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"Attitudes", Number 1 Industrial Engineer's Qualification Requirement for Thai Major Industries

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Abstract— **the research's objective is to study industrial engineers' qualifications required by an industrial sector for the year of 2009-2013 at an undergraduate level. The research methodology starts with the study of curricular models of industrial engineering education to describe the currently offered industrial engineering programs and their curricular contents. The other study is several industrial companies' recruitment qualifications of new industrial engineers. Identification of Thai industrial needs is conducted by using a questionnaire survey of three Thai major industries including Automotive Industry, a Plastic Industry and an Electrical & Electronics Industry. The result shows that the industries place the most important qualification category on engineer's attitudes with an average score of 4.24. Engineer's personality and characteristic gets an average score of 3.81. Computer skills get an average score of 3.48. Educational background gets an average score of 3.44. Working experience and special skills get the lowest average score of 3.21. In conclusion, industrial engineering education should prepare the graduates in higher workplace expectations by focusing on integrated knowledge and skill to strengthen core competence and communication ability as well as positive attitudes and social responsibility.**

Keywords— **Engineering Education, Industrial Engineer Qualification, Workplace Expectation, Questionnaire Survey, Attitudes**

I. INTRODUCTION

This research emphasizes engineering education, one of the important factors in stimulating the development of the industrial sector as well as the engineering community in a developing country. The research objective is to study Industrial engineers' qualifications required by an industrial sector for the year of 2009-2013.

To enter real-life work environment, nowadays engineering students are needed to be well-prepared. Employers have high expectations regarding new engineers' qualifications. These industrial needs change as time goes due to new technologies, new products and business opportunities. Engineering schools in colleges and universities play vital roles as knowledge sources and innovation creators. They must aware of these higher engineering graduates' qualifications. Thus, the curriculum design and teaching-learning processes can guarantee satisfaction from the industrial companies who are major customers.

The new paradigm of engineering education shows more expectations to new graduates. These expectations are:

- Ability to apply knowledge of math, sciences, and engineering
- Ability to design and conduct experiments, analyse and interpret data
- Ability to design a system component
- Ability to function on multi-disciplinary teams
- Ability to identify, formulate, and solve engineering problems
- Understanding of professional and ethical responsibility
- Ability to communicate effectively
- Ability to engage in life-long learning
- Ability to use techniques, skills, and tools.

Industrial needs studies and surveys have been done for more than 20 years according to new engineering graduates qualifications entering workplace including knowledge, skills, technical skill and attitudes. The qualifications required the most from industries are Teamwork skill, Communication skill, and Ethic. Moreover, new engineers are expected to understand Engineering profession role impacting society, economics and environment [1] – [6].

The Engineering faculty at Rajamangala University of Technology Thanyaburi, RMUTT was established in 1975. It consists of 10 academic departments offering two-level engineering programs. They are *Bachelor Degree* in Engineering (B.Eng.) and *Master Degree* in Engineering (M. Eng.). The faculty uses workforce demand from major industries to establish a strategy to produce engineering graduates. The strategy of producing adequate number of engineering graduates or mass production has changed into producing qualified persons who can contribute to workplace variously depending on industrial characteristics. The strategy is so-called a mass customized engineering graduates [7].

II. METHODOLOGY

In Thailand, engineers' qualifications of different disciplines are not the same. A company who hires industrial engineers and electrical engineers would have different expectations. The survey is designed to investigate only Industrial Engineering discipline. The result is used to improve an industrial engineering curriculum at Rajamangala University of Technology Thanyaburi (RMUTT). A research methodology is shown in figure 1.

A. Study of Models

Several curricular models of industrial engineering education are studied to describe the currently offered industrial engineering programs and their curricular contents.

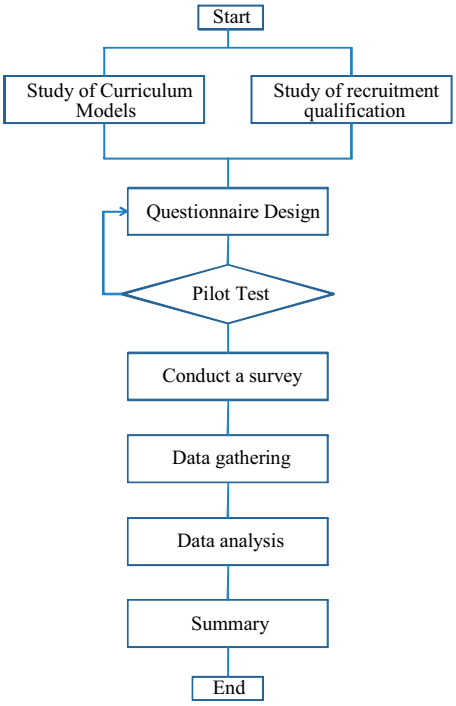

Fig. 1 A research methodology

B. *Study of Recruitment qualifications*

Another study is a number of industrial companies' recruitment qualifications for new industrial engineers. The studies of curricular models and recruitment qualifications are used to design a questionnaire.

C. *Select Industries*

The industries with high Thai Industries Sentiment Index (TISI) [8] are selected as Thai major industrial. They are an Automotive Industry, a Plastic Industry and an Electrical & Electronics Industry.

D. *Questionnaire Design*

Preliminary studies of industrial engineering curricula and recruitment qualifications result in the step of questionnaire design. The questionnaire contains 8 parts as shown below:

1) General information
2) Engineer's personality and characteristic
3) Working experience and special skills
4) Educational background
5) Computer skills
6) Attitudes
7) Job position for industrial engineering graduates
8) Comment and suggestion.

E. *Pilot Survey*

A pilot survey assures clarification of the designed questionnaire. Comments and suggestions from respondents are then used to adjust the questionnaire for better understanding.

F. *Conduct the survey*

Four hundred copies of the questionnaire are distributed to selected industrial companies. The length of the survey is approximately 2 months.

III. RESULTS

Of the 400 questionnaire, 177 are returned, resulting in a response rate of 44.25 percent. From 177 copies, 15 copies are dropped due to incomplete information. Of 163 questionnaires received, they are 65 from the automotive industry, 49 from the plastic industry and 48 from the electrical and electronic industry. The data received are statistically analysed using a Minitab for Windows software application. The statistical analysis composes of percentage, arithmetic mean, standard deviation and one-way ANOVA with a hypothesis test at a significant level of 0.05.

A. *Data Analysis*

The questionnaire uses Likert scale from 1 (least important) to 5 (most important). The interpretation designed by John W. Best of an average score is shown in Table I.

TABLE I : RESULT FROM THE SURVEY

Average score	Meaning
4.50 – 5.00	Highest, Most important
3.50 – 4.49	High, Important
2.50 – 3.49	Average
2.00 – 2.49	Low, Less important
1.00 – 1.99	Lowest, Least important

Comparing among 5 qualification categories: 1) engineer's personality and characteristic, 2) working experience and special skills, 3) educational background, 4) computer skills and 5) attitudes, Table II shows the result. The industries place the most important qualification category on engineer's attitudes with an average score of 4.24. Engineer's personality and characteristic gets an average score of 3.81. Computer skills get an average score of 3.48. Educational background gets an average score of 3.44. Working experience and special skills get the lowest average score of 3.21. Next, the survey in-depth investigates each category's content.

TABLE II : RESULT FROM THE SURVEY

Recruitment Category	Average Score	Standard Deviation	Meaning
Attitudes	4.24	0.71	Most important
Personality	3.81	0.74	Important
Computer Skills	3.48	0.95	Important
Educational Background	3.44	0.90	Average
Working Experience	3.21	0.85	Average

For attitudes which are considered the most desired qualification, fifteen attitude's dimensions are scored by using 1-5 scale. The outcome shows in order of highest

score to lowest score: 1) Responsibility, 2) Obedience, 3) Effort, 4) Trustworthiness, 5) Punctuality, 6) Human relation skill, 7) Sympathy, 8) Leadership, 9) Problem solving skill, 10) Decision making skill, 11) Communication skill, 12) Morals, 13) Self-effacing, 14) Humanity and 15) Creativity as shown in Table III.

TABLE III : SCORES FOR ATTITUDE'S DIMENSIONS

Attitude's Dimension	Score (1 to 5)	Meaning
Responsibility	4.61	Most important
Discipline	4.54	Most important
Diligent	4.54	Most important
Trustworthiness	4.47	Important
Punctuality	4.46	Important
Human relation skill	4.38	Important
Sympathy	4.30	Important
Leadership	4.28	Important
Problem solving skill	4.22	Important
Decision making skill	4.19	Important
Communicative	4.15	Important
Ethical	4.14	Important
Self-effacing	4.11	Important
Humanity	3.94	Important
Creativity	3.91	Important

For engineer's personality and characteristic, the highest average score is communication skill and personal confidence perceived during the job interview as shown in Table IV.

TABLE IV : SCORES FOR PERSONALITY'S DIMENSIONS

Personality's Dimension	Score (1 to 5)	Meaning
Communication Skill	4.38	Important
Self-confidence	4.15	Important
Personality	3.88	Important
Mood control	3.86	Important
Self-manner	3.76	Important
Looks and well-dress	2.85	Average

For computer skill, Microsoft Office software gets the highest average score following by Computer-aided Design software application and Decision Support software application as shown in Table V.

TABLE V : SCORES FOR COMPUTER SKILL DIMENSIONS

Computer Program	Score (1 to 5)	Meaning
Microsoft Office	4.03	Important
Auto CAD	4.01	Important
Solid Work	3.86	Important
Mechanical Desktop	3.65	Important
MRP	3.55	Important
Productivity	3.52	Important
Network	3.46	Average
Inventor	3.14	Average
Master CAM	3.08	Average

For educational background, the top ten industrial engineering courses are Manufacturing Processes, Engineering Drawing, Production Planning and Control, Quality Control and Quality Assurance, Production Design, Engineering Management, Work Study, Safety Engineering and Engineering Design as shown in table VI

TABLE VI : TOP TEN IE COURSES

Course Title	Score (1 to 5)	Meaning
Manufacturing Processes	4.51	Very important
Engineering Drawing	4.42	Important
Production Planning and Control	4.31	Important
Quality Control	4.28	Important
Quality Assurance	4.27	Important
Production Design	4.20	Important
Engineering Management	4.20	Important
Work Study	4.12	Important
Safety Engineering	4.07	Important
Engineering Design	3.97	Important

Lastly, English proficiency is the important requirement in the working experience and special skills category as shown in Table VII.

TABLE VII : SCORES FOR WORK EXPERIENCE AND SPECIAL SKILLS DIMENSIONS

Topics	Score (1 to 5)	Meaning
English usage	4.30	Important
Courses listed in transcript	3.88	Important
GPA on transcript	3.64	Important
Co-op training evaluation	3.54	Important
Senior project	3.46	Important

B. One-way Analysis of Variance (ANOVA)

One-way Analysis of Variance (ANOVA) is applied to examine the opinion's differences among these three industrial groups. The average score for each course is tested among the automotive industry, electronic industry and plastic industry. The hypothesis test is set as following:

H_0: Different industrial groups have the same opinion
H_1: Different industrial groups have different opinion

The p-value of less than 0.5 results in rejecting a null hypothesis at a significant level of 0.5. The end result shows different opinion among industrial groups in some courses. They are shown in Table VIII

C. Other comments from respondents

From the questionnaire, industrial sectors have several job positions offered for graduates who major in industrial engineering as shown below:

- Industrial engineer
- Planning engineer
- Production control engineer
- Design engineer
- Quality control engineer
- Maintenance engineer
- Safety engineer
- Project engineer
- Production engineer

The last part of the questionnaire is opened for comment and suggestion. The respondents suggest that new engineering graduates should aware of the significance of these following topics:

- Plant Safety
- Quality Management System
- Environmental System Management
- Kanban system
- 5S
- ISO9001, ISO/TS 16949
- ISO 14000, ISO14001

TABLE VIII : RESULT OF ONE WAY ANOVA

Same opinion	Different opinion
Fundamental Courses	
Basic Engineering Training	Fundamental of Electrical Engineering
Engineering Drawing	Engineering Mechanics
	Manufacturing Processes
	Computer Programming
	Engineering Materials
IE Core courses	
Material Testing Lab	Eng Metrology Lab
IE Pre-project	Machine Tool Practice
IE Project	Welding and Sheet Metal Practice
Seminar in Eng Prob	Engineering Management
Design of Machine Elements	Work Study
Maintenance Engineering	Operation Research
Statistics for IE	Engineering Economy
Safety Engineering	Quality Control
	Production Planning and Control
	Industrial Plant Design
IE Elective courses	
CNC Machine Practice	Mechanic of Production Machinery
Automatic Machine	Jig and Fixture Design
Press Tool and Dies Design	Metal Removable Processes
CAD	Plastic Mold Design
Engineering Metallurgy	Engineering Design
Tools Engineering	Production Design
Foundry Engineering	Packaging Technology
Control System	FMS
CIM	Machine Design
CAD/CAM	Piping Technology
Decision Making	Value Engineering
MIS	Industrial Cost and Budget Analysis
	Feasibility Study
	QA
	Ergonomics
	Industrial Environment and Pollution Control
	Industrial Law
	Simulation

IV. CONCLUSIONS

The industries who are the main customer of schools of engineering have looked for good people with good attitude to be part of their valuable human resources. Fifteen dimensions of attitudes include responsibility, discipline, diligent, trustworthiness, punctuality, human relation skill, sympathy, leadership, problem solving skill, decision making skill, communicative, ethical, self-effacing, humanity and creativity. They can also be known as "Life Skill". Life skill does not happen in just one day. It does not occur just after the student take courses in 4-year plan of study at the university. This reflects the entire educational system. Life skill must have been fostered to children from home and at every level of education.

An ability to use English as a second language is another high expectation from industrial sector that now competes globally.

In conclusion, engineering schools should have clear visualization of engineering qualifications when produce engineers to the market. They need short-term, intermediate and long-term plans with assessment and evaluation at every step. Industrial engineering education should prepare the graduates in higher workplace expectations for the year 2009-2013.

In addition to a proper educational philosophy, an effective teaching-learning-evaluation process, sufficient facilities and industrial engineering students' readiness, a well-designed curriculum is another significant factor impacting new engineers' qualifications. The industrial engineering curriculum improvement direction involves a focus on integrated knowledge and skill to strengthen core competence and communication ability as well as positive attitudes and social responsibility.

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