THE RELATIONSHIP BETWEEN HIGHER EDUCATION AND EMPLOYMENT: ACQUIRED AND REQUIRED COMPETENCIES AMONG ELECTRONIC ENGINEERS IN THE ELECTRONIC INDUSTRY

by

SIM HOCK KEAT

Thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

November 2009

ACKNOWLEDGEMENTS

The completion of this thesis depended on the supports, assistance and cooperation from many parties. I wish to express my gratitude towards them especially my supervisor Dr. Abdul Ghani Kanesan Abdullah from the School of Educational Studies, University Science of Malaysia. His advices and guidance were invaluable. I wish to thank the Ministry of education for providing me the scholarship and opportunity to conduct and complete the study.

I wish to thank the managers of the electronic firms who allowed me to conduct the study especially to Sony, Venture, AMD and Sci-Sanmina. To the engineers who willingly gave their time and cooperation for this study, I wish to express my sincere thanks. In addition, I like to thank the lecturers of University Sains Malaysia for their constructing ideas and comments in the completion of this study particularly Prof. Dr. Molly N. N. Lee, Prof. Madya Dr. Loo Seng Piew, and Dr. Halim Ahmad.

Finally, I wish to deliver my greatest appreciation to my wife Low Ka Hong who had supported me throughout the study.

TABLE OF CONTENTS

CONTENTS

CHAPTER THREE : Research Methodology

CHAPTER FOUR: RESULTS AND ANALYSIS

CHAPTER FIVE : Summary and Conclusion

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

AC	Acquired Competencies
AGCAS	Association of Graduate Careers Advisory Services, UK
CPK	Process Capability index ('equivalent') taking account of off-centeredness
E&E	Electronic and electrical
EMS	Electronic Manufacturing Services
FMEA	Failure Modes and Effects Analysis
FDI	Foreign direct investments
FTZ	Free Trade Zone
GDP	Gross Domestic Produce
ICT	Information and communications technology
IPI	(Industrial Production Index)
IMP2	Industrial Malaysia Plan Two
MNC	Multinational Companies
MIDA	Malaysian Industrial Development Authority
NCC	National Curriculum Council
NTMP	National Technology Mapping Programme
NVTC	National Vocational Training Council
NOSS	National Occupation Skills Standards
OEM	original equipment manufacturer
PDC	Penang Development Corporation
RC	Required Competencies
S&T	Science and Technology
SK	Subject Knowledge
ST	Technological Skills & Knowledge
R&D	Research and Development
SME	Small- and medium-scale Enterprises
TEVT	technical education and vocational training
UNCTAD	United Nations Conference on Trade and Development
UNi-TER	University Tertiary Education Groups (Background Education)

HUBUNGAN ANTARA PENDIDIIKAN TINGGI DAN PEKERJAAN : KOMPETENSI YANG DIPEROLEH DAN KOMPETENSI YANG DIPERLUKAN OLEH JURUTERA-JURUTERA ELEKTRONIK DALAM INDUSTRI ELEKTRONIK

Abstrak

Hubungan antara pendidikan tinggi dan pekerjaan adalah isu yang mendapat perhatian pihak pendidikan tinggi, perancang-perancang polisi pendidikan kebangsaan, pengusaha-pengusaha industri dan bakal-bakal graduan. Dalam kajian ini, hubungan antara pendidikan dan pekerjaan diselidiki daripada aspek ketidaksepadanan antara kompetensi yang diperoleh dan kompetensi yang diperlukan oleh jurutera-jurutera elektronik dalam industri elektronik. Kompetensi-kompetensi ini dikaji dari segi kompetensi generik dan kompetensi khusus. Kedua-dua kaedah kualitatif dan kuantitatif digunakan untuk memperoleh data dalam kajian ini.

Tujuhbelas temu bual (kajian kualitatif) dilakukan dengan wakil-wakil majikan industri elektronik di kawasan PDC (Penang Development Corporation Industrial Area), Malaysia. Sampel-sampel kajian terdiri daripada pengurus-pengurus bahagian latihan, pengurus–pengurus bahagian pengeluaran, pengujian dan lain-lain. Dapatan kualitatif menunjukkan bahawa wujudnya ketidaksepadanan antara kompetensi-kompetensi yang diperoleh (AC) jurutera–jurutera melalui pendidikan tinggi dan kompetensi–kompetensi yang diperlukan (RC) oleh industri elektronik. Selain itu, aspek-aspek ketidaksepadanan dalam kemahiran-kemahiran dan pengetahuan generik serta khusus turut dianalisis melalui kaedah kualitatif. Perbandingan dapatan–dapatan kualitatif berkaitan dengan spesifikasi tugas–tugas jurutera telah digunakan untuk menyediakan instrumen kajian kuantitatif (soal selidik) seterusnya.

Dua set soal selidik telah ditadbir kepada 72 orang jurutera–jurutera elektronik dan 20 orang pengurus-pengurus daripada kawasan industri PDC. Skala titik sepuluhan

digunakan dalam instrumen–instrumen supaya magnitud ketidaksepadanan boleh dinilai oleh respondan dan dikira. Analisis faktor menunjukkan kompetensi (kemahiran) generik boleh ditumpukan kepada 6 kategori (*Kaiser-Meyer-Olkin Measure of Sampling Adequacy* bersamaan dengan 0.866). Bagi kompetensi khusus pula, 6 kategori kompetensi khusus dikenal pasti (nilai KMO =0.893).

Analisis kualitatif menunjukkan bahawa wujudnya kemuafakatan antara pengurus-pengurus (majikan) tentang ketidaksepadanan kompetensi. Jurang kompetensi ini disokong oleh dapatan-dapatan daripada analisis kuantitatif seterusnya. Ujian T sampel berpasangan antara kompetensi yang diperoleh (AC) dan kompetensi yang diperlukan (RC) menunjukkan perbezaan ketara. Magnitud ketidaksepadanan kompetensi (jurang kompetensi) dalam tertib menaik bagi 6 kompetensi generik ialah kemahiran ICT, kualiti personal, kemahiran berfikir, kemahiran interpersonal, kemahiran mengurus, dan kemahiran komunikasi. Bagi kemahiran khusus pula, magnitud ketidaksepadanan kompetensi menaik dalam tertib berikut : 'Penggunaan alat perisian secara praktikal', 'Membina litar elektronik', ' Operasi dan membetulkan ralat system dan peralatan', 'Proses, kawalan dan pemasangan', serta 'Kualiti dan menguji kebolehpercayaan'. Ketidaksepadanan keseluruhan bagi kompetensi generik (skor purata = 2.17 dalam skala titik sepuluhan) adalah lebih besar daripada kompetensi khusus (skor purata = 1.73 dalam skala titik sepuluhan).

Jelasnya hubungkait antara AC –RC bagi kompetensi khusus (korelasi Pearson r = 0.491) adalah lebih besar daripada kompetensi generik (korelasi Pearson r = 0.349). Melalui pengubasuaian Teori Pembekalan dan Permintaan pasaran, hubungan antara Pendidikan Tinggi dan Pekerjaan dapat dilihat melalui hubungkait dan interaksi AC-RC kompetensi generik dan kompetensi khusus.

THE RELATIONSHIP BETWEEN HIGHER EDUCATION AND EMPLOYMENT: ACQUIRED AND REQUIRED COMPETENCIES AMONG ELECTRONIC ENGINEERS IN THE ELECTRONIC INDUSTRY

Abstract

The relationship between tertiary education and employment is an issue that concerns education providers, national education policy makers, industry operators and the undergraduates and their families. In this study, the education and employment relationship is studied from the aspect of the mismatch of acquired (AC) and required (RC) competencies of the electronic engineers in the electronic industry. The competencies were studied from the generic and subject specific aspects. Both qualitative and quantitative methodologies were used in this study.

Seventeen qualitative interviews with the representatives of electronic industry employers in PDC (Penang Development Corporation Industrial Area), Malaysia. The research samples comprised of the training managers, human resource managers, production managers and test managers. The results of the qualitative analysis revealed the existence of competencies mismatch between the engineers' acquired competencies (AC) through the tertiary education and the required competencies (RC) demanded by the electronic industry. The qualitative analyses also explored into the areas of competencies mismatch in terms of generic and subject specific (hard skills) skills and knowledge. Triangulations of the results of the qualitative analyses with the job specifications enabled the development of the quantitative instruments (questionnaires).

Two sets of questionnaires were administered to 72 engineers and 20 managers respectively from the PDC industrial parks. Ten point scales were used in these instruments so that observable magnitude of the mismatch can be computed. Factor analysis revealed that the generic skills were converged into 6 categories with Kaiser-

Meyer-Olkin Measure of Sampling Adequacy with KMO rating of 0866. Six subject specific (hard) skills were identified and constructed (KMO rating = 0.893).

Qualitative analysis showed that there was a common agreement among the managers (employers) on the existence of AC–RC competencies mismatch. This was further supported by the results of quantitative analysis. Paired sample t – test between the Acquired and Required competencies of the both soft and hard skills were significantly different. The magnitudes of competencies mismatch in the ascending order for the soft skills are ICT skills, Personal Qualities, Thinking skills, Interpersonal skills, Management skills, and Communication skills. In the hard skills categories, magnitudes of the mismatch ascending in the order of 'Practical usage of the software tools', 'Circuits Construction', 'Operate, troubleshoots systems and equipments', 'Process, Control and Installation', 'Quality and reliability testing'. The overall mismatch of the soft skills (mean score = 2.17 on a ten point scale) was significantly larger than the hard skills (mean score = 1.73 on a ten point scale).

The association of the AC-RC for the hard skills (Pearson correlation r = 0.491) was stronger than the soft skills (Pearson correlation r = 0.349). Adopted from the Theory of Supply and Demand, the relationship of the Tertiary Education and Employment can be observed through the association and the interaction of AC-RC generic and subject-specific competencies.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

A well-trained human resource through the tertiary education is the key to the economic growth and development of a nation. The nation is concerned on how ready a graduate employed into the organizations is. This is important not only to satisfy individual's interest from the perspective of educational return, but also to achieve the national economic growth. The common immediate focus of the graduates after completing their tertiary education is to secure a job - an employment. The next question is how well these outputs of the tertiary education can be efficiently become the inputs to the job environments. This study investigates the extent of the graduates' skills, knowledge, and attitudes in answering part, if not all the needs of their employers. In other words, it gives some insight of how close the graduates' acquired competencies have met the demands of employers. However, tertiary education is a vast combination of the various fields of studies from science, arts, education, engineering, law to management. Employments for the graduates are also in large number. It is not the intention of this study to map out the relationships of each individual fields of study to the corresponding employments. This study focuses on electronic engineering; a field of study in applied sciences.

Electronic Engineering is applied science (Goel, 2006) that involves technical knowledge. An electronic engineer's task involves conceiving and designing products, processes, and systems, and to predict the product's behavior using scientific knowledge. The nature of the engineering profession revolves around the practice of engineering science and technology. It is firmly rooted in fundamental science. Therefore, engineers must demonstrate good scientific knowledge (Johari, Abdullah, Osman, Sapuan, Mariun, Jaafar, Ghazali, Omar, & Rosnah, 2002). Electronic engineering also adopts the scientific ways of reasoning and thinking. As a discipline of applied science, engineering education enriches scientific knowledge, instills scientific investigation, develops technologies, and fulfils personal needs and career needs.

Regarding the fulfillment of personal and career needs, Josh Douglas, Eric Iversen, and Chitra Kalyandurg (2004) proposed that the values of engineering education can be further enhanced through the ability to create wealth, self-sufficiency and successful engineering entrepreneurship. Engineering lies at the interface between science on one hand and society on the other. It is concerned with the systematic application of scientific and mathematical principles towards practical ends for the benefit of people (Grimson, 2002). Traditionally the emphasis in engineering education has been on the scientific side, with students given a thorough grounding in the basic scientific and mathematical principles underpinning their discipline. However, the constraints on engineering problem solving today are increasingly not technical, but rather lie on the societal and human side of engineering practice. Therefore, the development of generic skills, such as those related to self-directed knowledge acquisition is becoming so vital that the engineers will be able to cope with the rapidly expanding amount of new knowledge in the world.

On the other hand, the fundamental approach of electronic engineering education is in line with the approaches employed in science education. The primary approach used by science education is to bring about the fundamental understanding of natural phenomena and systems. It serves to pass down and enrich the cumulative scientific knowledge and technological know how from generation to generation. Like science education, scientific facts, concepts and principles are the important ingredients in engineering education. As electronic engineering is closely linked to applied science, many of the skills, knowledge and attitudes are introduced as early as secondary science education in schools. In Malaysia, electronics and related topics are being taught in the form 5 (Curriculum Development Center, 2006) and form 6 Physics syllabi (Majlis Peperiksaan Malaysia, 2009). The early introduction of electronic topics in upper secondary school science education gives the students a glimpse into the field of electronic engineering.

Manipulative skills and scientific knowledge are learned through the formal science education syllabus. Desired scientific values and science attitudes are being stressed and cultivated. PEKA (Penilaian Kerja Amali) or practical assessment for Form 4 and 5 science students in Malaysia for instance, was introduced in 1998 with the intention of instilling scientific skills and attitudes in the science students. It stresses on the continuous and formative assessment on three main aspects, which are scientific manipulative skills, scientific process skills, and scientific attitudes and values.

Informal school activities are encouraged to enrich the scientific knowledge of the masses. Through these activities, scientific skills such as observation, reasoning and problem solving can be incorporated into individual everyday life. These scientific abilities are seen as important and required competencies for the electronic engineers in their career routines. The improvements of such skills can be used in day- to- day activities such as examining the data and information gathered, thus making fruitful inferences. This helps to extend the abilities and the confidence of oneself in applying scientific innovations to engineering career later.

Scientific knowledge and its application are dynamic, and constantly changing. Its fast changing nature requires life-long learning, an important component of knowledge acquisition. These abilities will act as a base for higher levels of scientific knowledge and scientific skills to be readily learned and absorbed. The scientific knowledge and skills learned will be a great help to the engineers in their career paths. These scientific skills, knowledge constitutes the major components of engineers' scientific competencies. Scientific competencies facilitate technological transfer; it will encourage investments, thus creating job opportunities and economic growth for our country.

Along the road of industrialization, greater demand for higher-level scientific competencies became a must. Modernization is taking place in most of the developing countries. Advancements in electrical and electronics industries, transport industries, aerospace, pharmaceuticals, metal and advanced material industries such as polymers, metals, composites, machinery and equipment industry are demanding higher quality and quantity scientific manpower. Scientific competencies of the workforce have to be extended to a higher level in to extract the benefits from the new scientific and technological changes. In a developing country like Malaysia, productivity and competitive enhancement become the key factors to sustain its economic growth. Global orientation leads the development strategies of a developing country. As a fast developing country, under the Second Industrial Master Plan (1996-2005), Malaysia emphasizes on the re-orientation from being a purely export-driven economy to one based on global orientation. It necessitates certain sectors such as the manufacturing sector, for instance, to focus on the changing global market trends by becoming world scale and world-class manufacturers. The industrialization process, which is substantiated by the manufacturing sector, has to develop global marketing capabilities, to compete internationally and not to rely entirely on cost advantages such as taxation incentives.

The industrial changes are necessary for the continual economic growth of Malaysia. The changes involve the development of institutional, social and psychological settings so that the society is able to react positively to the potential spreading effects of modern industrial activities. In this respect, differentiation and specialization of the fields of engineering education become a priority. For Malaysia, engineering education needs to broaden its scopes; to cater for various demands of manpower in various sectors. Engineering education needs to be specialized, to provide enough qualified research and development personnel in various sectors. In other words, engineering education needs to produce enough personnel who are able to bring about added values into the output of industries. Value-added means the value that an industry adds to its inputs by using manpower, materials and capital.

Hence, engineering education in Malaysia has a transforming role to play for the production of scientific and technological human resources to answer the demands of the rapidly expanding economy. In view of the urgency for the smooth transformation, the Ministry of Education of Malaysia formulated the 60 : 40 policy in 2001 under the 8th Malaysia Plan (2001-2005). This policy aims to increase the intake ratio of upper secondary science to arts students to 60 versus 40 percents respectively. More students are encouraged to enroll themselves into the science stream after the PMR level. This approach is to ensure sufficient scientific manpower to take Malaysia to a higher level of economic growth. Increasing the intake of students in tertiary engineering education is necessary. Eventually, the increased supply of scientific manpower will meet the industrial manpower demand, in both quality and quantity. Therefore, the emphasis is to provide enough engineering manpower supply to meet the demands of the industries.

The improvement of the quality of manpower (human capital) has became a very important component of capital accumulation. In conjunction with this, the certifying role of universities no longer guarantees a person of his fitness in the labor market with the same skill for the next 30 years. Tertiary education has to be sensitive to the dynamic changes in the workplace. Continuous life-long learning and the concept of recurrent training goes in line with the economic sustainability (Riquarts, 2000). People start to question the issues of knowledge and skills transferability: to what extent can the competencies acquired during the undergraduates' courses be transferred into productive knowledge and skills in the workplace after graduation?

Are we producing the graduates that meet most of the needs of the employers? Therefore, we need to re-examine the relationship of the world of work and academic preparation. It is difficult to establish a definite relationship between the world of tertiary education and the world of work. Traditionally, the universities serve as ideal places for the pursuit of knowledge and universities eventually become the source of productive workforce for society. However, in the preparation of professionals for the industries, tertiary engineering education needs to consider the dynamic changes and demands of the workplace. In this aspect, tertiary engineering education has to be sensitive to the discrepancies between what the student has learnt and what is needed in the workplace.

Knowledge is not only viewed as the result of 'curiosity' but as something that involves 'use value' and 'application'. Utility of knowledge or working knowledge is becoming more important in this context. Thus, knowledge and skills have their economic significances that involve production and consumption. Through the manpower requirement approach, we have seen a supply–demand relationship established between tertiary engineering education (knowledge production) and the industrial sectors (consumer). Immediate concerns after the completion of first-degree courses generally come from two perspectives: individual interest and national interest. The individual is more concerned with securing employment with immediate returns to their education investment. From the perspective of national interest, the government is keen to see a balance between the supply of manpower and the demand of employment sectors. However, problems of unemployability often occur after graduation. There are about 40,000 Malaysian graduates without jobs after their graduation and the number is increasing (Economic Planning Unit, 2002). In February 2005, for example, Ministry of Human Resource revealed that there were about 80,000 Malaysian graduates without jobs after their graduation with the number increasing. This could be due to a few possible reasons. First, the economy downturn leaves the industrial sectors with fewer job offerings and fewer new recruits intake. Downsizing of the industrial workforce freezes new recruitments in certain sectors. Consequently, more graduates became unemployed. Secondly, the emergence of rapidly growing economies like China has diverted much Foreign Direct Investment to such countries. Cheaper labour cost and attractive incentives have drawn away many new investments to these new economies. There seems to be more graduates but less job opportunities. As more and more people pursue higher education, the problem of graduate unemployment escalates. Thirdly, the output number of graduates specialized in a particular field each year may not correspond to the number of the employment opportunities in the particular field. The issue of over supply arises. Lastly, even if the number of graduates specialized in the certain field meets the number of employment opportunities; the competencies level acquired by the graduates may not meet the requirements of the employers. This situation results in two possible consequences. The employer may not be convinced by the acquired competencies of the applicant during the interview. Such a mismatch results in unsuccessful employment. The application for the position will then be rejected. A local university research team from University Sains Malaysia in its study of the university curriculum (Report on

University Curriculum: National Higher Education Research Institute USM, 2005) investigated and looked into the problems of graduates' unemployment. The team surveyed employers, undergraduates, graduates and university administrators. The report reveals that graduates today lack personal qualities and communication skills and are not able to market themselves. This offers some explanations between the mismatch of tertiary education and employment.

Another possible consequence will be the situation in which the graduates may be employed because they show high potential to develop the required competencies after recruitment. Problems may occur when the recruits are placed in their respective tasks and workplaces. If such situation arises, the recruits need more time to learn new skills in order to be independent workers and to maximize their productivity. The employer may have to provide extra allocation for On-the-Job training and Off-the-Job training. Inevitably, this may slow down the process of getting an efficient production unit. It would be unfavorable to the employer if excessive training and retraining were needed, as this will add to the production cost.

To recognize the required competency in the workplace, it is good to understand the meaning of competency. Competencies (Spencer, 1993) are defined as the ability to accomplish tasks. Woodruffe (1991) asserts that competency refers to the sets of behaviors that enable the performance of tasks. In this study, competencies are divided into generic and subject specific competencies. Generic competencies are the skills and knowledge commonly possessed by the public. These competencies are not occupationally specified and considered applicable in more than one context. The Accreditation Board for Engineering and Technology (ABET) which is monitoring the engineering programs in the United States defines the competencies that an engineering graduate should posses include certain generic skills. These generic skills are referring to the abilities (Anon, 2000) to function in multidisciplinary teams, to communicate effectively, to understand the impact of engineering solutions in a global and social context, and ethical responsibility. In this study, the main categorizations of such generic skills are personal qualities, critical thinking skills, interpersonal skills, communication skills, ICT skills and management skills. Most of these skills operate in the cognitive and affective domains.

Subject specific competencies are acquired through the curricula, which are exclusive to a particular discipline only. These discrete components of the knowledge and skills are discipline-specific. These knowledge and skills are academically relevant and form the basis for professional preparation. In other words, these knowledge and skills are not learnt through other courses but only acquired through a particular program. Skills and knowledge required in electronic engineering are highly discipline-specific. AGCAS regards electronics as the technology concerned with the development and behavior of electronic devices (computers, mobile phones) and circuits (memory chips, microprocessors), which make use of electronic components such as transistors and capacitors. Electronics engineers are required to develop, design, assemble and test electronic systems, components and equipment, developing the way electricity is used to control equipment. The work is usually carried out in cross-functional project management teams. Electronic engineers need to work with colleagues in research, design, production, testing, marketing and after-sales. They are involved in most stages of project development. Therefore, the required competencies in electronics engineering are specific and professional knowledge is required. These competencies are subject-specific. Subject-specific skills and knowledge refer to those special abilities, which allow one to participate in an occupation more effectively than the public who do not possess such skills or knowledge. In this study, subject-specific competency is categorized into technological skills and subject knowledge

This study intends to identify the components of the required competencies of electronic engineers in the electronics industry. It will be followed by an investigation of the magnitude of any mismatch between the competencies acquired by electronics graduates and the required competencies in the electronics industry. The perspectives (self-assessments) of both the employees and employers concerning the acquired and required competencies will be further analyzed to establish the magnitude of the mismatch, if any. Both qualitative and quantitative methods are needed in this study in order to enhance the reliability and validity of the study.

1.2 The Research Problem

On a year-to-year basis, Bank Negara Malaysia (2003) reported that the net outflow in the financial account widened by 260.7% from RM2.8 billion in 2002 to RM10.1 billion. The outflow was reflected by the net outflow of direct investment of RM1.1 billion (compared to a net inflow of RM2.5 billion in 2001). The other investment, which is made up of the public sector and the private sector, showed a higher net outflow of RM4.5 billion from that of RM3.1 billion in 2002 to RM7.6 billion in 2003.

Like most South-East Asian economies, Malaysia has experienced increased competition for foreign direct investment from China. In 2001, FDI approvals declined 41% ($2.95 billion). UNCTAD (United Nations Conference on Trade and Development, 2003) reported that FDI inflow into Malaysia was a fraction of the GDP and Malaysia's share of the total FDI into East Asia has shown a pronounced downward trend. This suggests that, relative to other countries in the region, Malaysia has become a less attractive destination for FDI. Net foreign direct investment fell from around 4% of GDP in 1997 to less than 0.5% in 2001. Although there was a slight recovery in 2002 to about 1% and a projected 1.2% was expected for 2003, Malaysia was still far from pre-crisis investment levels. For the first quarter of 2003, available data show an outflow in direct investment of RM 2,130 million ($560 million), compared with an inflow of RM 2, 334 million ($614 million) in the first quarter of 2002. This continued the outflow trend recorded since the second quarter of 2002. For the first five months of 2003, foreign applications of RM 3.5 billion were roughly half of the total number of applications. The largest sector was the electrical and electronics sector in competition with China as an FDI destination. The government has committed to further strengthening FDI efforts by implementing a proactive marketing strategy for MIDA. Industry operators have asked the government for more liberal FDI equity investment conditions in the industry sectors.

Weak private investment performance may be explained by micro-level rigidities in the system. World Bank study (2003) suggested that the medium-term growth and competitiveness prospects of Malaysia might be compromised by a few factors. First, firms report that the investment climate is weakened by the presence of a significant regulatory burden (The World Bank, 2006). Secondly, firms suffer from severe skills shortage. Evidence of skills shortages is apparent in the high wage premium paid for tertiary education graduates and the sub-optimal distribution of skilled labors across firms. The stock of skills is not growing quickly enough to make investment opportunities in Malaysia sufficiently attractive. In addition, increases in the quality of the workforce and higher rates of productivity growth are required to support future growth. Thirdly, firms display adequate adoptive and adaptive technological capabilities but are weak innovators. The share of sales from new products and new processes is well below that in more technologically advanced countries. In order to achieve its vision 2020, Malaysia needs to respond appropriately to tackle these constraints.

UNCTAD (United Nations Conference on Trade and Development,2003) recognizes the importance of FDI as a very effective way of building the competitiveness of the country in the globalizing environment. Continuing promotion and encouraging FDI alone will not sustain the competitiveness of the country. As more complex processes are introduced and technologies continue to evolve, it becomes important for the country to improve domestic capabilities: skills, supplier bases, R&D capabilities and the physical (particularly the ICT) infrastructure. MNCs contribute to building capabilities, of course. They train employees and diffuse technologies to local suppliers, but there are limits to how far this can improve national capabilities. Ultimately, it is up to the government to support capability development by creating higher-level skills for the knowledge-based economy, strengthening domestic firms and creating strong technology and research institutions. If this is not done, the most complex and value-creating activities may well be relocated in other countries – this is the strategic challenge facing the new Tigers, as China appears as a giant competitor with lower wages, massive domestic markets and capable suppliers. Ultimately, FDI-dependent strategy is not a substitute for building domestic capabilities. In the strengthening of the competitiveness, enhancing of the domestic competencies has a more important role than the ready–made technology from MNCs.

UNCTAD pointed out that Malaysia suffers from a growing shortage of skills, with its human capital base being increasingly out of line with its production and export structures. The government launched several efforts to correct demand-supply shortfalls emerging in the labour market from the late 1980s. In viewing the quest for skilled personnel, a double deduction from tax was introduced in 1988 to encourage in-house training in firms. Special directives and incentives were also introduced in the mid-1990s to expand the supply of science and technology graduates. Training programs and courses for low-level technical and vocational trades to engineering degrees were expanded and increased in numbers. The Private Universities Act of 1995 helped open the way for the growth of more universities, especially in the production of engineers.

These efforts resulted in producing larger quantities of academically qualified personnel. However, from the increasing number of unemployed graduates each year, we see that more than sufficient graduates are to be fed into the job vacancies. Indeed, we are facing the problem of oversupply. Ironically, many companies are complaining about the shortage of skilled personnel. On the other hand, many trained graduates remain jobless or employed in workplaces, which are unrelated with their study. Obviously, it is not so much of the issue of mismatch of quantity of graduates to the job market but rather the qualities of the graduates that we should be worried about (National Higher Education Research Institute USM, 2005). Thus, there is a need to examine the issue of qualities of graduates, and focus on the possible mismatch of the graduates' competencies. The competency requirements for engineers have also been debated in the UK and in other parts of Europe and beyond in recent years. Programs of study (Melvyn Dodridge, 2001) have been criticized because of their theoretical nature and lack of the application of engineering principles, which has led to a mismatch between the skills obtained by graduates during their studies in higher education and those, requires by industry and commerce.

In the Malaysian context, the related issue can be examined from three aspects here. Prior to that, we need to investigate whether the similar issue occurred in Malaysia context. Firstly, are the acquired competencies of the tertiary engineering education (in this study, electronics engineering) matching the needs of the electronics industry? In other words, does the gap exist? Secondly, what are the components of generic and subject-specific knowledge and skills that will enhance the graduates' competencies during their education programs? Lastly, are the contents learnt applicable and transferable to the new context, which is the workplace? Many graduates may have acquired competencies which have little job relevancy or they may have the acquired competencies which are not readily applicable in their field of work. Mismatch occurs when the acquired competencies do not match the required competencies. However, what are the competencies considered acquired and what are considered as required? Required competencies are the abilities needed and expected by the employers at the workplace. These are the abilities needed to perform a task assigned successfully. In this context, the abilities are categorized into generic and subject-specific competencies. Given the complexity of the context, identification of required competencies for all sectors might be difficult. Therefore, electronics engineering which is seen as the application of science is selected to be the area of study. Another way of looking at the competencies' mismatch is the existence of 'a gap'. Is there a gap between the graduates' competencies acquired through tertiary engineering education and the competencies required by the employers?

Assessing and examining this possible mismatch is the focus of this study. Should the gap between the acquired and required competencies exist, it has to be addressed with great attention by the education provider. Failure to narrowing down the gap may cause the employers to pay a higher training cost for their employees.

Inevitably, this will result in an unfavorable hike of production cost thus reducing the competitiveness of the graduates.

In addition, whenever a mismatch occurs, new recruits are not ready to work independently. This will create problems at the workplaces. Task specifications may not be accomplished according to the preset standard and the unnecessary rejects of the products may occur. On-the–Job training programs may help, but this will slow down operation and production. In electronic engineering, each mistake made by the employees would mean more rejects and results in the increase of the cost of production at the expense of the quality of production. Such financial burden would be borne out by the employer eventually. It will be unfavorable for the investor if the remedies and measures to narrow the gap are not attempted. If gap keeps on widening, the electronics industry will lose its competitiveness. The problem of mismatch may exist in other industrial sectors, but the focus of this study is on electronics engineers and semiconductor industries.

1.3 Rationale of Study

As one of the newly industrialized economies of East Asia, Malaysia is on its way to becoming the fifth 'Asian Tiger' after Taiwan, Korea, Hong Kong and Singapore. Before the financial crisis that started in Asia from mid-1997, Malaysia recorded an impressive annual growth of 8 per cent for 10 consecutive years. This was accompanied by low rates of inflation, rising per capita income and the reduction in the incidence of poverty falling from 16.5 per cent to 6.1 per cent (United Nations, 2003). The main economic pillars of Malaysia are manufacturing, agriculture and tourism. Malaysia is currently among the world's leading exporters of semiconductors, rubber gloves and consumer electronics.

The high export of electronics products shows the importance of electronics cluster as the driving force in Malaysia’s economy. The electronics sector is the leading contributor of Malaysia's manufacturing output, employment, and exports. The electronics industry is the focus of this competency study as it contributes significantly to the national economic growth and employment opportunities. Malaysia’s Department of Statistics reported a growth jump from 4.6 % to 207.7 % growths in the Industrial Production Index (IPI) for July 2003. The higher IPI was backed by the expansion in the indices of Manufacturing and Electricity Sectors by 5.7% (from 215.7 to 228.0) and 3.4% (from 241.2 to 249.5) respectively. The main contributor for the Manufacturing Sector is the electronics industry.

In the Malaysian Industrial Development Authority (MIDA, 2004) reports, the E&E industry in Malaysia comprises four (4) sub-sectors i.e. industrial electronics, consumer electronics, electronic components and electrical products. E&E continues to be the leading industry within the manufacturing sector and is the largest contributor to exports, output and employment. In 2004, exports amounted to RM241.5 billion representing 64.1 per cent of total exports of manufactured products. The industry provided 369,488 jobs or 36.6 per cent of total employment in the manufacturing sector while output amounted to RM183.1 billion or 44.9 per cent of total manufacturing output. This figure indicates the importance of the electronics industry as the key player in the economy of this country.

The overall increase in E&E exports was contributed mainly by the industrial electronics sub-sector, with exports registering an increase of 21.4 per cent to RM102.2 billion in 2004 from RM84.2 billion in 2003. Exports of electrical products also registered an increase of 27.4 per cent to RM17.2 billion in 2004 from RM13.5 billion in 2003. Consumer electronics is a sector that includes the manufacture of color TV sets, audio visual products, VCD players, DVD players, home theatres and video and digital cameras. It also provides opportunities for the local small and medium companies to become vendors in supplying parts, components and services to the MNCs. The capital investment in this sub-sector for the period 2000 until 2004 amounted to RM2.8 billion (US$0.75 billion).

Electronic Components is another sector that produces semiconductor devices, passive components (capacitors, inductors, resistors) and display devices. Capital investment for the year 2004 amounted to RM5.9 billion (US$1.6 billion). Within this sub-sector, the semiconductor industry is dominant in terms of production, employment creation and export contribution. Major semiconductor devices produced are linear and digital integrated circuits, memories and microprocessors, opto-electronics, discrete devices, hybrids and arrays. Malaysia was the second largest exporter of semiconductor devices among developing economies and it accounted for 7.1% of the global semiconductor exports. Exports of semiconductor devices in 2004 were valued at RM89.3 billion (US$23.5 billion) or 37% of total electrical and electronics export.

Industrial Electronics sub-sector covers the production of copier machines, fax machines, typewriters, automatic data-processing machines, i.e. computer and computer peripherals, telecommunications equipment and industrial controllers. Companies in this sub-sector have moved into the production of higher-end industrial electronic products such as computer networking equipment, new generation audio-visual digital equipment and data storage devices (MR magnetic heads, compact disc (CD) media and hard disc drives). The capital investment under this sub-sector amounted to RM1.5 billion (US$0.4 billion) for the year 2004.

The Electrical and Electronics (E&E) industry remains the largest contributor to the industrial output, sales, exports and employment in the manufacturing sector. Semiconductors and other electronic components, which are the main sub-sectors within the E&E industry recorded a growth in production of 24.9 per cent in 2004 (MIDA 2005 report) as a result of the higher demand for chips particularly in communications and consumer electronics. Production of radio, television sets, and recording equipment have declined by 15.6 per cent. Sales of semiconductors and other electronic components increased by 9.3 per cent due to continued growth in the US electronics market and outsourcing activities in the Asia Pacific region. Despite growth in production and sales, employment in the semiconductor and other electronics components sub-sector declined marginally by 1.1 per cent from 261,609 workers in 2003 to 258,718 workers in 2004.

Electrical and electronic products (E&E) were the largest contributor (64.1%) to the exports of manufactured products. The E&E sector recorded an increase of 14.4 per cent in export earnings to RM241.5 billion from RM211.2 billion in 2003. The E&E industry continued to attract high levels of investment. In 2004, E&E attracted investment commitments amounting to RM8.6 billion. Malaysia is the second largest exporter of semiconductor devices among developing economies, after Singapore. According to the UNCTAD Handbook of Statistics 2004, Malaysia's semiconductor exports accounted for 7.1 per cent of the global semiconductor exports. In 2004, Malaysia's exports of semiconductor devices were valued at RM89.3 billion.

From the contributions of the electronic industry revealed in 2003 and 2004, it is clear that the electronics industry is still the major player and contributor to the Gross Domestic Product of Malaysia and continues to contribute to the sustainable growth of the economy of Malaysia. Therefore, efforts should be made to sustain and promote the continual growth of this industry. Efforts must include the continuous supply of favorable and compatible human resource. It is crucial that the gap between the acquired competencies and required competency of the employees (electronic engineers) must be brought closer. The very first step is of course to explore the area of competency mismatch and its magnitude. This should be followed by summarizing and categorizing the components of competency mismatch in a more comprehensive manner. This will allow the education policy maker and curriculum designer to bridge the gap of the competencies. In other words, the acquired competencies of the electronics engineers need to correspond to the required competencies in the electronics industry.

1.4 Aim of Research

This study intends to find the extent of the employed electronic engineers meeting the demands of the electronic industry. The study also intends to find the areas of the mismatch and the extent of the mismatch. The mismatch will be studied in two aspects (components): Required competencies and the Acquired competencies.

The first part of the study is to identify the categories of the required competencies needed by the employers in the electronics industry. Systematic empirical evidence is needed (Teichler, Ulrich & Kehm, 1995) as the mismatch may not be context independent. In this case, the emphasis of the components of the competencies may vary from country to country and across cultures. The required competencies are divided into subject-specific and generic competencies. Preliminary understanding of the components of the Required Competencies through some of the literatures will act as the basis for the validation of the components of competencies required. Qualitative data collection will be done through structured interviews with the engineers, their technical managers and training / human resources managers of the electronics firms in PDC (Penang Development Corporation Industrial Areas) of Penang, Malaysia. Job specification provides another source of the useful information about the components of the Required Competencies.

The competencies required will be surveyed through three different sources: the employers as represented by the human resource officers, training managers, immediate superiors of the engineers and engineers themselves. The documented job specifications will provide another source of useful information. Lastly, the list of competencies derived from literature reviews will be the third source. The information on the acquired competencies will be obtained from the engineers themselves by two manners: (i) by finding out the extent that university education or training has helped or contributed to the job requirement of the electronics engineers. (ii) the cross examination of the shortfall of required competencies through the extent of their needs for further training in various aspects of competencies. This study is focused on getting a clearer picture and understanding of the required competencies and acquired competencies of the electronics engineers. Acquired and required competencies of the electronics engineers will be mapped out. The extent to which the acquired competencies can match the requirement of electronics industry will determine the magnitude of the gap. This would provide an analytical distribution of the areas of mismatch happened and how the magnitude of mismatch vary with different graduates' demographics. Through this study, meaningful relations and correlations between acquired and required competencies of higher engineering education and workplace can be obtained.

1.5 Research Questions

i. What are the kinds of competencies required by the employers in the semiconductor and electronics industries?

ii. What are the kinds of competencies acquired by the graduates employed in the electronic sectors upon their graduation from the tertiary education?

iii. Is there a mismatch between the acquired and required competencies of the graduates in the electronic industry?

iv. To what extent do the acquired competencies of the graduates match the required competencies in the semiconductor and electronics sectors?

v. What are the relationships among and between the soft-skills competencies and the hard-skills competencies?

1.6 Hypotheses

i. There is a significant difference between the mean of Acquired Competencies (AC) and Required Competencies (RC) of the engineers' generic skills from the perspective of employers.

ii. There is a significant difference between the mean of Acquired Competencies (AC) and Required Competencies (RC) of the engineers' subject-specific skills from the perspective of employers.

iii. There is a significant difference between the mean of Acquired Competencies (AC) and Required Competencies (RC) of the engineers' generic skills from the perspective of engineers.

iv. There is a significant difference between the mean of Acquired Competencies (AC) and Required Competencies (RC) of the engineers' subject-specific skills from the perspective of engineers.

v. The average score for the generic skills (soft skills) is more than the score for the subject-specified skills (hard skills).

vi. Average mean of D_e(engineers) > average mean of D_m (employers)

1.7 Operational Definitions

i. Acquired Competencies (AC) – Competencies (generic or subject – specific) that engineers acquired during their undergraduate (first degree) courses at a ten-point scale.

ii. Required competency (RC) – Competencies (generic or subject – specific) that is needed by an electronics engineer working in his / her firms at a ten point scale.

iii. Perspective of employers – the overall assessment of the managers (technical managers, training managers, production, human resources managers) on the AC and RC of their engineers in the respective firms.

iv. Perspective of engineers – the self-assessment scores of the engineers on the AC and RC.

v. Graduates employed – electronics engineers with at least 3 months of working experience.

vi. D_e – the difference in engineers' scores (at 10 point scales) between AC and RC for all category levels of the soft and hard skills.

vii. D_m – the difference in managers' scores (at 10 point scales) between AC and RC for all category levels of the soft and hard skills.

1.8 Significance of Research

This study intends to link the education service provider (engineering education) closer to its clients (employers) in the labor market (in this case the electronics industries). The outcomes and the feedback would serve as a guide to integrate the required elements of competencies in semiconductor and electronics industries into the curriculum and the activities planned in the higher institutions. It is hoped that the curriculum design units for the electronic engineering department of local public and private institutions of higher learning will benefit from this research. Awareness and follow-up instillation and cultivation of elements of required knowledge, values, and skills through various learning activities will enhance the competitiveness of our local graduates.

With the awareness of the required competencies, trainers and lecturers of respective higher learning centers may incorporate and highlight the required industrial competencies into their practical sessions, workshops, teamwork projects, laboratory administrations, discussions and seminars. Hence, simulation of workplace and job requirements and activities can be incorporated into the daily teaching and learning activities. The exposure of this planned and guided workplace simulation in stages throughout the undergraduates' studies will eventually acclimatize the graduates to the future job environments.

For the university students, this study will serve as a feedback of unemployablity and expectations of the employers at the workplace. They will be able to foresee the favorable and unfavorable elements in their career paths. A clearer picture of the demands of the workplace will urge and motivate them to grasp opportunities to sharpen their skills and broaden their knowledge. In addition, what we hope to see is a smoother transition from university to work. An early development and shaping of required competencies may help to reduce the time needed for the new recruits to become independent and productive workers. In short, the study will help in enhancing the competitiveness of the Malaysian workforce.

To the employers, this study will provide an insight into the specific and general training of electronics graduates. The employers will gain a clearer understanding of the acquired competencies, strength and weaknesses of their recruits. Employers will be able to anticipate the shortcomings and weaknesses of these recruits and take remedial steps by providing them On-the-Job and Off-the-Job training. This would help to reduce the time span for the graduates to adapt themselves into the work place.

In this study, the acquired and required competencies are categorized empirically through interviews with various sources and triangulations with the related documents. The final categorization of the subject and specific skills is verified through the quantitative factor analysis. The results of the factor analysis provide useful information to the curriculum design units, trainers, students and employers. Besides that, the study also provides a new perspective of the education-employment relationship after the categorization of the acquired and required competencies in the electronics industry. Attention and efforts may be drawn to the area of mismatch and necessary efforts may be channeled to bridge the gap.

1.9 Limitation of the Research

Models and relationships of the acquired and required competencies need to be established before meaningful theoretical generalization can be made. This study