Importance and Performance of Engineering Graduates' Competences: An Electronics Industry Perspective

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ABSTRACT

Every type of workplace relies on the skills and qualities of its workforce to expand and make progress in the marketplace. This study focuses on the engineering competences required in the electronics industry in Taiwan. The data was evaluated with paired-sample t-test and importance-performance analysis (IPA), and the results of the study will impact on curriculum content, since the study has isolated what competences the electronics industry expects from its workers. Engineering graduates will thus be provided with an education closely tailored to the jobs, which they will be taking up in the electronics industry.

Keywords: engineering education; importance–performance analysis; competences; electronics industry

INTRODUCTION

The electronics industry is crucial to the Taiwanese economy and has been expanding rapidly over the last 40 years. Back in the 1960s, domestic electronics manufacturing consisted of assembling transistor radios and tape recorders, as well as some packaging of transistors. In the 1970s, the industry advanced to start manufacturing electronic watches, CRTs, IC pilot production of ICs, along with VCR magnetic drum development. Ten years later, the country had risen to the fifth largest supplier in the worldwide PC market, and electronics became its leading export. In the 1990s, Taiwan had moved into manufacturing microelectronics and was the world's leading supplier of mice, motherboards, monitors and scanners. Nowadays, Taiwan is expanding into optoelectronics, semiconductors, displays and packaging markets.

However, it has not been a smooth journey; globalization and the consequent competition from other countries' electronics industries have proved testing and challenging. As a result, Taiwanese employers are keen to recruit outstanding engineers to maintain their place among competitors. The development of an industry-oriented engineering curriculum will ensure that graduates are equipped with the skills and knowledge conducive to their career performance. Zaharim et al (2009) and Gokuladas (2010) argued that the engineering education currently being offered is not meeting these criteria; that is, employers' demand for skilled workers is not being reached. As a result, graduates are not employment-ready when they complete their education.

The importance-performance analysis developed by Martilla and James (1977) provides

management with a useful focus on developing marketing strategies, of which the basic concept is to examine the importance and performance of an attribute. Ma et al (2011), Tzeng and Chang (2011), Joung et al (2014) indicated that IPA was frequently used to evaluate customer satisfaction and service quality. Some studies have examined how it has been applied to educational researches (Hamid, et al., 2014; Wang, et al., 2009). However, such studies scarcely explored whether or not engineering graduates have been fully acquainted and equipped with adequate competences to meet the requirements of the electronics industry. Accordingly, very little information is currently available discussing the academic proficiencies that electronics employers demand of their employees.

Among the questions this study targets to answer are the following:

1. What do employers think of the competences of engineering graduates?
2. Are these competences all important?
3. Are these competences being carried out to a high standard?

Thus, the study will focus on managers' views on the skills and attributes requisite to the electronics industry in Taiwan, and clarify whether or not a disparity exists between importance and performance in graduates' competences. The results of the study should benefit both the education authorities in Taiwan, and HR personnel in the field of electronics.

LITERATURE REVIEW

Competences

A number of researchers have defined competences as the attributes, knowledge and skills needed to find and hold on to employment (Coll et al., 2002; Parry, 1996; So, 2006). Obviously, it is employers who determine whether or not a candidate has the competences they need, so that an understanding of what competence is highly valued by employers is of great necessity **(**Garcia-Aracil & Van der Velden, 2008; Ho, 2015; Hodges & Burchel, 2003).

Coll et al (2002) identified 24 competences which impact positively on career. These were:

1. Hard skills: computer literacy, concept thinking, technical expertise, analytical think, planning and organizational skills, written communication.
2. Soft skills: team work and co-operation, flexibility, relationship building, quality and accuracy, influence on others, directiveness, team leadership, self control, organizational commitment, willing to learn, interpersonal understanding, self confidence, information seeking, achievement orientation, organizational awareness.

They noted that employers rated both "hard" skills and "soft" skills as important.

Garcia-Aracil and Van der Velden (2008) looked at the link between competences and the needs of a specific job. They categorized these competences into six types:

1. Organizational competences: working under pressure, accuracy, time management, working independently, concentration.
2. Specialized competences: field-specific theoretical knowledge, field-specific knowledge of methods.
3. Methodological competences: foreign language proficiency, computer skills, understanding organizational system, documenting ideas and information, problem-solving ability, analytical skills, learning abilities.
4. Generic competences: broad general knowledge, cross-disciplinary thinking, critical thinking, oral communication skills, written communication skills.
5. Participative competences: planning and coordinating, economic reasoning, negotiation talents, assertiveness and persistence, leadership, taking responsibilities.
6. Socio-emotional competences: reflective thinking, team work, initiative, adaptability, personal involvement, loyalty, tolerance.

According to the authors mentioned above, it was crucial that an individual's competences should match the features and qualities demanded by the job.

Ho (2015) listed the thirteen competences he believed employees should possess and subdivided them into three dimensions.

1. The organizational dimension: language and documents, leadership, creativity and innovation, interpersonal interactions, information and computer, team worker.
2. The field-specific dimension: field-specific operational skills, field-specific knowledge, and field-specific experiences.
3. The individual dimension: ambitious, discipline, persistence, and ethics.

Interestingly, Ho found that, across the competences, students rated themselves far more highly than employers did.

Having assessed and reflected on the literature, we sorted out all the competences considered to date and chose 14, which we then split into three categories.

1. Knowledge category: job knowledge, industry knowledge, job experience.
2. Skill category: creativity and innovation, language and communication, global perspective, computer literacy, planning and problem-solving¸ adaptability.
3. Attitude category: ambition and initiative, discipline and good manners, persistence and diligence, team work, loyalty and ethics.

Importance-Performance Analysis

As we have already noted, Martilla and James (1977) described IPA as a tool for assessing service quality. IPA enables businesses and organizations to pinpoint the attributes which need to be developed and improved, and what should be done to close the gulf between importance and performance. For our purposes, IPA can be applied to evaluating graduates' competences, and the results can be fed back to the educational institutions that train them.

IPA starts with listing the attributes which are going to be evaluated. Next, the attributes are rated according to their importance to customers and how competently they are carried out by the organization. Thirdly, the data coordinates are inserted into a four-quadrant graph, according to their rankings on importance and performance (Hendricks et al., 2004). An example of an IPA-informed quadrant can be seen in Figure 1.

Enright and Newton (2004) highlighted that each quadrant corresponded to a separate management strategy. Attributes that appear in Quadrant I are already good and should continue. Those appearing in Quadrant II are considered to be good performers, but they are ranked as being of lesser importance. It may be wise to reallocating these resources to other areas. Attributes in Quadrant III are low performing and considered to be less important, and thus will require the least amount of managerial response. In comparison, attributes appearing in Quadrant IV are major weaknesses and in need of improvement.

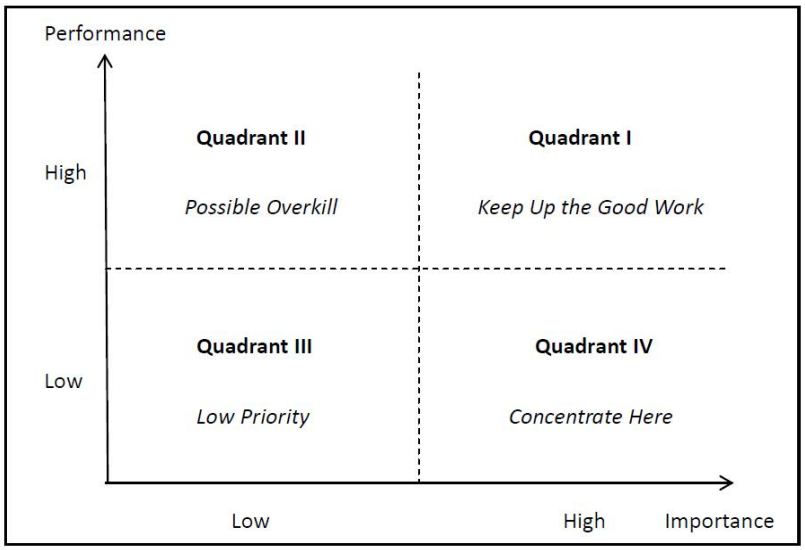

Figure 1. IPA Model

METHOD

Instrument

The first, and important, stage of the IPA analysis is drawing up a list of attributes, and the 14 we chose were gleaned from a review of research writings in the field. This study employed a questionnaire, which was subdivided into three sections and handed out to respondents to fill in themselves. Section one focused on demographics. Section two was made up of 14 questions, and a five-point Likert scale was used to isolate the competences that are crucial to the electronics industry. Competences were rated from 1, very unimportant, to 5, very important. Section three examined engineering graduates' competence as perceived by employers; it included the same 14 questions, and a five-point Likert scale was used for performance evaluation, 1 stands for very unsatisfied and 5 stands for very satisfied.

Sampling

A convenience sample of 300 companies was selected from the members of Taiwan Electronic Manufacturers' Association. A questionnaire, along with information on the relevance and importance of the study being undertaken, was sent to the engineering managers of the chosen company. The covering letter stressed the anonymity afforded participants of the study, and stamped self-addressed envelopes were enclosed to return the questionnaires. The response rate, after three weeks, was 40.32 per cent, or 121 returned questionnaires.

Data Analysis

Nunnally and Bernstein (1994) had set a minimum Cronbach's alpha of 0.70 to ensure the reliability in data analysis. Our testing of both importance and performance ratings exceeded this figure, with readings of 0.954 and 0.958 respectively. This proves the reliability of the scale we used. The questionnaire data was assessed with paired-sample t-test to identify if there is a significant difference between graduates' competences, in terms of importance and performance. Once this was done, IPA was used to isolate the competences which required to be improved and honed.

RESULT

The Perceived Importance and Performance of Graduates' Competences

Table 1 contains the mean scores and standard deviations (SD) of the importance and performance of graduates' competences, as assessed by employers. The mean scores varied from 3.71 to 4.21 for importance, and 3.27 to 3.69 for performance. The top three competences according to perceived importance were "adaptability" "loyalty and ethics," and "ambition and initiative." The top three

competences according to perceived performance were “adaptability” “discipline and good manners,” and “job knowledge.”

Using a paired-sample t-test, we set out to discover if there is a significant difference between the importance and the performance of each competence, perceived by employers. Table 1 confirms that this is, in fact, the case. Perceived performance was much lower than perceived importance in every one of the 14 competences. In short, engineering graduates failed to perform as well as expected.

Table 1. Importance and Performance of Engineering Graduates’ Competences.

Category	Attributes	Importance		Performance		Gap(P-I)	t-value
		Mean	(SD)	Mean	(SD)		
Knowledge	1. job knowledge	4.08	(0.62)	3.64	(0.60)	-0.45	-8.210***
	2. industry knowledge	4.09	(0.63)	3.56	(0.56)	-0.53	-8.912***
	3. job experience	3.90	(0.61)	3.50	(0.54)	-0.41	-7.069***
Skill	4. creativity and innovation	3.71	(0.73)	3.42	(0.53)	-0.29	-4.486***
	5. language and communication	3.98	(0.59)	3.56	(0.59)	-0.43	-7.099***
	6. global perspective	3.72	(0.63)	3.27	(0.61)	-0.45	-9.103***
	7. computer literary	3.75	(0.65)	3.63	(0.57)	-0.12	-1.971*
	8. planning and problem-solving	4.05	(0.56)	3.50	(0.70)	-0.55	-8.630***
	9. adaptability	4.21	(0.60)	3.69	(0.59)	-0.53	-8.020***
Attitude	10. ambition and initiative	4.19	(0.65)	3.60	(0.66)	-0.59	-8.119***
	11. discipline and good manners	4.17	(0.69)	3.65	(0.60)	-0.51	-7.765***
	12. persistence and diligence	4.15	(0.65)	3.50	(0.65)	-0.65	-8.811***
	13. team work	4.17	(0.69)	3.59	(0.65)	-0.59	-8.228***
	14. loyalty and ethics	4.20	(0.73)	3.60	(0.67)	-0.60	-7.816***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

IPA

The IPA figure is illustrated in Figure 2. It was drawn up by using two scales at the central point: the grand importance and performance scales. The next step was to plot the mean scores for each graduate’s competence in terms of importance and performance and add them to the IPA figure.

The “keep up the good work” quadrant contains seven competences, all of which need to be continued and maintained, since they are highly appreciated by employers both in importance and performance. These included: (1) job knowledge, (2) industry knowledge, (9) adaptability, (10) ambition and initiative, (11) discipline and good manners, (13) team work, and (14) loyalty and ethics.

The “possible overkill” quadrant contains two competences, which are rated low in importance but high in performance. Universities might consider how they can modify curriculums to enrich students with more employable prospects. The competences in this category were: (5) language and communication and (7) computer literacy.

Three competences fell into the “low priority” quadrant. Universities could reflect on this finding and not be attentive to the competences which are viewed as of low importance and performance. The competences in this category were: (3) job experience, (4) creativity and innovation, and (6) global perspective.

The last quadrant, “concentrate here”, contains the competences which employers want and value, but which they failed to see in the graduates who are working for them. Overall performance in this area thus has to be improved and measures have to be put in place to deal with this failure. The competences in this category were: (8) planning and problem-solving, and (12) persistence and diligence.

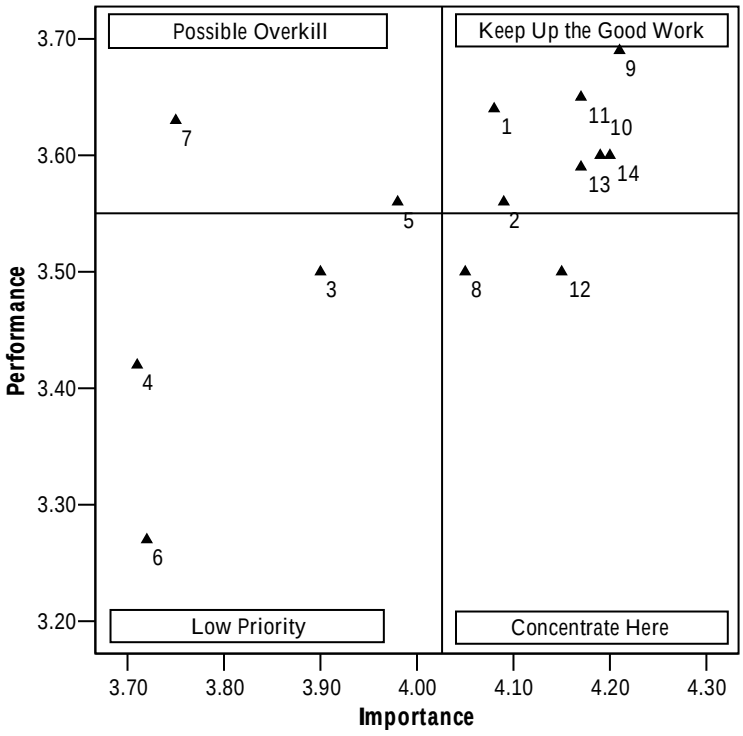

Figure 2. Result of IPA Model

DISCUSSION

This study provides a delicate exploration of what competences are needed in the Taiwanese electronics industry, of which the findings are intended to facilitate the curriculum teams drawing

up university engineering courses. Employers were required to evaluate the importance and the performance of graduates' competences, and the results indicated that perceived performance was much lower than perceived importance in each of the 14 competences; that is, engineering graduates failed to perform as well as expected.

Our sample of the electronics professionals did expect the graduates to enter the workforce with positive personality and working attitude, and singled out the attributes of their great concern, such as "ambition and initiative", "discipline and good manners" and "loyalty and ethics" to illustrate what mean a great deal to them. Noteworthy is that they did not believe that attributes as "global perspective" and "computer literacy" were essential to the profession success. Instead, they ranked how-to-do practical skills, such as "adaptability" higher than how-to-create talents, such as "creativity and innovation".

In addition, "planning and problem solving" and "persistence and diligence" were singled out as areas, which universities must take an immediate attention and action to improve while they are revising the engineering curriculums. It is desirable that the cultivation of planning and problem-solving qualities be integrated into engineering courses, either directly or as part of a suite of supplementary programs; besides, engineering majors can be arranged to work in small groups of three to four persons to work on a project challenging enough to cultivate the attributes of persistence and diligence through peer competition and cooperation.

To summarize, the results of this research can be used by universities to ensure that their students have been acquainted with academic competences and skills definitely relevant to what electronic employers require of. By creating a working partnership between the electronics industry and universities, both parties will benefit. Universities, accordingly, can provide knowledge and skills which are requisites for entry into electronic professions; certainly the electronics industry will see an intake of professional employees to join them for their growth and prosperity.

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