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Application of Fuzzy Delphi Approach Determining Element in Technical Skills among Students towards the Electrical Engineering Industry Needs

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ABSTRACT

Responsible development of a nation calls for knowledgeable and skilled human capital. Indeed, human capital plays a big role in the planning process and implementation of national development. To achieve this, one strategy is to enhance the skills of individuals, thereby also enhancing their marketability to ensure the availability of a flexible, technically skilled and efficient workforce. To produce and fulfil the requirement for a skilled workforce, the education delivery system and practical training of future graduates should become more responsive to the needs of the job market, which is dynamic and productive and geared towards global competition. This study aims to identify the elements of technical skills needed by electrical engineering students that would make them marketable today. A total of 21 experts were selected to analyse the fuzziness consensus of experts. All collected data were analysed using the Fuzzy Delphi Method. The results show 16 of the 23 elements meet the conditions, the threshold value (dkonstruk) is less than 0.2 and the percentage of the expert group is more than 75%. This shows that, based on the consensus of the experts, the elements of technical skills are needed by electrical engineering students for mastering technical skills.

Keywords: Electrical engineering, Fuzzy Delphi Technique, marketability, technical expertise

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INTRODUCTION

Skills is an important area, especially for developing countries that intend to get ahead in the 21st century. Malaysia is among the developing countries in Southeast Asia that are actively involved in producing skilled manpower to meet their manpower needs.

Skilled youth are necessary for the economic and technological development of Malaysia. In a knowledge economy, every individual should have the basic skills to compete in the market. A complete package of skills will help graduates secure a job as the job market no longer relies solely on academic excellence, but also on the marketability of employees (Mat Yazid, 2010).

Othman, Hamzah, Norihan and Aripin (2011) found that there was a significant gap in the performance expected by employers and that shown by graduates. They stated that some graduates did not know which technical skills were needed for their work. If this situation continues, graduates may face the threat of unemployment. In 2009, 27% of graduates of institutions of higher learning were still unemployed six months after graduation, while 33% of those who managed to get a job were earning less than RM1,500 per month (KPM, 2012).

PROBLEM STATEMENT

The quality of graduates is a major issue that is closely related to their employability after graduation. Generally, in considering the quality of graduates, emphasis and attention are given to the lack of skills, particularly in terms of technical skills to meet the needs of industry (Rahman, Mokhtar, Yasin, Jusoff, & Mohd Hamzah, 2011).

A study conducted by Othman (2012) found that the graduates studied were less competent in terms of technical skills, unable to do a good job as required by industry and weak in soft skills (KPM, 2012), while Rahman et al. (2011) found that technical graduates were less proficient in technical skills and employability. The studies showed that employers preferred employees who had the necessary skills when it came to recruiting new employees (Harun, 2002; Amiruddin, Nur, Bekri, & Hashim, 2015).

This study was carried out to identify the elements of technical skills that students are required to master in order to meet the needs of their career in general and industry in particular. The results will help in describing the problems associated with acquiring the methods and requirements of technical skills that are needed by students to meet the needs of industry, a study is needed to.

PURPOSE OF REVIEW

The main objective of this study was to identify the elements of technical skills that electrical engineering students would need to master to meet the needs of the job market. Technical skills are determined by the consensus of experts, what is required by employers and the needs of a particular field. The following research questions were studied:

1. Based on the experts' agreement, what are the values of the Delphi Fuzzy method for the elements of technical expertise?
2. Based on the consensus of the experts, how many elements of technical skills do polytechnic students of electrical engineering have to meet to fulfil the needs of industry?

SCOPE AND LIMITATIONS OF THE STUDY

This study focused on the elements of the technical skills required and mastered by electrical engineering students during the teaching and learning process in preparation for meeting the needs of industry and the job market. A total of 21 experts were chosen to sit on the panel of experts based on Jones and Twist (1978). Each selected expert had more than 10 years' experience in the field of technical and electrical engineering.

METHODOLOGY

In this section, we discuss how we analyzed the data based on all the data collection instruments that were selected. For the analysis of the Fuzzy Delphi technique, a questionnaire was developed by the researchers based on the literature and interviews were seven professionals in the field of technical and electrical engineering. The second step was to obtain the consensus of the experts on the elements of technical skills. The experts comprised five specialist engineering-industry skilled training workers, three liaison officers of industrial training who coordinate the placement of students at the Polytechnic, two senior officials from the Centre for Research and Development Polytechnic KPT, three officers of vocational training in electrical engineering in the Department of Manpower, three assistant vocational training officers in engineering at the Department of Manpower, three lecturers in electrical engineering, including a head of department and two lecturers with more than 10 years' experience in the field of electrical engineering.

Seven experts interviewed in the first step also answered the questionnaire. Table 1 below shows the simpler Fuzzy Delphi technique for determining the elements of technical skills based on the experts' consensus for the first phase.

Table 1
Fuzzy Delphi technique

Step	Total Expert	Instrument Design
First step (Establishment of survey instrument)	7 experts	Structured interview
Second step (Obtain consensus)	21 experts	Survey instrument

Fuzzy Delphi technique

After the interview with the seven experts, the questionnaire was produced. The questionnaire was administered to the 21 experts, including the seven who had been interviewed. The steps used in determining the Fuzzy Delphi technique are given below.

Step 1: Determining the experts. Twenty-one experts were invited to answer the questionnaire.

Step 2: Selecting a linguistic scale. The researchers chose a seven-point linguistic scale ranging from 'very strongly disagree' to 'strongly disagree', 'disagree', 'not sure', 'agree', 'strongly agree' and 'very strongly agree'. Table 2 shows the seven-point linguistic scale.

Table 2
Seven-point linguistic scale

Seven-Point Linguistic Scale				
Linguistic Variables		Scale Fuzzy		
1	Very strongly disagree	0.0	0.0	0.1
2	Strongly disagree	0.0	0.1	0.3
3	Disagree	0.1	0.3	0.5
4	Not sure	0.3	0.5	0.7
5	Agree	0.5	0.7	0.9
6	Strongly agree	0.7	0.9	1.0
7	Very strongly agree	0.9	1.0	1.0

Step 3: Getting the average value. The average value was determined according to the formula prescribed. Here is a formula used to obtain the average value:

$$d\left(\tilde{m},\tilde{n}\right)=\sqrt{\frac{1}{3}\left[(m_1-n_1)^2+(m_2-n_2)^2+(m_3-n_3)^2\right]}.$$

Step 4: Determining the value of 'd' (Threshold value). If the value of d is d<0.2, then all the experts had reached a consensus agreement. If the value of d is d>0.2, the researchers had to repeat the procedure.

Step 5: Getting a 75% consensus. At this point, the researchers had come to a decision or agreement on the expert group known as the consensus group. It was decided that a 75% consensus would be necessary to show agreement among the experts. If the consensus was less than 75%, the researchers would have to repeat the procedure to ensure there was at least 75% consensus among the experts.

Step 6: Get Fuzzy evaluation. Fuzzy evaluation is one method for determining the ranking of an item. It is quite a difficult process because it involves complex numbering and an alternative method of using a mathematical formula to determine ranking. This is called the defuzzified process.

Step 7: Defuzzified (Score determining process). Three formulae can be used in the defuzzified process to determine ranking/ scoring of the items:

i. Amax = 1/3 * (a1 + am + a2)
ii. Amax = 1/4 * (a1 + a2 + 2am)
iii. Amax = 1/6 * (4am + a1 + a2)

For this study, the researchers chose formula (i).

RESULTS AND DISCUSSION

Each study has its own requirements (Chu & Hwang, 2008). This study set out to select items only within the linguistic scale of 'strongly agree' and 'agree' on a 7-point Likert scale. Results of the analysis using the Fuzzy technique found 16 elements with a consensus percentage of >75%. Chu and Hwang (2008) and Murray, Pipino and

Gigch (1985) showed that the agreement of the expert group was also observed. About 75% of the items were disposed of as low-value deals. The table below shows the results for the position of the elements of technical skills based on the consensus of the experts. These data consisted of the threshold value of each element (item d), the threshold value constructs (d construct) and its elements by agreement among the experts. Analysis findings reported by the highest ranking item for each construct are as follows:

Table 3
Items by rank for each construct

Experts	Element of Technical Skill							
	1	2	3	4	5	6	7	8
1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1
2	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.1
3	0.1	0.0	0.2	0.1	0.1	0.1	0.2	0.1
4	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2
5	0.1	0.0	0.1	0.1	0.1	0.2	0.2	0.2
6	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
7	0.1	0.2	0.2	0.1	0.7	0.2	0.2	0.2
8	0.1	0.2	0.2	0.1	0.3	0.3	0.2	0.1
9	0.1	0.0	0.2	0.1	0.2	0.2	0.2	0.2
10	0.1	0.5	0.2	0.4	0.4	0.1	0.1	0.2
11	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.2
12	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.2
13	0.1	0.0	0.2	0.1	0.2	0.1	0.1	0.2
14	0.3	0.2	0.2	0.1	0.2	0.1	0.1	0.2
15	0.1	0.0	0.1	0.1	0.2	0.4	0.7	0.1
16	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.1
17	0.1	0.2	0.2	0.3	0.3	0.7	0.2	0.1
18	0.1	0.2	0.2	0.3	0.3	0.3	0.1	0.2
19	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.2
20	0.3	0.2	0.2	0.4	0.4	0.2	0.2	0.2
21	0.1	0.2	0.2	0.3	0.1	0.3	0.1	0.2
Threshold value (d) of each item	0.101	0.146	0.153	0.174	0.200	0.189	0.153	0.147
Percentage for each item $d \leq 0.2$	90%	100%	86%	76%	81%	85.7%	100%	100%
Defuzzification (Average Response)	0.91	0.86	0.82	0.79	0.76	0.77	0.76	0.81
Defuzzification (Fuzzy Evaluation)	19.10	18.00	17.20	16.60	15.90	16.10	16.00	17.10
Ranking of elements	1	3	6	12	16	14	15	8

Table 3 *(continue)*

Experts	Element of Technical Skill							
	9	10	11	12	17	18	19	20
1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1
2	0.1	0.2	0.2	0.2	0.1	0.0	0.1	0.1
3	0.1	0.2	0.2	0.1	0.1	0.0	0.1	0.1
4	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
5	0.2	0.5	0.1	0.1	0.1	0.1	0.2	0.1
6	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1
7	0.1	0.4	0.2	0.1	0.1	0.0	0.2	0.3
8	0.1	0.1	0.1	0.1	0.2	0.0	0.1	0.3
9	0.1	0.1	0.2	0.1	0.1	0.0	0.2	0.1
10	0.3	0.2	0.2	0.1	0.2	0.3	0.2	0.4
11	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.3
12	0.1	0.1	0.2	0.1	0.1	0.0	0.2	0.1
13	0.1	0.2	0.2	0.1	0.2	0.0	0.2	0.1
14	0.1	0.2	0.2	0.1	0.2	0.0	0.1	0.1
15	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.3
16	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1
17	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.3
18	0.2	0.4	0.2	0.1	0.2	0.1	0.2	0.3
19	0.4	0.2	0.2	0.1	0.8	0.3	0.8	0.7
20	0.1	0.2	0.1	0.1	0.1	0.0	0.1	0.3
21	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.3
Threshold value (d) of each item	0.141	0.203	0.153	0.139	0.157	0.096	0.178	0.203
Percentage for each item $d \leq 0.2$	90%	86%	100%	100%	95%	90%	95%	82%
Defuzzification (Average Response)	0.77	0.86	0.82	0.80	0.81	0.89	0.84	0.79
Defuzzification (Fuzzy Evaluation)	16.20	18.00	17.20	16.70	17.10	18.80	17.60	16.60
Ranking of elements	13	4	7	10	9	2	5	11

CONCLUSION

The findings clearly indicate that there are 16 elements of technical skills that are needed by electrical engineering students based on the consensus of expert opinion. Motivation is the basic element and the first choice of the experts. This study has enabled the identification of the elements of the technical skills of students of electrical engineering. This information will help lecturers prepare activities or programmes that are suitable for students to master

technical skills effectively and efficiently with an eye towards meeting the needs of industry. This study also provides a clear picture for institutions of higher learning that are required to prepare technical or psychomotor domains for teaching and learning tasks that are specific to the demands of the electrical engineering industry.

Information and feedback from industry can help in the preparation of a model or framework of elements of technical skills for students in the form of supporting documents such as handbooks to be used as reference. This will facilitate learning and teaching greatly. Feedback from the ministry on the measures and the elements that need improvement will also help to produce electrical engineering students who are ready to take their place in industry, thus reducing the unemployment rate among graduates.

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