

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

**by**

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## TABLE OF CONTENTS

	Page
<b>ACKNOWLEDGEMENTS</b>	ii
<b>TABLE OF CONTENTS</b>	iii
<b>LIST OF TABLES</b>	xi
<b>LIST OF FIGURES</b>	xvi
<b>LIST OF ABBREVIATION</b>	xxi
<b>ABSTRAK</b>	xxii
<b>ABSTRACT</b>	xxiii

## CONTENTS

### **CHAPTER ONE: INTRODUCTION**

1.1	Background of the Study	1
1.2	The Research Problem	10
1.3	Rationale of Study	16
1.4	Aim of Research	19
1.5	Research Questions	20
1.6	Hypotheses	21
1.7	Operational Definitions	22
1.8	Significance of Research	23
1.9	Limitation of the Research	24
1.10	Conclusion	25

### **CHAPTER TWO: Literature Review**

2.1	Introduction	27
2.2	The Development in Electronic Industry	27
	2.2.1 Recent Development Policy in Malaysia	27
	2.2.2 The Eight Malaysia Plan (2001-2005)	29
	2.2.3 The Role of OEM and EMS in Malaysia	34
2.3	Policies and Strategic Directions Of Malaysia E&E Cluster	35
	2.3.1 Heart of Manufacturing Industry – Penang	39
	2.3.2 Employment	41

2.3.3	Employability of graduates in Malaysia	43
2.4	Task & Duties of Electronic Engineers	43
2.4.1	Job Specification of Electronic Engineer	43
2.4.2	Formal Training at the workplace	44
2.5	Related Theories	45
2.5.1	Education-Industry Relation	45
2.5.2	Higher Education and Employment	46
2.5.3	Robbins & Dearing Reports	47
2.5.4	Efforts in Enhancing the Global competitiveness Reports on the relationship of the public and private sectors in Malaysia	48
2.5.5	Workplace Competencies and Education	51
2.6	Competencies	52
2.6.1	Types of Competencies	53
2.6.2	SCANs' Competencies	54
2.6.3	Competencies by National Curriculum , United Kingdom	56
2.6.4	Report on Regional Seminar On Values Education in ASEAN	57
2.6.5	Report On The Skill Requirements Of Engineers In Developing Country	58
2.7	Related Engineering Models	60
2.7.1	Professional Model	60
2.7.2	The Skills Component Model	61
2.7.3	The Malaysian Engineering Education Model	62
2.8	Electronic Engineering Curriculum Analysis	65
2.9	Required Competencies	70
2.9.1	Generic Competencies	71
2.9.2	Subject –specific Competencies	80
2.9.3	Categorization of Competencies	84
2.10	Theoretical Framework	86
2.11	Conceptual Framework	90
2.12	Conclusion	97

### **CHAPTER THREE : Research Methodology**

3.1	Introduction	99
3.2	Research Design	99
3.2.1	Qualitative Study	99
	Identification of the sub-categories of competencies	102
	Process Flow of qualitative analysis	103
3.2.2.	Quantitative Study	105
3.2.3	Ranking of Competency Categories	108
3.2.4	Linkages between university and industry	108
3.2.5	Justification of Behavior Event Interview	109
3.3	Research Population	110
3.4	Research Sample	111
3.4.1	Sample at the qualitative survey level (BEI interviews)	112
	Data Collection Techniques	
3.4.2	Sample for the quantitative survey level (questionnaire Q1 and Q2)	112
	Questionnaire Q1	
	Questionnaire Q2	
3.5	Instruments for the study	115
3.6	Data Analysis	117
3.6.1	Qualitative Analysis	117
3.6.2	Quantitative Analysis	117
3.7	Reliability & Validity	122
3.7.1	Validity Test	123
3.8	Conclusion	127

### **CHAPTER FOUR: RESULTS AND ANALYSIS**

4.1	Introduction	129
4.2	Qualitative Analysis	130
4.2.1	Qualitative Analysis – Job Specifications	130
4.2.2	Qualitative Analysis- Profile of Respondents	133
4.2.3	Participation of Respondents	134
4.2.4	Qualitative Analysis - Existence of the Gap	136
4.3	Identification of the subcategories of competencies	141

	Sub-categories of the Soft skills –Generic Skills	
4.3.1	The Soft skills- Generic Skills	143
	I. Communication skills (GC)	143
	II. ICT skills (GS)	151
	III. Interpersonal Skills (GI)	152
	IV. Management Skills (GM)	154
	V. Personal Qualities (GP)	156
	VI. GT- Thinking Skills (GT)	162
4.3.2	The Hard Skills –Subject Specific Skills	166
	I. Subject knowledge (SK)	166
	II. Technological Skills and Knowledge (ST)	169
4.4	Validation of the Instruments for Quantitative Study	179
	Respondent rate of quantitative study	179
4.5	Quantitative Analysis and Results	182
4.5.1	Factor Analysis	182
4.5.2	Categorization of the Soft Skills	183
	Management skills	
	Interpersonal skills	
	Thinking skills	
	Personal qualities	
	ICT skills	
	Communication skills	
4.5.3	Categorization of the Hard Skills	195
	i. Subject knowledge (SK)	
	ii. Technological Skills and Knowledge (ST)	
	Process control and installation	
	Operates and troubleshooting instruments, systems	
	Construction of the electronic circuits	
	Quality and Reliability Testing	
	Practical usage of software tools	
4.6	Initial Investigation of the relationship between the perspectives of the engineers and managers towards the acquired and required competencies of engineers	206
	Treatment of Missing Values	
4.7	Required Competencies of the Electronic Industry	216
4.7.1	Relationship of the demand of Soft skills (RC) with the type of industry	228

4.7.2	Relationship of the demand of hard skills (RC) with the type of industry	230
4.7.3	Relationship of the demand of Soft skills (RC) with the sector of industry	233
4.7.4	Relationship of the demand of hard skills (RC) with the sector of electronic industry	237
4.8	Acquired Competencies of the Electronic Engineers	241
4.8.1	Acquired Generic (soft skills ) Competencies of the electronic engineers by tertiary education groups	241
4.8.2	Acquired Subject -Specific (hard skills ) Competencies of the electronic engineers by tertiary education groups	246
4.8.3	Comparing soft and hard skills from the perspective of tertiary education	250
4.8.4	Acquired Competencies – Views from the tertiary Education Providers	252
4.9	Mismatch of Acquired Competencies and The Required Competencies of the engineers	255
4.9.1	Hypotheses Testing $H_1$ $H_2$ $H_3$ and $H_4$	256
4.9.2	Results of the hypotheses testing $H_1$ $H_2$ $H_3$ and $H_4$	266
4.10	Extent of the mismatch	268
4.10.1	Generic Skills	267
4.10.2	Subject – Specific Skills	268
4.10.3	Comparing the AC and RC of the Subject knowledge Category	271
4.10.4	Standardized the magnitude of the mismatch	274
4.10.5	Classification of the mismatch	278
4.10.6	Ranking of the Categories of Competency	279
4.10.7	Comparing the gaps in the generic skills and the gap in the subject –specific skills	284
4.10.8	Indications of the leads to the mismatch	287
4.11	Relationships between the Acquired Competencies and Required Competencies of the i) Soft $r_{ss}$ and ii) Hard Skills $r_{HH}$	294

4.11.1	Relationship among the AC competencies ( soft and hard), $r_{ac}$	299
	i.    AC soft and AC soft	
	ii.   AC hard and AC hard	
	iii.  AC hard and AC soft, $r_{ac}$	
	iv.   Correlations, $r_{ac}$ between AC soft and AC hard by groups of graduates	
4.11.2	Relationship among the RC competencies ( soft and hard), $r_{rc}$	307
	i.    RC soft and RC soft	
	ii.   RC hard and RC hard	
	iii.  RC hard and RC soft, $r_{rc}$	
4.11.3	Relationship between the AC and RC competencies ( soft and hard)	314
	i.    The relationship of AC and RC of the soft skills, $r_{ss}$	
	ii.   The relationship of AC and RC of the hard skills, $r_{hh}$	
4.11.4	The associations of AC soft skills with the gap	316
4.11.5	Relationship between the AC and RC competencies (soft and hard) by groups	319
	i.    The relationship of AC and RC of the soft skills, $r_{ss}$ by groups	
	ii.   The relationship of AC and RC of the hard skills, $r_{hh}$ by groups	
	iii.  Pearson Correlation Coefficient for AC – RC soft skills categories by groups of graduates	
	iv.   Pearson Correlation Coefficient for AC-RC hard skills categories by groups of Graduates	
4.12	Strength of AC-RC association with Training needs	324
	i.    Soft skills training needs	
	ii.   Hard skills training needs	
4.13	Comparing the competencies for engineers graduated from different sources of education	330
	i.    soft skills	
	ii.   hard skills	
4.14	Comparing the gaps perceived by the engineers and the employers	334



## **CHAPTER FIVE : Summary and Conclusion**

5.1	Summary of the Research Process	339
5.2	Instrument for the quantitative data collection	341
5.3	Views of the employees and employers on the competencies	341
5.3.1	The views of the employees and employers about the acquired competencies	341
5.3.2	The need of soft skills and the changing roles of engineers	342
5.4	The need of soft skills and the changing roles of engineers	343
5.5	Categorization (factorization) of the categories of competencies	344
5.6	Competencies Required by the Employers in Electronic Sector	345
5.6.1	The soft skills	
5.6.2	The Subject –specific skills (hard skills)	
5.6.3	Soft skills Requirement by nature of company	
5.6.4	Hard skills acquirement by groups of engineers	
5.7	Acquired Competencies of the electronic engineers in the electronic industry	350
5.8	Existence of the Gap	352
5.9	The Extent of Mismatch Recommendation for soft skills improvements	353
5.9.1	Critical Mismatch	353
5.9.2	Serious Mismatch	355
5.9.3	Medium mismatch	357
5.9.4	Tolerable Mismatch	359
5.9.5	Negligible Mismatch	359
5.9.6	Larger mismatch for generic skills than subject specific skills	360
5.10	Relationships between the acquired soft and hard skills competencies	361
5.11	Relationships between the required soft and hard skills competencies	364
5.12	Relationship between the AC and RC competencies (soft and hard)	367
5.13	Training Needs and the AC-RC relationship	369
5.14	Recommendation for the tertiary education providers	369
5.15	Recommendation to bridge the industry operators and education providers	370

5.16	Implications on the relationship of tertiary education and employment	372
	<b>REFERENCE</b>	384
	<b>Appendices</b>	393
	Appendix A: Structured Interview (BEI)	393
	Appendix B : Preliminary List of Competencies	398
	Appendix C : Questionnaire Q1	403
	Appendix D : Questionnaire Q2	410
	Appendix E : Job Lists J1 – J15	417

<b>LIST OF TABLES</b>		<b>Page</b>
Table 2.1	Enrolment and output for first degree courses	32
Table 2.2	The Penang Manufacturing Sector Profile as at June 2000	39
Table 2.3	Report of Malaysia Electronic Industry, 1997-2003	42
Table 2.4	Recommended Skills and Competencies in MEEM	64
Table 2.5	Comparison of the local colleges (diploma programs) skills composition	66
Table 2.6	Comparison of the local public universities and private institutions Bachelor degree engineering programs skills composition	66
Table 2.7	Comparison of local and foreign degree skills composition	66
Table 2.8	Skills composition of different streams of engineering program	66
Table 2.9	Examples of composition of foreign electronic engineering program curricula according to skills	68
Table 2.10	Example composition of local electronic engineering program curricula according to skills	69
Table 4.1.1	List of Required generic competencies extracted from the job specification list	130
Table 4.1.2	List of Required Subject Specific competencies extracted from the job specification list	131
Table 4.2.1	Profiles of the interviewees	133
Table 4.2.2	Profiles of the Companies in the qualitative data collection	135
Table 4.2.3	The Schedule of interviews with the 17 respondents of respective firms	136
Table 4.2.4	Summary of the perspectives of respondents about the gap	136
Table 4.3	Coding the qualitative data with tags according to patterns and setting used in Qualitative Analysis	142
Table 4.4	Return Rate of Respondents through Hard Copies	180
Table 4.5	Return Rate of Respondents through Soft Copies	181
Table 4.6	Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 40 variables for the Required Generic Skills	184
Table 4.7	Varimax –Rotated Component Analysis of Factor Matrix (Generic Skills)	185
Table 4.7.1	Reliability Analysis of Generic skills	189
Table 4.8	Mean scores of the management skills items and reliability	190
Table 4.9	Mean scores of the interpersonal skills items and reliability	191
Table 4.10	Components of thinking skills	191
Table 4.10.1	Mean scores of the thinking skills items and reliability	191
Table 4.11	Mean scores of the personal qualities items and reliability	192

Table 4.12	Mean scores of the ICT skills items and reliability	193
Table 4.13	Mean scores of the communication skills items and reliability	194
Table 4.14	Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 6 variables for the Required Subject-specific Competency – Subject Knowledge	195
Table 4.15	Total Variance Explained and number of factors for Subject-specific Competency – Subject Knowledge	196
Table 4.16	Factor loading for the items in the Subject –specific Competency – Subject Knowledge	196
Table 4.17.1	Mean scores of the Subject Knowledge items and reliability	197
Table 4.17.2	Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 30 variables (st1 to st30) for the Required Subject-specific Competency – Technological Skills and Knowledge	197
Table 4.17.3	Factor Analysis of Subject –specific (Hard Skills)	199
Table 4.18	Mean scores of the ‘Process and Control ‘Competency items and reliability	201
Table 4.19	Mean scores of the ‘Operates and troubleshooting instruments, systems’ Competency items and reliability	202
Table 4.20	Mean scores of the ‘Construction of the electronic circuits’ Competency items and reliability	203
Table 4.21	Mean scores of the ‘Quality and Reliability Testing’ Competency items and reliability	204
Table 4.22	Mean scores of the ‘Practical usage of software tools’ Competency items and reliability	204
Table 4.23	Mean score of AC generic skills for engineers and managers	207
Table 4.24	Independent Samples Test for AC generic skills	208
Table 4.25	Mean score of RC for generic skills for engineers and managers	210
Table 4.26	Independent Samples Test for RC generic skills	210
Table 4.27	Mean score of AC subject specific (hard skills) skills for engineers and managers	211
Table 4.28	Independent Samples Test for AC subject specific (hard skills) skills	212
Table 4.29	Mean score of RC for subject specific (hard skills) skills for engineers and managers	214
Table 4.30	Independent Samples Test for RC subject specific (hard skills) skills	215
Table 4.31	Analysis of the overall mean score of RC ( soft skills categories)	218
Table 4.32	Analysis of the mean score of RC ( soft skills categories) by	218

	groups (engineers and managers)	
Table 4.33	Descriptive analysis of RC of hard skills according to the categories	226
Table 4.34	Analysis of the mean score of RC ( soft skills categories) by groups (engineers and managers)	227
Table 4.35	Analysis of mean of RC of soft skills by type of industry	229
Table 4.36	Independent t-test of RC (soft skills ) by type of industry (OEM/EMS)	229
Table 4.37	Mean scores of RC (hard skills ) by type of industry (OEM/EMS)	230
Table 4.37.1	Independent t-test of RC (hard skills ) by type of industry (OEM/EMS)	231
Table 4.38	Anova test on the RC of soft skills by sector of industry	234
Table 4.39	Comparison of the AC (soft skills ) mean score for engineers graduated from different groups of education	243
Table 4.40	Anova test of the AC (soft skills ) mean score for engineers graduated from different groups of education	244
Table 4.41	Mean scores of AC (hard skills ) for engineers graduated from different tertiary education	246
Table 4.42	Paired sample statistics (mean scores) for all the categories of soft skills from the perspective of manager (employers)	257
Table 4.43	Paired sample statistics-t test (mean difference) for all the categories of soft skills from the perspective of managers (employers)	257
Table 4.44	Paired sample statistics (mean scores) for all the categories of subject –specific skills (hard skills) from the perspective of managers (employers)	259
Table 4.45	Paired sample statistics-t test (mean difference) for all the categories of hard skills from the perspective of managers (employers)	259
Table 4.46	Paired sample statistics (mean scores) for all the categories of soft skills from the perspective of engineers (employees)	262
Table 4.47	Paired sample statistics-t test (mean difference) for all the categories of soft skills from the perspective of engineers (employees)	262
Table 4.48	Paired sample statistics-t test (mean difference) for all the categories of hard skills from the perspective of engineers (employees)	264
Table 4.49	Paired sample statistics-t test (mean difference) for all the categories of hard skills from the perspective of engineers (employees)	264
Table 4.50	Mean scores of AC and RC from all respondents (soft skills)	268

Table 4.51	Mean score differences (magnitude of gaps) computed from all respondents (soft skills)	268
Table 4.52	Mean scores of AC and RC from all respondents (Hard skills)	270
Table 4.53	Mean score differences (magnitude of gaps) computed from all respondents (hard skills)	270
Table 4.54	Mean scores of AC and RC from the engineers (subject knowledge category)	272
Table 4.55	Mean difference of AC and RC from the engineers (subject knowledge category)	272
Table 4.56	Mean scores of AC and RC from the managers (subject knowledge category)	272
Table 4.57	Mean difference of AC and RC from the managers (subject knowledge category)	273
Table 4.58	Standardization of magnitude of mismatch into z scores by skills components	274
Table 4.59	Standardization of magnitude of mismatch into z scores by strength	275
Table 4.60	Descriptive statistics of the Z scores	275
Table 4.61	Classification of Deficiency ( gap)	278
Table 4.62	Ranking of the soft skills	280
Table 4.63	Ranking of the subject knowledge	281
Table 4.64	Ranking of the hard skills	282
Table 4.64.1	Ranking of Hard skills Categories (after factor analysis)	283
Table 4.65	Mean scores of AC and RC of the soft and hard skills	284
Table 4.66	The magnitudes of the gaps of soft and hard skills	284
Table 4.67	Test of significant difference of the difference between soft skills and hard skills gaps	285
Table 4.68	Mean scores of the AC and RC for soft and hard skills	295
Table 4.69	Correlations of the Soft skills (AC and RC) with the Hard skills (AC and RC)	295
Table 4.70	Correlations of the AC and RC (for both soft and hard skills)	295
Table 4.71	Correlation matrix among categories of AC soft skills	300
Table 4.72	Correlation matrix among categories of AC hard skills	300
Table 4.73	Correlation matrix between categories of AC hard skills and AC soft skills	302
Table 4.74	Correlations between AC soft and AC hard by groups of graduates	306
Table 4.75	Correlation matrix among categories of RC soft skills	307

Table 4.76	Correlation matrix among categories of RC hard skills	310
Table 4.77	Correlation matrix between categories of RC hard skills and RC soft skills	311
Table 4.78	Correlation matrix between AC and RC soft skills categories	314
Table 4.79	Correlation matrix between AC and RC hard skills categories	316
Table 4.80	Ranking of the correlation coefficient and the magnitudes of the gaps for soft skills categories	317
Table 4.81	Spearman rho of correlation ranking and gap's ranking	317
Table 4.82	Ranking of the correlation coefficient and the magnitudes of the gaps for soft skills categories	318
Table 4.83	Spearman rho of correlation ranking of r and gap's ranking for hard skills	318
Table 4.84	Ranking of the correlation coefficient and the magnitudes of the gaps for all skills	318
Table 4.85	Spearman rho of correlation ranking and gap's ranking for soft and hard skills	319
Table 4.86	Correlations-AC soft and RC soft for groups	320
Table 4.87	Correlations-AC soft and RC hard skills by groups	320
Table 4.88	Pearson correlation of AC to RC of the soft skills according to groups	321
Table 4.89	Pearson correlation of AC to RC of the hard skills according to groups	323
Table 4.90	Pearson correlations of TN and the mean of the gap for the soft skills categories	327
Table 4.91	Pearson correlations of TN and the mean of the gap for the hard skills categories	329
Table 4.92	Comparing the soft skills gaps perceived by the engineers and managers	335
Table 4.93	Independent Samples Test On $D_e$ and $D_m$ for Soft Skills	336
Table 4.94	Comparing the hard skills gaps perceived by the engineers and managers	337
Table 4.95	Independent Samples Test On $D_e$ and $D_m$ for Hard Skills	337
Table 5.1	Ranking of Soft skills Categories	346
Table 5.2	Ranking of Subject knowledge Categories	348
Table 5.3	Ranking of Hard skills Categories (after factor analysis)	348
Table 5.4	Examples of Local Public Institution of Higher Learning (IPTA) engineering course structure	374
Table 5.5	Examples of Local Public Institution of Higher Learning (IPTA) engineering course structure	375

<b>LIST OF FIGURES</b>		<b>Page</b>
Figure 2.1	Categorization of Competencies	85
Figure 2.2	The relationship between Price and Quantity Demanded	86
Figure 2.3	The supply relationship curve	87
Figure 2.4	Equilibrium of supply and demand	87
Figure 2.5	Relationship of Tertiary Education and Employment	89
Figure 2.6	Inverse AC-RC Relationship	90
Figure 2.7	Positive AC-RC Relationship	90
Figure 2.8	Conceptual Framework	91
Figure 2.9	Relationship of the Acquired Competencies of the electronics graduates with the Required competencies of the Employers in the Electronics Sectors	97
Figure 3.1	Identification of the Required Competencies	103
Figure 3.2	Flow Chart of qualitative data collection and analysis process	104
Figure 3.3.1	Ten-Point Scale For the Engineers (Q1)	107
Figure 3.3.2	Ten-Point Scale for the managers (Q2)	108
Figure 3.4	Competency Causal Flow Model	110
Figure 3.5	Magnitudes of the Competencies Mismatch	119
Figure 3.6	Relationships of soft and hard skills for the acquired and required competencies.	121
Figure 4.1	Manufacturer – Customer Relationship	171
Figure 4.2	Scree Plot of the generic skills	184
Figure 4.3	Scree Plot of the required competency of the subject – specific skills (Technological skills and knowledge )	198
Figure 4.4	Extraction of latent categories in the Technological Subject & Knowledge	206
Figure 4.5	Mean score of Overall Required generic skills (all samples)	217
Figure 4.5(a)	Factors contributing to the required soft skills	224



Figure 4.6	Mean scores for the subject- specific skills according to the categories	225
Figure 4.7	Profile of hard skills for Oem and EMS factory	233
Figure 4.8	Profile of RC soft skills by sectors of industry	234
Figure 4.9	Profile of hard skills for different sectors of industry	237
Figure 4.10	Factors contributing to the required competencies of hard skills	240
Figure 4.11	Boxplot distribution of the AC soft skills from the engineers of different streams of education background	242
Figure 4.12	The mean score of AC against the categories of soft skills from different groups of engineers	244
Figure 4.13	Boxplot distribution of the AC hard skills from the engineers of different streams of education background	246
Figure 4.14	Mean scores of AC (hard skills ) for different tertiary education	249
Figure 4.15	Mean score of AC against competencies (soft and hard) for different groups of education	251
Figure 4.16	Mean score of AC against different groups of education for soft and hard skills	252
Figure 4.17	factors contributing to the Acquired competencies	254
Figure 4.18	soft skills profile of RC and AC from the perspective of employers (managers)	258
Figure 4.19	Hard skills profile of RC and AC from the perspective of engineers.	261
Figure 4.20	soft skills profile of RC and AC from the perspective of engineers	263
Figure 4.21	Hard skills profile of RC and AC from the perspective of engineers	265
Figure 4.22	Soft skills profile of RC and AC from the perspective of all respondents	269
Figure 4.23	Hard skills profile of RC and AC from the perspective of all respondents	271
Figure 4.24	Comparing the AC – RC of Subject Knowledge by groups	273

Figure 4.25	Positions of the soft and hard skills categories on a linear standardized scale	277
Figure 4.26	Extent of Mismatch for both the soft and hard skills competencies	279
Figure 4.27	Cross correlations of the AC –RC competencies for the soft and hard skills	297
Figure 4.28	Covariance of the three closely related hard skills categories	302
Figure 4.29	The Relationship among the AC of soft skills and hard skills (r = Pearson correlation coefficient at two tailed 0.01 level )	305
Figure 4.30	The Relationship among the RC soft skills (r = Pearson correlation coefficient at two tailed 0.01 level )	309
Figure 4.31	The relationships between Subject knowledge and other hard skills categories	311
Figure 4.32	Association (for $r \geq 0.5$ ) of RC soft skills with RC hard skills	314
Figure 4.33	Training needs for soft skills by groups	325
Figure 4.34	Training needs for hard skills by groups	328
Figure 4.35	Boxplot distribution of the AC soft skills from the engineers of different groups	330
Figure 4.36	Boxplot distribution of the AC soft skills from the engineers of different groups	330
Figure 4.37	Boxplot Distribution of the RC –soft skills of engineers from different groups	332
Figure 4.38	Boxplot Distribution of the soft skills Training Needs (TN) from different groups of engineers	332
Figure 4.39	Boxplot Distribution of the Hard skills Training Needs (TN) from different groups of engineers	333
Figure 4.40	Boxplot Distribution of the hard skills Gaps as perceived by the Engineers	333
Figure 5.1	The supply Curve for AC-RC	373
Figure 5.2.1	RC soft skills and hard skills Pressure Balancing	377
Figure 5.2.2	RC Line of Equilibrium shifts downwards	377
Figure 5.2.3	RC Line of Equilibrium shifts upwards	377

Figure 5.3.1	AC soft skills and hard skills Pressure Balancing	379
Figure 5.3.2	AC Line of Equilibrium shifts downwards	380
Figure 5.3.3	AC Line of Equilibrium shifts upwards	380
Figure 5.4	Compartmentalize Pressure Balancing of AC-RC	381
Figure 5.5	Pressure Shift - Demand for RC bigger than AC	382
Figure 5.6	Different Scenario of Pressure Sift	383

## 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 PENDIDIKAN 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 sepuluh

digunakan dalam instrumen–instrumen supaya magnitud ketidaksepadanan boleh dinilai oleh responden 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 sepuluh) adalah lebih besar daripada kompetensi khusus (skor purata = 1.73 dalam skala titik sepuluh).

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 0.866. 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 8<sup>th</sup> 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 become 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 possess 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  $D_e(\text{engineers}) > \text{average mean of } D_m(\text{employers})$

### **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 unemployability 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