A Gap Study between Employers' Perception and Expectation of Engineering Graduates in Malaysia

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Abstract: This paper discusses a comprehensive study of employers' perception and expectation of Malaysian engineering graduates towards assessing measurable qualities. To have better overview in this issue, a survey on the needs, perception and expectation of Malaysian industries towards graduate engineers is conducted. In order to create a smoother transition from education to practice, some argue that engineering education should put more emphasis on the engineering-based knowledge. Thus, this study investigates also the gap analysis which is defined as the difference between expectation and perception among majority of Malaysian industries towards existing engineering graduates. Literally, it is to investigate the discrepancies between employers' perception and expectation towards future engineering work force of all the sectors or industries in Malaysia for non-technical and technical proficiencies**.** For the purpose of this paper, both technical and non technical attributes are analyzed and discussed. A total of 422 companies from various industries in Malaysia were chosen for the face-to-face interview sessions using a set of questionnaires. The respondents were mainly from high ranking personnel in their firm. The outcomes of this study will later be considered as a revision guideline for the engineering education curricula of Malaysian Institutions of Higher Learning.

Keywords: perception, expectation, gap analysis, technical attributes, non technical attributes

1 Introduction

What do industries expect of engineering graduates? At the present, there is a perception among industries in the United States of America that engineering students are not adequately prepared to enter the workforce [1]. There is an argument that the current engineering education does not provide enough emphasis on teamwork, communication, knowledge retention and the ability to synthesize and make connections between courses and fields [2]. In order to obtain better understand in the expectations of industries in Malaysia, a comprehensive survey on the perception and needs of Malaysian industries towards graduate engineers is currently being conducted.

The objectives of the survey are: to investigate the perception level of employers with regards to the competencies of engineering graduates; to investigate the expectation of employers with regards to the importance of the specific competencies of engineering graduates.

2 Methodology

A total of 422 companies from various industries were selected randomly and purposively using convenience sampling based on firms where engineering students normally undergo industrial placements. Sampling for the employer survey relied on a single level stratified random sample to ensure a fair representation based on the following elements such as location, engineering sectors and number of workers as the selection variable.

The breakdown of selected companies according to industry is shown in Table 1 and Figure 1. Data collection was carried out through face-to-face interviews using a set of questionnaires. As to ensure that the data collected is as accurate as possible, the interviews were conducted with Human Resource Managers or officers of higher rank within the company hierarchies. The distribution of respondents according to their designation can be shown in Table 2 and Figure 2.

Table 1: Distribution of respondents according to industry

Industry	No. of Responses	%
Healthcare, Social, Entertainment & Leisure	39	9.2
Education & Consulting	70	16.6
Commerce, Trade, Finance, Agriculture & Food	55	13.0
Communication, IT, Defence, Security, Transport	43	10.2
Engineered Materials, Energy & Natural Sources	102	24.2
Built Environment	113	26.8
TOTAL	**422**	**100**

Table 2: Distribution of respondents according to designation

Designation	No. of Responses	%
Chairman	8	2
CEO	24	6
COO	14	3
Executive Director	50	12
General Manager	139	33
Human Resource Manager	187	44
TOTAL	**422**	**100**

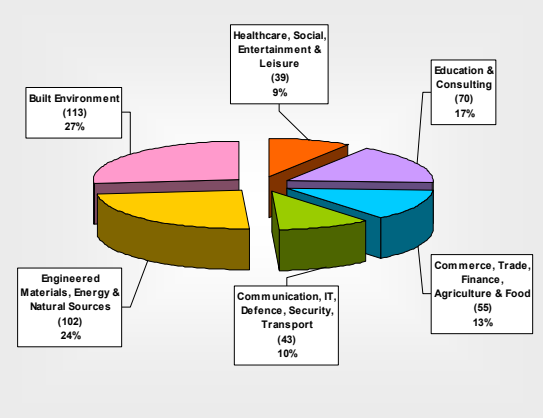

Figure 1: Distribution of respondents according to industry

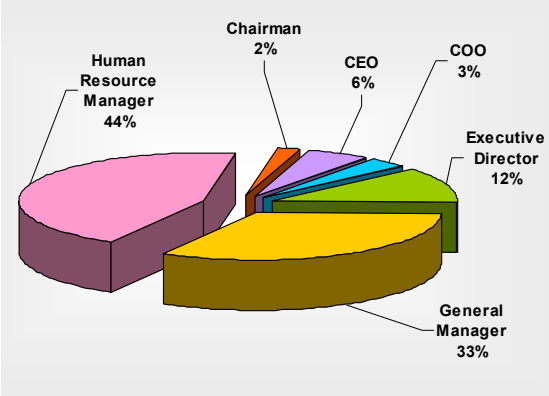

Figure 2: Distribution of respondents according to designation

3 Results and Discussions

In this study, the level of perception and expectation of employers towards a particular attribute (refer to Table 3) related to types of knowledge, skills and experience possessed by engineering graduates in their workplace required answers on a 5-point Likert's scale. As for instance, questions which required answers such as 'Most Important, Important, Neutral, Not Important and Not Important at All'. In order to simplify the 5-point scale, answers belonging to the first two categories are grouped as 'Important', while those belonging to the last two categories are grouped as 'Not Important'.

This paper will discuss the employers' satisfaction, expectation and also the measure of the degree of deficiency in achievement for each attribute which is defined as the average difference between the expectation and perception for all respondents.

Table 3: List of attributes used for this study

A	Ability to acquire and apply knowledge of engineering fundamentals.
B	Having the competency in theoretical and research engineering.
C	Having competency in application and practical oriented engineering.
D	Ability to communicate effectively, not only with engineers but also with the community at large.
E	Having in-depth technical competence in a specific engineering discipline.
F	Ability to undertake problem identification, formulation and solution.
G	Ability to utilise a systems approach to design and evaluate operational performance.
H	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member.
I	Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development.
J	Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so.
K	Ability to design and conduct experiments, as well as to analyse and interpret data.
L	Having the knowledge of contemporary issues.
M	Having the basic entrepreneurial skills

Those attributes can be categorised into technical and non-technical attributes or competencies. These can be shown as in Table 4 and Table 5.

Table 4: List of technical attributes

A	Ability to acquire and apply knowledge of engineering fundamentals.
B	Having the competency in theoretical and research engineering.
C	Having competency in application and practical oriented engineering.
E	Having in-depth technical competence in a specific engineering discipline.
G	Ability to utilise a systems approach to design and evaluate operational performance.
K	Ability to design and conduct experiments, as well as to analyse and interpret data.

Table 5: List of non technical attributes

D	Ability to communicate effectively, not only with engineers but also with the community at large.
F	Ability to undertake problem identification, formulation and solution.
H	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member.
I	Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development.
J	Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so.
L	Having the knowledge of contemporary issues.
M	Having the basic entrepreneurial skills

3.1 Employers' Satisfaction

This paper will discuss the employers' satisfaction regarding the technical and non-technical competencies of engineering graduates. Table 6 and Figure 3 show the level of satisfaction of employers of such attributes towards their engineering workforce. The employers are most satisfied with the aspect of utilising a systems approach to design and evaluate operational performance (attribute G) and also team working (attribute H) with 55.7% for both. They are most dissatisfied with the aspect of entrepreneurial skills of the workforce, scoring only 24.4% satisfactory level. Otherwise, other attributes scored around 47% or higher.

There were 7 outcomes or attributes received positive ratings by less than 50% of employers. The overall implication of the findings depicted in Table 6 and Figure 3 is that universities in general need to do a lot more to upgrade their programmes in order to improve satisfaction ratings by employers in the future.

Table 6: Employers' satisfaction on technical and non-technical attributes of their engineering workforce.

Attributes	Not Satisfactory	Neutral	Satisfactory	Did Not Respond
A	17 ***4.0%***	152 ***36.0%***	229 ***54.3%***	24 ***5.7%***
B	34 ***8.1%***	164 ***38.9%***	200 ***47.4%***	24 ***5.7%***
C	35 ***8.3%***	142 ***33.6%***	221 ***52.4%***	24 ***5.7%***
D	51 ***12.1%***	138 ***32.7%***	209 ***49.5%***	24 ***5.7%***
E	42 ***10.0%***	150 ***35.5%***	206 ***48.8%***	24 ***5.7%***
F	44 ***10.4%***	151 ***35.8%***	203 ***48.1%***	24 ***5.7%***
G	41 ***9.7%***	122 ***28.9%***	235 ***55.7%***	24 ***5.7%***
H	41 ***9.7%***	122 ***28.9%***	235 ***55.7%***	24 ***5.7%***
I	36 ***8.5%***	146 ***34.6%***	216 ***51.2%***	24 ***5.7%***
J	36 ***8.5%***	154 ***36.5%***	208 ***49.3%***	24 ***5.7%***
K	57 ***13.5%***	162 ***38.4%***	179 ***42.4%***	24 ***5.7%***
L	42 ***10.0%***	154 ***36.5%***	202 ***47.9%***	24 ***5.7%***
M	100 ***23.7%***	195 ***46.2%***	103 ***24.4%***	24 ***5.7%***

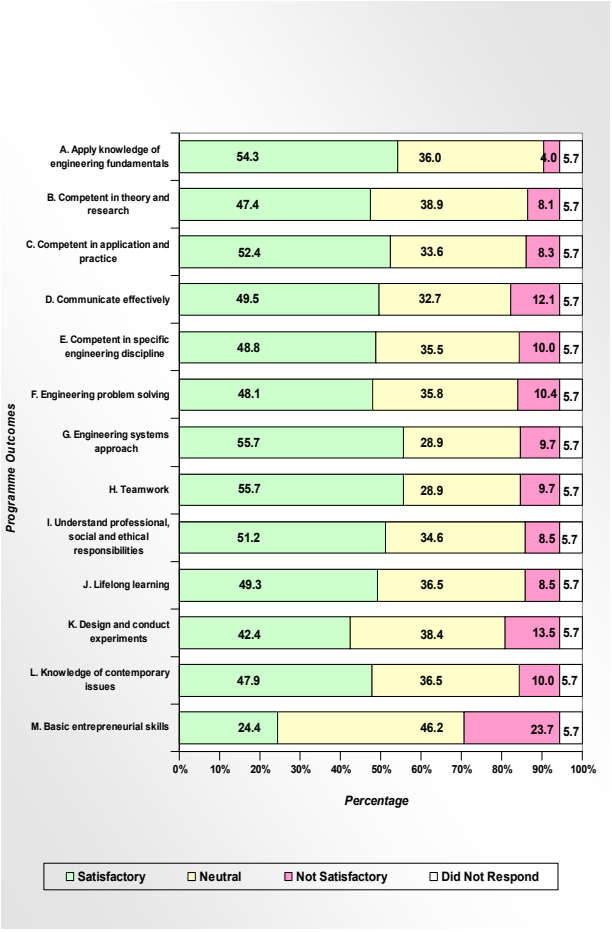

Figure 3: Employers' satisfaction on technical and non-technical attributes of their engineering workforce

Technical Competencies

Among all of the technical competencies, attribute G (ability to utilise a systems approach to design and evaluate operational performance) appeared to be the technical attribute which is most satisfied by the employers.

In contrary, the employers were most dissatisfied with engineering graduates' ability to design and conduct experiments, as well as to analyse and interpret data (attribute K).

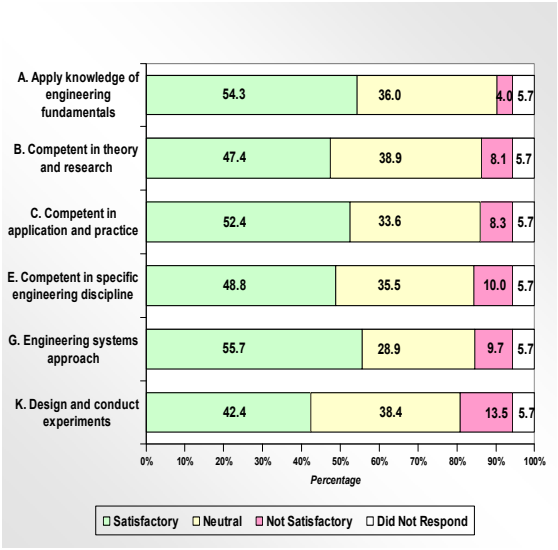

Figure 4: Employers' satisfaction on technical attributes of their engineering workforce

Non-Technical Competencies

As for the non-technical skills, the employers were most satisfied with the engineering graduates' ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member.

However, the basic entrepreneurial skills (attribute M) possessed by the engineering graduates were not at the satisfactory level for most of the employers. This can be referred in Figure 5.

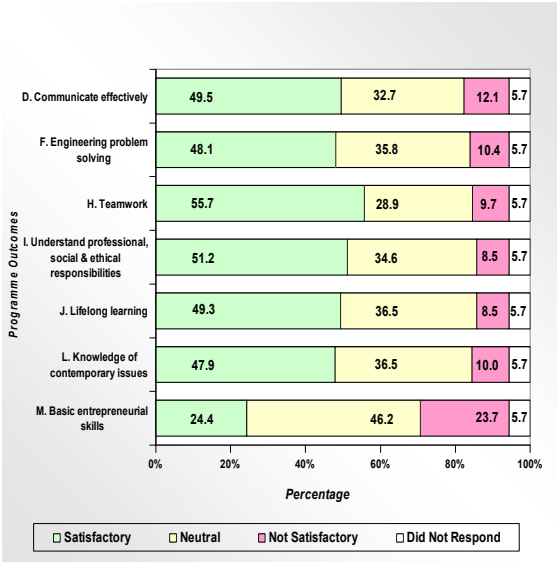

Figure 5: Employers' satisfaction on technical and non-technical attributes of their engineering workforce

3.2 Employers' Expectation

Figure 6 and Table 7 illustrate the expectation level of employers on the respective technical and non-technical attributes of their engineering workforce. Between 73% and 87% of respondents responded positively on the importance of all outcome statements, except for basic entrepreneurial skills, which obtained a moderate score of about 57%.

The low percentage scores for basic entrepreneurial skills (attribute M) reflected that this non-technical attribute is less important to the employers. On the other hand, attribute D (communicate effectively) scored the highest percentage for being one of the important competencies in engineering workforce. This indicates the high degree of importance that employers place on these attributes.

Table 7: Employers' perception on technical and non-technical competencies of their engineering workforce

Attributes	Not Important	Neutral	Important	Did Not Respond
A	9 *2.1%*	36 *8.5%*	353 *83.6%*	24 *5.7%*
B	14 *3.3%*	75 *17.8%*	309 *73.2%*	24 *5.7%*
C	9 *2.1%*	28 *6.6%*	361 *85.5%*	24 *5.7%*
D	7 *1.7%*	25 *5.9%*	366 *86.7%*	24 *5.7%*
E	10 *2.4%*	40 *9.5%*	348 *82.5%*	24 *5.7%*
F	14 *3.3%*	27 *6.4%*	357 *84.6%*	24 *5.7%*
G	14 *3.3%*	51 *12.1%*	333 *78.9%*	24 *5.7%*
H	11 *2.6%*	28 *6.6%*	359 *85.1%*	24 *5.7%*
I	13 *3.1%*	46 *10.9%*	339 *80.3%*	24 *5.7%*
J	9 *2.1%*	51 *12.1%*	338 *80.1%*	24 *5.7%*
K	21 *5.0%*	62 *14.7%*	315 *74.6%*	24 *5.7%*
L	13 *3.1%*	67 *15.9%*	318 *75.4%*	24 *5.7%*
M	37 *8.8%*	118 *28.0%*	243 *57.6%*	24 *5.7%*

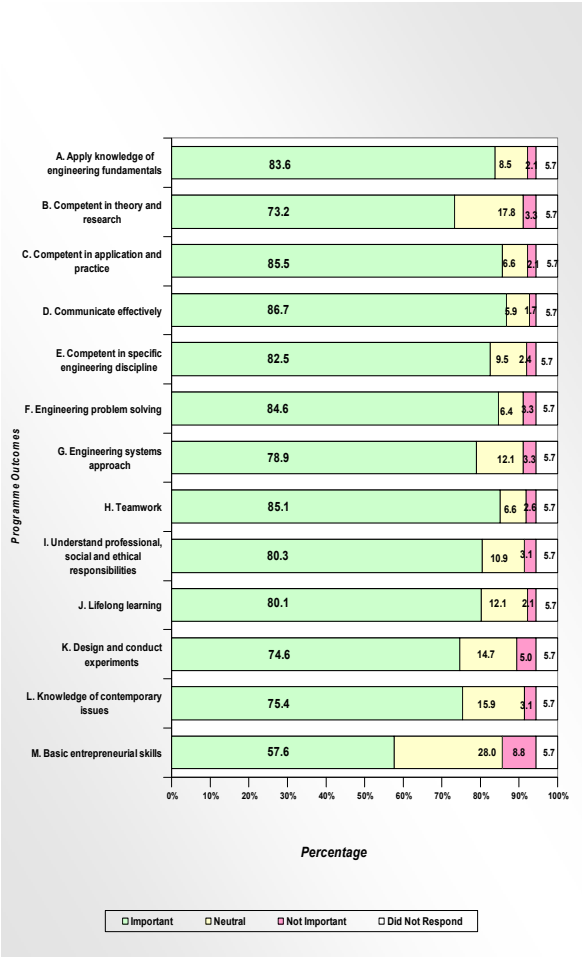

Figure 6: Employers' expectation on technical and non-technical attributes of their engineering workforce

Technical Competencies

Among all of the technical competencies, the employers expected the engineering graduates to be competent in both application and practical oriented engineering. The highest score of 85.5% illustrates its importance. However, other technical attributes were rated as important as well. All of the technical attributes scored at least 73% for being important. The Figure 7 shows the importance of technical competencies of the engineering work force.

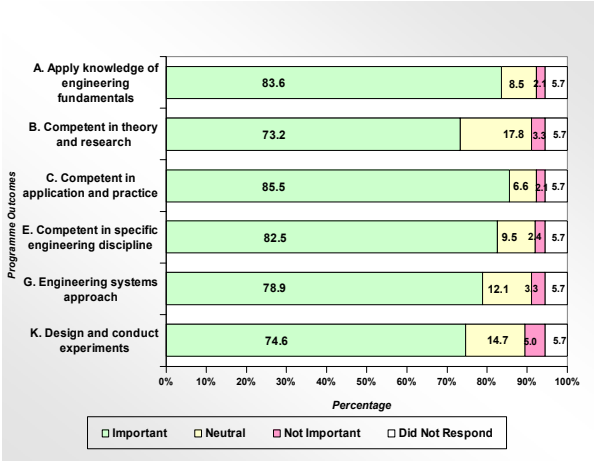

Figure 7: Employers' expectation on technical attributes of their engineering workforce

Non-Technical Competencies

As for the non-technical skills, the employers put most emphasis on the communication skill (attribute D) with the highest score of 86.7% followed by attribute H (teamwork) with 85.1%.

However, the basic entrepreneurial skills (attribute M) showed the lowest level of importance since the percentage obtained is only 57.6%.

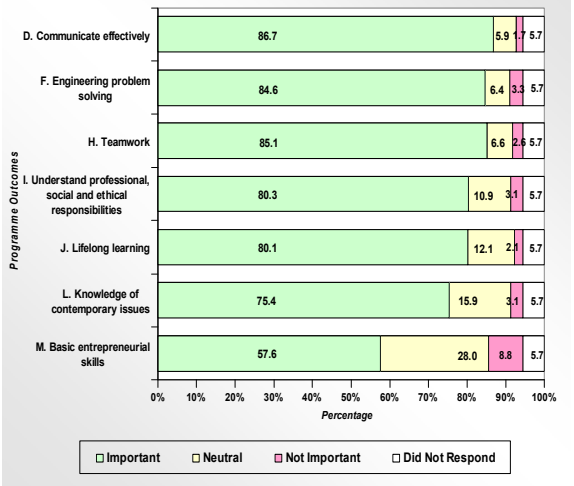

Figure 8: Employers' expectation on non-technical attributes of their engineering workforce

3.3 Gap Analysis

In this study, the gap analysis of all the sectors or industries in Malaysia towards future engineering work force is also discussed. The measure of the degree of deficiency in achievement for each attribute is defined as the average difference between the expectation and perception for all respondents, i.e.

$$Mean\ \ Gap_p = \frac{\sum_{i=1}^{n}[(Expectation)_i - (Perception)_i]}{n}$$

Where

- i refers to the ith respondent, i.e i = 1, 2, 3, …, n
- p refers to the pth attribute, i.e p = A, B, C,..,M and
- n refers to the total number of respondents

A higher mean gap value depicts a bigger discrepancy between what is expected of the work force and their performance as perceived by the employers. The attributes which show the worst score (highest mean gap) was the ability to undertake problem identification, formulation and solution (0.94), followed by the ability to communicate effectively (0.92), teamwork (0.82), ability to utilise a systems approach to design and evaluate operational performance (0.81). The best score (lowest mean gap) was recorded by attribute B (0.57) on theoretical and research engineering, indicating that employers are the least concerned about improving this particular outcome.

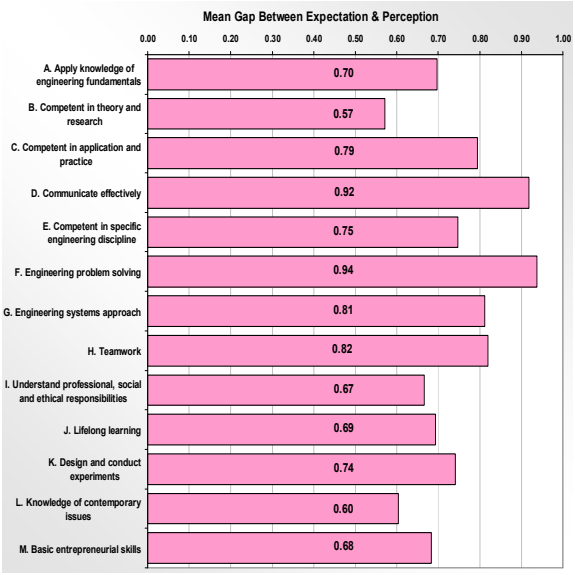

Figure 9: Mean gap between employers' expectation and perception on technical and non-technical attributes of engineering workforce

Technical Competencies

The employers dissatisfied with the skill of engineering systems approach since the mean gap appeared to be the largest score among all of other technical skills. This can be shown in the Figure 10.

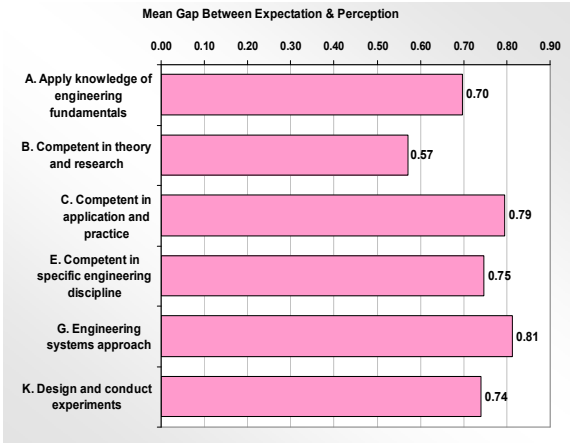

Figure 10: Mean gap between employers' expectation and perception on technical attributes of engineering workforce

The information of Figure 10 can then be expanded to detail information for six main industrial sectors, as shown in Figure 11 to 16. Figure 11 shows the responses of the employers' expectation of the workforce with

respect to engineering fundamental knowledge (attribute A). As predicted, all industrial sectors require their engineering workforce must have the ability to acquire and apply knowledge of engineering fundamentals. Refering to the mean gap of Attribute B (Figure 12), the Healthcare, Social, Entertainment and Leisure and also the Commerce, Trade Finance, Agriculture and Food sectors recorded the lowest score of discrepancies with 0.46 and 0.43 respectively.

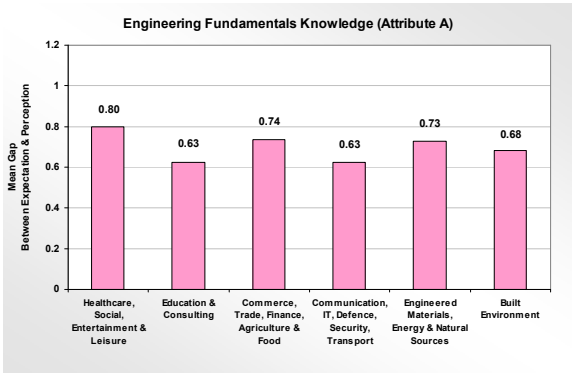

Figure 11: Mean gap of engineering graduates by industries with respect to Attribute A

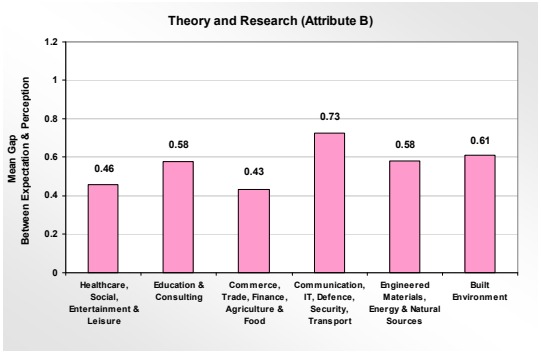

Figure 12: Mean gap of engineering graduates by industries with respect to Attribute B

In Figures 13 to 15, the Engineered Materials, Energy and Natural Resources sector shows the worst score (highest mean gap) for attributes C, E and G. This illustrates that the employers were not satisfied with the engineering graduates' competencies in application and practical oriented engineering, in-depth technical competence in a specific engineering discipline and ability to utilise a systems approach to design and evaluate operational performance. These competencies are believed to be the essence of good engineers.

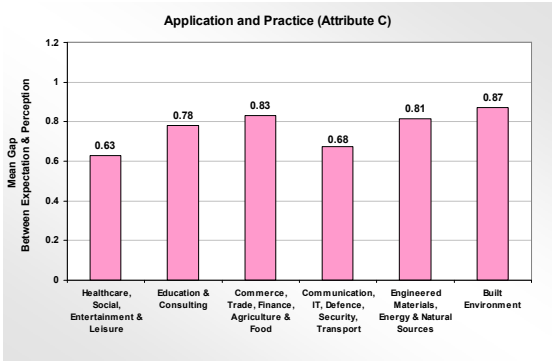

Figure 13: Mean gap of engineering graduates by industries with respect to Attribute C

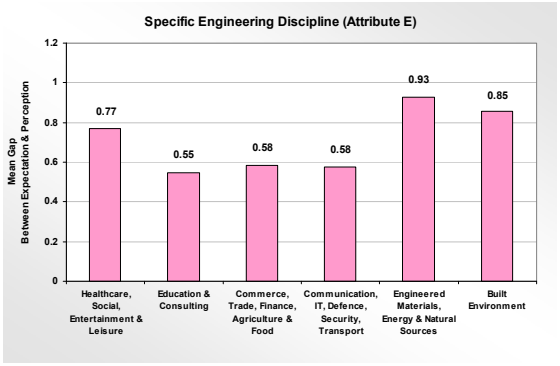

Figure 14: Mean gap of engineering graduates by industries with respect to Attribute E

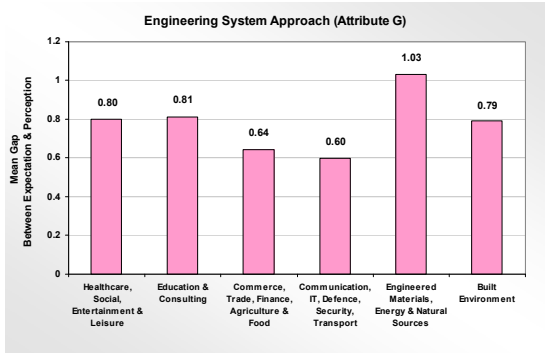

Figure 15: Mean gap of engineering graduates by industries with respect to Attribute G

In Figure 16, the mean responses range from 0.55 to 0.92. This illustrates different rate importance in attribute across the six main industries. The Communication, IT, Defence, Security and Transport sector recorded the best score (lowest mean gap) with 0.55. On

the other hand, the worst score was recorded by the Engineered Materials, Energy and Natural Resources with 0.92.

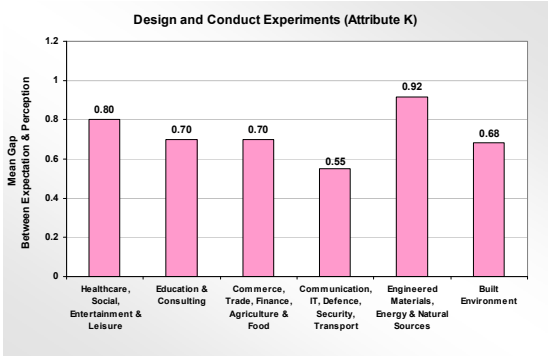

Figure 16: Mean gap of engineering graduates by industries with respect to Attribute K

Non Technical Competencies

In this study, it is found that the local engineering graduates lack of engineering problem solving skill and also effective communication skill. The worst score among the non-technical skills are exhibited by attributes F and D with mean gap 0.94 and 0.92 respectively.

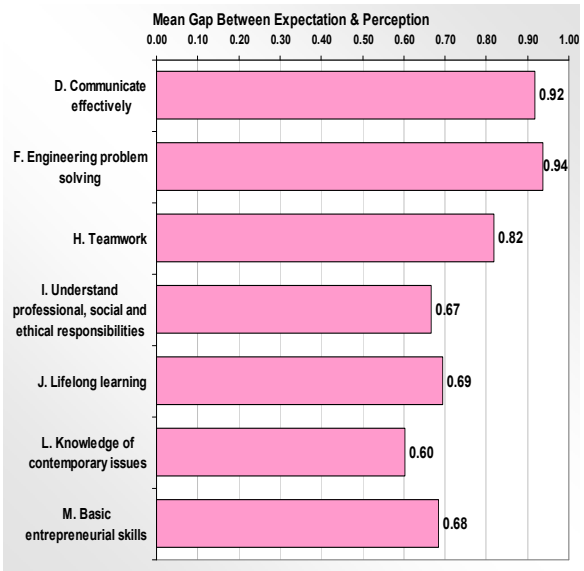

Figure 17: Mean gap between employers' expectation and perception on non-technical attributes of engineering workforce

The information of Figure 17 can then be expanded to detail information for six main industrial sectors, as in Figure 18 to 24. Figure 18 shows the mean gap of attribute on effective communication (attribute D) across the six main industries. As predicted, the sector of Communication, IT, Defence, Security, Transport recorded the best score (lowest mean gap) in the ability to communicate effectively (0.68). Refering to the mean gap of Attribute F (Figure 19), the Engineered Materials, Energy & Natural Sources sectors gave the worst score (1.10) was the ability to undertake problem identification, formulation and solution (attribute F). For communications and IT sector, again exhibits the best score (0.60) for the ability to work in group (attribute H) which can be observed in Figure 20. This indicates that the precondition of employment in this industry is high ability of working in team.

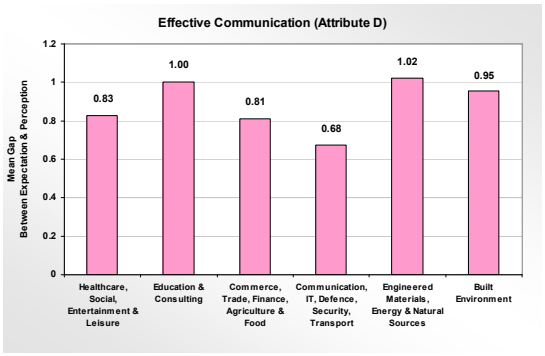

Figure 18: Mean gap of engineering graduates by industries with respect to Attribute D

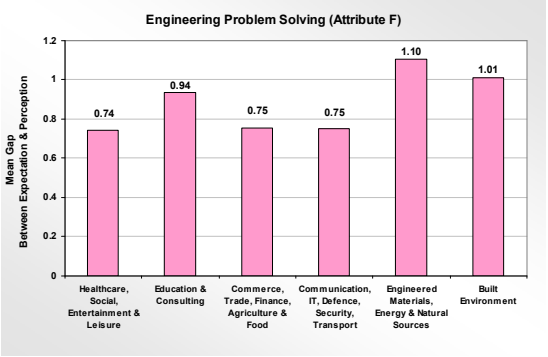

Figure 19: Mean gap of engineering graduates by industries with respect to Attribute F

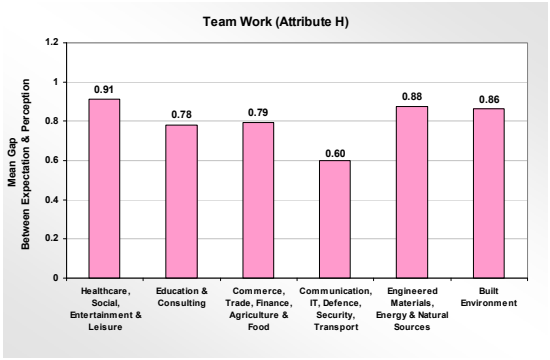

Figure 20: Mean gap of engineering graduates by industries with respect to Attribute H

In Figures 21 to 24, the Commerce, Trade, Finance, Agriculture and Food sector exhibit the least mean gap for attributes I, J and L with scores 0.49, 0.51 and 0.47 respectively. This indicate that this industry has the lowest level of discrepancy in the ability of understanding the professional, social and ethical responsible, lifelong learning and also the knowledge of contemporary issues.

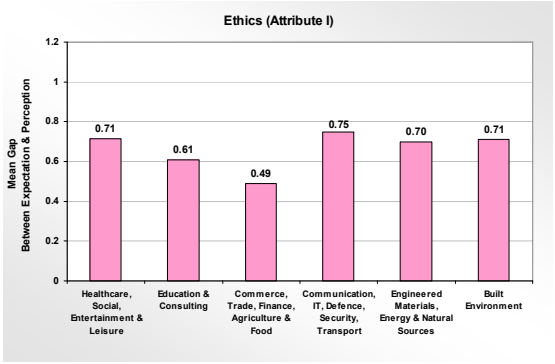

Figure 21: Mean gap of engineering graduates by industries with respect to Attribute I

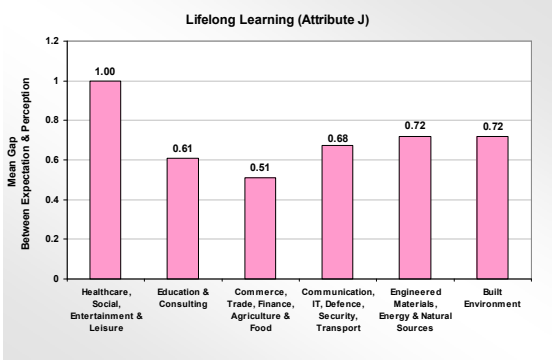

Figure 22: Mean gap of engineering graduates by industries with respect to Attribute J

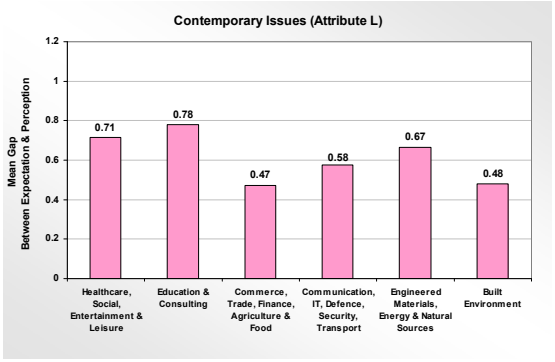

Figure 23: Mean gap of engineering graduates by industries with respect to Attribute L

In Figure 24, the Education and Consulting sector showed the worst score (highest mean gap) for the basic entrepreneurial skills with 0.91. It is due to the nature of the engineering industries which expect the future engineers should be more competence and knowlegeable in technical skills instead of business talent. On the contrary, the Commerce, Trade, Finance, Agriculture & Food sector recorded the best score (0.51) which their nature of work force requires them to communicate and to make business trades and such.

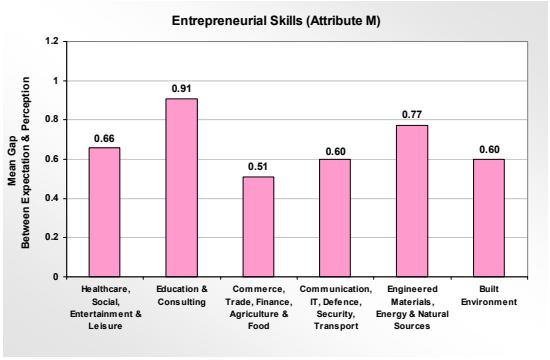

Figure 24: Mean gap of engineering graduates by industries with respect to Attribute M

4 Conclusion

In overall, this study discussed the discrepancy between what is expected of the work force and their performance as perceived by the employers according to thirteen competency attributes. 422 companies from six Malaysian industrial sectors were selected for the questionnaires study, and the

measurement parameters used for the questionnaires were the mean gap. From the study, Attributes D (ability to communicate effectively, not only with engineers but also with the community at large) and F (ability to undertake problem identification, formulation and solution) were given a top priority by all six industrial sectors in the process to find new engineering workforce.

The views of employers on graduate competencies clearly imply that is vital for engineering programmes to improve in all areas, particularly in several non-technical aspects of engineering education. Engineers must be educated to think broadly in fundamental and integrative ways about engineering. Apart from the application of mathematics and the sciences as core engineering subjects, engineering curriculla must stress more on the humanistic, as apposed to scientific and mechanistic, aspects of problem solving or project implementation.

There is also agreement among employers and leading engineers that local Institution of Higher Learning graduates lack effective communication skills, both orally and in writing. In preparing the student for his professional career, the importance of mastering these soft skills must be further emphasised.

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