count**
แผงต่อวงจรอิเล็กทรอนิคส์ (Electronic Training Board)	81.0%	17
ชุดฝึกดิจิตอลลอจิก (Digital Logic Experiment Board)	61.9%	13
ชุดฝึกวงจรดิจิตอล (Digital Circuit Experiment Board)	57.1%	12
ชุดฝึกอุปกรณ์วงจรอิเล็กทรอนิกส์ (Training System for Semiconductor Circuits)	52.4%	11
ชุดฝึกอิเล็กทรอนิกส์กำลัง (Training System for Power Electronics)	52.4%	11
ชุดดูดตะกั่วพร้อมปั๊มลม (Desoldering Tool)	47.6%	10
ชุดฝึกวงจรพัลส์และสวิตชิ่ง (Training System for Pulse and Switching Circuits)	33.3%	7
ชุดฝึกวงจร Integrated Circuits (Training System for Analog Integrated Circuits)	28.6%	6
ชุดฝึกการซ่อมอุปกรณ์ไฟฟ้าในบ้าน (Training System for Appliance Repair)	19.0%	4
ชุดฝึกเครื่องขยายเสียง (Training System for Amplifier)	9.5%	2
answered question	***21***	**21**
skipped question	***21***	**21**

Average Response Percent 44.3% Average Response Count 9

หน่วยปฏิบัติการไฟฟ้าสื่อสาร (Communications Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องวัดความถี่ (Frequency Counter)	80.0%	4
เครื่องมือวัดความถี่และสเปกตรัมของสัญญาณ (Spectrum Analyzer)	80.0%	4
ชุดอุปกรณ์ทดลอง Modulation และ Demodulation แบบต่างๆ (Modulation / Demodulation Training)	80.0%	4
ชุดทดลองสายอากาศ (Training System for Antenna Systems)	80.0%	4
เครื่องกำเนิดสัญญาณย่านRF (RF signal generator)	60.0%	3
มิเตอร์วัดกำลังสัญญาณวิทยุ (RF Power Meter)	60.0%	3
ชุดทดลองระบบสื่อสารอนาล็อคและดิจิตอล (Analog / Digital Communication Training)	60.0%	3
เครื่องวัดค่าสนามแม่เหล็กไฟฟ้า (Electromagnetic Field Meter)	40.0%	2
เครื่องมือวัดค่า SWR (Standing Wave Ratio (SWR) Meter)	40.0%	2
เครื่องมือวัดวงจรความถี่ LC (Digital Dip Meter)	40.0%	2
ชุดทดลองระบบสื่อสารไมโครเวฟ (Training System for Microwave Communication)	40.0%	2
อาร์เอฟดัมมี่โหลด (RF Dummy Loads)	20.0%	1
ชุดทดลองสายส่งสัญญาณ (Training System for Communication Transmission Lines)	20.0%	1
ชุดทดลองระบบสื่อสารออปติค (Training System for Optical Communication)	20.0%	1

เครื่องวัดสัญญาณแสง (Optical Signal Analyzer)	20.0%	1
เครื่องกำเนิดสัญญาณวิทยุ (AM / FM Signal Generator)	20.0%	1
ชุดฝึกติดตั้งเครื่องรับสัญญาณดาวเทียม (Training System for Satellite Receiver Installation)	20.0%	1
เครื่องกำเนิดสัญญาณภาพทดสอบโทรทัศน์ (TV Pattern Generator)	0.0%	0
ชุดทดลองเครื่องรับโทรทัศน์สี (Training System for Television Receiver)	0.0%	0
ชุดฝึกเครื่องส่งวิทยุ AM-FM Stereo (Training System for AM-FM Transmitter)	0.0%	0
ชุดฝึกเครื่องรับวิทยุ AM-FM Stereo (Training System for AM-FM Receiver)	0.0%	0
ชุดฝึกเครื่องรับส่งวิทยุสื่อสาร (Training System for VHF / UHF Radio)	0.0%	0
ชุดฝึกไมโครคอมพิวเตอร์และอุปกรณ์ประกอบ (Training System for Microcomputer Technology)	0.0%	0
answered question	***5***	**5**
skipped question	***37***	**37**

Average Response Percent 33.9% Average Response Count 2

หน่วยปฏิบัติการเครื่องจักรกลไฟฟ้า (Electrical Machine Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดทดลองมอเตอร์และเครื่องกำเนิดไฟฟ้าแบบต่างๆ (Motors, Generators, and Controls Experiment)	81.3%	13
ชุดทดลองเครื่องกลไฟฟ้า (Training System for Electric Machine)	68.8%	11
ชุดทดลองการควบคุมมอเตอร์ไฟฟ้า (Training System for Electrical Motor Control and Programming)	62.5%	10
เครื่องพันขดลวดแบบมือหมุน (Manual Winding Machine)	25.0%	4
เครื่องพันขดลวดแบบไฟฟ้า (Electric Winding Machine)	18.8%	3
ชุดทดลองส่วนประกอบมอเตอร์ (Training System for Dissectible Machines)	18.8%	3
ชุดทดลองการพันขดลวดมอเตอร์ไฟฟ้า (Training System for Motor Winding)	12.5%	2
answered question	***16***	**16**
skipped question	***26***	**26**

Average Response Percent 41.1% Average Response Count 7

หน่วยปฏิบัติการระบบไฟฟ้ากำลัง (Electric Power System Lab)		
Answer Options	**Response Percent**	**Response Count**
แอมมิเตอร์ (Ammeter)	94.1%	16
โวลต์มิเตอร์ (Voltmeter)	94.1%	16
โอห์มมิเตอร์ (Ohmmeter)	82.4%	14
เครื่องมือวัดความเร็วรอบ (Tachometer)	82.4%	14
วัตต์มิเตอร์ (Wattmeter)	76.5%	13
โต๊ะปฏิบัติการทางไฟฟ้า (Electrical Systems Workbench)	70.6%	12
อุปกรณ์ปรับค่าแรงดันไฟฟ้าชนิด 1 เฟส (Single Phase Voltage Stabilizer)	58.8%	10
อุปกรณ์ปรับค่าแรงดันไฟฟ้าชนิด 3 เฟส (Three Phase Voltage Stabilizer)	58.8%	10
วัตต์ฮาวร์มิเตอร์ (Watt-Hour Meter)	58.8%	10
ลักซ์มิเตอร์ (Luxmeter)	58.8%	10
เครื่องมือวัด Torque (Torque Meter)	52.9%	9
เพาเวอร์แฟคเตอร์มิเตอร์ (Power Factor Meter)	47.1%	8
ชุดอุปกรณ์ระบบควบคุมชนิดระบบเปิดและระบบปิด (Training for Open-Loop Control and Closed-Loop Control)	47.1%	8
วาร์มิเตอร์ (VAR Meter)	41.2%	7
ชุดทดลองหม้อแปลงไฟฟ้า (Training System for Distribution Transformer Trainer)	41.2%	7
ชุดฝึกเครื่องมือวัดทางไฟฟ้า (Training System for Electrical Instrumentation)	35.3%	6
ชุดทดลองระบบป้องกันไฟฟ้า (Training System for Electrical Protective Measure)	35.3%	6
ชุดทดลองระบบสายส่งกำลังไฟฟ้า (Training System for AC Power Transmission)	29.4%	5
ชุดฝึกระบบเซนเซอร์ (Training System for Sensor and Transducer)	23.5%	4
ชุดทดลองการวัดการต่อลงดิน (Training System for Electrical Grounding Systems)	17.6%	3

ชุดทดลองระบบป้องกันไฟฟ้ากำลัง (Training System for Power System Protection)	17.6%	3
เครื่องทดสอบค่าความปลอดภัยของเครื่องใช้ไฟฟ้า (Electrical Safety Tester)	11.8%	2
ชุดทดลองอุปกรณ์สวิตช์เกียร์และบัสบาร์ (Training System for Switchgear and Busbar)	0.0%	0
answered question	***17***	**17**
skipped question	***25***	**25**

Average Response Percent 49.4% Average Response Count 8

หน่วยปฏิบัติการไมโครโพรเซสเซอร์ (Microprocessor Lab)		
Answer Options	**Response Percent**	**Respon se Count**
ชุดฝึกไมโครคอนโทรลเลอร์และอินเตอร์เฟส (Microcontroller Tool Kit / Board (Arduino/Raspberry PI/Galileo/etc))	88.9%	16
แผงไมโครโพรเซสเซอร์ (Microprocessor Board)	72.2%	13
answered question	***18***	**18**
skipped question	***24***	**24**

Average Response Percent 80.6% Average Response Count 15

C-2. Survey results for basic equipment (technical colleges)

* Noting that the average response percentage and the average response count are given under each table. The equipment that receives response below the average response count is in red color (if the color can be seen).

หน่วยปฏิบัติการกลศาสตร์ของไหล (Fluid Mechanics Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกทดลองระบบไฮดรอลิกส์ (Hydraulic Training System)	80.0%	8
ชุดฝึกทดลองระบบนิวเมติกส์ (Pneumatic Training System)	70.0%	7
การไหลและความเสียดทานในท่อ (Flow and Friction in Pipe)	30.0%	3
ความสูญเสียในระบบท่อ วาล์วและข้อต่อ (Losses in Piping, Valves, and Fittings)	30.0%	3
ชุดทดสอบปั๊มหลายแบบ (Multi-Pump Test Set)	20.0%	2
ชุดทดสอบการต่อปั๊มแบบขนาดและแบบอนุกรม (Series and Parallel Pump Test Set)	20.0%	2
ชุดฝึกทฤษฎีของ Bernoulli (Bernoulli's Theorem Apparatus)	10.0%	1
ชุดทดลองการไหลแบบอัดตัวได้ (Compressible Flow Experiment Set)	0.0%	0
ชุดฝึกเครื่องกังหันแบบ Kaplan (Kaplan Turbine Trainer)	0.0%	0
ชุดทดสอบเครื่องกังหันแบบฟรานซิส และแบบเพลตัน (Pelton & Francis Turbine Sets)	0.0%	0
answered question	***9***	**9**
skipped question	***2***	**2**

Average Response Percent 26.0% Average Response Count 2.6

หน่วยปฏิบัติการยานยนต์ (Automotive Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกทดลองระบบไฟฟ้ารถยนต์ (Automotive Electrical Circuit Training)	50.0%	6
ระบบช่วงล่างรถยนต์ (Vehicle Suspension)	50.0%	6
ชุดถ่วงล้อรถยนต์ (Wheel Balancer)	50.0%	6
เครื่องทดสอบหัวฉีดเชื้อเพลิง (Fuel Injector Tester)	33.3%	4
ชุดตั้งศูนย์รถยนต์ (Wheel Alignment System)	33.3%	4
ชุดระบบส่งกำลังแบบอัตโนมัติ (Automatic Transmission Set)	25.0%	3
ระบบเบรครถยนต์แบบดิสและแบบดรัม (Drum/Disc Brakes System)	25.0%	3

ชุดฝึกการถอดประกอบเครื่องยนต์ (Engine Assembly Training)	25.0%	3
ชุดฝึกการควบคุมการทำงานของเครื่องยนต์ (Engine Management Training)	25.0%	3
ชุดระบบส่งกำลังแบบธรรมดา (Manual Transmission Set)	25.0%	3
ระบบเบรคแบบ ABS (Anti-Lock Braking (ABS) System)	16.7%	2
ชุดฝึกระบบทำความร้อนความเย็นในรถยนต์ (Automotive Heating and Cooling Training)	16.7%	2
ชุดทดสอบสมรรถนะเครื่องยนต์ (Engine Test Bed)	16.7%	2
ชุดส่วนประกอบเพลาหลังรถยนต์ (Real Axle Assembly)	16.7%	2
ชุดระบบพวงมาลัยรถยนต์ (Automotive Steering System)	8.3%	1
เครื่องยนต์ผ่าซีก (Sectioned Engine)	8.3%	1
ชุดอุปกรณ์ฟอกไอเสียแบบเร่งปฏิกริยา (Exhaust Gas Catalytic Converter)	0.0%	0
answered question	***10***	**10**
skipped question	***1***	**1**

Average Response Percent 25.0% Average Response Count 3

หน่วยปฏิบัติการอุณหพลศาสตร์และการถ่ายเทความร้อน (Thermodynamics & Heat Transfer Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดทดลองการปรับอากาศ (Air Conditioning Unit)	100.0%	1
ชุดทดลองระบบจ่ายลม (Air Duct Systems)	0.0%	0
ชุดหอทำความเย็น (Cooling Tower Unit)	0.0%	0
ชุดทดลองความบกพร่องของระบบไฟฟ้าในระบบทำความเย็น (Electrical Faults in Air Conditioning Systems)	0.0%	0
ชุดการก่อสภาพของของไหลและการถ่ายเทความร้อน (Fluidisation and Heat Transfer)	0.0%	0
ชุดทดสอบการพาความร้อน (Free & Forced Heat Convection Set)	0.0%	0
ชุดกังหันแก๊ส (Gas Turbine Unit)	0.0%	0
ชุดทดสอบการนำความร้อน (Heat Conduction Set)	0.0%	0
ชุดฝึกเครื่องแลกเปลี่ยนความร้อน (Heat Exchanger Trainer)	0.0%	0
ชุดปั๊มความร้อน (Heat Pump Unit)	0.0%	0
ชุดทดสอบการแผ่รังสี (Heat Radiation Set)	0.0%	0
ชุดทดลองการทำความเย็น (Refrigeration Unit)	0.0%	0
answered question	***1***	**1**
skipped question	***10***	**10**

Average Response Percent 8.3% Average Response Count 0.1

หน่วยปฏิบัติการพลศาสตร์และจลนศาสตร์ (Kinematics and Dynamics Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกการตั้งศูนย์ของระบบส่งกำลัง (Aligment of Drives, Shafts and Gears Trainer)	100.0%	3
โปรแกรมจำลองการทำงานของระบบพลศาสตร์ (Dynamics System Simulation Software)	0.0%	0
ชุดฝึกระบบควบคุมแบบป้อนกลับ (Feedback Control Training System)	0.0%	0
ชุดฝึกการประกอบระบบส่งกำลังด้วยเฟือง สายพานและโซ่ (Gear Assembly Trainer)	0.0%	0
ไจโรสโคป (Gyroscope)	0.0%	0
ชุดฝึก Micro Controller (Micro Controller Training Set)	0.0%	0
เครื่องสมดุลอเนกประสงค์ (Universal Balancing Machine)	0.0%	0
ชุดทดสอบการสั่นสะเทือน (Vibration Testing System)	0.0%	0
answered question	***3***	**3**
skipped question	***8***	**8**

Average Response Percent 12.5% Average Response Count 0.4

หน่วยปฏิบัติการทดสอบวัสดุ (Material Testing Lab)		
Answer Options	**Response Percent**	**Respons e Count**
เครื่องทดสอบแรงดึงอเนกประสงค์ (Tensile Testing or Universal Testing Machine)	100.0%	2
เครื่องทดสอบความแข็งของวัสดุแบบ Brinell Rockwell และ Vickers (Brinell, Rockwell and Vickers Hardness Tester)	50.0%	1
เครื่องทดสอบการคืบ (Creep Testing Machine)	0.0%	0
เครื่องทดสอบด้วยการกระแทกแบบทิ้งน้ำหนักแนวดิ่ง (Drop Weight Impact Testing Machine)	0.0%	0
เครื่องวัดความล้า (Fatigue Testing Machine)	0.0%	0
เครื่องทดสอบแรงบิด (Torsion Test Machine)	0.0%	0
เครื่องทดสอบด้วยการกระแทกแบบอเนกประสงค์ (Universal Impact Testing Machince)	0.0%	0
answered question	***2***	**2**
skipped question	***9***	**9**

Average Response Percent 21.4% Average Response Count 0.4

หน่วยปฏิบัติการการวัด (Measurement Lab)		
Answer Options	**Response Percent**	**Respon se Count**
ออสซิลโลสโคป (Oscilloscope)	42.9%	3
เครื่องมือวัดค่าความร้อน (Bomb Calorimeter)	28.6%	2
ชุดฝึกการวัดการไหลของของไหล (Fluid Flow Measurement Set)	28.6%	2
เครื่องมือวัดและวิเคราะห์กำลังไฟฟ้า (Power Meter and Analyzer)	28.6%	2
เครื่งมือวิเคราะห์ไอเสียและเขม่า (Exhaust Gas Analyzer & Smoke Detector)	14.3%	1
เครื่องมือวัดค่าความร้อนของไอเสีย (Exhaust Gas Calorimeter)	14.3%	1
เครื่องวัดความหนืดของน้ำมัน (Viscometer)	14.3%	1
ชุดฝึกการวัดการไหลของอากาศ (Air Flow Measurement Set)	0.0%	0
เครื่องมือวัดความเร็วลม (Anemometer)	0.0%	0
เครื่องมือวัดความชื้น (Humidity Measurement Set)	0.0%	0
เครื่องมือวัดความเข้มแสง (Lux Meter)	0.0%	0
ชุดฝึกการวัดความดัน (Pressure Measurement Set)	0.0%	0
เครื่องมือวัดเสียง (Sound Measurement)	0.0%	0
ชุดฝึกการวัดด้วย Strain Guage (Strain Guage Training System)	0.0%	0
ชุดฝึกการวัดอุณหภูมิ (Temperature Measurement Set)	0.0%	0
answered question	***7***	**7**
skipped question	***4***	**4**

Average Response Percent 11.4% Average Response Count 0.8

หน่วยปฏิบัติการเครื่องจักรกลและการขึ้นรูป (Machining and Fabrication Laboratory)		
Answer Options	**Response Percent**	**Respon se Count**
ชุดเครื่องมือพื้นฐานสำหรับงานช่างกลโรงงาน (General Equipment (Drilling, Bender, Slotter, Grinder, Bandsaw, Boring, Fraise, Shaper))	100.0%	3
เครื่องกลึงขนาดเล็ก (Lathe Machines (Small Size))	100.0%	3
เครื่องกัดแบบอเนกประสงค์ (Universial Milling Machine)	100.0%	3
เครื่องเชื่อมแบบ MIG/MAG (Welding Machine (MIG/MAG))	100.0%	3
เครื่องเชื่อมแบบ TIG (Welding Maching (TIG))	100.0%	3
เครื่องกลึงขนาดใหญ่ (Lathe Machines (Large Size))	66.7%	2
ชุดโปรแกรมเพื่อการวิเคราะห์ Finite Element (Software Package for Finite Element Analysis)	66.7%	2

เครื่องเชื่อมแบบ MMA (Welding Maching (MMA))	66.7%	2
เครื่องตัดแบบ Wire Cut (Wire Cut Machine)	66.7%	2
ชุดเครื่องกลึง CNC (Computer Numerical Control (CNC) Machining Center)	33.3%	1
โปรแกรมจำลองการทำงานของเครื่อง CNC (Computer Simulation Program for CNC)	33.3%	1
เครื่องปั๊มขึ้นรูประบบไฮดรอลิกส์ (Hydraulic Compressor Machine)	33.3%	1
เครื่องตัดแบบพลาสม่า (Plasma Cutter)	33.3%	1
ชุดตรวจสอบรอยเชื่อม (Weld Inspection Sets)	33.3%	1
answered question	***3***	**3**
skipped question	***8***	**8**

Average Response Percent 66.7%   Average Response Count 2

หน่วยปฏิบัติการวงจรไฟฟ้า (Electrical Circuits Lab)		
Answer Options	**Response Percent**	**Respon se Count**
เครื่องจ่ายแรงดันไฟฟ้ากระแสตรง (DC Power Supply)	100.0%	6
ดิจิตอลมัลติมิเตอร์ (Digital Multimeter)	100.0%	6
เครื่องกำเนิดสัญญาณฟังก์ชั่น (Arbitrary Function Generator)	83.3%	5
อนาล็อคมัลติมิเตอร์ (Analog Multimeter)	83.3%	5
ออสซิลโลสโคปแบบอนาล็อค (Analog Oscilloscope)	83.3%	5
เครื่องจ่ายแรงดันไฟฟ้ากระแสสลับ (AC Power Supply)	66.7%	4
เครื่องปรับแรงดันไฟ AC (AC Slide Regulator)	66.7%	4
แคล้มป์มิเตอร์ (DC Clamp Meter)	66.7%	4
ชุดฝึกวงจรไฟฟ้ากระแสตรง / กระแสสลับ (Training System for DC / AC Electric Circuits)	50.0%	3
ออสซิลโลสโคปแบบพกพา (Handheld oscilloscopes)	33.3%	2
answered question	***6***	**6**
skipped question	***5***	**5**

Average Response Percent 73.3%   Average Response Count 4.4

หน่วยปฏิบัติการอิเล็กทรอนิคส์ (Electronics Lab)		
Answer Options	**Response Percent**	**Respon se Count**
แผงต่อวงจรอิเล็กทรอนิคส์ (Electronic Training Board)	71.4%	5
ชุดฝึกอุปกรณ์วงจรอิเล็กทรอนิกส์ (Training System for Semiconductor Circuits)	71.4%	5
ชุดฝึกอิเล็กทรอนิกส์กำลัง (Training System for Power Electronics)	57.1%	4
ชุดฝึกวงจรพัลส์และสวิตชิง (Training System for Pulse and Switching Circuits)	42.9%	3
ชุดฝึกวงจร Integrated Circuits (Training System for Analog Integrated Circuits)	42.9%	3
ชุดฝึกดิจิตอลลอจิก (Digital Logic Experiment Board)	42.9%	3
ชุดฝึกวงจรดิจิตอล (Digital Circuit Experiment Board)	42.9%	3
ชุดฝึกการซ่อมอุปกรณ์ไฟฟ้าในบ้าน (Training System for Appliance Repair)	28.6%	2
ชุดฝึกเครื่องขยายเสียง (Training System for Amplifier)	14.3%	1
ชุดดูดตะกั่วพร้อมปั๊มลม (Desoldering Tool)	14.3%	1
answered question	***7***	**7**
skipped question	***4***	**4**

Average Response Percent 42.9%   Average Response Count 3

หน่วยปฏิบัติการไฟฟ้าสื่อสาร (Communications Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องมือวัดค่า SWR (Standing Wave Ratio (SWR) Meter)	100.0%	4
เครื่องกำเนิดสัญญาณย่านRF (RF signal generator)	75.0%	3
เครื่องวัดความถี่ (Frequency Counter)	75.0%	3
ชุดฝึกเครื่องส่งวิทยุ AM-FM Stereo (Training System for AM-FM Transmitter)	75.0%	3

ชุดฝึกเครื่องรับวิทยุ AM-FM Stereo (Training System for AM-FM Receiver)	75.0%	3
ชุดฝึกติดตั้งเครื่องรับสัญญาณดาวเทียม (Training System for Satellite Receiver Installation)	75.0%	3
เครื่องมือวัดวงจรความถี่ LC (Digital Dip Meter)	50.0%	2
อาร์เอฟดัมมีโหลด (RF Dummy Loads)	50.0%	2
เครื่องมือวัดความถี่และสเปกตรัมของสัญญาณ (Spectrum Analyzer)	50.0%	2
ชุดอุปกรณ์ทดลอง Modulation และ Demodulation แบบต่างๆ (Training System for Modulation / Demodulation)	50.0%	2
ชุดทดลองระบบสื่อสารอนาล็อคและดิจิตอล (Training System for Analog / Digital Communication System)	50.0%	2
ชุดทดลองสายอากาศ (Training System for Antenna Systems)	50.0%	2
ชุดทดลองสายส่งสัญญาณ (Training System for Communication Transmission Lines)	50.0%	2
เครื่องกำเนิดสัญญาณวิทยุ (AM / FM Signal Generator)	50.0%	2
ชุดฝึกเครื่องรับส่งวิทยุสื่อสาร (Training System for VHF / UHF Radio)	50.0%	2
ชุดฝึกไมโครคอมพิวเตอร์และอุปกรณ์ประกอบ (Training System for Microcomputer Technology)	50.0%	2
เครื่องวัดค่าสนามแม่เหล็กไฟฟ้า (Electromagnetic Field Meter)	25.0%	1
มิเตอร์วัดกำลังสัญญาณวิทยุ (RF Power Meter)	25.0%	1
ชุดทดลองระบบสื่อสารไมโครเวฟ (Training System for Microwave Communication)	25.0%	1
ชุดทดลองระบบสื่อสารออปติค (Training System for Optical Communication)	25.0%	1
เครื่องกำเนิดสัญญาณภาพทดสอบโทรทัศน์ (TV Pattern Generator)	25.0%	1
ชุดทดลองเครื่องรับโทรทัศน์สี (Training System for Television Receiver)	25.0%	1
เครื่องวัดสัญญาณแสง (Optical Signal Analyzer)	0.0%	0
answered question	***4***	***4***
skipped question	***7***	***7***

Average Response Percent 48.9% Average Response Count 2

หน่วยปฏิบัติการเครื่องจักรกลไฟฟ้า (Electrical Machine Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องพันขดลวดแบบมือหมุน (Manual Winding Machine)	66.7%	6
ชุดทดลองเครื่องกลไฟฟ้า (Training System for Electric Machine)	66.7%	6
ชุดทดลองการควบคุมมอเตอร์ไฟฟ้า (Training System for Electrical Motor Control and Programming)	66.7%	6
ชุดทดลองมอเตอร์และเครื่องกำเนิดไฟฟ้าแบบต่างๆ (Motors, Generators, and Controls Experiment Board)	55.6%	5
เครื่องพันขดลวดแบบไฟฟ้า (Electric Winding Machine)	22.2%	2
ชุดทดลองการพันขดลวดมอเตอร์ไฟฟ้า (Training System for Motor Winding)	11.1%	1
ชุดทดลองส่วนประกอบมอเตอร์ (Training System for Dissectible Machines)	11.1%	1
answered question	***9***	***9***
skipped question	***2***	***2***

Average Response Percent 42.9% Average Response Count 3.9

หน่วยปฏิบัติการระบบไฟฟ้ากำลัง (Electric Power System Lab)		
Answer Options	**Response Percent**	**Response Count**
วัตต์มิเตอร์ (Wattmeter)	90.0%	9
วัตต์ฮาวร์มิเตอร์ (Watt-Hour Meter)	70.0%	7
เพาเวอร์แฟคเตอร์มิเตอร์ (Power Factor Meter)	70.0%	7
แอมมิเตอร์ (Ammeter)	70.0%	7
โวลต์มิเตอร์ (Voltmeter)	70.0%	7
โอห์มมิเตอร์ (Ohmmeter)	70.0%	7
ชุดฝึกเครื่องมือวัดทางไฟฟ้า (Training System for Electrical Instrumentation)	60.0%	6
โต๊ะปฏิบัติการทางไฟฟ้า (Electrical Systems Workbench)	50.0%	5
อุปกรณ์ปรับค่าแรงดันไฟฟ้าชนิด 1 เฟส (Single Phase Voltage Stabilizer)	50.0%	5
วาร์มิเตอร์ (VAR Meter)	50.0%	5

ลักซ์มิเตอร์ (Luxmeter)	50.0%	5
เครื่องมือวัดความเร็วรอบ (Tachometer)	50.0%	5
เครื่องมือวัด Torque (Torque Meter)	50.0%	5
อุปกรณ์ปรับค่าแรงดันไฟฟ้าชนิด 3 เฟส (Three Phase Voltage Stabilizer)	40.0%	4
ชุดทดลองหม้อแปลงไฟฟ้า (Training System for Distribution Transformer Trainer)	40.0%	4
ชุดฝึกระบบเซนเซอร์ (Training System for Sensor and Transducer)	30.0%	3
ชุดทดลองอุปกรณ์สวิตช์เกียร์และบัสบาร์ (Training System for Switchgear and Busbar)	30.0%	3
ชุดทดลองระบบป้องกันไฟฟ้ากำลัง (Training System for Power System Protection)	30.0%	3
เครื่องทดสอบค่าความปลอดภัยของเครื่องใช้ไฟฟ้า (Electrical Safety Tester)	20.0%	2
ชุดทดลองระบบป้องกันไฟฟ้า (Training System for Electrical Protective Measure)	20.0%	2
ชุดทดลองการวัดการต่อลงดิน (Training System for Electrical Grounding Systems)	20.0%	2
ชุดอุปกรณ์ระบบควบคุมชนิดระบบเปิดและระบบปิด (Training System for Open-Loop Control and Closed-Loop Control)	10.0%	1
ชุดทดลองระบบสายส่งกำลังไฟฟ้า (Training System for AC Power Transmission)	10.0%	1
answered question	***10***	**10**
skipped question	***1***	**1**

Average Response Percent 45.7%　　　　Average Response Count 4.6

หน่วยปฏิบัติการไมโครโพรเซสเซอร์ (Microprocessor Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกไมโครคอนโทรลเลอร์และอินเตอร์เฟส (Microcontroller Tool Kit / Board (Arduino/Raspberry PI/Galileo/etc))	100.0%	2
แผงไมโครโพรเซสเซอร์ (Microprocessor Board)	50.0%	1
answered question	***2***	**2**
skipped question	***9***	**9**

Average Response Percent 75.0%　　　　Average Response Count 1.5

D-1. Survey results for advance equipment (universities)

* Noting that the average response percentage and the average response count are given under each table. The equipment that receives response below the average response count is in red color (if the color can be seen).

หน่วยปฏิบัติการกลศาสตร์ของไหล (Fluid Mechanics Lab)		
Answer Options	**Response Percent**	**Response Count**
อุโมงค์ลมแบบเปิด (Open Wind Tunnels)	31.3%	5
คุณลักษณะของนอสเซิล (Characteristics of Nozzles)	18.8%	3
โปรแกรมเพื่อการวิเคราะห์พลศาสตร์ของของไหลเชิงตัวเลข (Computer Software for Computational Fluid Dynamic (CFD))	18.8%	3
ชุดฝึกทดลองนิวเมติกส์ไฟฟ้าและออโตเมชั่น (Electropneumatic and Automation Training System)	18.8%	3
โปรแกรมเพื่อการจำลองระบบกำลังของของไหลและออโตเมชั่น (Computer Simulation for Fluid Power and Automation)	6.3%	1
ชุดฝึกระบบไฮดรอลิกส์ไฟฟ้าและออโตเมชั่น (Electrohydraulic and Automation Training System)	0.0%	0
อุโมงค์ลมแบบซุปเปอร์โซนิค (Supersonic Wind Tunnels)	0.0%	0
answered question	***16***	**16**
skipped question	***26***	**26**

Average Response Percent 13.4%　　　　Average Response Count 2

หน่วยปฏิบัติการยานยนต์ (Automotive Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดทดลองการเผาไหม้ (Combustion Experimentation Unit)	50.0%	6
ชุดทดสอบสมรรถนะรถยนต์ (Chassis Dynamometer)	25.0%	3
ชุดทดสอบปั๊มหัวฉีดเครื่องยนต์ดีเซล (Diesel Injection Pump Test Bench)	25.0%	3
ระบบปรับแต่งสมรรถนะการทำงานของเครื่องยนต์ (Engine Management and Performance Tuning System)	16.7%	2
เครื่องมือตรวจสอบความผิดปกติของรถยนต์ (On-Boarded Diagnosis II Scanner Set)	16.7%	2
โปรแกรมจำลองการทำงานของเครื่องยนต์ (Engine Simulation Software)	8.3%	1
ชุดเก็บข้อมูลเพื่อการวิเคราะห์สมรรถนะรถยนต์ (Data Logging for Automotive Performance Analysis)	8.3%	1
โปรแกรมจำลองการทำงานของรถยนต์ (Vehicle Simulation Software)	8.3%	1
ชุดทดสอบการทำงานของระบบคอมมอนเรล (Diesel Common Rail Test Bench)	0.0%	0
ระบบออกแบบระบบควบคุมต้นแบบในยานยนต์ (Programmable Automotive Control Prototyping System)	0.0%	0
ชุดทดสอบการเคลื่อนที่ของรถแบบล้อเดียว (Quarter Car Test Rig)	0.0%	0
เครื่องมือทดสอบยางรถยนต์ (Tire Testing Machine)	0.0%	0
answered question	***12***	**12**
skipped question	***30***	**30**

Average Response Percent 13.2% Average Response Count 2

หน่วยปฏิบัติการอุณหพลศาสตร์และการถ่ายเทความร้อน (Thermodynamics & Heat Transfer Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกพลังงานแสงอาทิตย์ (Photovoltaics Training System)	15.8%	3
ชุดฝึกต้นกำลังไอน้ำ (Steam Power Plant)	15.8%	3
ประสิทธิภาพพลังงานในระบบทำความเย็น (Energy Efficiency in Refrigeration System)	10.5%	2
โปรแกรมการจำลองสำหรับอุณหพลศาสตร์และการถ่ายเทความร้อน (Thermodynamics & Heat Transfer Simulation Software)	10.5%	2
ชุดฝึกอุปกรณ์เทอร์โมอิเล็คทริก (Thermoelectric Device Training)	5.3%	1
ชุดฝึกพลังงานลม (Wind Power Plant Trainer)	5.3%	1
การควบคุมความสามารถและความบกพร่องในระบบทำความเย็น (Capacity Control and Faults in Refrigeration System)	0.0%	0
answered question	***19***	**19**
skipped question	***23***	**23**

Average Response Percent 9.0% Average Response Count 2

หน่วยปฏิบัติการพลศาสตร์และจลนศาสตร์ (Kinematics and Dynamics Lab)		
Answer Options	**Response Percent**	**Response Count**
แขนกลแบบ 6 แกน (6-Axis Robot Arm)	35.7%	5
กล้องถ่ายวีดีโอความเร็วสูง (High Speed Video Camera)	35.7%	5
ระบบจำลองการทำงานแบบ HIL (Hardware-in-the-Loop System)	7.1%	1
answered question	***14***	**14**
skipped question	***28***	**28**

Average Response Percent 26.2% Average Response Count 4

หน่วยปฏิบัติการทดสอบวัสดุ (Material Testing Lab)

Answer Options	Response Percent	Response Count
เครื่องมือวัดความหยาบของผิว (Roughness Tester)	31.3%	5
เครื่องทดสอบความล้าแบบเชิงกลร่วมกับความร้อน (Thermal Mechanical Fatugue (TMF) Testing Set)	18.8%	3
เครื่องมือวัดความแข็งของยาง (Rubber Hardness Tester)	0.0%	0
answered question	***16***	**16**
skipped question	***26***	**26**

Average Response Percent 16.7% Average Response Count 3

หน่วยปฏิบัติการการวัด (Measurement Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกการเก็บข้อมูลด้วยระบบคอมพิวเตอร์ (Data Acquisition Training)	27.3%	6
เครื่องมือวิเคราะห์สัญญาณและสเปคตรัม (Signal and Spectrum Analyzer)	27.3%	6
กล้องถ่ายภาพความร้อน (Thermal Image Camera)	13.6%	3
เครื่องมือวัดแบบ 3 มิติ ความละเอียดสูง (Coordinate Measuring Machine (CMM) System)	9.1%	2
answered question	***22***	**22**
skipped question	***20***	**20**

Average Response Percent 19.3% Average Response Count 4

หน่วยปฏิบัติการเครื่องจักรกลและการขึ้นรูป (Machining and Fabrication Laboratory)		
Answer Options	**Response Percent**	**Response Count**
โปรแกรมสำหรับการออกแบบ 3 มิติ และงาน CAD/CAM (Computer Program(s) for 3D CAD/CAM)	70.6%	12
ชุดสร้างต้นแบบผลิตภัณฑ์แบบ 3 มิติ (3D Printer)	47.1%	8
ชุดเครื่องฉีดพลาสติก (Plastic Injection Molding Machine Center)	29.4%	5
เครื่องตรวจสอบรอยร้าวด้วยอัลตร้าโซนิกส์ (Ultrasonic Flaw Detector Equipment)	23.5%	4
เครื่องตรวจสอบงานเชื่อมด้วยรังสี x-rayระบบดิจิตอล (Digital X-Ray Welding Inspection Equipment)	5.9%	1
เครื่องตรวจสอบสภาพพื้นผิวภายในด้วยกล้องวีดีโอความละเอียดสูง (High Resolution Visual Surface Inspection Equipment)	5.9%	1
answered question	***17***	**17**
skipped question	***25***	**25**

Average Response Percent 30.4% Average Response Count 5

หน่วยปฏิบัติการวงจรไฟฟ้า (Electrical Circuits Lab)		
Answer Options	**Response Percent**	**Response Count**
ออสซิโลสโคปแบบเก็บภาพดิจิตอล (Digital Storage oscilloscope)	72.0%	18
เครื่องมือวัด impedance (LCR meter)	52.0%	13
ซอฟต์แวร์จำลองการทำงานวงจรไฟฟ้า (Electrical Circuit Simulation Tools)	52.0%	13
ออสซิลโลสโคปแบบสัญญาณผสม (Mixed-signal oscilloscope)	24.0%	6
โลจิกอนาไลเซอร์ (Logic Analyzer)	24.0%	6
ออสซิลโลสโคปแบบสารเรืองแสงดิจิตอล (Digital Phosphor Oscilloscope)	20.0%	5
ออสซิลโลสโคปแบบโดเมนผสม (Mixed-domain oscilloscope)	16.0%	4
answered question	***25***	**25**
skipped question	***17***	**17**

Average Response Percent 37.1% Average Response Count 9

หน่วยปฏิบัติการอิเล็กทรอนิคส์ (Electronics Lab)		
Answer Options	**Response Percent**	**Response Count**
ซอฟต์แวร์สร้างวงจรอิเล็กทรอนิกส์และแผ่นวงจรพิมพ์ (Schematic Capture and Printed Circuit Board Prototyping Software)	38.1%	8
ชุดโปรแกรมจำลองและออกแบบอิเล็กทรอนิกส์กำลัง (Power Electronics Simulation Software)	33.3%	7
ออสซิโลสโคปสำหรับวัดค่าพลังงานต่ำ (Low Power Oscilloscope)	19.0%	4
answered question	***21***	**21**
skipped question	***21***	**21**

Average Response Percent 30.1% Average Response Count 6

หน่วยปฏิบัติการไฟฟ้าสื่อสาร (Communications Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องวิเคราะห์โครงข่าย (Network Analyzer)	60.0%	3
ชุดฝึกระบบคอมพิวเตอร์เครือข่าย (LAN) (Training System for Local Area Network System)	20.0%	1
ชุดปฏิบัติการโทรศัพท์เคลื่อนที่ (Training System for Mobile Phone)	20.0%	1
ซอฟต์แวร์ออกแบบและจำลองสายอากาศ (Antenna Design and Simulation Software (e.g., Zeland))	20.0%	1
ซอฟต์แวรจำลองระบบเครือข่าย (Network Level Simulation Software (e.g., OPNET or NS2))	20.0%	1
ซอฟต์แวร์จำลองการแพร่กระจายคลื่นวิทยุ (RF Propagation Software)	20.0%	1
เครื่องวัด OTDR (Optical Time-Domain Reflectometer)	0.0%	0
เครื่องวิเคราะห์สเปกตรัมแสง (Optical Spectrum Analyzer)	0.0%	0
ชุดฝึกตู้สาขาโทรศัพท์ (Training System for Private Branch Exchange (PBX) Telephone System)	0.0%	0
ชุดฝึกระบบโทรศัพท์ ISDN (Training System for Integrated Services Digital Network (ISDN) System)	0.0%	0
ซอฟต์แวรจำลองระบบสื่อสาร (System Level Simulation Software (e.g., SPW or COSSAP))	0.0%	0
answered question	***5***	**5**
skipped question	***37***	**37**

Average Response Percent 14.5% Average Response Count 1

หน่วยปฏิบัติการเครื่องจักรกลไฟฟ้า (Electrical Machine Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดฝึกการควบคุมความเร็วมอเตอร์ไฟฟ้ากระแสสลับ (Training System for AC Variable Speed Drive Control)	68.8%	11
ชุดฝึกการควบคุมความเร็วมอเตอร์ไฟฟ้ากระแสตรง (Training System for DC Variable Speed Drive Control)	68.8%	11
ชุดทดลองควบคุมอุตสาหกรรม (Training System for Industrial Controls)	43.8%	7
เครื่องทดสอบมอเตอร์-สเตเตอร์-ขดลวด (Motor Stator Comprehensive Tester)	18.8%	3
ชุดโปรแกรมจำลองและออกแบบวงจรไฟฟ้า เครื่องกลไฟฟ้า และหม้อแปลงไฟฟ้า (Electric Machine Systems Simulation Software)	18.8%	3
เครื่องมือกลซ่อมบำรุงรักษาเครื่องกลไฟฟ้า (Training System for Mechanical Maintenance of Electrical Machine)	12.5%	2
เครื่องมือซ่อมบำรุงเครื่องกลไฟฟ้า (Training System for Electrical Maintenance of Electrical Machine)	12.5%	2
answered question	***16***	**16**
skipped question	***26***	**26**

Average Response Percent 34.9% Average Response Count 6

หน่วยปฏิบัติการระบบไฟฟ้ากำลัง (Electric Power System Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดอุปกรณ์ทดลองการควบคุมตามลำดับขั้น (PLC) (Training System for Sequential Control / Programmable Logic Controller (PLC))	76.5%	13
โปรแกรม MATLAB/Simulink พร้อมด้วย Power System Analysis Toolbox (MATLAB/Simulink with Toolbox for Power System Analysis)	47.1%	8
ชุดอุปกรณ์ทดลองการควบคุมแบบเชิงเลข (Training System for Numerical Control)	29.4%	5

ชุดทดลองระบบพลังงานทดแทน (Training System for Renewable Energy System)	29.4%	5
ชุดเครื่องมือติดตั้งไฟฟ้าในอาคาร (Indoor Electrical Wiring/Installation Equipment)	23.5%	4
ชุดทดลองระบบ SCADA (Training System for Supervisory Control And Data Acquisition (SCADA))	23.5%	4
ชุดเครื่องมือติดตั้งไฟฟ้านอกอาคาร (Outdoor Electrical Wiring/Installation Equipment)	17.6%	3
ชุดเครื่องมือทดสอบในงานติดตั้งไฟฟ้า (Electrical Installation Tester)	11.8%	2
ชุดเก็บข้อมูลและเครื่องมือวัดแสดงผลทางคอมพิวเตอร์ (Data Acquisition and Control Interface)	11.8%	2
ซอฟต์แวร์สำหรับออกแบบและวิเคราะห์ระบบไฟฟ้ากำลัง (Power System Analysis software)	11.8%	2
ชุดทดลองระบบ Smart Grid (Training System for Smart Grid Technologies Training System)	0.0%	0
answered question	***17***	**17**
skipped question	***25***	**25**

Average Response Percent 25.7% Average Response Count 4

หน่วยปฏิบัติการไมโครโพรเซสเซอร์ (Microprocessor Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดเครื่องมือเพื่อการพัฒนา DSP FPGA หรือ ARM (DSP / FPGA / ARM Development Tool Kit)	50.0%	9
ชุดเครื่องมือเพื่อการพัฒนาอื่นๆ (Other Development Tool Kits (Bluetooth, RFID, ZigBee, etc.))	38.9%	7
อุปกรณ์เชื่อมต่อเพื่อการเก็บข้อมูล (Data Acquisition Device)	38.9%	7
answered question	***18***	**18**
skipped question	***24***	**24**

Average Response Percent 42.6% Average Response Count 8

D-2. Survey results for advance equipment (technical colleges)

* Noting that the average response percentage and the average response count are given under each table. The equipment that receives response below the average response count is in red color (if the color can be seen).

หน่วยปฏิบัติการกลศาสตร์ของไหล (Fluid Mechanics Lab)		
Answer Options	**Response Percent**	**Response Count**
โปรแกรมเพื่อการจำลองระบบกำลังของของไหลและออโตเมชั่น (Computer Simulation for Fluid Power and Automation)	10.0%	1
โปรแกรมเพื่อการวิเคราะห์พลศาสตร์ของของไหลเชิงตัวเลข (Computer Software for Computational Fluid Dynamic (CFD))	10.0%	1
ชุดฝึกทดลองนิวเมติกส์ไฟฟ้าและออโตเมชั่น (Electropneumatic and Automation Training System)	10.0%	1
คุณลักษณะของนอสเซิล (Characteristics of Nozzles)	0.0%	0
ชุดฝึกระบบไฮดรอลิกส์ไฟฟ้าและออโตเมชั่น (Electrohydraulic and Automation Training System)	0.0%	0
อุโมงค์ลมแบบเปิด (Open Wind Tunnels)	0.0%	0
อุโมงค์ลมแบบซุปเปอร์โซนิค (Supersonic Wind Tunnels)	0.0%	0
answered question	***2***	**2**
skipped question	***8***	**8**

Average Response Percent 4.3% Average Response Count 0.4

หน่วยปฏิบัติการยานยนต์ (Automotive Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดทดสอบปั๊มหัวฉีดเครื่องยนต์ดีเซล (Diesel Injection Pump Test Bench)	50.0%	6
เครื่องมือตรวจสอบความผิดปกติของรถยนต์ (On-Boarded Diagnosis II Scanner Set)	33.3%	4
ชุดทดสอบการทำงานของระบบคอมมอนเรล (Diesel Common Rail Test Bench)	25.0%	3

ชุดทดสอบสมรรถนะรถยนต์ (Chassis Dynamometer)	16.7%	2
โปรแกรมจำลองการทำงานของเครื่องยนต์ (Engine Simulation Software)	16.7%	2
ชุดเก็บข้อมูลเพื่อการวิเคราะห์สมรรถนะรถยนต์ (Data Logging for Automotive Performance Analysis)	16.7%	2
โปรแกรมจำลองการทำงานของรถยนต์ (Vehicle Simulation Software)	16.7%	2
ชุดทดลองการเผาไหม้ (Combustion Experimentation Unit)	8.3%	1
ระบบปรับแต่งสมรรถนะการทำงานของเครื่องยนต์ (Engine Management and Performance Tuning System)	8.3%	1
ระบบออกแบบระบบควบคุมต้นแบบในยานยนต์ (Programmable Automotive Control Prototyping System)	8.3%	1
ชุดทดสอบการเคลื่อนที่ของรถแบบล้อเดียว (Quarter Car Test Rig)	8.3%	1
เครื่องมือทดสอบยางรถยนต์ (Tire Testing Machine)	8.3%	1
answered question	***10***	**10**
skipped question	***1***	**1**

Average Response Percent 18.1% Average Response Count 2.2

หน่วยปฏิบัติการอุณหพลศาสตร์และการถ่ายเทความร้อน (Thermodynamics & Heat Transfer Lab)		
Answer Options	**Response Percent**	**Response Count**
การควบคุมความสามารถและความบกพร่องในระบบทำความเย็น (Capacity Control and Faults in Refrigeration System)	0.0%	0
ประสิทธิภาพพลังงานในระบบทำความเย็น (Energy Efficiency in Refrigeration System)	0.0%	0
ชุดฝึกพลังงานแสงอาทิตย์ (Photovoltaics Training System)	0.0%	0
ชุดฝึกต้นกำลังไอน้ำ (Steam Power Plant)	0.0%	0
โปรแกรมการจำลองสำหรับอุณหพลศาสตร์และการถ่ายเทความร้อน (Thermodynamics & Heat Transfer Simulation Software)	0.0%	0
ชุดฝึกอุปกรณ์เทอร์โมอิเล็คทริก (Thermoelectric Device Training)	0.0%	0
ชุดฝึกพลังงานลม (Wind Power Plant Trainer)	0.0%	0
answered question	***0***	**0**
skipped question	***11***	**11**

Average Response Percent 0.0% Average Response Count 0

หน่วยปฏิบัติการพลศาสตร์และจลนศาสตร์ (Kinematics and Dynamics Lab)		
Answer Options	**Response Percent**	**Response Count**
แขนกลแบบ 6 แกน (6-Axis Robot Arm)	0.0%	0
ระบบจำลองการทำงานแบบ HIL (Hardware-in-the-Loop System)	0.0%	0
กล้องถ่ายวีดีโอความเร็วสูง (High Speed Video Camera)	0.0%	0
answered question	***0***	**0**
skipped question	***11***	**11**

Average Response Percent 0.0% Average Response Count 0

หน่วยปฏิบัติการทดสอบวัสดุ (Material Testing Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องมือวัดความหยาบของผิว (Roughness Tester)	0.0%	0
เครื่องมือวัดความแข็งของยาง (Rubber Hardness Tester)	0.0%	0
เครื่องทดสอบความล้าแบบเชิงกลร่วมกับความร้อน (Thermal Mechanical Fatugue (TMF) Testing Set)	0.0%	0
answered question	***0***	**0**
skipped question	***11***	**11**

Average Response Percent 0.0% Average Response Count 0

หน่วยปฏิบัติการการวัด (Measurement Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องมือวิเคราะห์สัญญาณและสเปคตรัม (Signal and Spectrum Analyzer)	14.3%	1
กล้องถ่ายภาพความร้อน (Thermal Image Camera)	14.3%	1
เครื่องมือวัดแบบ 3 มิติ ความละเอียดสูง (Coordinate Measuring Machine (CMM) System)	0.0%	0
ชุดฝึกการเก็บข้อมูลด้วยระบบคอมพิวเตอร์ (Data Acquisition Training)	0.0%	0
answered question	***2***	**2**
skipped question	***9***	**9**

Average Response Percent 7.2% Average Response Count 0.5

หน่วยปฏิบัติการเครื่องจักรกลและการขึ้นรูป (Machining and Fabrication Laboratory)		
Answer Options	**Response Percent**	**Respon se Count**
โปรแกรมสำหรับการออกแบบ 3 มิติ และงาน CAD/CAM (Computer Program(s) for 3D CAD/CAM)	66.7%	2
ชุดเครื่องฉีดพลาสติก (Plastic Injection Molding Machine Center)	66.7%	2
ชุดสร้างต้นแบบผลิตภัณฑ์แบบ 3 มิติ (3D Printer)	33.3%	1
เครื่องตรวจสอบงานเชื่อมด้วยรังสี x-rayระบบดิจิตอล (Digital X-Ray Welding Inspection Equipment)	33.3%	1
เครื่องตรวจสอบสภาพพื้นผิวภายในด้วยกล้องวีดีโอความละเอียดสูง (High Resolution Visual Surface Inspection Equipment)	33.3%	1
เครื่องตรวจสอบรอยร้าวด้วยอัลตร้าโซนิกส์ (Ultrasonic Flaw Detector Equipment)	33.3%	1
answered question	***3***	**3**
skipped question	***11***	**11**

Average Response Percent 44.4% Average Response Count 1.3

หน่วยปฏิบัติการวงจรไฟฟ้า (Electrical Circuits Lab)		
Answer Options	**Response Percent**	**Respon se Count**
ออสซิโลสโคปแบบเก็บภาพดิจิตอล (Digital Storage oscilloscope)	50.0%	3
เครื่องมือวัด impedance (LCR meter)	33.3%	2
ออสซิลโลสโคปแบบสารเรืองแสงดิจิตอล (Digital Phosphor Oscilloscope)	16.7%	1
ออสซิลโลสโคปแบบสัญญาณผสม (Mixed-signal oscilloscope)	16.7%	1
ออสซิลโลสโคปแบบโดเมนผสม (Mixed-domain oscilloscope)	16.7%	1
โลจิกอนาไลเซอร์ (Logic Analyzer)	16.7%	1
ซอฟต์แวร์จำลองการทำงานวงจรไฟฟ้า (Electrical Circuit Simulation Tools)	16.7%	1
answered question	***6***	**6**
skipped question	***5***	**5**

Average Response Percent 23.8% Average Response Count 1.4

หน่วยปฏิบัติการอิเล็กทรอนิคส์ (Electronics Lab)		
Answer Options	**Response Percent**	**Respon se Count**
ออสซิโลสโคปสำหรับวัดค่าพลังงานต่ำ (Low Power Oscilloscope)	42.9%	3
ซอฟต์แวร์สร้างวงจรอิเล็กทรอนิกส์และแผ่นวงจรพิมพ์ (Schematic Capture and Printed Circuit Board Prototyping Software)	14.3%	1
ชุดโปรแกรมจำลองและออกแบบอิเล็กทรอนิกส์กำลัง (Power Electronics Simulation Software)	14.3%	1
answered question	***3***	**3**
skipped question	***8***	**8**

Average Response Percent 23.8% Average Response Count 1.7

หน่วยปฏิบัติการไฟฟ้าสื่อสาร (Communications Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องวัด OTDR (Optical Time-Domain Reflectometer)	25.0%	1
ชุดฝึกตู้สาขาโทรศัพท์ (Training System for Private Branch Exchange (PBX) Telephone System)	25.0%	1
ชุดฝึกระบบคอมพิวเตอร์เครือข่าย (LAN) (Training System for Local Area Network System)	25.0%	1
ชุดฝึกระบบโทรศัพท์ ISDN (Training System for Integrated Services Digital Network (ISDN) System)	25.0%	1
เครื่องวิเคราะห์โครงข่าย (Network Analyzer)	0.0%	0
เครื่องวิเคราะห์สเปกตรัมแสง (Optical Spectrum Analyzer)	0.0%	0
ชุดปฏิบัติการโทรศัพท์เคลื่อนที่ (Training System for Mobile Phone)	0.0%	0
ซอฟต์แวร์ออกแบบและจำลองสายอากาศ (Antenna Design and Simulation Software (e.g., Zeland))	0.0%	0
ซอฟต์แวรจำลองระบบเครือข่าย (Network Level Simulation Software (e.g., OPNET or NS2))	0.0%	0
ซอฟต์แวรจำลองระบบสื่อสาร (System Level Simulation Software (e.g., SPW or COSSAP))	0.0%	0
ซอฟต์แวร์จำลองการแพร่กระจายคลื่นวิทยุ (RF Propagation Software)	0.0%	0
answered question	***4***	**4**
skipped question	***7***	**7**

Average Response Percent 9.1% Average Response Count 0.4

หน่วยปฏิบัติการเครื่องจักรกลไฟฟ้า (Electrical Machine Lab)		
Answer Options	**Response Percent**	**Response Count**
เครื่องมือซ่อมบำรุงเครื่องกลไฟฟ้า (Training System for Electrical Maintenance of Electrical Machine)	55.6%	5
ชุดฝึกการควบคุมความเร็วมอเตอร์ไฟฟ้ากระแสสลับ (Training System for AC Variable Speed Drive Control)	33.3%	3
ชุดฝึกการควบคุมความเร็วมอเตอร์ไฟฟ้ากระแสตรง (Training System for DC Variable Speed Drive Control)	33.3%	3
ชุดทดลองควบคุมอุตสาหกรรม (Training System for Industrial Controls)	33.3%	3
เครื่องมือกลซ่อมบำรุงรักษาเครื่องกลไฟฟ้า (Training System for Mechanical Maintenance of Electrical Machine)	22.2%	2
เครื่องทดสอบมอเตอร์-สเตเตอร์-ขดลวด (Motor Stator Comprehensive Tester)	11.1%	1
ชุดโปรแกรมจำลองและออกแบบวงจรไฟฟ้า เครื่องกลไฟฟ้า และหม้อแปลงไฟฟ้า (Electric Machine Systems Simulation Software)	11.1%	1
answered question	***6***	**6**
skipped question	***5***	**5**

Average Response Percent 28.6% Average Response Count 2.6

หน่วยปฏิบัติการระบบไฟฟ้ากำลัง (Electric Power System Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดเครื่องมือติดตั้งไฟฟ้าในอาคาร (Indoor Electrical Wiring/Installation Equipment)	60.0%	6
ชุดเครื่องมือติดตั้งไฟฟ้านอกอาคาร (Outdoor Electrical Wiring/Installation Equipment)	60.0%	6
ชุดอุปกรณ์ทดลองการควบคุมตามลำดับขั้น (PLC) (Training System for Sequential Control / Programmable Logic Controller (PLC))	40.0%	4
ชุดอุปกรณ์ทดลองการควบคุมแบบเชิงเลข (Training System for Numerical Control)	30.0%	3
ชุดเครื่องมือทดสอบในงานติดตั้งไฟฟ้า (Electrical Installation Tester)	30.0%	3
ซอฟต์แวร์สำหรับออกแบบและวิเคราะห์ระบบไฟฟ้ากำลัง (Power System Analysis software)	10.0%	1
โปรแกรม MATLAB/Simulink พร้อมด้วย Power System Analysis Toolbox (MATLAB/Simulink with Toolbox for Power System Analysis)	10.0%	1
ชุดทดลองระบบพลังงานทดแทน (Training System for Renewable Energy System)	0.0%	0
ชุดทดลองระบบ Smart Grid (Training System for Smart Grid Technologies Training System)	0.0%	0
ชุดเก็บข้อมูลและเครื่องมือวัดแสดงผลทางคอมพิวเตอร์ (Data Acquisition and Control Interface)	0.0%	0
ชุดทดลองระบบ SCADA (Training System for Supervisory Control And Data Acquisition (SCADA))	0.0%	0
answered question	***8***	**8**

skipped question	***3***	**3**

Average Response Percent 21.8% Average Response Count 2.2

หน่วยปฏิบัติการไมโครโพรเซสเซอร์ (Microprocessor Lab)		
Answer Options	**Response Percent**	**Response Count**
ชุดเครื่องมือเพื่อการพัฒนา DSP FPGA หรือ ARM (DSP / FPGA / ARM Development Tool Kit)	0.0%	0
ชุดเครื่องมือเพื่อการพัฒนาอื่นๆ (Other Development Tool Kits (Bluetooth, RFID, ZigBee, etc.))	0.0%	0
อุปกรณ์เชื่อมต่อเพื่อการเก็บข้อมูล (Data Acquisition Device)	0.0%	0
answered question	***0***	**0**
skipped question	***11***	**11**

Average Response Percent 0.0% Average Response Count 0

ANNEX 11

Annex 11: The results of career path study of ten successful engineers

About the career path study

In-depth interviews were conducted of ten (10) "successful engineers." The selection of target engineers was made based on engineers with innovative products registered at the National Research Council of Thailand (NRCT) and through recommendations from companies and educational institutes.

Most of the engineers interviewed were in their 40s, with one person 35 years of age and one person in his late 50s. All were males. Half of the interviewed engineers have their own innovative product(s). Half of them have developed products or tools to improve the productivity of their company.

The breakdown of the interviewees is as follows:

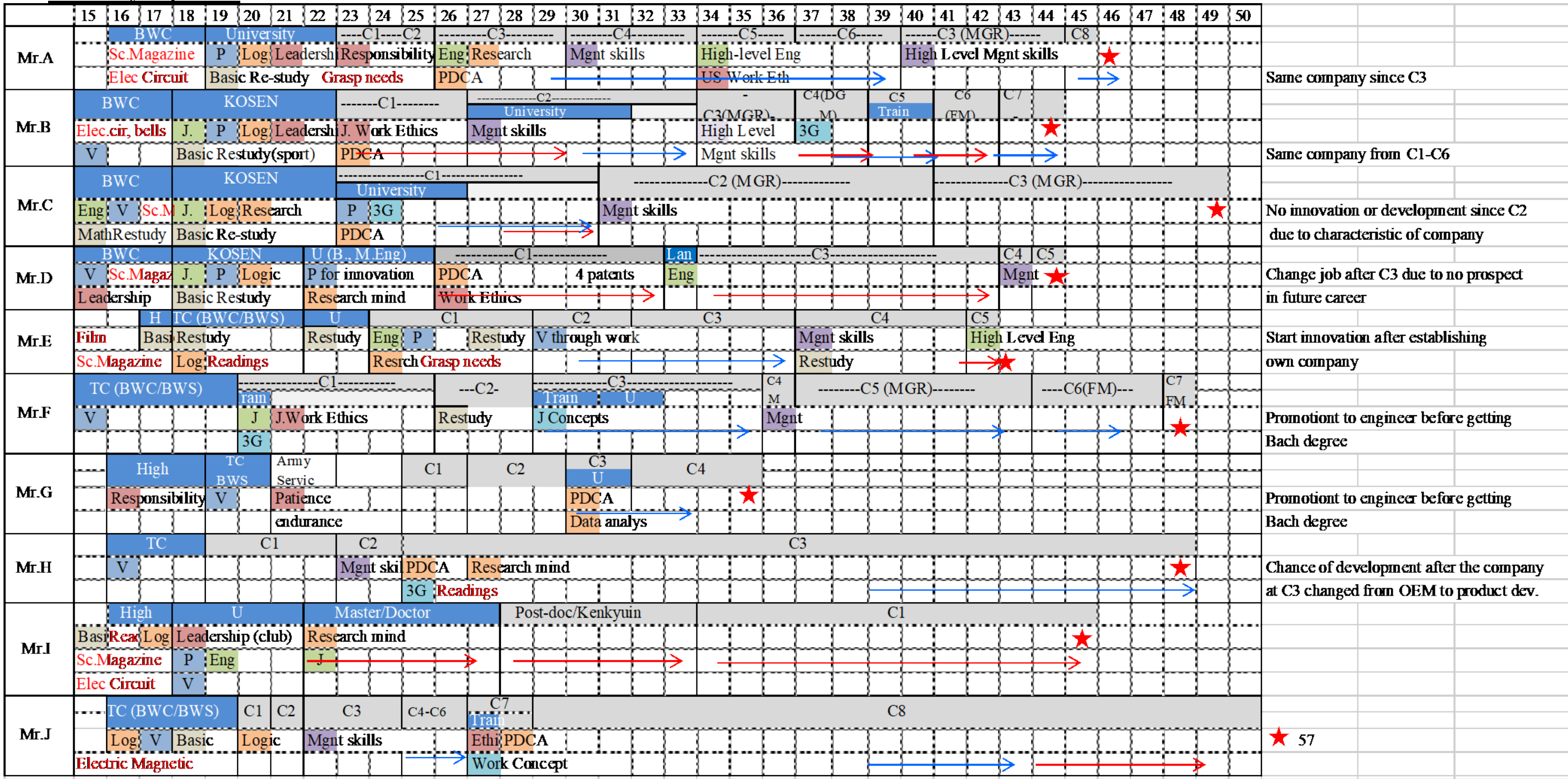
- Four people graduated from a Technical College (TC) before work, two of them pursued their studies at the university level after work;
- Two people graduated from a KOSEN before work, and both pursued their study at the university level after coming back to Thailand;
- Two people graduated from a university in Thailand before work, and both are originally from TC at the high school level; and
- Two people finished graduate schools in Japan before work.

Career Path's Typologies and Necessary Qualifications

An analysis was performed to determine when each engineer first gained the following abilities and their experiences along their career path.

1. Basic knowledge of math and science necessary to apply for work
2. Vocational and professional skills and knowledge
    a. TC: vocational skills – necessary knowledge on how the system works and how to produce products or fix the system
    b. U: professional knowledge – necessary knowledge on how to produce/improve the system and improve or produce new products
3. Language proficiency necessary to carry out their task
4. Work ethics and attitudes (diligence, patience, responsibility, punctuality, etc.)
5. Work concepts (5s, Zero Defect, Pokayoke, 3G, Kaizen, Product Innovation, Muda, FMEA, ATW and etc.)
6. Logical thinking, mind-set for research, trying to solve problems and find solutions
7. Managerial capacities (team management, facilitation, supervisory knowledge, etc.)

Summary of profiles



★ Age

→ (red) Period in which innovation was produced

→ (blue) Period in which product/tools were developed for better productivity

1. Basic knowledge on math and sciences necessary to apply for work
2. Vocational and professional skills and knowledge

   V: vocational skills – necessary knowledge on how the system works and how to produce produces or fix the system,

   P: professional knowledge – necessary knowledge on how to produce/improve the system and improve or produce new products

3. Language proficiency necessary to carry out their task
4. Work ethics and attitudes (leadership, diligence, patience, responsibility, punctuality, etc.)
5. Work concepts (5s, Zero Defect, Pokayoke, 3 Gen, Kaizen, Product Innovation, Muda, FMEA, ATW)
6. Logical-thinking, mind-set for research, trying to solve problems and find solutions
7. Managerial capacities (team management, facilitation, supervisory knowledge, etc.)

Case study 1: Mr. A (TC > University)

Mr. A had good academic results since primary schools. He read science magazines ("Chaiyapruk Science," "The 4th Dimension" and "Science Skills") since grades 2-3. His elder brother always brought electrical circuit equipment home from schools and he always watched when his brother tried to connect these circuits. When he was in secondary school, his math and science teachers were extremely bad. His grades in secondary school were terrible, but he learned much more from science magazines.

Mr. A decided to go to a TC after gaining a good impression of the TC he passed every day. He obtained both skills and theoretical knowledge before pursuing an engineering major at a four-year university. The reasons he selected a four-year university were: 1) having only a vocational certificate would lessen the chance of being successful in his career; 2) a Bachelor of English, which requires four years, would be more acceptable than TC college and two years to earn a Bachelor of Industrial Technology.

He had more chances to practice at the university since there were more equipment, tools and machines for actual practice. In addition, independent learning was needed when studying at university, unlike TC, where teachers guided students in everything so that they never needed to struggle.

The academic knowledge he gained from the university could be utilized in his first career since it involved day-to-day optimization. After working for a while, his experiences at work and what he learned from mentors was much more useful than the knowledge or skills he had gained from the university.

The interviewee also had a chance to work as a salesperson in his second career, where he learned the client's needs. After that he went back to be a process engineer and did day-to-day optimization and trouble shooting. In his fourth position, he became more involved in planning and cost-effectiveness management. Self-learning was essential in pursuing such tasks.

In his fifth position, he got a chance to be dispatched to the head office, where acquired more skills in planning and cost-effective management. In his sixth position as a lead engineer, he needed to take responsibility for day-to-day optimization of the plant and lead other engineers. His main responsibilities in this period were "learning by doing, and looking for information by reading, critical thinking and logical thinking." He was promoted to manager, and the majority of his tasks involved management. He decided to quit the management position and returned to take charge of the technical department after working as a manager for six years. Now his present tasks are to provide suggestions and solutions to the plant engineer and plan for the highest productivity of the product. He also works on product design and process design.

Mr. A believes that his success can be attributed to characteristics he was born with; a tendency to take thing seriously and explore issues deeply; an ability to use critical thinking and logic in dealing with any issues; an ability to work independently with a sense of responsibility and express ideas to arrive at solutions.

Recommendations/comments from Mr. A

- ✓ Critical thinking is a must in working as an engineer. New graduates from European countries seemed to have more advanced critical thinking skills and a sense of responsibility than the Thais. Thai new graduates would end their assignment by saying that they are unable to do it, while those from European countries would find ways to solve the problems they faced.
- ✓ Three things needed to be a successful engineer: 1) logical/critical thinking, 2) fundamental knowledge on engineering, 3) communication skills.
- ✓ Present engineers' situation: 1) Unable to communicate (in English) with others and no sense of responsibility, 2) fundamental knowledge of engineering is weak, 3) technical skills of graduates are at the same level for graduates of TCs or Us.
- ✓ Education for TC and U students need to focus more on research. Give them issues that they have to solve and arrive at conclusions so that they can practice conducting research.

- ✓ Graduates should write proposals when applying to TCs or universities, as in the US, so that their passion for the profession of engineer can be highlighted.
- ✓ Present Thai educational style focuses on 'lecturing'. More discussion in class and research projects are needed.

Case study 2: Mr. B (TC > KOSEN)

The poor quality of teaching at schools and the lack of laboratory equipment at schools made Mr. B reluctant to go to school and gave him a dislike for science and mathematics. When he was in Grade 3, his elder brother brought speakers and electrical circuits home and that was the first time he felt an interest in electronic things. He tried to think all the time about why noises were coming out from the speaker. At the secondary level, teachers showed him how to make an electric bell using wires. He was successful in making the bell ring and started getting the top grade in mathematics and science. He intended at that time to go to TC, assuming that TC would have an electronics department. He had also seen a motorcycle made by TC students demonstrated in front of the college and was impressed. There was no negative image of TC students at that time.

At TC, skill training was very good. When he was in the second grade at TC, he volunteered to set up a stereo system at school and could work a lot on radios. He was selected as a representative in skill contests among technical colleges in Southern provinces

After that, he earned a scholarship to go to KOSEN. He went to the third grade of KOSEN after studying Japanese for six months. At that time, he did not know about diff/integrate/limit, but all KOSEN students had already studied those things in the second grade of KOSEN. He needed to study basic subjects again, including science, mathematics, physics and chemistry. On the other hand, the TC was better in technical skills. Third grade KOSEN students did not know how to connect electrical circuits or even assemble them, while TC (high school level) graduates can fix broken TVs.

In Mr. B's first position, he had the chance to develop TV software and to support the Japanese R&D Team and Malaysian Team to develop on-screen TV in the Thai language. He was promoted to be an Assistant Manager after four years, but still continued working on development products. Language proficiency was key to his success. Being able to speak Japanese led to more discussions to exchange views with Japanese engineers.

He developed a 25" CRT TV that gained market share in Thailand. At this time, he went to a university in Thailand, but learned nothing. Thai teachers based their explanations on their understanding of theory, but not on understanding gained from actual experiences, which made subjects look difficult. He lost both time and money, but at least obtained a Bachelor degree on paper. He never used the knowledge he gained at university in actual work.

He was successful in his career, earning promotions to DGM, GM and factory manager every two years. When he was a factory manager, the MD requested that he increase the productivity of plasma TVs. After observing the production process for three months, he initiated an idea to lessen MUDA based on discussion with Japanese engineers. An additional machine was designed and tested within six months, and it increased efficiency to earn him the prize at HQs. It decreases space, manpower and energy consumption.

In the end, he started his own company and has already improved the products of a Japanese joint venture company.

Recommendations/comments from Mr. B

- ✓ TC does not let you work independently. The habit of solving problems should be nurtured from a young age and the prime time for this is during primary-high school.

- ✓ TC graduates can repair electrical equipment and assemble them, but cannot design products. University graduates in Thailand also cannot design products. KOSEN graduates were not keen on repairing equipment, but have good knowledge about design.
- ✓ KOSEN teaches students how to think and how to find solutions by yourself, but TC just provides you with electrical circuits and asks you to assemble them. (Thai students were not trained to think and work on their own.)
- ✓ In the fourth grade of KOSEN, teachers requested that students create CPU8 bits without any guidance. Students started by searching for information in the library, and then discussed how to create one with classmates and teachers. After obtaining full information, the teacher ordered related equipment for us to create the CPU. It took two full years to develop it.
- ✓ Both KOSEN and universities can provide basic know-how on design according to the functions needed. However, issues that TC and university cannot address are: 1) proving the reliability of the product, 2) safety, 3) productivity and 4) cost. KOSEN and universities do not need to try to put everything in the curriculum, since each industry has its own conditions for product reliability, product safety and other areas. What TC and universities should do is to provide strong fundamental knowledge about engineering.
- ✓ Knowledge and skills gained from either TC or U will count for only 5-10% in actual work. It is only a foundation for work. Skills to produce a single product are obtained from experience in companies. Hence, TC and U should just focus on giving students a solid background on mechanics, electrical and electricity and software.
- ✓ Not sure that WiL would help or not. Students should just know the purpose for studying a particular subject. Only one year in a company through WiL would not help one to be an engineer.

Case study 3: Mr. C (TC > KOSEN)

When Mr. C was in secondary school, he did poorly in every subject. He decided to go to TC because of economic restraints since school fees at TC were low. After getting in, he re-studied mathematics and science by reading books at the library, and he became interested in physics. At his TC, equipment was at a high standard thanks to support from Germany.

When he went to KOSEN, he needed to re-study science, physics and mathematics in the first six months after studying Japanese. A tutor was assigned to personally tutor him. However, KOSEN has very limited skill training. At the KOSEN, he needed to do experiments before graduation. A research topic, with research funds, was provided by a private company. It took one whole year to find the result. Teachers at KOSEN did provided only guidance when the students were carrying out research.

At his first job, he went through training in Singapore and Thailand before starting work and it helped a lot in designing a new machine and equipment.

Mr. C went to an engineering faculty at a Thai university (one of the RMUTs) right after entering the first company. He felt that the university provided more applicable knowledge on mechanics than the KOSEN. The knowledge he gained could actually be used in designing equipment for testing material qualities.

After changing his job to another company as a QC manager, Mr. C had no involvement in development, but only controlled products to be used according to specification. His third company was also an OEM company, so he had no chance to do R&D. The former MD tried to change from OEM to RD with its own brand name. The MD recruited new engineers to the RD department to design new products. However, the RD department was terminated after three years in operation. The reason for the failure was a lack of knowledge on GENBA since those recruited to the RD department were new graduates, no experience, working alone in the RD department without any relationship with other departments, and a failure to learn lessons from other units employed in developing new products.

Recommendations/comments from Mr. C

- ✓ The employee who carries out R&D should be the one who knows the nature of the company's process and products well. PCDA only led to improvements, but not innovation.
- ✓ English competency. Communication capabilities led to more acceptance from the Japanese management team. English is also a major language used when having meetings on how to improve products. Another KOSEN graduate who could not speak English stopped his career as a leading engineer on the production line.
- ✓ Being able to work in many sections provided opportunities to think and create new things.
- ✓ KOSEN and TC did not teach students to design, while development required knowledge and skills on design.
- ✓ Being in the QC/QA section gave the interviewee a full understanding of all the processes of the company and led to a chance to develop products.
- ✓ Skill training would be principally done at TC (high school level). Hence, those graduating from TC (college) with a background in a regular high school are not applicable at companies as technicians.
- ✓ Knowing both practice and theory was essential to becoming a successful engineer.
- ✓ Foundation subjects (mathematics, science and physics, since this knowledge is needed when developing products), AUTOCAD, etc. should be taught at TC if TC graduates need to work as engineers.
- ✓ KOSEN teaches students to take responsibility by assigning tasks to students and letting them manage the task independently. TC did not allow students to take any responsibilities.
- ✓ Acceptance form society also counts. Formerly, those graduated from Thai-German TC were well-accepted by companies since they were assured that they had obtained Germany's techniques. However, after it changed to RMUTI and German style was neglected, the reputation has declined. The Japanese brand might be needed. It seems that RMUTI tried to rebrand its system by reemploying Germany technologies.
- ✓ Companies nowadays only acknowledge those graduating from the faculty of engineering at a university level and treat TC graduates as labor force. Companies should also change their attitude

Case study 4: Mr. D (GRADUATE SCHOOL IN JAPAN, with background from TC and KOSEN)

At secondary school, Mr. D focused on playing sports at school and helping with the family business on weekends. His grades in science, mathematics and English were not good. He decided to go to TC for economic reasons so that he could be employed right after graduating from TC (high-school level). He selected electronics/computers as a major. At that time, not everyone could own a computer so it was a good chance to use computers at school. He started gaining confidence after being selected as a TC representative in individual contents in repairing radios and TVs (practical skills/written test) and got No.1 in NE Thailand and later second place in the country. His grades at TC were excellent.

After that, he went to the electronic department at a KOSEN. He had language problem in the first year, but could act as teaching assistant on electronic and electric subjects. Thai TC had already been taught how to repair electrical problems and the logic behind them, so he could teach other students. After graduation, he went to master and doctoral courses at a Japanese university. His major was material engineering, which would be useful when working in TV or automobile industries.

His first job was in an R&D department in Japan. He was in charge of censor development. Research was carried out, followed by design, prototype development and assessments. He was able to develop products that acquired three to four patents in six years. After working at this first company, he went to study English in Canada and went back to work in an R&D department in an automobile company in Thailand. He started with market research and moved on to product development. All the staff working here are university graduates.

Recommendations/comments from Mr. D

- ✓ One trait that was key to his success was 1) logical thinking and the capability for problem solving gained during studies at TC and KOSEN. At TC, he needed to find an explanation for why a radio had no sound, so he needed to think in logical ways. Other key traits were 2) good basic knowledge about chemistry and biology gained at KOSEN, which is helpful when carrying out R&D on devices; 3) language capability, since being able to communicate with Japanese would lead to trust, and tasks would be assigned if you are can be given information and instructions; and 4) having a specialty, with management skills and communication skills (S/M/C).
- ✓ It is possible for TC graduates to be promoted to a position as engineer. However, it is very difficult to be promoted to the management level in the company. One person out of a 1,000 might be promoted to an engineer position. It also depends on the characteristics of the company.
- ✓ However, even with good job performance, the HR system impedes promotion. So, it also depends on the timing, how long the person was in that company (whether he could bear staying until promotion) and communication skills at the management level.
- ✓ In Thailand, those wanting a higher salary all had to change their career to management positions. Those who could not go to management positions focus on being a specialist. However, the salary is lower than for management positions. In Japan, both specialist and management positions have a similar salary range.
- ✓ It is better to have a success model (such as a TC with a high reputation). The model TC might focus on one specific major such as airplane maintenance, robots for elderly welfare or railways and promote that so that if attending for five years, they would be able to do maintenance work on airplanes after graduation. Coming to this special TC should mean that graduates are more qualified than those graduating from other TCs. Ideally, English and Japanese proficiency would also better for graduates from some TCs compared to others. Railway specialties might be interesting as well. At present, railway repairs need to be done in Malaysia or Singapore.
- ✓ Strengthening a single department in a TC might be easier than strengthening the entire TC. TNI also focuses only on some fields.

Case study 5: Mr. E (TC > UNIVERSITY)

When in primary school, Mr. E saw 8mm movies and wondered why it could be shown on screen. He explored how the film projector works. He also tried using coconut shells and a candle to make his own movies. Mr. E got good grades in secondary school, especially in mathematics. He pursued his studies at ordinary high school for one year before changing to TC (high school) since he could not understand high-school mathematics, science, physics and chemistry. However, the knowledge he obtained in grade 10 of the ordinary high school seemed to be useful for his current research.

TC's strength was that students are able to practice skills, but the negative point was the extremely poor quality of TC teachers. TC taught students to be technicians, but not to think and find solutions. On the other hand, the ordinary high school's good point was its superiority in providing basic knowledge in math, science, physics, chemistry and biology, which has contributed to his current research.

Mr. E was a student leader in after-class activities at TC. In his academic work, he always used logical thinking to find solutions. For example, when getting an assignment, he would not just provide results, but always think about why he got a certain result and tried finding external factors that might change the results, while other students just stopped after they got a result.

At TC (college level), teachers in electronics were good, but the TC lacked the equipment needed to learn about computers. He was able to use a real computer in the last semester of his studies. Teachers also had no knowledge about computers. TC's practices were closer to the real workflow than studies at the university.

He went to one of the RMUTs' universities. He needed to compete with those from regular high school who had a good foundation. It took him two years to get a Bachelor of English (currently three years are compulsory). He felt that the university's curriculum was out of date and he could not follow the extremely fast developments of the IT industry.

At his first job, he felt that what he learned in school was very out of date, and he could not work with present technology. At that time, the interviewee needed to read white papers in English to know what was going on in the real world. There was no teaching on system networking at school, so the interviewee had to learn this by himself. Everything he learned was through reading and practicing by himself at work. He also worked at the help desk as a system engineer. He gained a good understanding of the problems of clients, but his boss managed the flow of problems in different ways. He listened to clients and thought of a more appropriate management system.

His second job was a net band consulting company. He needed to work alone to develop techniques tailored to the requirements of clients. His third job was in a western company where he needed to create data communication by satellite to control vessels worldwide. He acquired English speaking and writing skills here, which was good for further study since most articles were in English. He also had a chance to see technologies worldwide. After that, he took on a new job as an in-house IT manager of a western company, but he felt that the working style was too systematic. There was no equipment for testing and research and he needed to do only management job. He started gaining knowledge about people management, but started losing his techniques as an engineer. He began watching news to learn about advances in the IT industry since he felt that being an in-house IT manager put him behind with the constantly changing advanced IT technologies. He also searched for information on economics and politics since he was in the position of a manager. He finally opened his own company, where he could do research and development. He finally had his own innovative product that was well accepted in the IT industry. In developing such a product, basic skills learned at TC could be well utilized. There was also a great need for logical thinking in developing it.

Recommendations/comments from Mr. D

- ✓ The company needs to adjust as well. Technicians have a good understanding of the situation and they would be the one to carry out R&D and develop products.
- ✓ Skills development only is not enough. English/Japanese efficiency is a must. Otherwise, manuals and research papers cannot be read.
- ✓ Basic knowledge at the regular high school level is required. Mathematics, pure sciences and physics are needed as the basic for research. Teachers should teach why diff/integrate is important. He just knew that diff/integrate was important after developing products and understand that it is a logic needed when producing products. Teachers also did not know ways that skills and knowledge could be used. For this reason, teachers need to be trained.

Case study 6: Mr. F (TC)

Mr. F practiced lathing a lot during his TC period (high school level and college level). After graduation, he worked in a Japanese company and obtained training in Singapore on the Japanese language for one month and skills for six months. He was part of the first group of employees, so he returned to be a line leader and was promoted to be a supervisor to manage operators and graduated M3 and BWC. He wanted to work as an engineer and saw no chance to do so at the first company since he could only do control of the line process, so he moved to another company which had no engineers. He was accepted as an engineer there without any academic certificate (university degree). He learned from Japanese engineers and started studying electrical systems by himself at this second company. He moved to his third job with an interest in learning about the press process. He was well-trained both in technical techniques and Japanese work concepts such as 5s, Zero Defect, Pokayoke, 3Gen, Kaizen, Product Innovation, MUDA alleviation, FMEA, Toyota Production System and Advance Toyota Way. At this company, he was able to work on developing products and improving the work process. He learned techniques from engineers in the first company and from training from his present company.

The interviewee earned a Bachelor of Science in Industrial Technology from Rajabhat Universit (three years after entering the company, just so that he would have a degree since all newcomers have bachelor degrees). After that, he got a new job as a production manager, where he was not involved in engineering, but needed to work on management of manufacturing and planning for production. He then changed jobs to become a plant manager and was more involved as a QA engineer. He gave advice on modifying broken molds and developing a new device, which was accepted by a leading automobile company. He felt that work-schedule control and habits of recording data helped a lot in improving products and in having better efficiency. He also had a chance to reduce waste ("muda") and improved layout in his sixth job. Now he is planning for ISO in a new company.

Case study 7: MR. G (Ordinary High School>TC)

Mr. G got very bad grades in junior high school and high school. After high school, he went to TC (college level) and selected the welding department, which required no entrance examination. Coming from an original track high school made him feel that his welding skills were poor, so he went to a car maintenance shop near his house to practice welding. He felt he lagged behind those from TC (high-school level), so he did a lot of practice. Teachers said he needed to sharpen iron six hours a day and he did so, while others did not. He also worked a part-time job on weekends at any places needing welding. The TC he went to was not well-equipped with equipment. There were only four PC for 30 students.

After graduating, he served in the army for one year, where he gained discipline and learned the concept of endurance. At his first job, he worked as an operator and moved to his second job as a technician to test mold. He worked with the foreman and gained a lot of techniques. His third job was as a welding staff (technician). Three months after entering this company, he went for a bachelor degree at a university. He chose the Faculty of Industrial Management. He did not select the engineering faculty since his friend told him that there is no good career path for engineers. Industrial management would pave the way to reach the management level in the future and the learning content was similar to that in engineering faculties.

Recommendations/comments by Mr. G

- ✓ He always thought that he needed to do better and be the best. Other staff just did what they were told to do, but the interviewee would observe what and how the Japanese performed their work and would seek a better way. Previously, only Japanese could do jig roll, but the interviewee copied it and adapted it to a better version.
- ✓ He always recorded all information and data and analyzed it. Statistics are important for the interviewee. He learned the need to collect data during university. He tried and knew that data can tell many things. For example, he would record the time needed after setting up jig and calculate the lead time needed. After that, he would try developing another jig and did a trial by recording time as well. After many

failures, he could successfully develop a jig that helped the production process in terms of efficiency. Learning the timing to set up jig was helpful since it could be immediately utilized at work.

- ✓ Keys to success were self-learning, a lot of experimenting, a lot of trial and failure and adjustment, chances given by the company to try anything.
- ✓ BWS>BWS and M6>BWS skills are not different. It is up to how much the person practiced during BWS or outside the campus. (The interviewee worked at a lathing company when he was in BWS to brush up on his skills every weekend.) M6>BWS are better at calculation.

Case study 8: Mr. H (TC)

Mr. H graduated from TC (high school level) with a major in mechanics. At that time, there was a subject called "endurance practices". Students need to practice doing one thing, such as sharpening iron, for several hours. This subject seems to have been deleted from the curriculum. This is one of the reasons that present TC students cannot work after graduation.

At his first job, he was in charge of plastic injection and spare parts for three years. After that, he worked as a leader at another company. He needed to provide solutions at the production line. When a machine broke, he needed to manage workers (such as shifting workers so that more worked in one place and fewer in another place) to prevent stoppage along the production line. The interviewee utilized the knowledge and skills gained at TC to fix machines. Management skills were learned from the former leader.

After that he changed to his present company. His first involvement in product development was after the economic crisis in 1997, when the MD hired a university-graduate engineer to develop dental products. The interviewee worked in the same room as the engineer and saw what the engineer was trying to do for five to six months. The engineer utilized the PLC system but could not develop anything. The interviewee knew nothing about PLC but observed a lot.

After observing what the engineer did every day, Mr. H used basic knowledge about electrics and his experience in fixing machines to develop the product. At that time, all autoclaves had to be imported at a high price, but Mr. H utilized basic techniques to produce the first Thai "basic autoclave." The electrical circuit used in the autoclaves came from the knowledge gained at TC. After that, he improved a lot of models since products need to comply with the Industrial Standard. The interviewee cannot use computers, but he studied design at TC. He designed by hand before asking others who can use computers to write in blueprint. Now he is trying to develop touch screen autoclaves.

Recommendations/comments by Mr. G

- ✓ The knowledge and skills gained at TC are not enough to produce things. For example, during TC, there was still no censor. This meant that extra study and extra searches for information were needed to gain more knowledge.
- ✓ Keys to success: 1) knowledge and skills gained at TC, 2) many failures when fixing machines. When facing failures, everyone needed to keep asking and obtain techniques from others (repetition of PCDA), and 3) learn independently (he always observed products, designs, functions, etc. from abroad by reading and going to BITEC whenever there were events), and 4) seeking advices from others at all times.

Case study 9: Mr. I (GRADUATE SCHOOL IN JAPAN, with background from TC and KOSEN)

When Mr. I was around 10-12 years old, he loved reading science magazines ("Chaiyapruk"). He performed experiments based on what he read in magazines. For example, when the science magazines showed how to connect electrical circuits, he bought equipment to connect the circuit as an experiment. At the age of 13, his parents bought him a PC and he had to read many English books since the PC was very new to Thailand, and no other Thais were using PCs. He tried writing programs and also tried developing his own TV. He gained all significant knowledge by reading books.

He went to a high school (highest ranked in Thailand) where there was a lot of competition in academics. He got a top score when entering the faculty of engineering at a public university. His major was electrical engineering and he needed to sharpen iron as a skill practice every day. He earned a first-class honor gold medal when graduating. After that he got a Monbusho Scholarship to Japan and studied there until getting a D. Eng there. His major was Control System Engineering.

During the D. Eng, he worked as a research assistant (RA). He developed software in the Thai language and developed a Thai software website. Then NACSIS (Gakujutsujohou Center) saw the products and asked for cooperation from the interviewee. At that time, NACSIS cooperated with NECTEC Thailand. As a result, the information developed by the interviewee was incorporated in the NECTEC's servers.

At his post-doc, he continued to do research with NACSIS by developing an on-line dictionary. In addition, he developed robots an e-learning system (the professor registered for patent without his name) and robot expert system. All research was published. After workng a Gaikokujin Kenkyuin, he returned to Bangkok and established his own company. He did not apply for a job since companies in Thailand do not do research, but simply buy software from aboard and sell it.

Recommendations/Comments from Mr. I

- ✓ Now his company has graduates from Chula, KMITL and TNI. TNI Students are able to 'somehow' write programs but they are not good. It is up to each individual, not to the university. There is little difference between graduates from TNI and top universities. It all depends on whether that person learned by themselves or not. Self-study is key to success. At present, there are very few graduates who can work well.
- ✓ We need to think why the Japanese normally study by themselves. Japanese students would try searching for information by themselves while the Thai students would wait for answers from teachers. In addition, Thai students would try finishing what was assigned, but will not test the products they developed. In contrast, the Japanese would test it more than 20 times to find out whether there were any problems. When the Japanese said the product was finished, it means that it is nearly 100% completed. This concept or way of thinking should be built up in Thai students.
- ✓ In Japan, all university students (undergraduate level) needed to go to a robot contest to get a credit to graduate. While in Thailand, teachers would pick only the top five students to do so.
- ✓ We need to think why the Japanese pay attention to every detail. What is it about their educational system at the primary level that ensures that all students are so detail-oriented? It might come from TV. TV programs that are about the occupations of craftsmen ("shokunin") show that individuals need to practice until they are a full-fledged craftsman.

Case study 10: Mr. J (TC)

Mr. J came from a poor family. He loved mathematics and creating magnetic system (electric magnetic systems). He did not love reading. Previously, all Grade 9 students needed to study industrial arts, including lathing. The interviewee decided to go to TC since he was very good at lathing. Mathematics and science at TC were easy, but technicians do not use that theory much. He thought that the mathematics level was too high for those wishing to work as a technician and there was too many theory in the curriculum for TC students. The theory learned was not used in actual work in companies. When he was in TC (high school level), many projects were assigned. Teachers would not tell students what process to follow, but asked students to think by themselves. The workshop had all the equipment and students needed to figure out by themselves what to do. When that failed, they needed to try other equipment and thus learn all skills. At present, teachers would tell students that this product needs to be drilled or needs lathing. It seems that the present curriculum specifies how to teach, so teachers seem to tell everything to students and students do not have to think anything. It is necessary to teach that failure is normal, but the present curriculum does not allow failure. At that time, all graduates were good. Teachers would not let students who could not do the work pass—the student would need to practice until he was really able to do the work so that all students have skills at the same level. Previously, it was very difficult to graduate BWC. Anybody could fail. As a result, those who graduated 25 years ago would have good skills. Since 2007, 95% of BWC graduates cannot do good work after graduation, but all are allowed to graduate. Now, the government provides support based on the number of students at each TC, so all TCs accepted all students. Previously, students needed to take entrance examinations to get into a TC. Mr. J also went to TC (college level), but he thought that he gained nothing from the college level since they primarily studied theories that were not used at work.

At his first job, Mr. J needed to repair machines. He could see molds and learned the logic behind why each machine was able to produce quickly or slowly. At his second job, he worked as a maintenance officer, which allowed him to see all processes and equipment. He was then assigned to make molds for six months before being promoted to be a factory manager. He later changed his job to work at an aluminum die casting company. He was quickly promoted from draft drawing officer, technician, mold officer and factory manager. He had a chance to go to Japan for six months right after being promoted to be a factory manager, after the company jointed with a Japanese company. This was a turning point since Japanese culture has changed his mind-set. All systems should be punctual, the product manufactured should be perfectly correct and quality should be a top priority. After that he came back to open a factory in Thailand. He had learned the Japanese way of trying and continuing efforts until success is achieved. He learned from Japan that responsibility is highly regarded and that he needs to provide solutions in time. He also experienced repeated trial and failure when developing products for an automobile company. However, he worked until he found solutions for the product.

After that, he established an OEM factory. He started inventing his product after the economic crisis. He first designed by himself, but could not get a good product that had no bad effects on dental equipment. He then hired an engineer with an M.Eng from a private university, but that person could not find solutions either. This may have been because he had no experience in working in factories and could not persist in working on one issue. The M.Eng graduates thought that they would like to be manager to manage people, but we think that M.Eng graduates are needed to provide solutions. In developing the company's own product, he failed a lot and did not give up for one year by repeating trial and error. He called this "learning by doing when not knowing any theory".

Recommendations and comments from Mr. J

- ✓ Many people think that engineers tend to think that moving jobs will get the more experience but product development or innovation can emerge from experiences at one job with observation of the whole production process.
- ✓ Education is just a coupon granting entrance to a company, but after that actual results counts. This means that companies should not rely too much on educational background but on the actual results each staff produce.
- ✓ The project should introduce the education system of Japanese TC to Thailand. If the Kosen system of five consecutive years is employed, the last two years should involve "how to invent" to let students

think. One to three projects could be assigned, with teachers providing coaching rather than explicit instruction.

- ✓ The capacity of teachers must be improved. Even if the curriculum is good, it will not work if teachers don't know how to teach it. Now the Thai Tool and Die Industry Association is working on capacity building of teachers by providing three-month training to teachers from 28 TCs at Samut Songkram TC (trainers are from committees of the association). But after the trained teachers went back to teach and incorporated their training, there were problems because students didn't want to take such majors (molding) since they had to work harder here than in other departments.

ANNEX 12

Annex 12: List of the companies registered with the Revenue Department engaged in R&D

	Automobile / Auto Parts	Location	Area of R&D
1	R&D Section AAPICO Hitech Public Co., Ltd	Ayudhaya	Pickup parts JIG
2	R&D Section Lenso Wheel Co., Ltd.	Chacheongsao	
3	Research and Technology Development Department, Complete Auto-rubber Manufacturing Co., Ltd.	Chonburi	Tire
4	R&D Department, Xsense Information Service Co., Ltd.	Nonthaburi	Auto parts
5	Compact International (1994) Co., Ltd	Petchaburi	Brake
6	R&D Department, CH. Vatanayont	Samutprakarn	Automotive boiler
7	R&D Center, Summit Autoseat Industries Co., Ltd.	Samutprakarn	Spare parts
8	Summit R&D Center Co., Ltd	Samutprakarn	Automotive parts / JIG Die
9	Summit Auto Body Industry Co.,LTD. (R&D)	Samutprakarn	Automotive parts / JIG Die
10	R&D Section, Thai Koito Co.,Ltd.	Samutprakarn	Automotive parts
11	R&D Section, Thai Mould Mate Co.,Ltd.	Saraburi	Tire

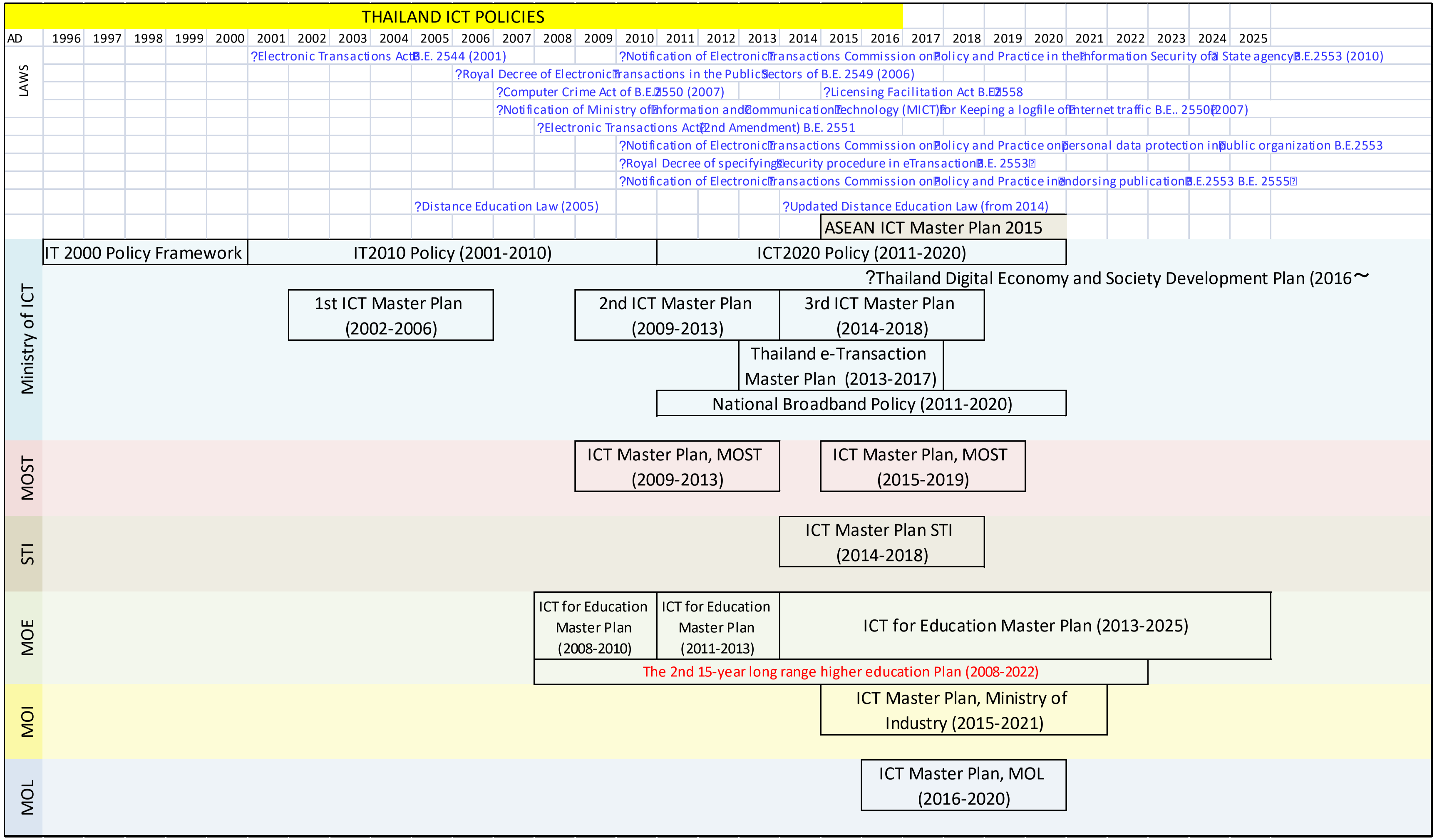
	Electronics	Location	Area of R&D
1	Production Technology R&D Section, Pantec R&D Co., Ltd.	Bangkok	Electronics Equipment
2	R&D Section, Calcomp Electronics Thailand Co., Ltd.	Bangkok	Electronics
3	R&D Center Thai samsung electronics Co. Ltd.	Bangkok	
4	R&D Section, Design Gateway Co., Ltd.	Bangkok	Electronics
5	Product R&D Section, Forth Corporation Public Co. Ltd.	Bangkok	Electronics/Tracking System
6	R&D Center, Electronics Industry Public Co., Ltd	Bangkok	
7	Product R&D Center, Forth Corporation Public Co., Ltd.	Bangkok	Electronics
8	DMC CORP (154) Co., Ltd.	Bangkok	Electronics
9	Grace Technology and Consultant Co., Ltd.	Bangkok	Electronics
10	Sony Technology (Thailand) Co., Ltd	Chonburi	
11	KPE RESEARCH CO., LTD	Khon Kaen	Electronics and Electrical Parts Research
12	R&D Section, Samart Research and Development	Nonthaburi	Electronics Equipment, computer and software
13	R&D Section Spansion Thailand Limited	Nonthaburi	Radio TV
14	R&D Section, Greattech Cybernetics Co., Ltd	Pathumthani	Electronic Parts
15	R&D Section, Elcom Research Co., Ltd.	Samutprakarn	Electronics (radio), Set-top equipment
16	R&D Section, KV Electronics Co., Ltd.	Samutprakarn	

	Electric	Location	Area of R&D
1	Research and Development Center, Minibea Thai Co., Ltd.	Ayutthaya	Electrical Appliance, IT Equipment, Aerospace & Automobile
2	R&D Unit, Siam Compressor Industry Co., Ltd (Under Mitsubishi Electric)	Bangkok	Electric appliance
3	R&D Section, NETGADGETS CO., LTD.	Bangkok	
4	Mobicrat Co., Ltd.	Bangkok	

5	Research and Technology Development Department, Digital Economic Co., Ltd.	Bangkok	Electrical Appliance
6	New Technology Department, Union Zojirushi Co., Ltd.	Bangkok	
7	Tycoon Research and Development Limited Partnership	Bangkok	Air-conditioning devices / Robot
8	Production and Maintenance Unit, Cement Thai Energy Conservation Co., Ltd.	Bangkok	Electrical Production
9	Research and Technology Development Department, Dyno Electric Co., Ltd.	Nakorn Pathom	
10	Thai Toshiba Electric Industry Co., Ltd	Nonthaburi	
11	R&D Section, Pattara Methakij Co., Ltd.	Nonthaburi	Electric and Air-conditioning
12	R&D Section, Matsushita Electric AVC (Thailand) Co., Ltd.	Samutprakarn	Radio Electronic parts
13	R&D Section, VF Lighting Co., Ltd.	Samutprakarn	
14	R&D Section, Bitwise Co., Ltd.	Samutprakarn	Air-conditioning
15	Research and Technology Development / Engineering Section, Uniaire Corporation Co., Ltd.	Samutprakarn	Air-conditioning
16	Meter Engineering Section, Mitsubishi Electric Automation Co., Ltd.		

ANNEX 13

Annex 13: ICT Policy Matrix



ANNEX 14

Annex 14: Categorization of ICT Personnel

Categorization of ICT personnel is according to ILO's International Standard Classifications of Occupations (ISCO). ICT personnel will be in the following group code.

25 Information and Communications Technology Professionals
- 251 Software and Applications Developers and Analysts
  - 2511 Systems Analysts
  - 2512 Software Developers
  - 2513 Web and Multimedia Developers
  - 2514 Applications Programmers
  - 2519 Software and Applications Developers and Analysts Not Elsewhere Classified
- 252 Database and Network Professionals
  - 2521 Database Designers and Administrators
  - 2522 Systems Administrators
  - 2523 Computer Network Professionals
  - 2529 Database and Network Professionals Not Elsewhere Classified

35 Information and Communications Technicians
- 351 Information and Communications Technology Operations and User Support Technicians
  - 3511 Information and Communications Technology Operations Technicians
  - 3512 Information and Communications Technology User Support Technicians
  - 3513 Computer Network and Systems Technicians
  - 3514 Web Technicians
- 352 Telecommunications and Broadcasting Technicians
  - 3521 Broadcasting and Audiovisual Technicians
  - 3522 Telecommunications Engineering Technicians

13 Production and Specialized Services Managers
- 133 Information and Communications Technology Services Managers
  - 1330 Information and Communications Technology Services Managers

21 Science and Engineering Professionals
  - 2152 Electronics Engineers
  - 2153 Telecommunications Engineers
  - 2166 Graphic and Multimedia Designers

23 Teaching Professionals
- 235 Other Teaching Professionals
  - 2356 Information Technology Trainers

24 Business and Administration Professionals
  - 2434 Information and Communications Technology Sales Professionals

32 Health Associate Professionals
- 321 Medical and Pharmaceutical Technicians
  - 3211 Medical Imaging and Therapeutic Equipment Technicians

4 Clerical Support Workers

42 Customer Services Clerks

422 Client Information Workers
4222 Contact Centre Information Clerks

5 Services And Sales Workers
52 Sales Workers
524 Other Sales Workers
5244 Contact Centre Salespersons
7 Craft and Related Trades Workers
74 Electrical and Electronics Trades Workers
742 Electronics and Telecommunications Installers and Repairers
7422 Information and Communications Technology Installers and Servicers

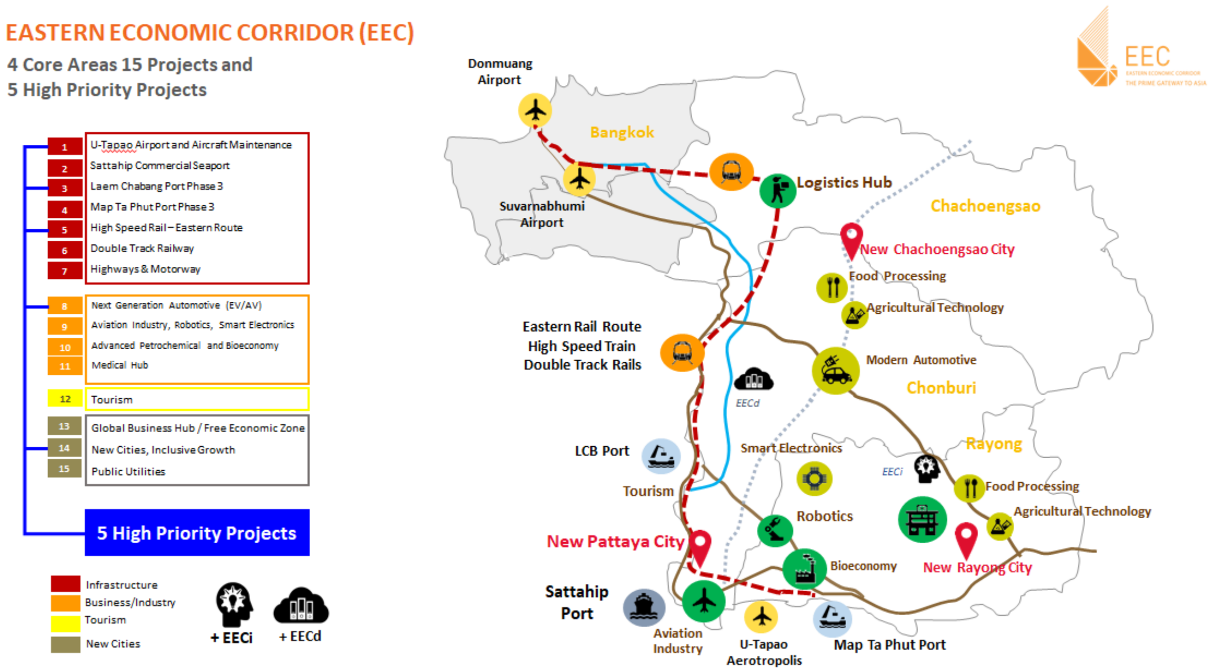
ANNEX 15

"The current situation of EEC's human resource development policy and progress"

Eastern Economic Corridor (EEC) is considered as a key strategy to realize "Thailand 4.0". "Thailand 4.0" is a new economic model which focuses on creativity and innovation, trying to transform the country from labor-intensive industry to knowledge-based economy, in order to escape from "middle-income trap." "Thailand 4.0" is targeting 10 industries including 1) next-generation automobiles, 2) smart electronics, 3) medical and health tourism, 4) agriculture and biotechnology, 5) future food, 6) robot technology, 7) aviation and logistics, 8) biochemistry, 9) digital industry, and 10) medical hub. The current government set a goal for Thailand to be a high-income country by 2036 and EEC is a major strategy to realize this vision of "Thailand 4.0."

EEC is a special economic zone covering 13,000 square meters of Chachoengsao, Chonburi, and Rayong. EEC sets 4 core areas, 15 projects and 5 high priority projects to be a driving force of "Thailand 4.0" as shown in Figure 1.

Figure 1: Eastern Economic Corridor

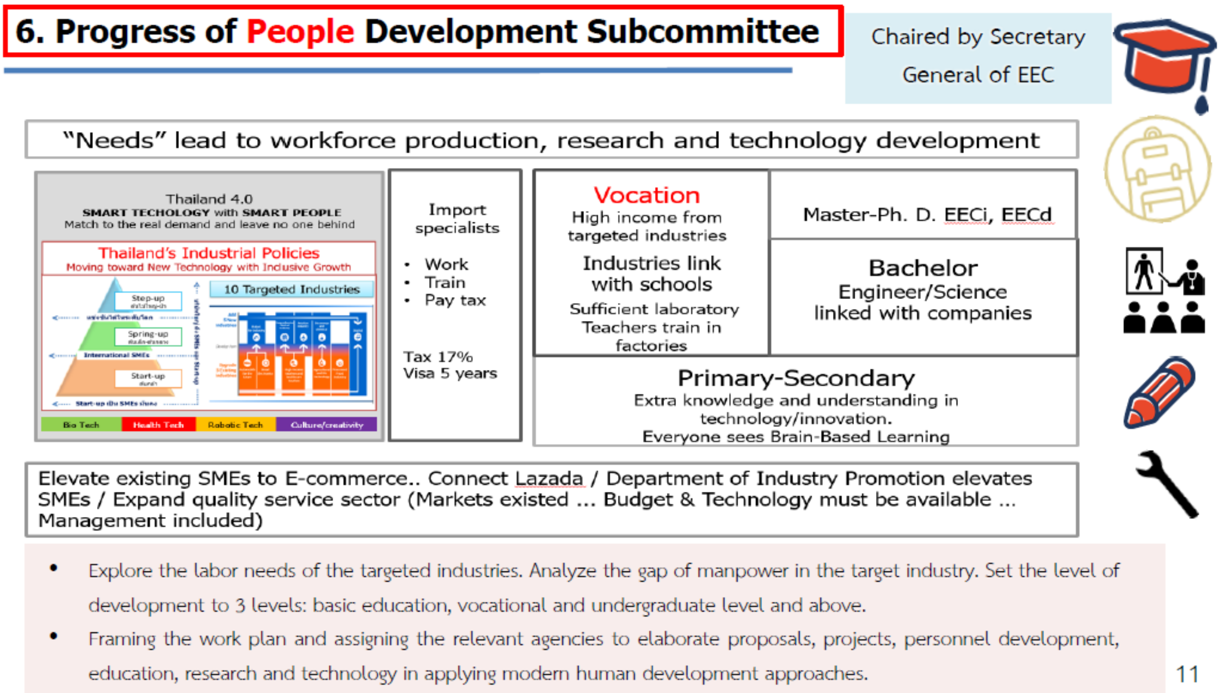


Source: Thailand 4.0. Dr. Kanit Sangsubhan, Eastern Economic Corridor: Update, June 22, 2017

While the Thai government is vigorously promoting EEC, EEC has some challenges to overcome. First of all, the involvement of private sector is a mandatory to succeed in developing EEC. The Thai government has announced attractive tax measures and other services to induce private sector involvement. Secondly, this policy needs to be consistent and sustainable regardless of change in government. Thirdly, competent human resources that can serve advanced industry with quality knowledge and skills is an important factor to support EEC development. Providing attractive research and development environment, strengthening the digital literacy and system development to invite foreign experts and specialists are also important to attract highly-qualified human resources.

Human resource development is an important issue for EEC. EEC has set up "People Development Subcommittee" chaired by Secretary General of EEC, Dr. Kanit Sangsubhan which has been making a comprehensive plan for human resource development for EEC based on the framework shown in Figure 2. Currently the draft plan has been circulated among the related agencies, but has not been made to the public yet.

Figure 2: EEC's human resource development framework



Source: EEC

Eastern Economic Corridor of Innovation (EECi) is a science park which promotes technology and innovation for three targeted industries in EEC, including Aripolis (automation, robotics, intelligent systems, IoT, Sensors, Big Data, and ICT security), Biopolis (smart agriculture, functional ingredient/nutraceutical, biofuel/bioenergy, bioplastic/biomaterial, biochemical, biomedical/biopha) and Space Krenovapolis (ground station & operations support,maritime solutions, agriculture solutions, navigation and location-based services). EECi is administered under the National Science and Technology Development Agency (NSTDA), Ministry of Science and Technology and it aims at promoting innovation through partnerships among government, industry, university and the local community. As to Japanese universities, currently, Kyoto University and Tokyo Institute of Technology have signed Minutes of Understanding with NSTDA; however, they are the expression of interests and detailed implementaiton plans have not been concluded yet.

Other government programs include EECi and EECd. EECi is going to provide 300 scholarships for the next five years. The recipients will study at gradute school levels, mostly at foreign academic institutions. Upon completing their studies, they are expected to work for the industries in EEC. Eastern Economic Corridor of Digital (EECd) is a digital park which promotes digital industry. EECd is to provide an ecosystem for leading digital normads and global players to "invest-work-learn-play." EECd is planning to provide training at three levels:1) Below diploma level; 2) degree level; and 3) professional training. As to below diploma level, EECd is already implementing a pilot program for 80 students to do work-integrated learning. The target will be 5,000 students in the field of IoT and AI for the next five years. As to degree level, Institute of Field Robotics (FIBO) at King Mongkut University of Technology, Tonburi (KMUTT) is developing the curriculum for IoT and AI which is not currently established in Thailand. The first batch will be accepted in August, 2018, starting at KMUTT and expanding to Burapha University and Rajamongala Universities gradually. The students in senior year will participate in the IoT institute program for 8 months, in addition to 3-month internship at companies. As for professional training, EECd is planning to offer courses in collaboration with degital global partners such as Microsoft and Apple. For the first year, 100 courses are to be offered. The course period can be one month and EECd will compensate 60% of the training fees. For the first year, the target will be 2,000 persons and by the fifth year, 5,000 persons. This type of training is scheduled to start in January 2018.

The ministry of education is also prepareing the human resource development plan for EEC. Office of Higher Education Commission (OHEC) set up a Committee on Promotion of Education Provision by Renowned Foreign Higher Education Institutions (CPEF). Knowledge transfer by renowned foreign higher education institutions to produce human resources with state-of-art high quality knowledge and skills is considered as necessary to pursue education reform and especially important to develop EEC. In normal practice, when foreign education institutions plan to establish a univerisity in Thailand, they have to follow the regulations of Private Higher Education Law and it takes one to two years to obtain a license. However, when CPEF approves the foreign institutions, they do not have to go through the normal practice and it is possible to obtain a license in one month. The related laws and regulations are in the process of proceeding and when they are approved, not only simplification of obtaining license process but the tax benefits will be applied as well.

Currently, Carnegie Melon University and National Taiwan University (both Faulty of Engineering) have submitted proposals to OHEC. Carnegie Melon University is planning to confer a joint degree with King Mongkut Institute of Technology, Lakrabang. The first batch is planned for 2018 to accept 10 master students and 5 Ph.D. students. As to Japanese universities, the Japan Embassy of Thailand is planning “Flex Campus” for EEC to offer short-term courses according to the needs of industry.

OVEC is planning human resource development for 10 targeted industries for EEC, which was approved by the cabinet in July 2017. The major strategies are 1) curriculum development; 2) cooperation with the private sector; and 3) improvement of English skill. Curriculum will be developed for each level of PWC, PWS, bachelor’s and short-training. In terms of cooperation with the private sector, at least one-term internship at companies will be required for both PWC and PWS levels. As to English skill, a pilot program which offers 30 hours English classes after school is provided at two technical colleges. If this is succssful, the program will be extended to other schools.

At the time of writing this report, human resource development for EEC is still an initial stage of planning. While vigorous efforts are being made by the Thai government, stability and continuity of the policy are strongly expected. A closer monitoring of the progress could provide the foundation for the Japanese government and private sector to support EEC.