INVESTIGATING UNIVERSITY-INDUSTRY PARTNERSHIP OF HIGHER ENGINEERING EDUCATION USING CAUSE-EFFECT ANALYSIS AND MULTI-CRITERIA DECISION MAKING: A MALAYSIAN PRESPECTIVE

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ABSTRACT

In recent years, there has been growing interest towards integrating industry into the teaching and learning processes. This is due to many factors including increased concerns about the mismatch between the skills and abilities of the talent pool, strengthening partnership and improving quality of engineering education. Thus, greater emphasis on the teaching and learning processes to enhance the students' learning experience leads to the university-industry partnership to the forefront interest of the university. On the other hand, exclusion of industry's engagement in the teaching and learning processes have been identified as the main source of chronic criticism on the higher engineering education segment in recent years.

This study demonstrates a research model that hypothesised the influence of teaching and learning domains on the university-industry partnership towards enhancing the learning experience of the engineering students. Using the structural equation modelling (SEM), the hypothesis was tested on the primary data collected from 212 communities of the industry. Furthermore, the study investigated the preference of industry on the type of linkages to foster university-industry partnership using analytical hierarchy process (AHP).

The results revealed that nine out of the thirteen hypotheses had significant associations including six direct paths and three indirect effects in the model. The findings indicated the need for industry-university partnership in three main constructs including cooperation in education, the mobility of people and intellectual enhancement. Moreover, internship programme was the important linkage in achieving the overall university-industry partnerships goals, followed by the staff training programme, academic development, consultancy work, student learning activity and publication activity.

In summary, the study demonstrates that teaching and learning relevance could be enhanced through optimizing industry's enrichment activities into the learning process, improving the measures for accreditation in narrowing the gap between theory and practice and proactively improving the quality of teaching by exploring the staff training programmes.

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LIST OF ABBREVIATIONS

ABET	Accreditation Board for Engineering and Technology
ACD	Academic Advisory Panel for Curriculum and Skills Development
AIC	Akaik Information Criterion
AHP	Analytic Hierarchy Process
AMOS	Analysis and Moment of Structure
ASEAN	Association of South-East Asian Nations
AVE	Average Variance Extracted
BMI	Building Information Modelling
CE	Cooperation in Education
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CITP	Construction Industry Transformation Programme
CR	Construct Reliability
CW	Consultancy Work
DV	Dependent Variable
EAC	Engineering Accreditation Council
ELECTRE	Elimination and Choice Translating Reality
GOF	Goodness of Fit
IBS	Industrialized Building Systems
ICT	Information and Communication Technology
IE	Intellectual Enhancement
IFI	Incremental Fit Index
IM	Improvement
IP	Internship Programme
IV	Independent Variable
KU	Knowledge Up-Gradation
MCDM	Multiple Criteria Decision Making
MITI	Ministry of International Trade and Industry
MLE	Maximum Likelihood Estimation
MNC	Multi National Company
MV	Measured Variable
MP	Mobility of People

NFI	Normed Fit Index
OBA	Outcome Based Accreditation
OBE	Outcome Based Education
PA	Academic Publication Activity
PNFI	Parsimonious Normed Fit Index
PR	Partnership
RAHP - MAHP	Revised – Multiplicative Analytic Hierarchy Process
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modelling
SLA	Student Learning Activities
SPSS	**S**tatistical **P**ackage for the **S**ocial **S**ciences
STP	Support Continue Training Programme for Academicians
TLI	Tucker-Lewis Index
TOPSIS	Technique for Order Preference by Similarity in Ideal Solution
TRIZ	Theory of Inventive Problem Solving
WA	Washington Accord
WPM	Weight Product Model
WSM	Weight Sum Model
UITT	University Industry Technology Transfer
UNESCO	United Nations Educational, Scientific and Cultural Organization

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DECLARATION

I declared that the work contained in this thesis is all my own work and has not been submitted for any other award. I also confirm that this work fully acknowledges opinions, ideas, and contributions from others.

This study was approved by the Northumbria University of Newcastle's Postgraduate Research Ethics Committee on 26 May 2016.

I declare that the word count of this thesis is 64,636 words.

Name: Sivajothi Paramasivam

Signature:

Date: 28th December 2016

Chapter 1
INTRODUCTION: THE PROBLEM AND ITS SETTING

1.0 Overview

The engineering industry is undergoing enormous structural changes at an unprecedented pace over the last few decades. This has led to an increased need for broader knowledge and skill sets among the entry-level engineering graduates. The industry has been an integral of the professional engineering education by being an important stakeholder that provides employment opportunities to entry-level graduate engineers. As such, the communities of industry have high expectation and demand for good work quality talent pool from the universities. Nevertheless, recent studies have indicated that increasing number of industrial communities have catechized the quality of teaching and learning processes of professional engineering education. This is because the university has failed to empower the aspiration of evolving industry by creating the positive impact on the technical manpower requirement.

Over the last decade, there has been substantial criticism on the academic development domains despite tremendous growth and pedagogical advances mooted by “outcomes” culture. Generally, the criticisms are related to the structure and delivery of the undergraduate professional engineering education in terms of the engineering practice and employability skills of the graduates (May & Strong, 2006; Patil Nair & Codner, 2008; Zaharim et al. 2009; Shah & Nair, 2011).

The educational change in the engineering program was primarily initiated by US while Australia and UK were driven to address the gaps between the engineering education and the complex engineering practice of the 21st century. In fact, a strategic direction aimed towards minimizing the impact of chronic complaints made on the entry-level graduates, critically asserted that the graduates are ill prepared to fulfil the current demands of the workforce. Nonetheless, the expected yield of this mission was marginal, where the teaching and learning processes of the current engineering academic structure were rather slow to resonate with the changes in the workplace.

In the light of this, pressure on modernizing the teaching and learning with a greater inclusive representation of industry became the central focus of universities across the globe. The professional engineering education becomes a challenging field due to rapid technical transformation, globalisation, rapid advancement of technology and cognitive science which have affected the engineering practice worldwide (Felder, Brent & Prince, 2011). In fact, this is in contrast to the phasing in the modest improvement approach of "outcomes" culture in the professional engineering education. The "outcomes" culture was introduced into the teaching and learning to better harness the work abilities of graduates while at study.

The university-industry partnership is viewed as one of the efforts to enhance students' learning experience, especially in nurturing the desirable work abilities. Hence, the strategic partnership between university and industry is increasingly intensified and has become integral agenda of university policy-making. As such, the partnership has a direct impact in providing validity and relevance to student learning outcomes that aligns towards meeting industries expectation.

Outcome-based education is an initiative to facilitate and develop desirable work abilities and attributes of learners that aligns towards meeting the expectation of modern industries (Walther & Radcliffe, 2007; Palmer & Ferguson, 2008; Dowling & Hadgraft, 2011). A study indicated that students were suggested to participate in academic activities beyond their classroom setting to bridge the gap between expectation and reality of the engineering practice (Jones, 2010). For example, the extra-curricular activities or "other curriculum" outside the formal curriculum is essential in modernizing the outcome-based education.

The university plays a dominant, yet adaptive role within academic development framework in disseminating in-depth knowledge, skills, and abilities that positively nurture the students' learning experiences (2011). Thus, is timely to bolster the efforts that emphasize the primary role of the university towards enhancing the students' learning experience in terms of promoting holistic knowledge in engineering concepts, exposure towards real-world engineering practice and needs for professional outlook (Onwuka, 2009; Bullen, 2010).

An outreach effort involving greater inclusiveness of industry's representation in the higher engineering education is essential due to the increasing demand for the academic development framework-covering relevancy of knowledge within the curriculum, personal development characteristics, and competence of the graduates for the global appeal. Moreover, an outreach effort is crucial as engineering practice and technology are undergoing significant changes due to the need for greater enhancement of students' learning opportunities beyond their classroom and engagement towards exploring new knowledge (Smith et al. 2005; Redish & Smith 2008; Morell, 2008; Brundiers, Wiek & Redman, 2010). For example, in the UK, some universities developed innovative approaches such as innovate curricula, industrial attachment for students and staff professional development opportunities as outreach efforts to form partnerships with the industry (Heesom et al. 2008; Morell, 2008; Lambert Review 2003; Leitch Review 2006).

According to the Science & Business Commission Report on university-industry partnership, many industries are urged to foster partnerships with universities in their attempt to contribute towards modernization of the curricula and improve the knowledge and skills of the future graduates (2012). Nevertheless, the current trend of the competitive business environment that is supported by the advancement of technological development, has deprived the industry to provide the luxury to train the graduates for a protracted period.

There should be aggressive initiatives directed towards establishing a significant relationship with university-industry to cope with the rapid evolution of the industrial landscape. Hence, the engineering schools (university) should proactively formulate suitable academic-led linkages, which are geared towards enhancement of teaching and learning outcomes activities within the academic development domain. This is crucial as the failure to commit towards an open and mutually beneficial collaboration would result in the academic marginalization of the engineering schools (Onwuka, 2009; Shah and Nair, 2011; Mandal and Banerjee, 2012). Moreover, there should be further investigation on the extent of involvement of the industry in the partnerships with the university, particularly to alleviate chronic complaints on teaching and learning processes in engineering programme.

1.1 Background of Scope of Study

In recent years, the university is undergoing the transformation of its education system, particularly in the professional engineering education segment. Consequently, strategic initiatives are formed to enhance the students' learning experience that will significantly influence the professional development and industrial practice during the early course of the study. Thus, fostering the partnership with industry by establishing suitable linkages is well-established as an innovative mode of enhancing students' learning experience (Patil, Nair & Codner 2008, Thune 2011). While these strategies are vital to producing desirable work abilities of the graduates, forming, and building a sustainable partnership between industry and university is proven to be challenging.

The teaching and learning activities of engineering education have become increasingly active in forming students' learning curve. University's approach to fostering quality teaching is aimed to fulfil the growing demand for innovative and relevant academic framework and to demonstrate the reliability in providing good quality higher education, which is on par with international standard. Furthermore, the university is also committed to keeping abreast with the rapid changes in technology that requires progressive improvement of the programme content, pedagogies and educational missions.

Building capable talent pool to survive in an evolving industrial labour market is among the core missions of a university. Impeding factors are, however, the mismatch between the demand of industry and the reality of teaching practices and student learning experiences, which require reformation of the existing teaching and learning approach (Barrie, 2005). The mismatch is evident due to the significant differences observed in the current work demand and circumstances faced by the engineers compared to the previous generation of engineers. In reality, the newly recruited engineering graduates are subjected to a wide range of job roles. They are responsible to contribute in the highly innovative workforce and fulfil high expectation from their employers (Child & Gidson, 2010; Sthapak, 2012; Saad et al. 2013).

Historically, the academic development is a dynamic activity within the engineering education process that is crucial in generating the talent pool through positive teaching and learning processes (2007).

Table 1-1 demonstrates the four teaching and learning activities of the academic development process. The academic development process contains four blocks, which are important for providing quality teaching towards enhancing the learning experience of the students.

Table 1-1: Academic Domains of Teaching and Learning Activities

(Source: interpretation of Mishra, 2007; Seppo & Lilles, 2012)

Teaching and Learning Outcomes Activities	Description of Domain
Cooperation in Education (CE)	Focuses on innovation and reformation of the curricula and the teaching and learning experiences which aimed to meet needs the of evolving industrial landscape
Mobility of People (MP)	Emphasizes on mobilizing the students and graduates to explore, experience and embark the challenges in engineering practice through internship and employment opportunities
Knowledge Up-Gradation (KU)	Focuses to innovate the curriculum through educational enrichment activities that supplement the theoretical knowledge in view of stimulating students' learning curve towards engineering practice and development in industry
Intellectual Enhancement (IE)	Focuses to innovate the curriculum on the collaborative initiatives and projects that integrate research and education that leads to academic publications as the output of real-world setting.

(1) Crafting and designing a curriculum that nurtures students to gain a broader range of knowledge. This includes adopting an innovative pedagogical approach to respond towards diversity in their learning process. This anticipated by assuring the curriculum contents and its educational missions are aligned towards the industrial needs, employment demands and keeping abreast towards the technological development. These elements are encompassed into a teaching and learning domain known as cooperation in education (CE).

(2) A production of knowledge-based human capital aptly competent with the desired skill sets. The university education and the mode of learning should be able to address the students' competency for employability skills, knowledge, values and attributes that are nurtured whilst at the university. Thus, this aid in forming the main pillar towards producing the skilled workforce mobility. These elements are encompassed into a teaching and learning domain known as mobility of people (MP).

(3) Educational establishment strives to develop skills and competencies that are essential to harness the learners' ability for a flexible continuing education mode. This entails a value-added knowledge through enhancement activities such as specialized training skills via seminars, workshop, and mentorship. These activities help to steer interest and awareness towards understanding the needs of industry for several specialized segments. Thus, this forms an initial step towards impressing the potential employers. These elements are encompassed into a teaching and learning domain known as knowledge-up gradation (KU).

(4) A training ground to encourage the pursuit of new breakthroughs to harness its potential to produce innovative outputs that directed towards dealing with the real-world industrial problems. The training and projects in the industrial settings would be valuable in terms of understanding the mechanics of the industrial sector. Thus, propelling intellectual drive towards frontiers of knowledge by collaborating through publications and transmission of knowledge. These elements are encompassed into a teaching and learning domain known as the intellectual enhancement (IE).

In general, due to the dynamic nature of the industry in terms of job scope and demands, the university requires paying close attention to the teaching and learning outcomes in the engineering practice. Hence, it is important to establish a synergy between engineer-in industry and engineer-in academia. Studies indicated that engaging industry in the curriculum implementation involving teaching and learning processes had positive effects. The positive effects observed include shaping of the curricula in terms of insights on the contents and skills requirement, empowerment of lecturers and students on the real world challenges, technological products and emphasis on the learning scenarios inside and outside of the classrooms (Onwuka, 2009; Nghiem, Goldfinch & Bell, 2010; Shah and Nair, 2011; Pinnelli, Hall & Brush, 2013).

Recently, studies have demonstrated the mismatch between the quality of teaching and learning in university and expectation of the industry (Patil, Nair and Codner, 2008; Parkinson, 2009; Zaharim et al., 2009; Male, 2010; Shah and Nair, 2011). This is largely due to the inefficiencies of the universities to produce graduates with good quality workability in the engineering practice. This creates dissatisfaction among the industry in terms of recruitment. For example, a study conducted by the Lowden and colleagues to explore the employers' perception on the employability skills of the new graduates revealed that industry has a greater expectation on the graduates to demonstrate broader skills and attributes that are beyond technical and discipline competencies (Zaharim et al., 2009; Shah and Nair, 2011). Additionally, the study asserted the disparity between the requirement of industry for its employers and academic framework of several universities. Hence, it is essential for the universities to infuse innovative learning and teaching methods, relevant and dynamic course contents and other measures to stimulate students' learning experience that could assist in addressing the low employability rate of the graduates (2011).

According to a report by UNESCO on graduate employability in Asia, it was indicated that current employers demand good work quality and well-trained graduates from universities across Asia (2012). This entails efforts to foster partnerships by formulating suitable linkages with industry as part of the solution to bring the richness of industrial practice to the classroom in view of enhancing students' understanding of the theory and its potential application in the modern industry. In fact, the cultural shift of engaging industry is necessary to stimulate the learning experience of industrial practice and professional relevance during the early course of the study while fostering university-industry partnerships on a different dimension (teaching and learning activities).

Similar scenario as observed by many universities across the globe, universities in Malaysia are also facing the issues of not on par with the expectation of the modern industry. Hence, the universities are required to set the clear articulated institutional mission that stipulates the excellent outcomes of their engineering education system, which could produce good quality engineering graduates suitable for the evolving industrial landscape. A survey indicated that the deficiencies in the teaching and learning processes were the main reason for the existence of the gap between theory and practice which resulted in 15.3% of the engineering graduates to be unemployed (Shah, 2008).

Moreover, there have been increasing concerns raised on the manner and mechanism adopted by the university in teaching and learning activities of the engineering education (Zaharim et al. 2009; Yusoff, Omar and Zaharim 2011). Hence, there should be a transformation in the teaching and learning outcomes activities of the professional engineering education.

Evidence has shown the existence of mismatch between the skills and abilities gained by students and the need of current practice in the field (Patil, Nair & Codner, 2008; Zaharim et al., 2009; Trevelyan, 2010). This was due to the lack of sufficient feedbacks obtained from the industry. The workplace performance of engineering graduates has been constantly a subject of criticism. Therefore, a study indicated that the evaluation of educational quality has reached a turning point that requires joint interpretation, vis-a-vis hold on the expectation of industry and the assumptions made by the university in common (Tsubaki & Kudo, 2011).

In this pursuit, (Kaushik & Khanduja. 2010) indicated that the university should prioritise improvement of quality teaching and learning because educational mission identifies students as the product and the customer as the employers (industry). Hence, defects of “product” that is unable to meet the aspiration of employers should be significantly improved in view of supporting future technical manpower requirements.

The university-industry partnerships have great potential to improve the quality of engineering education through both teaching and academically inclined research projects. Consequently, the strategic partnerships of industry-university are geared to significantly improve the efforts to bridge the gap between teaching and learning outcomes and the need of engineering practice in terms of relevance of its contents, theoretical knowledge, technological development, broadening skill sets and improving the professional outlook (Giuliani & Arza, 2008; Bullen, 2010; Symes, et al. 2011).

Industry plays an important role to bridge the gap between teaching and learning outcomes and engineering practice by prompting the regulatory and professional bodies to pressure the university to sustain partnerships. This will eventually enhance the quality of engineering education that excludes the traditional research and commercialisation activities. For example, the Malaysian Engineering Accreditation Council (EAC), which recommends the outcome-based approach under the requirements of the Washington Accord as a member country, has requested the engineering degree programme providers in Malaysia to engage actively with industry to seek inputs on academic development strategies as part of the improvement measures (Engineering Accreditation Council, 1999). Consequently, this forms as a common accrediting principle shared by the accrediting agencies of “outcomes” culture to drive the improvement measures (Patil, Nair & Codner, 2008; Megat, 2010; Dowling & Hadgraft, 2011). Hence, this forms a radical change that advocates a reappraisal in the professional engineering education in Malaysia.

1.2 Research Scope of Study

Growing evidence has shown that greater access of engineering practice into the classroom settings via partnership with industry had significantly shaped the students' learning curve (Patil, Nair & Codner 2008; Onwuka, 2009; Zaharim et al., 2010; Shah and Nair 2011; Alexander et al. 2012; Pinelli, Hall and Brush, 2013). Generally, the goal of the university-industry partnership is to improve the pursuit of knowledge-based human capital who are able to meet the aspiration and demand of workplace.

Historically, the collaborative pursuit of research initiatives is based on the outcome-based accreditation criteria of the Accreditation Board for Engineering and Technology (ABET), which aimed to engage the industry's perception on the curriculum development of engineering education (Lang et al., 1999). It should be noted that ABET, serves as a professional accrediting organisation that accredits engineering-related programmes in the United States. ABET forms as an important outcome-based accreditation framework which has a widespread use of the criteria required to provide the structure for quality engineering education at the undergraduate level.

Exploring on approach as suggested by ABET, this research study, however, focuses on the outcome-based accreditation criteria developed by Engineering Accreditation Council (EAC), Malaysia, which has its root from the ABET framework. The research emphasizes the important element of the accreditation criteria, which is the academic development that forms as an important quality assurance element adopted in outcome-based accreditation (OBA) of professional engineering undergraduate programme.

Additionally, this study involves dissecting the academic development Criterion 1 of EAC framework into four teaching and learning activities of the academic domain as highlighted by Mishra (2007). This is to explore important multidimensionality stages of its significance towards fostering the university-industry partnership. In this regards, the study entails developing teaching and learning activities framework created based on the EAC accreditation framework as illustrated in **Figure 1-1**.

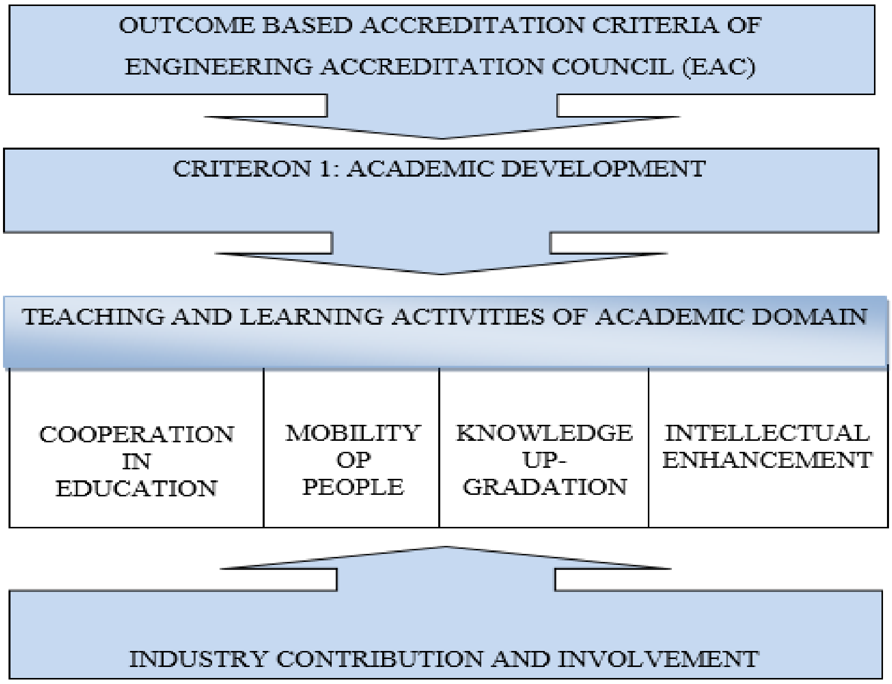


Figure 1-1: Dissected Accreditation Framework Illustrating the Teaching and Learning Activities within Academic Development Criterion

This research focuses on the nature of the interaction between the teaching and learning activities within the academic development criterion of the professional engineering education. Moreover, the research focuses on the manner and perception influences towards the formation of university-industry relationship in enhancing the students' learning experiences towards improving the talent pool during their course of the study.

On the grounds that, to the best of author's knowledge, there has been little development on the significance of engagement of communities of the industry with the universities especially for the teaching and learning activities within the academic development criterion of the outcome-based accreditation of Engineering Accreditation Council (EAC) in Malaysia. Therefore, against the background, the study was conducted based on the following aims:

(1) Firstly, to investigate a conceived research model that hypothesised the influence of teaching and learning activities of the academic domain of academic development criterion based on the partnership with industry.
(2) Secondly, to develop and examine the hierarchical model that provides a locus for the industry to rank the preference of academic-led linkages with the university for the teaching and learning activities in the professional engineering undergraduate programme.

This research is aimed to address the following research questions:

- Overall, does the research structural equation model (SEM) created indicates a satisfactory degree of fit to the observed data?

- Do the teaching and learning activities have statistically significant effects on the partnerships with industry?

- What is the preference of the communities of the industry on the academic-led linkages that could narrow the gap between the theory and practice in enhancing students' learning experience?

The forefront of the university interest should be in the quest of achieving excellence in education that improves students learning experience and exposure through the greater inclusiveness of industry in the teaching and learning outcome activities. Studies have indicated that academic-based links are established between the university and industry as the form of investigation to acknowledge the level of diversification of industry (Morell, 2008; Zaharim et al., 2010; Shah and Nair, 2011). Therefore, it is necessary to investigate the perception of industry on the preference of academic-led linkages, which supports the efforts taken by the university in minimizing the impact of chronic complaints made on the quality of teaching and learning.

1.3 Research Objectives

Growing evidence indicates that it is crucial to investigate whether the greater inclusive representation of the industry in the teaching and learning activities of academic development criterion would have positive significance in fostering the partnerships towards producing better talent pool of graduates. As such, engagement of university-industry partnerships requires exploitation of industry's preference of the academic-led linkages in supporting the university in its educational mission, specifically for the teaching and learning activities of the professional engineering education.

The aim of the current research builds based on the evidence from the past studies that form the basis to conceive and investigate a research model. Hence, the model hypothesised the influence of teaching and learning activities of the academic domain on the partnerships with industry towards improvement efforts of engineering graduates. In fact, this research is the first of its kind to investigate the correlation of teaching and learning activities adopted in an "outcomes" culture of the professional engineering education in relation to university-industry partnerships in Malaysia.

In view of the above, the proposed study herein involves the investigation of the pedagogical reform activities as listed below:

1. To carry out the scholarly review that provides collective insights towards the significance of industry's inclusive representation in bolstering the quality of teaching and learning in shaping the work quality of the talent pool.

2. To investigate university-industry partnerships using a cause-effect approach based on the triangulation from data of published domains and industry is input.

3. To investigate the influence of subjective preference of industry towards establishing successful university-industry partnership using multiple criteria decision-making (MCDM) theory.

1.4 Overview of the Research Methodology

The research seeks to develop and validate a conceptual framework on the correlation of teaching and learning activities adopted in an "outcomes" culture of the professional engineering education to establish partnerships with industry. In addition, the study aimed to investigate the perception of industry on various academic-based linkages in fostering partnerships with the university. Nonetheless, the industry's preference of academic-led linkages is based on their strength, expertise and corporate policy to support the university to be part of the solution aiming towards enhancing the quality teaching and learning in professional engineering education.

In this study, the SEM technique was used to evaluate the extent to which the observed data fit the overall model. SEM allows diagramming the hypothesised set of relations (the model) and consequently addresses the research questions. Additionally, a survey instrument tool that adopts a 10-pointer Likert-scale type was developed. The survey was distributed to industries based on their engineering activity across Malaysia. The data were collected through self-administered questionnaires distributed, particularly to the field engineers.

The research methodology comprises of two stages as follows:

Stage 1: Literature research to determine the research focus.
Part A: Industry profile information and preference on the type of linkages.

Stage 2: General survey of the stakeholders (engineers in the industry) of various demographics, which include the regional coverage, ownership type, the type of industrial sector and work experience of target respondents for the study. A specific survey that uses a pairwise comparison method to obtain the preference of the type of the linkage that promotes partnerships between the university and industry.
Part B: Perception of the industry towards teaching and learning domains of academic development. A specific survey that uses the conceived structural equation model to examine the correlation of teaching and learning outcomes activities, which significantly influences the university-industry partnerships.

The data were analysed using SPSS 21.0 and AMOS 21.0 to address the research question 1 and 2 for examining the structural relationship of six constructs in the developed cause-effect model. In addition, the collected responds were verified for any detectable error for exclusion. The sample size of the study was 212 samples, which was used to analyse the conceptual model. The data analysis for the goodness-of-fit between the cause-effect model and empirical data was conducted based on the set of parameters that are described in Chapter 4.

To address the research question 3, a multi-criteria decision-making (MCDM) approach was adopted to decide the ranking when criteria are conflicting in nature. It should be noted that the analytic hierarchy process (AHP) forms as an effective problem solving multi-criteria decision-making method that is used to explore industry's preference on the type of linkages in their quest to establish partnerships with the university. Subsequently, the output was optimized to identify the best linkage to harness their expertise to foster the partnership with the university in view of bolstering the quality of teaching and learning.

1.5 Significance of the Study

This study has both the theoretical and practical perspectives as listed below:

(i) The purpose of the university directed towards engaging the industry in its efforts to enhance the students' learning experience of real-world orientation within the academic development criterion.

Over the past decade, universities were pressured to play a pivotal role to adopt the quality teaching approaches in enhancing student's learning experience to offset the educational enrichment gap observed in the current practice of its teaching and learning activities (Bullen & Silverstein, 2005; Patil, Nair & Codner, 2008; Male, Bush & Chapman, 2009; Burli, Bagodi & Kotturshettar, 2012). Moreover, the theory on the quality teaching in the professional engineering education has been explored extensively to assure the improved and balanced outcomes in the learners learning experience for both theoretical and practical teaching with the greater interaction of industry in the learning domain.

The survey studies conducted previously indicated lack of efforts in obtaining sufficient feedbacks from the industries. This resulted in the mismatch between the skills and educational enrichment (Patil, Nair & Codner, 2008; Sthapak, 2012; Saad, et al., 2013).

(ii) The real-world orientation involves the development of certain learning abilities of "added value" among learners through academic-based linkages.

Nowadays, universities realize the potential benefits of university-industry partnerships as the way to improve the "added value" elements in the teaching and learning. As such, the university views partnerships with industry as a mutually benefiting endeavour, which aids the university to be part of the solution to overcome the gaps between theory and practice. Additionally, this effort aid to infuse additional skills as "added value" into the learning process (Morell, 2008; Onwuka, 2009; Shah and Nair, 2011; Morell & Trucco, 2012). The "added value" is related to the partnerships, where it is expressed in terms of technical knowledge add-ons or in terms of financial advantages and so on.

The current literature indicates the importance of industries' commitment to establishing partnerships with universities from a global perspective. Nevertheless, there is no evidence for potential variables that could be derived from the above theoretical basis in Malaysia.

(iii) The effort towards greater inclusive representation of industry in the teaching and learning is particularly noticeable in fulfilling continual improvement measures as encouraged by Engineering Accreditation Council (EAC), Malaysia.

Universities are held accountable to focus on the continuous improvement strategies to its stakeholders especially students and industry as advocated by "outcomes" as indicated by the professional bodies (De Jager & Niewenhuis, 2005; Patil & Codner, 2007; Megat, 2010). Furthermore, the professional accreditation bodies emphasize on other measures including monitoring the achievement of learning outcomes of students, strengthening academic rigorous programmes and its relevance to current trends and demands of the industrial landscape. These measures are aimed to enhance the students' learning experience in relation the engineering practice. Therefore, by gaining valuable insights as a basis for continuous improvement efforts as proposed by Engineering Accreditation Council (EAC), Malaysia, the result of this study will provide a promising dynamics towards the relationship between the university and industry on teaching and learning outcome activities.

1.6 Scope and Limitation of Study

1. This study is limited to obtain constructive feedbacks and assistance to formulate enhancement strategy in the professional engineering undergraduate programmes within the academic development framework.

2. The study is limited to provide insights towards fostering the engagement with industry players of technical in nature inclusive of consultancy establishment within Malaysia.

3. This study is confined to university setting which refers to Engineering school or faculty that offers four years of Bachelor degree programmes approved by EAC/WA manual 2012 in Malaysia.

1.7 Outline of the Research

The thesis is organized into five chapters as follows:

Chapter 1: Contains general introduction and the background of the thesis.

Chapter 2: Presents the literature and background of the study. The chapter discusses the importance of initiating quality teaching and learning activities and its implications towards stakeholders (students) and industry. It discusses the basis of the conceptual frameworks, which is developed through the gathered theoretical materials.

Chapter 3: Describes the methodology adopted in this research. It covers the survey method and the target respondents. The chapter also describes the data collection method, the tool used for analysis to determine the correlation between teaching and learning activities and the university-industry partnership and preference of linkages by the industry experts.

Chapter 4: Outlines the findings of the survey analysis using the data collected from various industrial sectors in view of investigating the reliability and validity of the developed framework.

Chapter 5: Concludes all the chapters and discusses the research conclusion, significance of the study in terms of contribution to new knowledge. This chapter also provides recommendation and implications for further research.

Chapter 2
LITERATURE REVIEW

2.0 Overview

The research is explored under two-fold drive: firstly, it focuses on investigating the cause-effect of the greater inclusive representation of industry into the teaching and learning outcomes activities of engineering education. Furthermore, it focuses on the manner it influences university-industry relationship for improvement in enhancing students' learning experience. Secondly, it explores the preference of industry experts in ranking the teaching and learning domains.

2.1 Teaching and Learning of "Outcomes" Culture

The beginning of 21st century has steered a huge change in the educational landscape of the higher education segment especially on the teaching and learning of professional engineering education. Concurrently, the engineering practice is undergoing the significant transformation over the past decades. According to a report by UNESCO on engineering (2010), the university has a crucial role towards emphasising the teaching and learning activities of its engineering programmes to produce good work quality talent pool with relevant knowledge and broader skills.

The new learning environment that complements the conventional approaches to learning process such as lectures, tutorials, and experiments should be explored further to enhance the students' learning experience. In addition, the contents and its educational outcomes need to be designed in a way it could stimulate curiosity amongst the learners with in-depth exposure to a real-world engineering practice during their course of the study. Thus, several studies suggested that universities should intensify efforts towards creating the teaching and learning activities beyond the classroom settings to spark curiosity, the element of probing and questioning that are critical for the professional development and industrial practice of the engineering students (Prince and Felder, 2006; Borrego, et al., 2010).

In many countries, educational mission and outcomes of the professional engineering programme emphasize on the teaching and learning activities towards improving the students' learning experience. It is envisaged that universities would adopt proactive role to optimize the condition for the success of its learners in a challenging manner. This eventually stimulates the development of knowledge, skills, and performance with greater industry interaction.

Studies have indicated that a diverse mode of teaching and learning approaches exist in the professional engineering education. In this context, relying only on traditional teaching methods including classroom lectures, assessments encompassing quiz, and exams are inadequate to positively influence the learners' learning experience. In agreement with this, (Burns & Chisholm, 2005); Streveler & Smith 2010) revealed that the traditional teaching and learning processes that solely dependent on classroom setting had a low correlation to a real-world situation. Hence, there should be a shift in the teaching and learning methods that will enable the students to translate the theoretical knowledge gained in the classrooms to solve problems in the real industrial settings.

The outcome of a survey conducted on the students demonstrated that the traditional lecturing method had a very low score in all categories as it failed to motivate them in a challenging approach (Simcock, Shi & Thorn, 2008). On the other hand, the better rating was recorded for an approach that exposed students with industry-based problems with broader understanding of local industry that demonstrated to improve the students' learning experience. Thus, this asserts that harnessing the potential richness of engineering practice into the teaching and learning activities allow learners to immediately assess the relevance of their academic materials.

In general, the teaching methodologies and strategies of learner-centered practices are effective. Nonetheless, it might inadequate to impose the importance of real-world and professional relevancy (Prince and Felder, 2006). Moreover, many studies demonstrated that the paradigm shift on engagement of industry in the teaching and learning was directly driven to address the identified mismatch of skills and abilities of the talent pool embarking into the industry (Arlett et al., 2010).

The engineering educational navigators have suggested that there is a need for the significant changes to the engineering curricula, specifically to knowledge and skill sets of the current talent pool (Pandi & Rao, 2006; Male, Bush & Chapman, 2009; Oladiran et al. 2012). This imposes greater accountability on the university to produce the talent pool with the global mentality and highly productive for the local industries through enhancement of teaching and learning activities to the forefront of higher education policies. Moreover, it is imperative that university should move towards the process radical change in providing better training “incubator” for its learners.

Research has shown that neglecting the emerging radical changes in the teaching and learning leads to inabilities among the graduates to meet the changing needs of the competitive environment within today’s industry (Patil, Nair & Codner, 2008; Shah and Nair 2011). Nevertheless, irrespective of significant of changes to engineering practice, many universities offering professional engineering education tends to respond very slowly towards developing better understanding and demands of engineering practice and professional relevance among its learners. Therefore, this demands an adoption of “outcomes” pedagogical approach in the professional engineering education that ensures significant involvement of the industry as part of the teaching and learning processes.

There is a growing demand for good workability and capable engineering graduates to fulfill the industry needs. Thus, this demands many countries to reform their education system and structure by adopting a new learning approach known as outcome-based education (OBE). OBE is one of learning approaches that produce critical success in curriculum development to produce the globally competent workforce to meet the “outcomes” climate in the professional engineering education. Furthermore, adoption of this teaching pedagogy coupled with the systematic approach of improvement stages significantly improves the innovative talent needed by the industry among the graduates (Paramasivam and Muthusamy, 2012). This is essential where restraining this would reflect badly on the university and its ability to understand the trends and needs of industry.

Many countries have adopted outcome-based education as a constructive effort to modernise teaching and learning. The approach useful as an assessment process in developing learners’ abilities of the professional engineering education. Moreover, the learning outcomes should be achieved in a holistic yet measurable manner. This is essential especially in the professional engineering programmes as for the “outcomes” culture; the university is accountable to gauge quality of the teaching outcomes in improving the students' learning experience during their course of the study (Patil & Pudlowski, 2005; Pandi & Rao, 2006; Patil & Codner, 2007; Palmer & Ferguson, 2008).

The outcome-based approach uses the learning outcomes as the basis to design the curriculum, which is endorsed by the Washington Accord. Washington Accord is an international accreditation agreement for the professional engineering degree programmes. The Washington Accord facilitates international mobility of the engineering graduates and contributes to improving the quality of engineering education through benchmarking (Bullen and Silverstein, 2005; Memon, Demigoden and Chowdhry, 2009; Megat, 2010; Rajaee et al., 2013). In addition, the Accord compels the university to conduct proactive improvement measures towards safeguarding the educational standards specifically on educational processes such as teaching-learning, curricular development, training and competency development and best practices in teaching-learning processes. This will eventually form engineering accreditation of outcomes, which directed for specific engineering educational programmes.

The academic accreditation process is challenging yet critical for engineering education providers for ensuring quality assurance. Accreditation is proposed as a platform to maintain quality assurance where it is advocated by the professional society or accrediting body. The accreditation enables the universities to strategically meet the challenges revolving industry's expectation, which are primarily driven by fluctuating demands and stiff competition within the regional industrial landscape. Moreover, in agreement with this, (Mishra, 2007; Bullen, 2010; Miszalski, 2011) indicated that accreditation process of an outcome-based engineering programme significantly influenced the teaching and learning outcomes activities in terms of improvement. The process requires the detailed evaluation of a scale for measuring the students' engagement in learning activities, which include the coverage of the curriculum content, the pedagogical approach in harnessing students' skills and abilities, enrichment activities and work integrated learning.

In Malaysia, EAC was established in 2000 to assure the good quality of its higher education system especially the professional engineering programmes (Megat, 2010). The formation of EAC empowers Malaysia's aspiration to generate global engineers with the high level of competency to tackle challenges of 21st century. This professional accreditation outfit enforces the quality improvement by developing accreditation criteria and policies to ensure education providers are equipped with proper guidance for teaching, learning, and assessment practices. The accreditation criteria developed adopt accreditation and assessment processes that are proposed by Accreditation Board for Engineering and Technology (ABET), which has been practiced in the USA and many other countries. It should be noted that ABET has outlined the outcome-based accreditation criteria for engineering education, which also emphasizes on the improvement that primarily associated with trends of engineering practice and labour demands (Patil and Pudlowski, 2005; Thandpani et al, 2010; Chugh and Dixit, 2012).

The establishment of outcome-based accreditation approach of accreditation bodies has changed the landscape of professional engineering education to focus on the continuous improvement strategies for its stakeholders especially students and industry. In pursuit of this, (Megat, 2010; Felder et al., 2012) indicated that the professional and accrediting bodies developed an accreditation framework as a guide to be adhered by universities offering professional engineering undergraduate programme.

Fundamentally, the mission of many higher education institutions across the globe including Malaysia is directed towards establishing academic excellence by providing good quality engineering education with globally accepted engineering standard. Thus, Malaysia, as one of the WA member, under the purview of EAC, has formed the local setting, monitoring and evaluation of quality teaching and learning by establishing the accreditation framework, which consists of five criteria (Basri,2009; Megat, 2010) as shown in **Figure 2-1**.

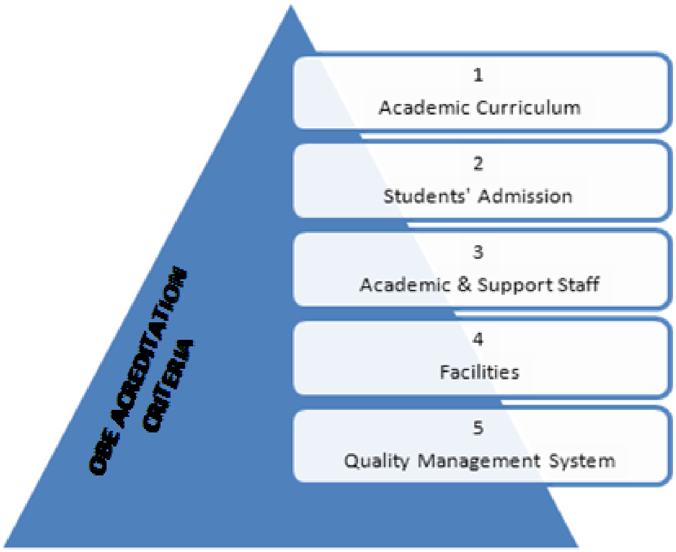


Figure 2-1: Outcome Based Accreditation Criteria of EAC for Professional Engineering Programmes in Malaysia

(Source: Interpretation from EAC Manual, 1999)

Moreover, (Chugh & Dixit, 2012; Saad et al., 2013) demonstrated that a gap analysis of knowledge, skills, and attributes of graduates' ability could map the accreditation that complies with the global standard. Particularly, the professional accrediting bodies are responsible to assess the performance of engineering programme outcomes and the educational mission in a developed accreditation framework. Outputs of the gap analysis could be used as a measure of continuous improvement to enhance the teaching and learning activities, engineering practice, and professional outlook.

(i) Criterion 1: Academic Curriculum

Curriculum development is an important process that shapes capabilities of the graduates in terms of knowledge, qualities, skills, and values during their course of the study. Hence, knowledge, values, and skills that are useful for employability should be prioritized in the developed programme.

As such, the academic curriculum criterion established by EAC provides a vital guide for the universities to develop curriculum contents of the professional programme that ensures sufficient knowledge, values, and skills. It also emphasises on the adoption of "outcomes" pedagogical approach that improves the students' learning curve. Furthermore, knowledge and skills directly related to the subjects in the programme and the integration of soft skills through enrichment activities involving workshops and activities beyond classrooms especially through collaboration with industry partners should not be neglected. This is because the above activities are geared towards forming the balanced and holistic development of the students' abilities, which are required by the employers. In short, the designed curricula for engineering programme should emphasize the students to gain significant real-world exposure and experiences, which are common in industrial processes.

(ii) Criterion 2: Students' Admission

The students are the main stakeholders of the institution of higher learning where they have a leading role in ensuring the programme to gain popularity and sustainability. As such, criterion 2 outlines the selection of qualified candidates by the education providers. A proper and uniform entry qualification scheme is developed to control the selection process and preserve the good reputation of the academic programme in terms of producing good talents for the workforce.

(iii) Criterion 3: Academic and Support Staff

The outcome of an educational experience is largely influenced by the professional competence and outlook of the community of educators. Simultaneously, teaching the professional engineering programme is a challenging endeavour faced by many institutions. In view of this, criterion 3 indicates the need for sufficient and qualified academic and support staffs for a developed and approved programme. Thus, institutions are strongly encouraged to emphasize on initiatives to encourage the academic staffs to be proactive in embarking on an applied research, engaging in collaborative and consultancy works with the industry partners.

(iv) Criterion 4: Facilities

Strategies to support the teaching, learning and research activities are important components of an educational institution in its mission to create a conducive learning environment. Therefore, the university should be well equipped with physical resources and educational facilities such as classrooms, lecture halls, and technical facilities. Moreover, the library and academic resource center should be equipped with a wide collection of academic materials coupled with a good range of electronic database systems.

(v) Criterion 5: Quality Management System (QMS)

The quality management system is an integral part of an academic programme. This criterion strongly encourages the engineering education providers to perform curriculum reviews periodically, and to actively involve in the selection of members of the industry. The aim of these efforts is to keeping up with the current trends of technological advancements, and industry's need.

Substantial feedbacks from the industry help to assess and improve the outcomes of the programmes. The tool developed based on QMS should assist the institution to progressively improve the objectives of the listed programme. This, in turn, could lead to improved teaching, which is essential in changing the learning curve of the students and development of graduate attributes. Hence, in overall QMS aids in forming a good balance between the academic rigor and quality of graduates produced for the workforce.

2.2 Significances of Industry in Stimulating the Learning Experience

As both industry and engineering practice are undergoing rapid transformation, universities across the globe acknowledged the need for reformation in the engineering education to withstand the continuous criticism hurled by the industry players (Bullen & Silverstein, 2005; Bridgestock, 2009; Shah and Nair, 2011). In addition, the mismatch between industry and engineering practice as pointed out by the industry should be viewed as an indictment for further improvement of the teaching and learning processes of the existing education system (Onwuka, 2009; Shah and Nair, 2011; Mandal and Banerjee, 2012).

Despite the cardinal role of classroom experiences in enhancing students' knowledge, the preparation for embarking on the job market was significantly associated with the involvement of industry in shaping the educational mission (Prince and Felder, 2006). This was in agreement with a study, which suggested that innovative strategies in the teaching and learning processes, particularly fostering partnerships with industry, resulted in the broadening of the intellectual ability of the learners towards excellence practice in the evolving industrial landscape (Onwuka, 2009).

Beyond developing the technical and non-technical competencies, greater exposure to real-world engineering practice should be introduced in the teaching. Therefore, students' learning experiences through teaching and learning outcome activities are required to have greater representation of the industry. Moreover, as a part of the constructive approach in addressing the critics from the industry, universities are increasingly recognizing the significant involvement of communities of industry and its value to the relatively conventional class dynamics (Alexander et al. 2012; Pinelli, Hall and Brush, 2013).

Evidence has demonstrated that lack of coordination between university and industry resulted in the production of engineering graduates who are inadequately prepared for the cutting-edge technologies to build modern industries (Zaharim et al., 2010; Shah and Nair, 2011). Referring to the report by Royal Academy of Engineering (RA Eng) on excellence in engineering education (2012), the academic development of engineering education should be reviewed to enhance the students' learning experience and provide exposure towards the changes through the teaching and learning activities.

Now the biggest challenge is for the university, to be responsible towards modernisation of the educational mission, which will provide the avenue for the industry to be part of the solution in overcoming the deficiencies observed in the teaching and learning processes. In agreement with this, the Science & Business Commission Report on university-industry partnership stated that a strategic academic-led collaboration that adopts insights and recommendations of employers (industry) yielded positive outcomes in improving the educational mission of the programme (Edmondson et al., 2012).

The university-industry partnership is directly relevant to the curriculum development and enhancement of teaching and learning activities. This will eventually produce a talent pool of desirable skills and abilities of current and future modern industry. Moreover, the advancement in technology directly influences the demand for good work quality characteristics among the new engineers to the forefront of industry's interest. **Figure 2-2** summarizes the characteristics of good quality graduates as perceived by the employers, which was adopted from a report by UNESCO on graduate employability in Asia (2012).

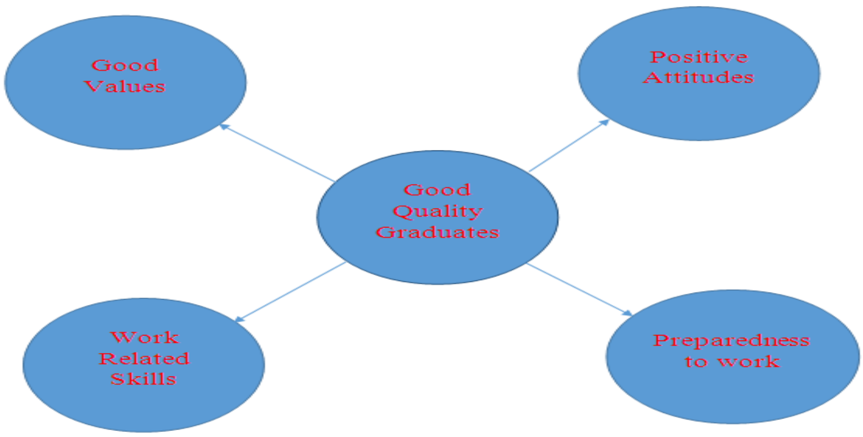


Figure 2-2: Employers' Perception of Positive Characteristics of Graduates
(Source: UNESCO on Employability of Graduates in Asia Report, 2012)

The report (2012) reinforces that university should be more proactive towards nurturing work attitudes of industry appeal in terms of good values that encompasses honesty, confident, innovative and creative; positive attitudes which require graduates to be hardworking, highly motivated and curiosity driven; work-related skills which covers communication, entrepreneurship and leadership skills; and preparedness to work which covers on industry-ready skills and ability to perform well in a working environment.

The employers' perception towards the positive characteristics of the graduates should be considered critically especially during the current challenging era that is swiftly changing the role of engineers in society and consequently the nature of engineering practice. Therefore, the engineers equipped with these positive characteristics are expected to contribute their acquired knowledge to conceive and transform scientific ideas to fulfill the demands of the fast-paced and innovative industry after graduation.

The universities across the globe are at the pace of facing the international requirements for producing a good quality talent pool. Hence, the university-industry linkages are being formulated to fulfill the aspirations of the industry in creating the "right" talent pool of engineers. Moreover, establishing partnerships with industry is vital where this forms a learning platform for the university to understand the mechanics and trends of rapid technological innovation.

As part of improvement efforts, communication between educators and field engineers must be emphasized through a partnership to successfully nurture the next generation of engineers. Additionally, most of the critics from industries emphasized on the mismatched nature of the teaching and learning outcomes activities (Patil, Nair & Codner, 2008; Zaharim et al., 2009; Rasiah, 2009; Male, 2010; Shah and Nair, 2011). Therefore, by exploring the evidence gathered from previous studies, this study attempts to integrate the academic domain of teaching and learning outcome activities as described by (Mishra, 2007) and the engagement with industry to form partnerships with the university to support the described domains as shown in **Figure 2-3**.

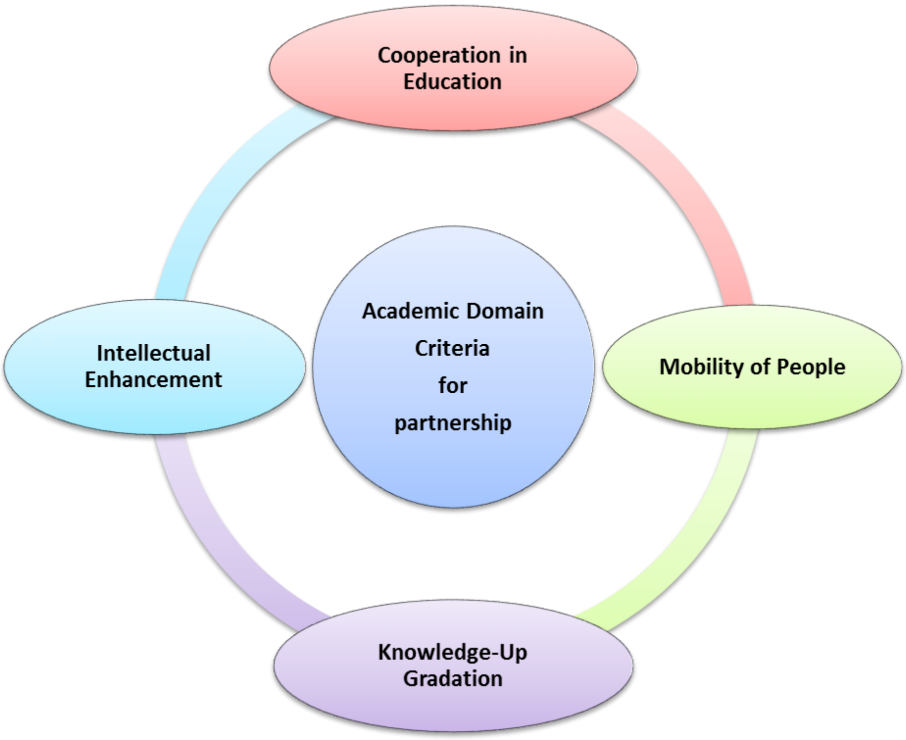


Figure 2-3: Exploration of Industry's Involvement in Teaching and Learning Activities of Academic Domain

Universities recognize that the rapid innovation in terms of ground-breaking technology directly influences the work abilities of the engineering graduates. Hence, the graduates are required to be adaptable to the dynamics of the industry on a global scale and work efficiently.

In general, enhancement of teaching and learning is a decisive factor to produce graduates with good workability and skills. Moreover, it is a significant factor towards establishing collaborative ventures with industry. This was clearly indicated in a report by UNESCO on graduate employability in Asia (2012) where a study was conducted across selected countries in Asia, which explored the employers' perception of the employability skills of new graduates.

A report by UNESCO on the graduate employability in Asia (2012), revealed the existence of negative perception of employers towards the talent pool within Asia. The report indicated that the graduates from Asia are inadequately equipped with competencies required for good quality work. Furthermore, the report concluded that universities are required to clearly understand the types of skills required by the industry to meet their technical manpower requirements. In addition, another study reported that that the engineering students within the Asian regions are inadequately equipped with the desirable work skills to face the competitive global work environment (Zaharim et al., 2009). This was in agreement with findings from an industry-based survey conducted on 87 respondents (out of 1000 targeted) who are employers of various organizations (Cade, 2008). The study indicated the existence of the disparity between the learning contents of graduates and needs of the workplace. Moreover, about 55% of the employers recommended that universities should be proactive in preparing graduates for better future. For instance, establishing working ties between universities and employers (industry) could significantly improve the learning experience of the students.

The universities across the globe impose an inadequate emphasis on the critical skills and abilities in their educational mission. This has resulted in continuous criticism from industry players, which directly affected the employability rate of the talent pool (Barrie, 2005; Mishra, 2007; Patil, Nair & Codner, 2008, Abdullah, 2009; Zaharim et al., 2010). Hence, apart from focusing on the students' intellectual development, the universities also need to focus on identifying the gaps between the critical skills and abilities required from engineers at the workplace. In addressing the current issues, increased emphasis made in fostering the development of skills and abilities in the engineering education as advocated by WA-derived student learning outcomes (2011).

In Malaysia, towards anticipating the critical need for positive values among graduates, the EAC has formed a greater emphasis on the curriculum design and development criterion as part of the recent revisions of the professional body's requirements for the continuous quality improvement (Megat, 2010). This revision came to light as industries are suffering to secure good quality graduates due to the mismatch between theory and practice. In addition, the feedback from industry surveys indicated that graduates failed at the workplace due to inability to use their technical skills efficiently. As such, failure to impress employers in such critical domains resulted in a negative perception towards the entry-level graduates (Yusoff, Omar & Zaharim, 2012; Khoo, Maor & Schibeci, 2011).

Industries require current graduates with contemporary workplace professional attitudes, understanding, and skills. As shown in Figure 2-4, communication, problem solving, team-work, and increased knowledge of information technology are required by industries across many nations including Hong Kong, Singapore, Japan, and Malaysia. Fostering the development of these generic abilities in learners is challenging, yet crucial. Nonetheless, the industries perceive that securing the talent pool with good work quality abilities would positively enable them to fit and remain in the challenging work environment.

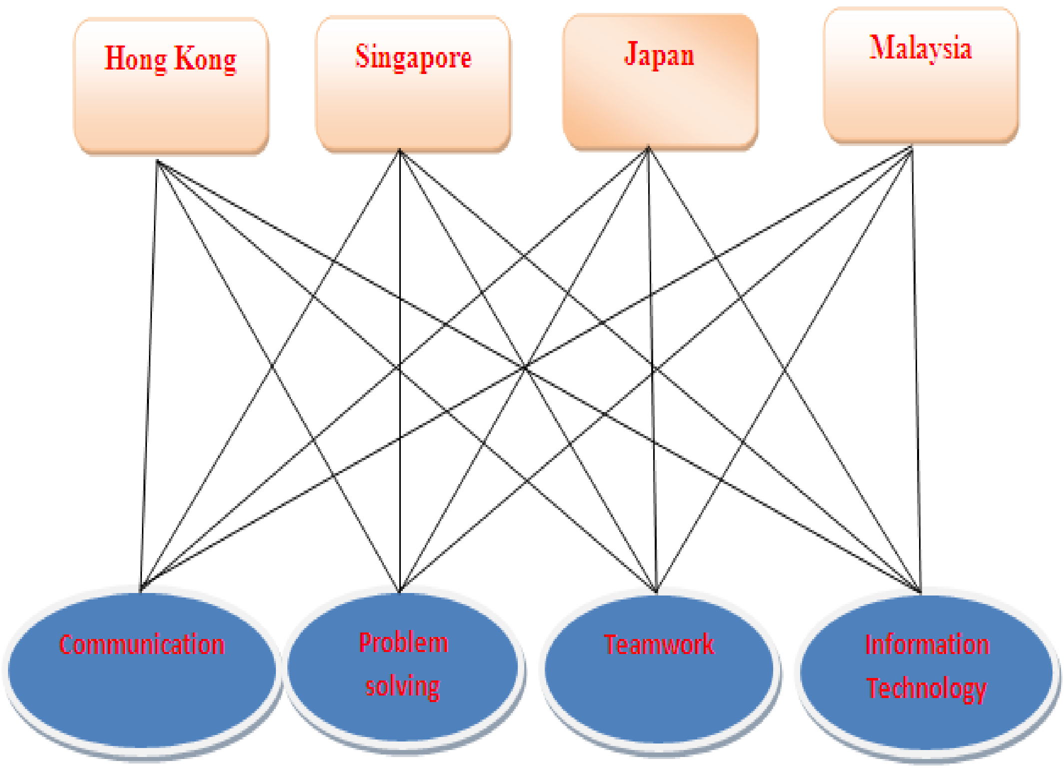


Figure 2-4: Essential Skills Desired by Industries across the Several Countries in Asia (Source: Zaharim et al. 2009)

The students are required to have different levels of motivation and attitudes about teaching and learning with different responses to specific classroom environments and interactions especially with field engineers (Felder, Brent & Prince, 2011). Therefore, the generic skills are best encouraged when they are supplied with instructional goals. Moreover, explicit teaching in the classroom and via interactive activities with the field engineers from industry was found to ultimately improve the students' learning experience (Zaharim et al., 2009; Shah and Nair, 2011).

A challenging landscape in Malaysia is that the industrial researchers view universities are outdated. This is because the higher learning institutions in Malaysia are still grappling with the theories with a minimal focus on the needs of the modern industries. Moreover, they are lack of effective strategies in developing skills among the learners to face the challenging industrial landscape. This is partly due to insufficient provision on the real-world industrial exposure and opportunity to collaborate and work along with the field engineers during their course of the study (Yusoff et al. 2008; Zaharim et al. 2010). In addition, it was lamented that the universities in Malaysia are not highly productive in enhancing the teaching quality despite gaining large budget allocations amounting RM56 billion in 2015 Budget. This amount was shown to be the highest budget allocated among countries in the ASEAN region (Mei, 2014).

Recently, the UNESCO report on graduate's employability in Asia (2012) indicated that approximately 34.9% and 30.2% graduates of technical field in 2006 and 2009 respectively from both public and private higher education systems in Malaysia had difficulty in securing employment. Moreover, 80% of employers suggested that universities should reform their curriculum to reflect realities of the current labour market. Additionally, 62% of employers indicated their concern over finding the talent pool of graduates with the necessary skills (Mei, 2014).

Despite this undesirable scenario in the labour market, 34% of industries indicated that they have never been approached by universities to form partnerships to overcome the issues related to curriculum, knowledge and skills, and work abilities. This directly influences the production of a good quality workforce. Due to this alarming scenario, universities have been pressured by EAC as part of improvement measures to strengthen their quality of teaching by forming collaborative ties with industry primarily to increase the employability of its graduates. As such, significant outcomes can be achieved with the formation of university-industry partnerships primarily to provide good quality education to its stakeholders, specifically the students.

Echoing the pressure to meet the increasing demand of the industry, the entry-level engineering graduates are expected to play a dynamic role in transforming the future technological landscape of Malaysia (Basri, 2009; Megat, 2010). Hence, the university should adopt a roadmap that significantly provides greater inclusiveness of industry into the teaching and learning activities of engineering education to raise the quality of its academic programme. Developing sustainable linkages with industries, however, is one of the challenges faced by the universities. In this context, the accrediting body instituting the improvement criteria on teaching and learning outcomes is viewed as a Triple Helix. Triple Helix is an academic-industry-link collaboration model utilized by the accrediting body, which focuses on the teaching and learning activities. The activities consist of separate institutional spheres, where the professional or accrediting body (government), the university, and industry operate individually.

The university could play an important role in the training for better work quality talent pool. This could achieve through forming greater partnerships with industry to maximize the “capitalization of knowledge” in its attempt to improve the students’ learning experience. Moreover, it is expected that the industry operates independently and establishes relatively close integration with the university to provide feedback and insights into the evolving industrial landscape and proactive involvement in assisting towards improving the students’ teaching and learning activities. The above strategies have direct effects on producing the talent pool, which is globally competent and mobile.

The professional or accrediting body, the EAC safeguards the quality standards of the training processes for the entry-level engineering graduates to meet the requirements of the industrial landscape. The accrediting body has developed an academic development criterion, which is an associating mechanism that is optimised to link the university with the industrial sector in the context of quality assurance of professional engineering education. This criterion assures that the university proactively engages with industry to seek inputs, recommendations, and collaboration to improve various elements in the programme (Mishra, 2007).

In short, the drive towards improving students' learning experience through the teaching and learning processes has led to university-industry partnerships to the forefront of higher education policies in Malaysia. A systematic study of the dynamics of the university-industry collaborative ventures is crucial to establish fruitful amendments in academia (Shah and Nair, 2011; Morell and Trucco, 2012). This scenario also applies to Malaysia, where success in this context largely depends on the support from industry players in the teaching and learning processes.

2.3 Synthesis

Over the past years, numerous studies have revealed the concept of an effective university and industry partnership that focuses solely on exploring a mechanism towards addressing the skill gaps and employment trends (Giuliani & Arza, 2008; Zaharim et al., 2009; Prescott et al., 2011). Nevertheless, there is a number of concerns pertinent to the teaching and learning activities and industry relationships, which will be discussed in this section.

Firstly, the university acknowledges the need to synergize innovative methods in pedagogical development that emphasize the greater interaction of industry in its effort to systematically map out the learning objectives and outcomes (Prince and Felder, 2006; Simcock, Shi and Thorn, 2008; and Borrego et al., 2010).

Secondly, engagement of industry was found to be essential to not be marginalized by the impact of technological developments affecting the trends in engineering education and the manner (Onwuka, 2009; Shah and Nair, 2011).

Thirdly, numerous reports from reputable bodies such as UNECSO (2012) and Research Commission by the (Lowden et al., 2011) indicated that the graduates are ill prepared to face the current workforce as they lack broader knowledge, skills, and abilities that are relevant to the engineering practice of the modern industry. Therefore, this emphasizes the need to enrich students' learning experience through interaction with industry.

Finally, the quality and accreditation of WA-derived students' learning outcomes are known as the prime drivers in promoting the measures to bridge the teaching and learning outcomes with the growing needs of engineering practice. This positively stimulates the students' learning experiences (Patil and Codner, 2007; Male, Bush and Chapman, 2009).

2.4 Research Model and Hypotheses of Relationship

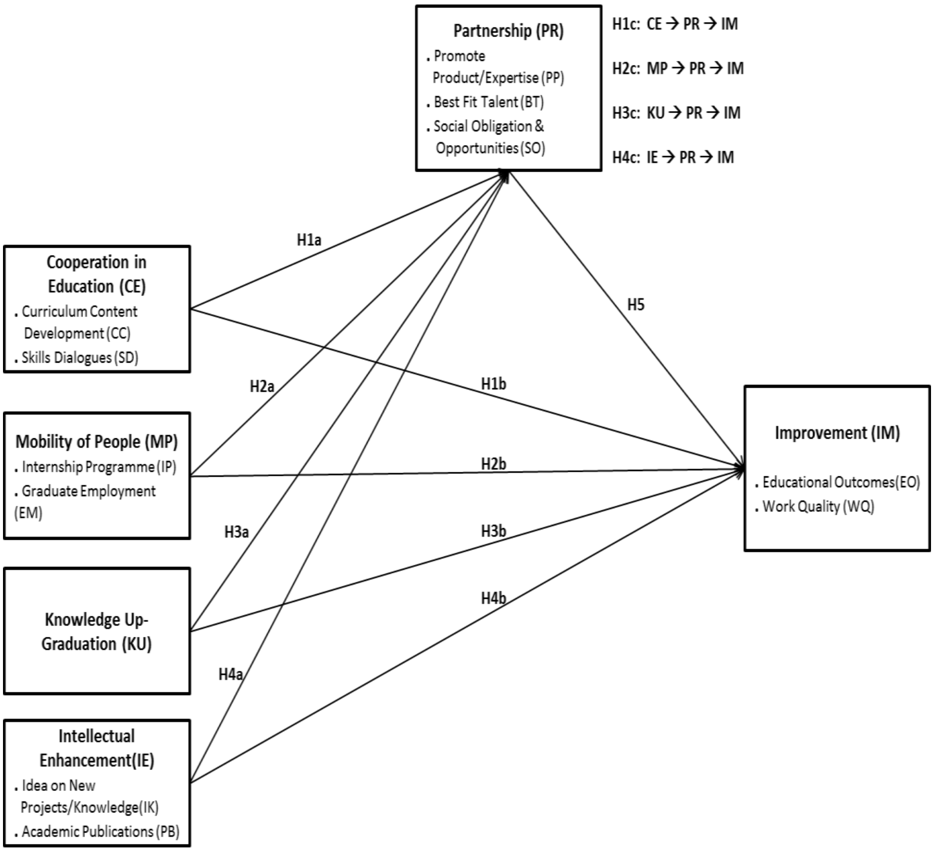


Figure 2.5: Conceptual Framework of Study: Research Paths and Relative Hypotheses

The conceptual framework presented in **Figure 2-5**, summarizes the findings from the literature reviews and the qualitative focus groups. As highlighted in the literature, there is a relationship between the four teaching and learning outcomes activities and its impact on partnerships. Consequently, teaching and learning outcomes activities including cooperation in education **(CE)**, mobility of people **(MP)**, knowledge up-gradation **(KU)** and intellectual knowledge **(IE)** are hypothesised to directly stimulate the partnership **(PR)** effects in influencing improvement **(IM)** on students' learning experience towards generating a good quality talent pool.

The hypothesis of study and its associated cause-effect model was developed as shown in **Table 2-1** and **Figure 2-5** respectively.

Table 2-1: Proposed Hypotheses of Study for Empirical Test

No	ID	Hypothesis Statements	Statistical Test
1	H1a	Dynamic **cooperation in education (CE)** positively effect on the sustainable **partnership (PR)**	Path Analysis in SEM
2	H2a	Effective **mobility of people (MP)** positively effect on the sustainable **partnership** (**PR**)	Path Analysis in SEM
3	H3a	Engagement of **knowledge up-gradation (KU)** positively effect on the sustainable **partnership (PR)**	Path Analysis in SEM
4	H4a	Stimulating **intellectual enhancement** (**IE**) positively effect on the sustainable **partnership (PR)**	Path Analysis in SEM
5	H5	Active **partnership (PR)** positively effect on the **improvement (IM)** efforts	Path Analysis in SEM
6	H1b	**Cooperation in education (CE)** positively effect on the **improvement (IM)**	Path Analysis in SEM
7	H2b	**Mobility of people (MP)** positively effect on **the improvement (IM)**	Path Analysis in SEM
8	H3b	**Knowledge up-gradation (KU)** positively effect on **the improvement (IM)**	Path Analysis in SEM
9	H4b	**Intellectual enhancement** (**IE**) positively effect on the **improvement (IM)**	Path Analysis in SEM
10	H1c	**Partnership (PR)** moderates the relationship between **cooperation in education (CE)** and **improvement (IM)**	Path Analysis in SEM
11	H2c	**Partnership (PR)** moderates the relationship between **mobility of people (MP)** and **improvement (IM)**	Path Analysis in SEM
12	H3c	**Partnership (PR)** moderates the relationship between **knowledge up-gradation (KU)** and **improvement (IM)**	Path Analysis in SEM

13	H4c	**Partnership (PR)** moderates the relationship between **intellectual enhancement (IE)** and **improvement (IM)**	Path Analysis in SEM

Hypothesis 1: Dynamic **cooperation in education** positively effect on the sustainable **partnership**

The ultimate focus of the engineering education is to guide and support students towards nurturing the theoretical knowledge and stimulating their intellectual capabilities. Therefore, the teaching and learning processes should focus on the contents, strategies, assessments, and other relevant parameters that meet the requirements of the evolving industrial practice (Parashar & Parashar, 2012). This process is dependent on the curriculum development of the professional programmes, which serves as an important activity of the university. Furthermore, it is designed to foster better learning experiences by emphasizing gain of the knowledge and skills related to the engineering practice.

Designing the curriculum is a strategic platform yet a critical process that requires analysis of the design of effective graduate profiles, educational mission, contents, skills and abilities, and assessments (Passow, 2007; Heesom et al., 2008). In addition, the desired learning outcomes of the teaching and learning processes should be measured. This assists in measuring whether the learners are well equipped with sufficient exposure to engineering practice and the professional relevance during the course of the study. As such, the above factors are essential for the students to enter the workforce.

A holistic curriculum should focus on the students' learning outcomes that emphasise three apprenticeships as defined by the outcome-based accreditation process including intellectual development, skills development, and modes of thinking. This is crucial to narrow the gap between skills of the industrial engineer and the engineer-in academia (Froyd, Layne & Watson, 2006; Olorunfemi & Ashaolu, 2008). Therefore, the university adopted a new paradigm that includes representation of industry to provide insights towards shaping the content of the curriculum in terms of knowledge, technological trends, skills, and professional outlook.

Many universities are engaging leaders of industry as their industrial advisory boards to obtain valuable comments, recommendations, and technologies to accommodate the periodical changes in its curriculum and educational mission (Genheimer and Shehab, 2009: Rose and Stiefer, 2013). In supporting this partnership, a study indicated that a curriculum that addresses the gap between theory and practice is essential to produce graduates who meet the work demands of industry (Childs & Gibson, 2010). This was also in agreement with the findings from a survey, which indicated that an effective monitoring system is essential to obtain sufficient feedbacks and engagement from the employers (industry) about their perception of entry-level graduates joining the workforce (Shah and Nair, 2011).

The work performance of engineering graduates receives constant criticism due to the mismatch between the professional skills and real-world exposure. In addition, a UK-based recruitment agency indicated that the graduates exhibit substantially better academic achievement but lack generic skills sought by the industry (Schutz, 2008). Furthermore, collective reviews conducted in Germany revealed that there is an urgent need to integrate critical generic skills into the academic curriculum to overcome the shortfall claimed by the industry. Hence, a robust academic development domain is needed to strategically support the evolving demands of industry.

The main responsibility of universities is to improve the capability of the talent pool by establishing a good curriculum that balances knowledge and appropriate skills. Thus, the universities are required to leverage on the professional expertise of its faculty members to form a comprehensive and yet flexible curriculum development framework. Moreover, the role of faculty members is crucial for the development of engineering curriculum framework that encompasses modules and contents relevancy, the skills and related attributes development, and enhancement activities that stimulate greater learning curve of students beyond the classroom settings (Onwuka, 2009; Alves et al., 2014).

There are surprisingly few educators are neither sufficiently vigilant nor resourceful in addressing the changing needs of the professional engineering practice. Critically, engineering educators are expected to be conversant with traditional practices in the industry as well as taking part in innovation and improvement strategies in the teaching and learning domains (Heesom et al., 2008; Howard & Campbell, 2013).

Generally, teaching the professional engineering programme requires the ability to equip the graduates with skills and attributes that allow them to contribute in challenging industrial environments in future (Trevelyan, 2010). Contrarily, the universities tend to develop undergraduate programmes based on their own requirements and policies that may not necessarily meet the industry's requirements. Hence, the resulting mismatch between the industry's expectations and education provided by universities leads to the production of graduates who are not up-to-date with the current technologies (Patil, Nair & Codner, 2008; Sthapak, 2012).

By being the 'architects' of the curriculum and its associated skills, and abilities, the educators should aware and responsive towards technological changes to improve the students' learning experiences (Boles, Hadgraft & Howard, 2009). Nevertheless, the educators are shown to have high tendency to focus on the courses related to their expertise that they teach. This, in turn, produces students who are ill prepared with lack of knowledge on the global issues especially on the changes in engineering practice. Furthermore, the educators tend to dilute the core engineering contents, which complicate the teaching and learning outcomes of the learners to contribute effectively in the industry (Parashar & Parashar, 2012; Alves et al., 2014).

The contents of the undergraduate curriculum are minimal as engineering education tends to be technically inclined as elements of soft skills embedded within the curriculum are often ignored by the educators (Trevelyan, 2010). Thus, a flexible curriculum is more desirable than a rigid framework to provide a platform to exploit more competencies for upcoming challenges of the industry. Competencies are referred as knowledge, skills, abilities, attitudes, and other characteristics that enable a person to exhibit and contribute skillfully in a given situation or in the work environment (Yusoff et al., 2008). Nonetheless, lack of current knowledge and professional skills to tackle the pressing issues in industry necessitates greater action from industry to create an impact on teaching and learning activities (Chadha and Nicholls, 2006; Jamali and Hashmi, 2010; Shah and Nair, 2011; Moalosi, Oladiran and Uziak, 2012).

The analysis of the perspective and interaction of industry in terms of the workforce has been minimal. Nonetheless, the trend has a high tendency towards creating a minimal job market for the fresh graduates to explore their potential (Zaharin, et al., 2009; Yusoff, et al., 2012). Hence, fostering partnerships with industry allow integration of valuable additional skills into the curriculum to enhance learners' capability and creating positive impacts on the industry (Morell, 2008; Shallcross et al., 2010; Shah and Nair, 2011). Therefore, institutions of higher learning should be responsive towards the job market requirements especially in preparing the entry-level graduates with suitable skill sets and abilities to manage the rapid evolution and uncertainties of the industrial landscape (Paul, 2012).

The industry has a significant role in determining and re-aligning the intended outcomes of the educational programmes to maintain connectivity and keep pace with evolving requirements of engineering practice (Genheimer and Shehab, 2009; Megat, 2010; Emmer, 2013). Consequently, this engagement would reflect as part of the continuous curriculum improvement process that assures a good balance between the academic rigor and quality of graduates produced for the workforce (Bohmann et al., 2007; Basri, 2009). In short, the partnership with industry, particularly for curriculum and skills development substantially improves students' learning curves. This will eventually produce graduates with the critical content knowledge to join the current and future workforce.

Hypothesis 2: Effective **mobility of people** positively effect on the sustainable **partnership**

The competency level of present-day graduates relies on their ability to solve the industrial problems. Students assume that most of the problems encountered are well defined in terms of inputs, processing modules, and outputs. Nevertheless, they are unable to meet the expectations of the industry in solving real-world technical problems, which lead to poor performance in the workplace. Hence, graduates should have good understanding and appreciation of the profession and industry prior to joining the workforce especially as the industry is continuously evolving to meet changing trends, demands, and practices (Symes, et al., 2011).

University, as the proponent of professional education, is responsible to stimulate greater inclusiveness of industry in the teaching and learning domain through industrial training as a supplement or complement to the academic instruction. According to (Bukaliya, 2012), this engagement yields positive significance in detecting and understanding the skills, knowledge, and attitude of students during their studies. Moreover, it forms as an antidote for dealing with real-world engineering practice within the curriculum that provides the opportunity for students to experience first-hand experiences outside the classroom, activities, and functions, which are directly related to the application of knowledge.

There is a growing trend in utilizing the mobility platform as a mode of career training to shape the engineering curricula for fulfilling the demands of the workforce. It should be noted that the industrial training is a career-related, professionally supervised work term, which allows interns to experience the first-hand experiences of the current practices and technologies in a technical-based industry. The interns are expected to gain interactive working sessions with the field engineers to explore and understand the demands of the industry. Additionally, industrial training may display the potential opportunities that could be unlocked by the rapidly evolving industrial landscape.

The quality of education and its graduates seeking employment are often questioned, as there are increasing concerns about the manner and mechanisms adopted by universities in their teaching and learning processes. Globally, the industries are facing the pressure of increased subject knowledge and skills to keep pace with current technological development at work. This condition is worsened with graduates who are inadequately prepared for the employment market (Afonja, Latey & Oni, 2005; May & Strong, 2006; Heesom et al. 2008).

The academic development criterion of “outcomes” culture emphasizes the development of educational concepts includes the constructive alignment of learning outcomes, teaching and learning activities, and outcome-based assessment (Felder, Sheppard and Smith 2005; Megat, 2010). The higher learning institutions especially those offering engineering programmes should place greater emphasis on providing opportunities for students to gain exposure of engineering practice during the course of the study (Yusoff, 2008; Zaharim et al., 2009). Therefore, the professional engineering programmes are proposed to consider the industrial training as an important module in preparing the students’ learning experience in preparing for a challenging engineering practice.

An industrial training program is known as a bridge between the university and industry in terms of interaction and collaboration in a strategic partnership to ascertain the quality and effectiveness of the programme, based on the ability of the interns. The industrial training program is developed, formulated, and administered by the university to act as a buffer to reduce the shock among the graduates before venturing into the industry (Haddara & Skanes, 2007). In addition, the industrial training remains as the common linkage that merges education and practice that supports the students' learning experience in terms of mobility during the early course of the study (Pinnelli, Hall & Brush, 2013).

An industrial training program is an educational component that provides mobility to interns to build a better relationship with the field engineers. This potentially enhances other generic skills such as communication skills, teamwork, responsibility, resourcefulness, and critical thinking (Rodzalan & Saat, 2012). Thus, the module forms a platform that develops personal attributes, which are deemed crucial for engineering (Yuzainee, Zaharim and Omar, 2011). This was particularly indicated by the local and regional employers through surveys. In addition, previous studies demonstrated that the industrial training had positive effects on the students' mobility where it was observed as the key enabler that enhances employability skills of future engineering graduates (Hassan et al., 2012).

The deficiencies of acquired skills amongst the graduate engineers are usually reflected through survey studies obtained from their employers (Male, Bush & Chapman, 2009; Kakepoto et al., 2013). This displays the importance of engaging industry in addressing some of the shortfalls, the alignment of courses, contents, exposure to real-world problems, trends, and technical nature of engineering practice. In addition, barrier towards employment forms due to the gap between graduates' knowledge and competencies and the demands of the industry sectors. Hence, it is important for the education providers to work closely with the industrial partners through internship programmes to reduce the gap between real-world practices and engineering education.

The manner in which engineering education is taught and delivered decides the future of the engineering profession (Onwuka, 2009). Therefore, it is beneficial to involve stakeholders especially the industry in the following activities:

(i) Involving technically competent field engineers in the curriculum design and delivery.
(ii) Jointly overseeing the academic process with the industry partners.

The industry is the primary employer of engineering students and a major supporter of engineering internship programs. Moreover, it provides the avenue for creating employability for engineering graduates. Therefore, it is clear that mobility of people in the teaching and learning outcome activities yields positive responses in nurturing the talent pool. In summary, the mobility of people through industrial training involving industry players has positive impacts towards fostering partnerships.

Hypothesis 3: Engagement towards **knowledge up-gradation** positively effect on the sustainable **partnership**

Engineering education features dynamic process of transformation of the students' learning curve. Nonetheless, there is an argument for the universities to evolve beyond transmitting the content knowledge. This is because the traditional curricula of engineering courses are designed to provide foundational knowledge, skills, and development of professional skills primarily for students to enter the workforce. As such, creating a condition that enhances students' learning experience in universities has never been more important.

In today's "outcomes" climate, however, engineering educators are striving to master many pedagogical approaches to stimulate, teach, motivate students, and acquire more knowledge. Nevertheless, it is inevitable that at some point, the educators realize that their efforts are in vain as the gap between students' performances and the industry's expectations still persists (Fink, Ambrose and Wheeler, 2005; Saha & Ghosh, 2011). Therefore, there should be an integration of the elements that would spark curiosity, creativity, and learners' empowerment in the process of crafting the curriculum.

Many learners have unrealistic expectations about the workplace challenges. In fact, (Smith, et al., 2006) indicated that the learning outcomes could be enhanced with value-added activities within the curricular, which are tailor-made to incorporate other features into the teaching delivery system. Evidence indicated a correlation between the enrichment activities outside the classroom and the students' learning outcomes. Hence, the professional engineering programmes are required to progressively provide evidence that the programmes and procedures are accountable and value-added to be relevant in providing true learning activities.

Intellectual capacity alone is no longer the benchmark for the academic excellence but rather, enriching educational experience through industry interaction forms important benchmarks. In addition to the traditional student-faculty interaction, the students' engagements should be directed towards enhancing learning opportunities inside and outside the classroom (Smith, et al., 2005; Vogt, 2008). This is because students' engagement through teaching and learning activities of industrial value improves their minimal tacit knowledge of their career direction in the industry. Hence, many universities have undertaken efforts to foster and establish partnerships with the industrial sector to add value to students' learning experiences.

Imparting technical knowledge to the engineering graduates is often considered as a delicate task as multiple elements are needed for an effective transfer of knowledge during the learning process. In this context, (Kumar and Iman, 2010) lamented that the lack of partnership marginalizes the utilization of the latest technologies from industry as appropriate teaching aids. Moreover, the financial constraints faced by the university may potentially deprive learners of using the industry standard equipment. For instance, engagement of industry to conduct technical workshops related to their business or developed product as a teaching tool in the classroom would greatly assist students to understand the progression of technology and its utilization level across the modern industry (Vasileiou, 2009). Thus, the technical-based enrichment activities in providing learners relevancy of technology development, are shown to further strengthen the relationship between universities and industry (Vasileiou, 2009; Kakepoto, et al, 2013).

Many multinational organizations have initiated efforts to improve the learning outcomes (Vest, 2005; Morell, 2008). For example, inviting a field engineer into the classroom to give seminar or lecture would stimulate students' interests towards the chosen field. Furthermore, this will provide opportunities for the students to observe, work, and collaborate closely with the field engineer to overcome the real-world problems in engineering. Consequently, this will also boost their confidence as they are assured to keep abreast of technological developments at an appropriate learning pace.

Science and Business Innovation Board for Europe reported that huge industries dominantly establish working ties with the university (Edmondson et al., 2012). For example, IBM funded e-commerce learning platform for students to understand the service needs of their organization. Additionally, Cisco system spearheaded internal protocol (IP) based network technologies that are geared to harness instruction and Nokia collaborated to drive innovation in mobile or entertainment and communication sector. The outcomes of such initiatives led to desirable learning outcomes where students' expectations and experience are appropriately aligned and matched to the practical applications. In addition, the initiatives to collaborate with industrial partners for acquiring special industrial-based skills such as project management, Six Sigma, Cisco networking, 5S training, and TRIZ would help the students to acquire additional skills under the mentorship of field engineers with relevant expertise as guest lecturers. Consequently, this approach provides an opportunity for the education providers to convince the students and parents that the academic programmes are relevant to the advancement of technology. This also displays that the institutions are working closely with industry to ensure students are able to cope with industry demands and needs.

Research has indicated that organizing technical and industry visits help the students to obtain baseline assessments of current practices adopted by the industry while increasing their knowledge. Furthermore, students would gain an insight into the operations and the appearance of the equipment and devices used in the actual worksite settings (Prasad, Subbaiah, & Padmavathi, 2012; Kakepoto, et al, 2013). Moreover, it was suggested that the inclusion of enrichment activities such as fieldwork and project work with industry partners, industrial site visits, competitions organized by industry, and talks by guest lecturers would enhance the students' perception of the demands, expectations and the requirements of the industrial landscape. For example, the collaboration between Shell

and institutions of higher learning in developing an online competition to engage their future recruits was shown to nurture the intellectual ability of the students and increase awareness of the current and future needs of industry (Walleley & Forber, 2008).
In short, the partnership with industry through enrichment activities is essential in enhancing the engineering curricular by creating awareness on the role of engineers in the society as an added value learning experience.

Hypothesis 4: Stimulating the **intellectual enhancement** positively affects the sustainable **partnerships**

The university is expected to build a good work quality talent pool with a high level of creativity and innovativeness. These traits are highly desired by the industry, as the graduates will be able to understand the mechanisms to solve problems encountered in the workplace. At this juncture, (Albayrak and Sag, 2011; Plewa et al., 2013) indicated that the teaching and learning activities should not be limited for imparting in-depth knowledge but should also stimulate the learners' intellectual capabilities.

The field of engineering is the prime transformative force that dominates many technological innovations that are harnessed by many industrial sectors to sustain their competitive edge globally. Thus, the engineering education is viewed as a critical field that requires excellent students' learning experiences with high order thinking skills to produce good quality design work and solving complex issues faced by the industry. Moreover, intellectual enhancement is essential in the business-driven industries, which depend on the products or services of innovative value to meet the aspiration and sustainability of their business (Jamali & Hashmi, 2010; Sthapak, 2012; Islam, 2012).

Universities acknowledge that industries are facing difficulties in sustaining their business growth especially the sectors dependent on the cutting-edge technology. This results in the shortfall of several business prospects as the expectations are generally based on highly innovative and creative technical designs where the industries are in a critical position to impress both their local and foreign clients (Nicolai, 1998). As such, integration of the practical skills needed for engineering practice into the learning outcomes should be prioritized in engineering education. Therefore, universities are pressured to produce a talent pool that is robust, dynamic and able to contribute to solving problems innovatively while enhancing the efficiency and productivity of industry.

In addressing the demands of globalization and commercialization, fostering partnerships between university and industry to form an innovation culture is crucial to propel business growth (Faiz & Naiding, 2012; Othman and Omar., 2012). Hence, the engineering design is well established as the main factor for innovation and creativity that is essential for engineering practice. Furthermore, (Megat, 2010) indicated that the "outcomes" culture relies largely on the integration of design and its associated attributes of innovative solutions to complex problems into the programme. Hence, a mechanism is needed to enhance the students' capability for cultivating innovative culture to generate great ideas, discoveries of commercial value, sufficient exposure and hands-on experience of the commercialization processes (O' Brien & Eng, 2011).

In recent years, the knowledge creation and technology development have become focal approaches of many universities. These approaches are heavily relying on the industries for innovative products that could be commercialized for sustainable business growth. In addition, the proactive initiative provides a platform to engage and manage progressive outcomes to complete a task. Moreover, the partnership is likely to enable students to gain valuable guidance from the field engineers of relevant expertise and to encourage them to be vocal in sharing ideas and thereby be inspired to put their ideas into motion. For example, capstone projects, which are based on realistic problems, should be included in engineering programmes (Moalosi, Oladivan & Uziak, 2012). Nonetheless, the challenge is that implementation of a high-quality capstone design course in a technology-based curriculum programme significantly requires collaboration with industry. As the key player, the industry has dynamic roles in coordinating capstone courses to support the teaching and learning outcomes of students (Friesen & Taylor, 2007). The industry's dynamic roles include providing the projects, sponsorship and formal or informal assessments to the students. For example, the industry may offer prizes for capstone competitions or contribute as a "jury" to evaluate the capstone projects in an informal setting and evaluating the final papers or projects in a formal setting. Furthermore, the industry could play the dynamic role by being the project liaison, client to the student or team of students, and technical resource or consultant.

Commonly industry prefers the joint academic projects, which are not labour-intensive and time-consuming (Schubert, 2012). In light of this, the joint collaboration in capstone projects involving lecturer-student approach with industry partners ideally forms a unique link that fits the requirement. Furthermore, this creates a platform for hands-on experience in solving practical problems, which are complex and challenging unlike the theoretically based projects given in a classroom setting.

Universities have a better position to nurture the students in the pursuit of better practical knowledge as the students will appreciate the development of practical knowledge and the ability to speak the practitioners' language (Kantonidou, 2010). Therefore, initiatives to strengthen the existing workflow between universities and industry should be developed and policies to encourage new university-industry linkages must be implemented. In addition, the engineering educators are required to have sound knowledge to produce talents with the desired attributes. Hence, the mechanism to enable them to share their knowledge and discovery for the betterment of education in addition to the advancement in engineering knowledge is increasingly gaining importance in universities. In addition, the practitioners in engineering education have a professional obligation to keep abreast of the trends and changes in the industrial landscape to share and nurture the learning process of budding engineers in the classroom (Becket & Brookes, 2008).

The academic staffs are required to be proactive in embarking on applied research and engaging in collaborative and consultancy work with the industry partners (Plattner, 2004; Heesom et al., 2008; Abang Abdullah, Mohd Ali and Mokhtar, 1995). Furthermore, this collaboration allows educators to be aware of current transformation in the engineering practice and need for solving the practical problems (Schubert and Andersen, 2012).

The existence of partnership tie between the university and industry stimulates greater significance towards academic publication (Estanol, Bonyet & Meissner, 2010). A study demonstrated that joint research projects could result in high-quality academic publications where it improves the students' skills in academic writing (Schubert, 2012). Moreover, the partnerships outcomes in terms of the academic publications are viewed as innovations or processes. Nevertheless, while academic publishing is a core interest of academia, it is not a favoured endeavour among the communities of the industry. Nonetheless, such partnerships enable the field engineers to learn new research techniques with the faculty members. It should be noted that the type of linkage preferred by the industry to foster tight university-industry ties is still inconclusive (Onwuka, 2009).

The possibility of exploring innovative ideas with academic researchers could enhance the status of the industry. In fact, discoveries of new scientific or product innovation breakthrough that are of great value could be channelled into sharing of knowledge mode through this platform. Furthermore, the outputs from collaborative projects in the form of co-authorship of journal publications are much valued (Junaini, 2008). Consequently, the publications' outcome that emphasizes on latest technology would indirectly improve the reputation of a university and contributes towards nation building (Schubert & Andersen, 2012).

In summary, it is imperative that intellectual enhancement of teaching and learning activities should be explored in a coordinated effort involving industry players through a sustainable partnership, which results in mutual benefits.

Hypothesis 5: Active **partnership** positively effects towards **improvement** efforts

The idea of fostering partnerships between the university and industry is well established globally. Nonetheless, the main challenge is to narrow the gap between theory and practice in professional engineering education. The impact of university-industry partnership in enhancing the students' learning experience has gained favorable acknowledgment by EAC as the approach complies with industry needs. Moreover, this approach integrates crucial professional skills with opportunities for interaction between students and field engineers to deepen the knowledge and understanding of business constraints through hands-on activities.

A proactive initiative on partnership facilitates continuous improvement of the professional engineering programmes, which forms the core of "outcomes" process of WA (Megat, 2010). In fact, the changes in the structure of engineering education that directed towards the globally acclaimed WA framework are primarily mooted to overcome the chronic complaints on the work performance of entry-level graduates.

Despite enormous effort towards improving the quality of engineering education, the disparity between outcomes of engineering education and the need for engineering practice still exists. This is partly due to the dynamic nature of engineering education, which has to be constantly reviewed and improved in a beneficial manner. Moreover, the responsible parties in the higher engineering education are suggested to craft their educational objectives to improve the teaching and learning activities (Karapetrovic, 2002; Becket & Brookes, 2008).

Holistically, the educational missions relevant to the teaching and learning outcomes need to be flexible in enabling continuous improvement and reassessment to enhance students' learning capabilities. The principle of continuous improvement is to drive the enhancement of teaching and learning by providing a greater representation of industry to sustain the technical and engineering manpower requirements. Moreover, continuous improvement forms an important bridge between the developed academic curriculum and quality of trained graduates to fulfill the requirements of the industry. Progressive initiatives to establish mutually beneficial and yet successful working synergy between the university and industry are widely proposed to resonate towards changes in engineering practice (Heesom et al., 2008; Morell & Trucco, 2012). Therefore, forming the close tie between the university and industry are strongly encourage via dialogue session.

There is a strong need to work effectively in meeting business demands as the new generation of engineers joining the workforce are forced to face fresh and complex challenges (Abche & Alameddine, 2012). This directly reflects on the image and reputation of the industry and its competitive edge in the market. Hence, universities should be aware of this shift and formulate strategies through engagement with industry communities. This is necessary; as valuable insights and dynamic involvement of industry have shown to bridge the teaching and learning outcomes and the engineering practice of the modern industry (Molly, 2007; Becket & Brookes, 2008; Rasiah, 2009).

Globalization creates a competitive labour market. Thus, the collaboration between universities and industries are able to alleviate concerns of unemployed graduates. The partnerships between universities and industry would essentially be a focal point for engineering related programmes to harness talent pool with good work quality for industry practices locally and internationally. In fact, employers are keen to ensure that the graduates have developed awareness and aptitude to adapt to the changes in business and technological developments, especially during the early course of the study (Chadha & Nicholls, 2006; Muhammad, 2012).

Industry and universities are governed by different cultures and associated practices. Nevertheless, it is crucial that they respond to the concern to produce good work quality graduates equipped with an expanded set of capabilities, primarily as they are expected to deal with:

(i) Fast-paced technological developments across the industrial landscape.

(ii) The gap between teaching and learning outcomes and the engineering practice (Edward, Sanchez-Ruiz & Sanchez-Diaz, 2009; Parashar & Parashar, 2012 and Pinnelli, Hall & Brush, 2013).

In fact, emphasizing improvement is a strategic move to address the challenges involving stakeholders' expectations, fluctuating demands, and stiff competition. Hence, this demonstrated to enhance the improvement of product or services (Sabet, et al., 2012; Burli, Bagodi & Kotturshettar, 2012).

As such, work by (Molly, 2007; Bullen, 2010; Shah, and Nair, 2011) indicated that effective curriculum renewal initiatives through university-industry partnerships are particularly evident to:

(i) Bolster the confidence of industry that budding engineers are being sufficiently exposed to the current and future needs of the industrial landscape.

(ii) Significantly fulfill the aspirations of the industry towards broadening students' knowledge and professional development that directed towards cutting-edge work.

(iii) Create a talent pool that is flexible and adaptable to the changes in the current era of technological explosion.

The engineering education segment is undergoing a metamorphosis in identifying and creating academic linkages that would foster partnerships between universities and industry to improve the learning curve in the engineering programmes by cultivating the desired attributes (Clark & Andrews, 2010; Morell & Trucco, 2012). Universities view this collaboration as a mutually beneficial endeavour as they consider students and prospective employer (industry) as their important stakeholders within the higher education setting. Moreover, complaints arising from issues related to engineering education could also be minimized by initiating a university-industry partnership that mutually benefits all the stakeholders including educators, students, and industry.

In summary**, Figure 2-6** represents the graphical illustration of initial and best structural equation modeling (SEM) that is yet to be fitted with surveyed data.

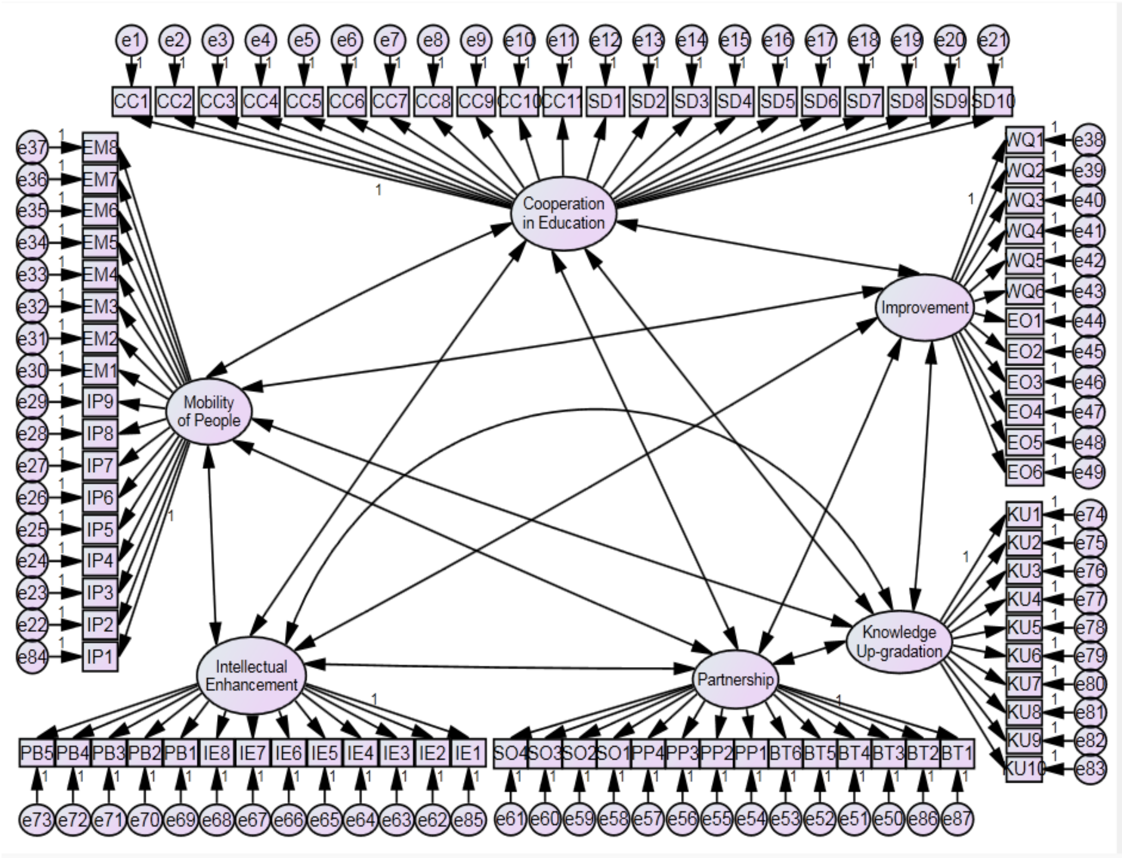


Figure 2-6: Conceptual Model of Cause-Effect of Study in Graphical Representation Using Structural Equation Modeling (SEM)

2.5 Strategic University-Industry Partnership

Over the last decade, industries have exerted considerable efforts in collaborating with universities by primarily focusing on conventional research and commercialization between the university and industry. Historically, outreach to industry was driven by the need to strengthen the core employability skills in the engineering degree programme and students' learning experiences. In addition, a survey indicated that the level of skills demanded by employers increased mainly due to the global competitiveness, rapid technological development and quality demand (Blom & Saeki, 2011).

In early years, universities in the UK have been urged to establish collaborative initiatives with industry, especially in the educational curriculum to produce graduates who are fit to work in industry (Heesom et al., 2008; Lambert Review, 2003; Leitch Review, 2006). This is mainly because the industry could play a dynamic role in a collective effort with universities in shaping the graduates' employability skills (Morell, 2008). Moreover, a report on employability, revealed that out of 100 engineering graduates, only 10 are employable in Russia and China; 13 in Brazil; 25 in India and 20 in Mexico. A close relationship between the university and industry would promote best practices in knowledge sharing and lessons learning, and continuous improvement that would be beneficial in bolstering students' learning experience and employability skills. Thus, outreach for partnerships paves a way towards addressing constant criticism echoed by industry while improving the employability skills of the engineering graduates

In Malaysia, the local industries require 202,000 engineers for the workforce by 2020 and are currently experiencing a significant shortfall (70%) of suitable talents for employment (Suan, Mat and Im, 2012). As poor teaching practice is known as one of the factors contributing to this scenario, the enhancement of teaching quality is crucial because industries are re-strategizing their policy and approaches to be relevant to the changing needs of the global economies (Yusoff et al., 2011).

The trend of global competition and internationalization of education resulted in a new dimension for better collaboration between the university and industry. Consequently, according to the Science & Business Commission Report on the university-industry partnership by (Edmondson et al., 2012) this relationship was found to be vital to:

(i) Enable the industry to perform analysis for the requirement based on the demographic change at work-front.

(ii) Provide support for students and faculty members in terms of the final year industrial projects and consultation activities respectively.

(iii) Provide valuable input and advice pertaining to technological advancements and market demands that would be valuable for the development of curriculum or new programme.

Universities in Malaysia are well aware of the importance of forming knowledge sharing processes with greater industry interaction as this dramatically improves WA-derived student learning outcomes. The collaboration initiatives will facilitate the learning process and assure the potential pressure of new knowledge and skills amid technological advancement at the workplace to be addressed efficiently. In relation to this, both university and industry should make pro-active and appropriate decisions in their future collaborations. Consequently, this will form a strong drive towards improving engineering education through linkages with industry to overcome the concerns of universities.

The exposure towards challenges of engineering practice and enhancement of teaching and learning methods through the university-industry partnership will mold the students to become creative, focused, and relevant to the demands and needs of the industry. Therefore, as similar to other parts of the world, universities in Malaysia are required to establish a range of flexible linkages to foster partnerships with industry. These include research and development, consultancy, seminars and specialist training courses, industrial attachment programmes, graduates employment, enrichment activities, which include guest lecture series, seminars of industrial rigour, plant visits, competitions, research collaboration leading to academic publications, and the inclusion of advisory board members for curriculum improvements and associated skills development (Giuliani & Arza, 2008; Onwuka, 2009; Othman, 2011; Morell & Trucco, 2012).

The universities could build on the existing relationships to form closer and longer-term strategic linkages with industry for mutual benefit. The strategic plan towards enhancing industry's representation in the teaching and learning outcomes activities involves decision-making about the most suitable form of linkages. Consequently, at the current point, an important yet unexplored question is the type of academically inclined linkages that are preferred by the industry for sustainable partnerships. This is crucial to creating an impact on the teaching and learning of the professional engineering programmes.

2.6 AHP-Based Model for Decision-Making on Linkage

Evidence has shown that achieving a sustainable partnership leads to good quality teaching and learning with the emphasis on shaping highly skilled future employees. Nonetheless, in this context, one of the key challenges faced by universities is the ability to implement strategic linkages in fostering greater industry interaction in the professional engineering programmes. **Table 2-2** demonstrates various types of academic-led linkages commonly adopted by universities to foster partnerships with industry.

Table 2-2: Type of Academically Inclined Activities of Linkages with Industry (source: Interpretation of Giuliani & Arza, 2008; Onwuka, 2009; Morell & Trucco, 2012)

Type of short-term linkages	Description
Internship Programme (IP)	Placements for undergraduates in industry to gain experience and exposure to engineering practice in an actual workplace setting
Academic Advisory Panel (ACD)	Appointment of members of the industry to provide insights and recommendations on technology and skills dialogues need/trend of the industry covering transformation in the curriculum and relevancy of new programme development.
Quality Advisory Panel (QAP)	Support as industry representatives in university committees for quality improvement on processes related to higher engineering education developments
Employment of Graduates (EG)	Referred as employment opportunity by industry for improving work quality of entry-level graduates

	produced on their acquired teaching and learning outcomes
Consultancy Work (CW)	Refers to an agreement between academia and industry to provide technical services or produce prototypes of economic value.
Workshop and Seminars (SLA)	Educational sessions conducted by field engineers (industry) in an academic setting on related industry-based skills or products of current technology for knowledge enhancement
Guest Lectures (GL)	Educational sessions conducted by invited field engineers (industry) as partial lectureship in collaboration with academics to share and enhance knowledge and learning outcomes based on the expert matter of subject within the programme
Continuing Training for Academicians (STP)	A specially tailor-made training programme of current industrial trend as part of exposure/enhancement for academic staffs
Academic Publication activities (PA)	Publications by academics on new knowledge or concepts as outcomes of final year or capstone design joint projects with field engineers (industry)

The success of this investigative study relies on understanding industries' preferences and their willingness to commit towards partnerships with the university. In pursuit of this mission, industries are encouraged to select suitable linkage types that leverage on their strength so that efforts could be met in:

(i) Fostering efficient partnerships with the university.

(ii) Sustaining the interactive support of industry towards enhancing knowledge transfer in preparing good quality talent pool.

Forthwith, the industry is at a crucial point to select suitable types of linkages to meet the educational missions of the university. As such, one of the main assumptions of this scope is the exclusion of three linkages stated in this study, which are the employment of graduates, quality advisory panel, and guest lectures. Based on the pilot study conducted with two industry experts in Klang Valley, it was found that quality advisory panel was indicated as unclear or not conversant in that role while employment of graduates and guest lectures were viewed as common and traditional choices of linkages preferred by many field engineers. Hence, these linkages were excluded to ensure the perception of the surveyed respondents are reflected in a reliable and yet meaningful manner.

The decisions on the importance of teaching and learning activities, which gauge the preferences of academic-led linkages to foster partnerships between university and industry are frequently observed to be different from the original goals and perspectives. In this regard, multiple attribute decision-making analysis should be used to choose the most suitable decisions from communities of the industry to foster sustainable partnerships. Utilizing the MCDM method was suggested to be a decision support tool, but not for deriving the final solution (Triantaphyllou & Mann, 1995). The MCDM method seeks the best alternative by ranking a finite number of decision alternatives, each of which is explicitly described as different characteristics, also known as attributes, decision criteria, or objectives. Thus, the quality of decisions is enhanced by utilizing the decision-making process, which is more explicit, rational, and efficient. In addition, Saaty's analytic hierarchy process (AHP) is among the most important methods of MCDM that provides a framework and deals with convoluted problems in intricate environments (Ren, Yusuf & Burns, 2005; Alexander, 2012; Wu, Lin & Wang, 2013).

AHP has three distinct components including analytic, hierarchy, and process where it is instrumental in solving the complex problems that incorporate both tangible and intangible factors (Saaty, 1990). The advantage of AHP is that it makes the selection process very transparent, which benefits an educational environment since it reveals detailed thoughts of a field engineer. This, in turn, demonstrates the extent to which an industry understands the objectives of improvement analysis of the engineering education being explored in a coordinated manner. In addition, AHP is a simple and accurate technique used to express one's opinion based on only two alternatives than simultaneously on all the available alternatives (Ho, Higson & Dey, 2007 Vaidya & Kumar, 2006; Brent et al., 2007; Alam et al., 2012; Prusak et al., 2013). In this study, AHP will be applied and validated to investigate the university-industry partnership initiatives with the following approaches, namely participant identification, hierarchy development, data collection, weight assignment, and outcome generation.

As the industry is known as an important stakeholder in the professional engineering segment, where the decision-making process within the teaching and learning domain can be highly challenging and demands a well-organized framework. Therefore, it is essential to develop a hierarchical structure that can break down the issues that need to be addressed in this study. The AHP-based model uses three stages for data hierarchy as indicated in **Table 2-3**. The first stage contains the research goals, the second stage contains the criteria of ranking and the third stage contains the alternatives.

Table 2-3: Stages of AHP Hierarchy of Study

Stage 1: **Goal**	**Rank preference of linkage type**
Stage 2: **Teaching and Learning Domain**	1. Cooperation in Education 2. Mobility of People 3. Knowledge Up-gradation 4. Intellectual Enhancement
Stage 3: **Alternatives (Linkage type)**	1. Advisory panel for curriculum and skills development (ACD) 2. Support for internship programme (IP) 3. Support for learning activities for student (plant visit, seminars, workshops) (SLA) 4. Support for continuing training for academicians (STP) 5. Collaborate on academic publications on new knowledge (PA) 6. Collaborate on consultancy work with academicians (CW)

For level 1, the overall goal of AHP hierarchy study is to rank the type of academic linkages. Level 2 comprises the teaching and learning criteria that contribute to the decision-making: cooperation in education, mobility of people, knowledge up-gradation, and intellectual enhancement. Level 3 consists of the six solution possibilities. For empirical analysis, the six alternatives are selected for ranking the type of linkages by industry. Thus, each criterion in level 2 contributes differently to the focus.

In the process of evaluating the developed hierarchical structure, firstly, the respondents have to rank the teaching and learning activity domains according to their importance. This information contains a description of the reviewed domain and the characteristics of each type of linkage for this criterion. Secondly, the respondents have to rank their preferences on the linkage type on each alternative following the provided information that is needed to make a decision. The descriptions of the alternatives are presented again, where complete information is provided. Therefore, in this scope of the study, industries face the challenging tasks in choosing the alternatives as their preferred linkages and ranking them into the order of importance for establishing the partnership with the universities.

The industries are required to assist universities in their mission to improve the teaching and learning outcome activities as they have direct responsibility in producing good quality graduates for the workforce. The decision-makers are usually the senior engineers from various industrial sectors. These decision-makers have the choice of choosing between being on the advisory boards for curriculum & skills development, internship programmes, enrichment activities, retraining programme for academics, publications activities and consultancy work with academics. **Figure 2-7** demonstrates the generated decision criteria by means of a hierarchical structure.

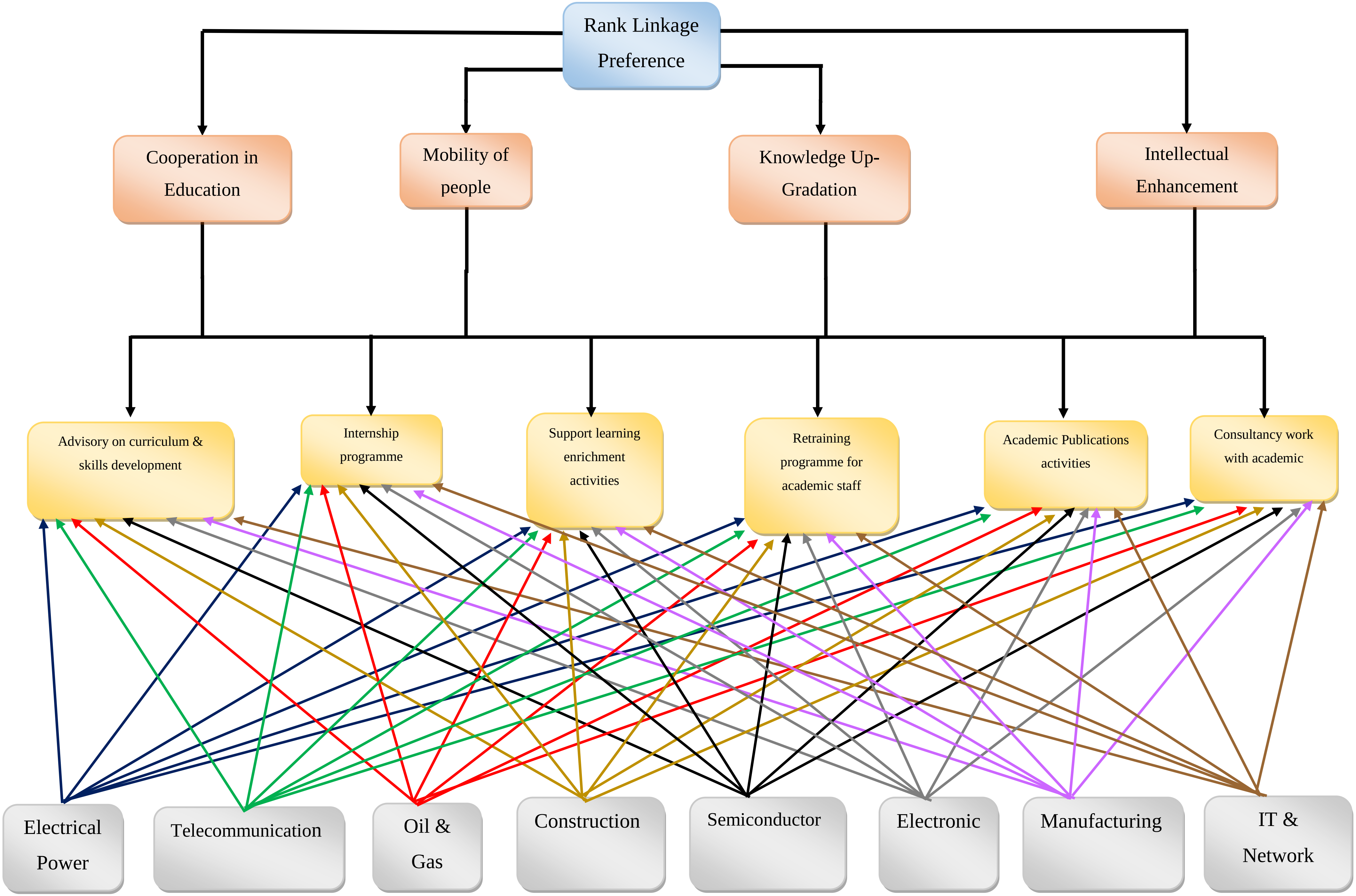


Figure 2-7: AHP hierarchy of goals, criteria and alternatives of study

2.7 Conclusion

In a nutshell, the current professional engineering education requires proactive measures in modernization and improvement of teaching and learning outcome activities. This is due to many factors including the minimal emphasis on the knowledge, skills and competence development of talent, the gradual reduction in quality of engineering education, changes of practice in the industrial landscape, and poor workability of the talent pool.

Over the years, many studies have revealed the concept of the effective university and industry partnerships that focus solely on exploring the mechanisms towards addressing the skill gaps and employment trends (Giuliani & Arza, 2008; Zaharim et al., 2009; Prescott et al., 2011). Moreover, the studies have demonstrated unique approaches towards investigating the relationship between teaching and learning activities of engineering education and fostering university and industry partnerships as improvement measures. In fact, this is a common audit query by professional accreditation bodies in encouraging efforts towards narrowing the gap between expectation and reality.

Involvement of industry through partnerships with universities is crucial for the overall learning curve of students during their undergraduate courses. Nonetheless, both university and industry should involve in a real intellectual engagement in terms of strategies and approaches to create a conducive educational environment that trains and produces engineering graduates with the desired characteristics through outcome-based learning activities.

Chapter 3
RESEARCH METHODOLOGY

3.0 Overview of the Methodological Approach

This chapter describes the research approach with a view to selecting the suitable methodology for the scope of the study.

In this context, the proposed research framework and analytical pathway require the adoption of the followings:

- ► Specific methodological direction to investigate the variables and scales to represent outcomes.
- ► Suitable statistical analysis for interpretation of outcomes.
- ► Approach to explore knowledge through the scientific search for the cause and effect.

3.1 Research Strategy and Settings

The literature review of this study includes the theories and facts, concepts and procedures and a skill development component. The empirical research approach (Felder, 2007; Castellan, 2010) consists of four stages as follows:

(i) Review: seeking information and critical issues of an existing phenomenon that warrants development of a problem statement and the research questions.
(ii) Hypothesis: a formal expression of preconceived factual relationship, which provides a tentative explanation.
(iii) Experimentation: the designing of the study leading to a systematic and controlled testing of the hypothesis.
(iv) Induction: a generalization of the experimental results to a formal statement of the theory.

Therefore, this study applied a realistic approach to ascertain the influence of industry in the teaching and learning processes in improving students' learning experience during the early course of the study.

The background content knowledge was gained through analysis and synthesis of the published literature, particularly the influence of industry on the engineering education. The research presented in this thesis is based on the facts of objective reality, where the empirical research was adopted in this study. Furthermore, the drive to conduct this work depends on two-fold belief as described below:

i. To investigate a conceived research model that hypothesised the influence of teaching and learning activities of the academic domain of academic development criterion based on the partnership with industry.
ii. To develop and examine the hierarchical model that provides a locus for the industry to rank the preference of academic-led linkages with the university for the teaching and learning activities in the professional engineering undergraduate programme.

The research objectives and questions are as listed below:

1. To investigate university-industry partnership using a cause-effect approach based on triangulation from data of published domains and industry's input.

   Research questions:

   - Overall, does the research structural equation model (SEM) created indicates a satisfactory degree of fit to the observed data?

   - Do the teaching and learning activities have statistically significant effects on the partnerships with industry?

2. To investigate the influence of subjective preference of industry towards university-industry partnership using the MCDM theory.
   Research question:

   - What is the preference of the communities of the industry on the academic-led linkages that could narrow the gap between the theory and practice in enhancing students' learning experience?

The conceptual model demonstrates that the research undertakes an empirical setting to investigate the theoretical relational path drawn from the literature and test it through hypotheses. In consideration of this, the proposed conceptual model seeks to measure the data for explaining the cause-effect relationship.

Historically, research in education focuses on the results to generate new theorems or improve existing ones. It has been dominated by the use of quantitative methodological approach that utilizes the power of mathematics to justify general laws and principles and qualitative research, which is characterized by the collection and analysis of textual data (surveys, interviews, focus group, and observation) (Felder, 2007; Bernhard & Baillie, 2013).

Evidence has shown that both qualitative and quantitative methods are used in research related to engineering education (Felder, 2007; Borego, Douglas & Amelink, 2009). Nonetheless, the quantitative method is preferred in engineering education for supporting a theory or hypothesis towards addressing a narrowly defined research questions, often supported by data collection using survey exercise (Borego, Douglas & Amelink, 2009). On the other hand, the qualitative approach is well known as a challenging technique as it is extremely time-intensive in terms of planning, collecting, and analysing. In addition, it is designed to support smaller sample size, especially for unusual or non-traditional cases as it aimed to describe in-depth knowledge of a scenario. Contrarily, the quantitative method supports research work that underpins hypothesis generated by theory by using statistical analysis of data collected from a larger population. Nonetheless, an important distinction between the quantitative and qualitative research is the sequence in which these activities are carried out. The quantitative research conducted in a linear way while qualitative research is intentionally very iterative. The current research utilized both quantitative and qualitative methods to achieve the overall research objectives. The quantitative method is known as the best choice to investigate the significance of teaching and learning of engineering education towards the relationship with industry in Malaysia. Additionally, a qualitative method is adopted to understand the perspectives, opinions, and experiences of individuals involved in the university-industry partnership on different issues and experiences towards the development of the engineering education in Malaysia.

3.2 Survey Strategy

The main goal of conducting a survey is to obtain quantifiable results such as opinions, attitudes, or trends. Many studies utilize survey methods specifically to tackle the scope that seeks employer's perspective in improving the curricular design of an ABET driven framework (Borego, Douglas & Amelink, 2009).

Survey questionnaire with a suitable scope, which was separated into sections, was developed to capture the observed variable. Thus, the survey instrument was designed in reference to work done by other researchers to maintain relevancy and appropriateness (Esham, 2008; Blom & Saeki, 2012). As the questionnaire is designed to elicit information, closed-ended questions are used to capture insights and perspective of respondents. Hence, a questionnaire was developed based on the critical reviews from reliable sources, which were compiled in the form of hypotheses for this research.

The primary respondents were the field engineers from industry who received questionnaires at their workplace. In fact, many channels were established to communicate with these respondents. The study was carried out by communication via electronic mail directly to the respondents. The respondents were initially contacted by fficial emails and then the self-administered questionnaires were delivered to the participants. This resulted in the increased participation rate and improved data quality.

The goal of SEM is to determine the relationship between the observed and latent variables, which are of significance to the study. The "latent variables", are inaccessible to direct measurement. Traditionally, the SEM technique requires a large sample (Bentler, 1993). Nevertheless, a smaller sample size may be possible with SEM with the presence of strong factor loadings (Nevitt & Hancock, 2000 and Kline, 2011). In general, it is more likely to draw statistically significant conclusion about a target population with high response rate from the participants (Bird, 2009).

SEM research model that consists of parameters in the form of latent constructs needs to deal with quantity data, which could be measured indirectly using a set of suitable scale for each item in the questionnaire (Zainudin, 2012). The Likert scale is widely used for measuring challenging attributes in many qualitative research studies. Multiple variants of Likert scales evolved ranging from 4-point, 5-point and 7-point Likert scale (Boone & Boone, 2012; Barua, 2013). Previous studies recommended adopting a 1 to 10-pointer scale so that data collected is independent and not forced onto the respondents (Zainudin, 2012). As such, this allows wider pointer scale to measure the opinion of industry experts, which are not confined to a space of 5 scales. Hence, the responses were measured using a ten ordered points scale where [10] for strongly agree and [1] for strongly disagree.

As outlined by the scope of the study, questions were developed and strategically arranged into two major parts. Subsequently, the two parts were further divided into multiple sub-sections as outlined below:

Part A: Industry Profile Information and Preference of Type of Linkages

Section 1: Questions on the demographics of industry and the primary respondent.

Section 2: Questions on the employment distribution and trends of the particular industry.

Section 3: Questions on the industry's linkage with universities and its preference for ranking the types of linkages within the scope of academic development.

Part B: Perception of Industry towards Teaching and Learning Domains of Academic Development.

Section 1: Questions on the hypothesis that seeks industry's perspective towards cooperation in education that related to the curriculum and skills development

Section 2: Questions on the hypothesis that seeks industry's perspective on industrial training and employability of both students and entry-level graduates.

Section 3: Questions on the hypothesis that seeks industry's perspective on involvement and support for enrichment activities that able to enhance students' learning experience.

Section 4: Questions on the hypothesis that seeks industry's perspective on involvement in final year project and scholarly and publication activities.

Section 5: Questions on the hypothesis that seeks industry's perspective on justification towards sustaining the partnership with the university.

Section 6: Questions on the hypothesis that seeks industry's perspective on the improvement activities that mutually benefit the stakeholders.

Overall, Part A comprised of 28 questions concerning the demographic features of industry and recruitment preference of the engineering graduates. Part B was designed to meet the objectives of the study, which is to determine the perspective and insights of the industry in relation to identifying the unobserved factors influencing the trends in the university-industry partnership. A minimum of four items is required to measure each construct in each analysis Zainudin, A (2012). As outlined in this study, the questions in Part B consists of six constructs. Thus, these constructs, which were used in Part B were cooperation in education (21 items), mobility of people (17 items), knowledge up gradation (10 items), intellectual enhancement (13 items), partnership (14 items) and improvement (12 items). Moreover, the principal construct measures were based on the existing instruments. **Table 3.1** summarizes the measurement items of the research variables with the first-order and second-order constructs.

Table 3-1: List of Constructs and Measurement Items

Second-Order Construct	**First-Order Construct**	**Number of Items** (87)
Cooperation in Education (CE)	Curriculum Content Development (CC)	11
	Skills Dialogues (SD)	10
Mobility of People (MP)	Internship Programme (IP)	9
	Graduate Employment (EM)	8
Intellectual Enhancement (IE)	Idea on New Projects/Knowledge(IK)	8
	Academic Publications (PB)	5
Partnership (PR)	Promote Product/Expertise (PP)	4
	Best Fit Talent (BT)	6
	Social Obligation & Opportunities (SO)	4
Improvement (IM)	Educational Outcomes (EO)	6
	Work Quality (WQ)	6
	Knowledge Up-Gradation (KU)	10

3.3 Pilot Study

A pilot study was conducted with two industry experts and academic professionals. Based on their feedbacks, modifications were made to enhance the clarity of the items in the survey. A pre-test phase containing two stages was undertaken for the development of the survey instrument.

In the first stage, three academicians with vast experience in the statistical and structural equation modeling from Vinayaga Mission International University College (VMIUC), Selangor, University Technology Mara (UiTM), Kelantan and University Malaya (UM), Kuala Lumpur were consulted. They were engaged to comment on the validity and reliability of the content of the questionnaire with respect to the intended scope of the study. Their responses were used in a constructive manner to further refine the questionnaire. As a result, this led to modifications to reduce the number of items, repetitive questions, un-bias statements, code sequence on questions and sufficiency of items for each construct. This is important for the software to work efficiently on the questionnaire for analysis.

The second stage involves engagement of two senior engineering executives of Mahkota Research Sdn Bhd and ABB Malaysia Sdn Bhd for further exploration of the set of questions. This was done to obtain their response, assuring the language clarity, checking the structure and contents, the difficulties and problems in responding and content consistency. These field engineers were selected due to their active involvement in developing enrichment activities into the academic structure as well as part of the advisory panel for the engineering programmes. Consequently, outcomes of their valuable insights were used to further revise the survey instrument for reliability.

A copy of the questionnaire and a covering lettering explaining the purpose of the pilot study are enclosed in Appendix A. Instructional guidelines were inserted at the headings of each section of the questionnaire to enable the respondent to provide the inputs accordingly. Approximately, 45 minutes was required for each participant to complete the questionnaire.

3.4 Data Source

The setting of this research includes the industry as the crucial stakeholders who are affected by the outcome of this study. Hence, the unit of analysis of this study comprises primarily the industries of various demographics that are strongly associated with engineering activities in Malaysia. In addition, both local and foreign-based industries were fairly engaged to gain a holistic approach to this intended research. Moreover, the field engineers were the main respondents for this study in representing their technical landscape. The potential respondents were initially identified in terms of their suitability and willingness to participate voluntarily in this study. Furthermore, they were given the assurance for protection of their anonymity and maintaining the confidentiality of the data.

3.4.1 Set Criteria for Respondents

The respondents whom directly represent the industry were required to meet the following criteria to be included in the study. Each respondent should:

I. be solely employed by the identified organization of either private or public domain and MNC, which is located in Malaysia
II. holds a mid-level managerial or senior level technical position in the organization
III. works in an industry that hires or interacts with entry-level engineering graduates
IV. have had technical or engineering related experience in the identified organization
V. be attached to the technical or engineering department that performs engineering activity(s) in the identified organization.

Several mid-level managerial engineers and technical executives who agreed to participate in this study have changed employment across few companies during their working span of 5 to 10 years. Hence, some of the respondents recorded their working experience as 1 to 3 years in the current organization despite having working experience of approximately 6 to 10 years. The core section of industry identified holds strong credibility of actively involved in engineering activities as their main source of business. Overall, the study constitutes the sample of industries to understand the dynamics of the partnership between industry and university.

3.5 Data Collection

The data collection was conducted between November 2013 and July 2014. The data collection period was relatively shorter as the potential industrial respondents were extracted from the list of alumni and industrial training partners of the school. The respondents were contacted for their consent simultaneously during the process of improving the set of questions in the questionnaire.

A set of two documents containing a copy of the questionnaire and a cover letter was sent through email to the selected respondent. Moreover, some of the questionnaires were personally distributed to participants of various industrial segments. About a month after the date of distribution, follow-ups were done via phone calls and frequent visitations were made to the non-respondents to encourage them to complete the survey. When necessary, the second round of follow-ups was done to increase the response rate.

According to the population size of respondents as proposed for SEM Zainudin (2012), a sample size of 150 is required for a structural model with seven or less latent constructs; with each construct having more than 3 items. Nevertheless, a convenient sample containing 290 respondents from various industries were included in the study to obtain a high response rate within Malaysia. In addition, relevancy of stipulated criteria of respondents was verified and a database was created to efficiently manage and monitor the respondents' engagement process.

3.6 Statistical Methods and Theory

3.6.1 Structural Equation Modeling (SEM)

In this study, SEM is the multivariate statistical technique was used for hypothesis testing to test how well a hypothesized model fits the data. Models that did not fit the data were rejected, whereas models that fit the data were provisionally accepted. SEM was selected as the suitable approach to determine the significance of associations between the multi-item constructs, where it is useful to analyse the inter-relationship among hypothetical constructs in a structural model (Chiandotto & Masserini, 2011). Moreover, this approach was proven effective in examining the teaching effectiveness (Heffernan et al., 2009).

SEM is capable to incorporate multiple independent and dependent variables where the hypothetical latent constructs that cluster of observed variables might represent (Lee, et al., 2007). In addition, SEM found to be more powerful in investigating the causal relationships among the categorical variables as it simultaneously performs the factor and test analysis of hypothesis. Hence, it greatly expands the researchers' capability to study a set of interrelated relationships simultaneously (Hair, et al., 1998).

Application of SEM in the engineering education research is still limited despite its wide usage in many studies examining teaching effectiveness (Lurain, et al., 2009). This study applied SEM because it has broader application and it is capable to analyse inter-related systems consisting of a mixture of observed and latent variables represents hypotheses of a developed model.

Figure 3-1 summarizes the techniques that were involved in the SEM related study. Firstly, a theoretical hypothesis was developed based on the review of the previous studies in the literature. This is followed by establishing a conceptual model, which comprises the measurement and forming structural models based on the identified variables. Moreover, a survey was conducted using questionnaires where the questionnaires were distributed to the respondents. The collected data were analysed in terms of the overall fit of the developed model. The developed model that supported the theories was analysed using analysis of moments structure (AMOS) software. Data were entered into SPSS 21.0 and AMOS 21.0 where AMOS used for conversion of the theoretical framework into a graphical representation in the form of path diagram using appropriate tools. Subsequently, the empirical model was tested against the hypothetical relationship to access the overall goodness of fit based on the modification indices.

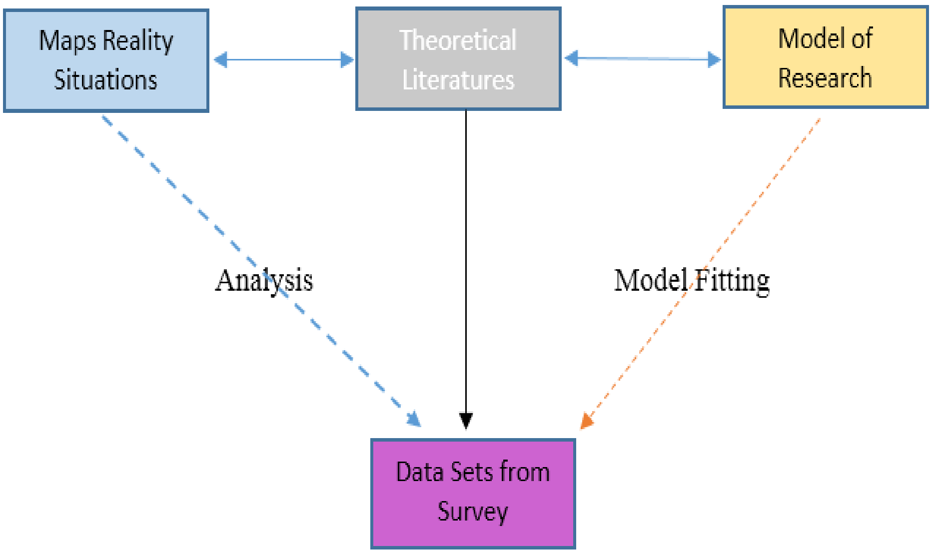


Figure 3-1: An Underlying Idea of SEM Related Study

(Source: Guo, Perron & Gillespie, 2008)

According to (Bollen & Pearl, 2012), the SEM analysis technique is divided into two sections. Firstly, it is based on a set of equations that reflect the causal relationship between the substantive variables of interest, also called "latent variables". The latent variable model highlights the causal relationships between these variables in the absence of measurement error.

The equations involved can be represented by structural equation (1) and measurement equation (2) (Shrestha, Hanaoka & Tanaboriboon, 2007; Chiandotto & Masserini, 2011).

$$\Psi_{(m*1)} = B_{(m*m)}\Psi_{(m*1)} + \Gamma_{(m*n)}\Theta_{(n*1)} + \tau_{(m*1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

$$\left.\begin{array}{l} Y_{(p*1)} = \Lambda_{Y\,(p*m)}\,\Psi_{(m*1)} + \lambda_{(p*1)} \\ X_{(q*1)} = \Lambda_{X\,(q*n)}\,\Theta_{(n*1)} + \mho_{(q*1)} \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

where, $(\Psi') = (\Psi_1, \Psi_2 \ldots\ldots\ \Psi_m)$ and $(\Theta') = (\Theta_1, \Theta_2 \ldots\ \Theta_n)$ are latent dependent and independent variables respectively. Similarly, vectors $Y' = (Y_1, Y_2 \ldots\ Y_p)$ and $X' = (X_1, X_2 \ldots X_q)$ are known as dependent and independent variables respectively.

B $(m \times m)$ and Γ $(m\times\ n)$ are coefficient matrices and $\tau' = (\tau_1, \tau_2 \ldots\ldots\ \tau_m)$ is a random vector of residuals. The vectors of errors of measurement in Y and X are λ and $\mho$, respectively. The matrices $\Lambda_{Y\,(p*m)}$ and $\Lambda_{X\,(q*n)}$ are regression matrices of Y on Ψ and of X on Θ respectively.

Figure 3.2 demonstrates the path diagram for structural equation model for the identified respondents.

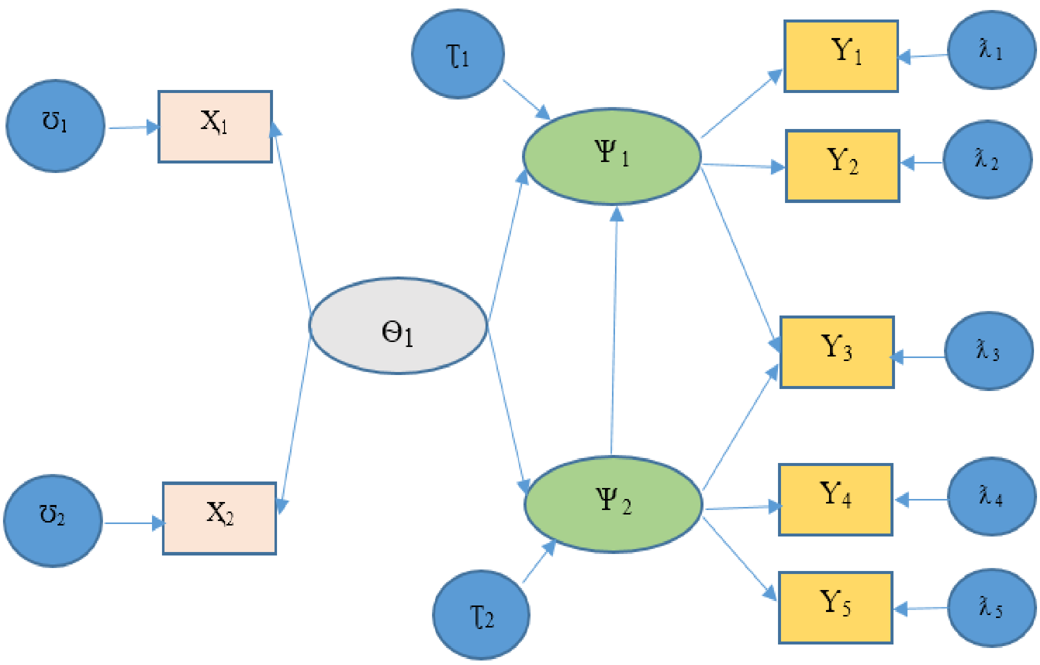


Figure 3.2: Path Diagram of SEM

(Source: Shrestha, (Hanaoka & Tanaboriboon, 2007; Bollen & Pearl. 2012))

SEM supports the hypothesis testing of causal models in the observational studies. It includes path analysis and factor analysis where it represents the models by a path diagram, which is not in the form of equations. Thus, this reflects the relationships among the variables in the models (Lurain et al., 2009).

SEM is able to form a meaningful outcome on the relationships among the variables (Schreiber, et al., (2006; Hoe, 2008; Strang, 2009). **Table 3-2** demonstrates the general list of issues suggested to be reported. It should be noted that missteps compromise results' validity, which inhibits the researchers' ability to gain valuable insights and knowledge of the established model of the study.

Table 3-2: Suggestive Reporting Elements with Respect to SEM Studies

Issues	**Elements to be reported**
Sample	● General description ● Number of observations ● Distribution of samples
Measurement	● Reliability of measures ● Measures of discriminant validity ● Measures of convergent validity
Reproduce-ability	● Name and version of software package used ● Analytical anomalies encountered
Equivalent models	● Potential existence acknowledged as a limitation
Re-specification	● Re-specified models which were not given status of hypothesized model

SEM was analysed in two phases, which include measurement model or confirmatory factor analysis (CFA) and the structural equation model. The measurement model (CFA) is the phase of the model that examines the relationship between the latent variables and their measures while the structural model examines the relationship between the latent variables**.** It should be noted that the analysis of the measurement model requires the structural model to be saturated by allowing all the latent variables to correlate.

Moreover, any misfit in the measurement model was removed (Ho, 2006; Zainudin, 2012).

Each construct was tested via individual CFA, which was then followed by the measurement model analysis (Hair, et al., 1998). The outcome of the analysis provides specifics and evaluation based on the goodness-of-fit (GOF) indices and evidence of construct validity. The maximum likelihood estimation (MLE) approach, which is an estimation method, was used in this research work for testing the individual direct effects and error term correlation.

The SEM model contains a priori hypothesis about a pattern of linear relationships among a set of observed and unobserved variables. The observed variables are known as manifest or measured, MV while unobserved variables are known as underlying or latent, LV (Zainudin, 2012). Furthermore, the unobserved variables are hypothetical constructs that cannot be directly measured where multiple MVs serve as indicators of the underlying constructs in SEM.

In this study, the proposed model consists of observed and latent variables where the observed variables are known as indicators and the latent variables are known as factors or constructs. Moreover, the indicators are the items in the questionnaire, which were used to observe the construct. Therefore, the present study involves the development of a structure model that revolves on six major constructs (unobserved variables) namely cooperation in education, mobility of people, knowledge up-gradation, intellectual enhancement, partnership, and improvement. The indicator or indicators for the six major constructs are described as follows:

i) Cooperation in education was reflected by two observed indicators, namely curriculum contents and skills dialogues.

ii) The mobility of people was reflected by two observed indicators, namely internship programme and graduate employment.

iii) The knowledge upgradation was reflected by one observed indicator, which is enrichment activities.

iv) The intellectual knowledge is reflected by two observed indicators such as new project/knowledge and academic publication.

v) The partnership was reflected by three observed indicators such as best fit talent, promote expertise and product and societal obligation and opportunity.

vi) The improvement was reflected by two observed indicators such as educational outcome and work quality.

3.6.1.1 Assessment of hypothesised model

The initial process involves filtering of the unwanted parameters collected in this study. Data screening was performed to ensure that the data collected from the respondents were correctly entered, free from missing values, outliers and normally distributed (Tempelaar et al. 2007).

Appendix B outlines all the exogenous and endogenous variables along with their relative estimation errors found in this study.

Missing data problem occurs when respondents left out to answer one or two questions in a survey but answered the rest. A survey study suggested that expected maximisation (EM) is a suitable approach to address the missing data problem (Graham et al., 1997). Generally, in the screening of the data, a minimal amount of missing data (5%-10%) has less significant towards the interpretation of the outcome of findings (Cohen and Cohen., 1983). Nevertheless, the preference of method may not have any significant influence on the results since the impact of missing data was minimal (Hair, et al., 1998). In this study, the missing data were replaced with the variable median responses, which are based on the valid response for each variable. This is because the median substitution is the most common (Schwab, 2005) and widely used method (Hair et al., 1998) in addressing the missing data problem.

This study also includes detection of outliers. Outliers refer to observations with a unique combination of characteristics identifiable as distinctly different from other observations (Hair, et al., 1998). Outliers were identified using univariate (histograms, box-plots, and standardised z score) and multivariate detection (Mahalanobis D^2 distance). Treatment of outliers is crucial as it could affect the normality of the data, which leads distortion of the statistical results (Hair, et al., 1998; Tabachnick and Fidell, 2007). For univariate detection, each variable was examined for the standardised (z) score in addition to histograms and box-plots.

Reliability and factor analyses were performed on the latent variables. Factor analysis was performed to enable the correct positioning of the variables to be determined with respect to data consistency. The validity of an instrument is the degree to which an instrument measures what it is intended to measure, in this case, the construct (Zainudin, A 2012). It should be noted that the development or assessment of scales in SEM is often associated with convergent validity and discriminant validity.

Convergent validity refers to the degree to which all the items in the measurement model are statistically significant. The convergent validity could be verified by examining the size of factor loading (standardised regression weights), average variance extracted (AVE), and construct reliability (CR) among sets of the items in the construct. The factor loading estimates with values 0.5 or greater and extracted average variance of 0.5 or higher indicate significant convergence among the items in the construct (Hair, et al., 1998). In addition, the average variance extracted is obtained by dividing the sum square of the standardised factor loading by the factor loading number. CR is obtained based on the square sum of factor loading and the sum of error variance terms for a construct (Hair, et al., 1998). As recommended by a previous study, the CR should be 0.6 or higher to reflect sufficient internal consistency (Bagozzi and Yi, 1988).

Discriminant validity refers to testing whether two constructs are statistically different. Discriminant validity can be verified by comparing the square root of the AVE for two constructs and their square of correlations. The results of discriminant validity are satisfactory when the correlation between the two constructs is smaller than the square root of the AVE for each construct (Fornell and Larcker, 1981; Hair, et al., 1998) where the correlations between the factors should not exceed 0.85 (Kline, 2005).

Reliability is the degree of consistency, which an instrument measures the latent construct it is designed to measure (Zainudin, 2012). Reliability can be assured by minimizing the sources of measurement error like data collector bias. The internal reliability analysis is used to verify the measurement items that represent each individual variable. This verification process involves examination of the Cronbach's alpha coefficient for internal consistency, which ranges from 0 to 1. The higher value of Cronbach's alpha refers to higher reliability, where for a reliable scale, Cronbach's alpha should not be lower than 0.7 (Nunnally and Bernstein, 1994).

Maximum likelihood estimation (MLE) technique is one of the normal theory estimation techniques, which provides the model parameter estimations simultaneously. The main assumption of MLE is the normal distribution of the data. The data is considered to be normally distributed if data skewed within the scale of -2 to +2.

SEM is distinguished by its overall model fit that determines the degree to which the structural equation model fits the sample data (Hair, et al., 1998; Ho, 2006). The GOF is a principal mechanism used in SEM that reflects the fitness of the proposed model to the observed data. GOF indices summarize the discrepancy between the observed and expected values (Kline, 2010).

As indicated by (Zainudin, 2012), in general, there are three index categories, namely:

(i) Absolute fit measures such as chi-square statistic, goodness-of-fit Index (GFI), and root mean square error of approximation (RMSEA).
(ii) Incremental fit measures such as tucker-lewis index (TLI), normed fit index (NFI), incremental fit index (IFI), and comparative fit index (CFI).
(iii) Parsimonious fit measures such as akaik information criterion (AIC) and parsimonious normed fit index (PNFI).

The chi-square ($\chi 2$) statistic forms as absolute fit indexes, used for verifying a non-significant value in support of hypothesised model being able to significantly reproduce the sample covariance matrix. GFI is a non-statistical index ranging from 0 (poor fit) to 1 (perfect fit) (Ho, 2006) where values of over 0.90 indicate a good fit (Hoyle, 1995). Moreover, RMSEA is another absolute fit index used to provide a mechanism for adjusting the sample size if chi-square statistics is used. RMSEA should be lower than 0.1 to indicate a good fit (Schumacker and Lomax, 2010). Nonetheless, the RMSEA values of between 0.03 and 0.08 demonstrate a better-fit model (Hair, et al., 1998; Ho, 2006). For incremental fit indices such as TLI, NFI, IFI, and CFI, values range between 0 (poor fit) and 1 (perfect fit). Evidence of a good fit between the model and the data is when the values of **0.90** and above (Bagozzi and Yi., 1988; Hair et al., 1998; Ho, 2006).
In general, the models with lower AIC values (near to 0) and higher value PNFI indicate a better fit and parsimony (Ho, 2006). The use of three to four fit indices for adequate evidence of model fit proposed by several studies (Hair et al., 1998; Zainudin, 2012).

This includes one incremental index, one absolute fit measure and the chi-square value and associated degrees of freedom.

Therefore, in this study, absolute fit measures such as chi-square statistic, relative chi-square ($\chi 2/df$), GFI, and RMSEA and the incremental fit indices TLI, IFI, and CFI were used to measure the level of model fit.

3.6.2 Theoretical Underpinnings of Analytic Hierarchy Process (AHP)

The strategic planning and decision-making in relation to greater industry interaction in the teaching and learning outcome activities are required for transformation of the engineering education to improve students' learning experience, which includes knowledge, skills, and abilities of industry and evolving engineering practice. Therefore, universities in Malaysia have developed linkages that are closely associated with the teaching and learning processes. Nonetheless, it is necessary for the university to identify and confirm what type of support and contribution industry could offer as a partner in the academic development.

In general, important decisions receive more attention and by nature, they are more complex. If decisions become more complex, the university needs to understand that expert opinion of members of the industry as valuable inputs to aid them in setting the priorities and making the best decision towards fostering better university-industry partnerships. According to (Stirn and Groselj, 2010;Ishizaka and Labib, 2011), it was critical to weight the available options for making decisions by taking into account the various criteria to strategically draw a conclusion. The primary objective is to conceive the best option that would be effective for successfully tackling the given task.

The primary focus of second part of this study is to identify the preference of the industry on the type of linkages by applying the AHP-based model. In this context, the decision-making is the process to choose among the alternatives based on the multiple criteria. The process of determination of criteria and alternatives are very subjective. Thus, there is no correct or wrong criterion because it is subjective to the opinion as most of the decision-making processes are based on the individual judgments. Various tools are available for the decision-makers to choose the best decision for situations that have more than one criterion (Wang & Triantaphyllou, 2006). This includes MCDM, weighted sum model (WSM), eight product model (WPM), elimination and choice translating reality (ELECTRE), the technique for order preference by similarity to ideal solution (TOPSIS), and revised (Multiplicative) AHP (RAHP-MAHP). In this study, MCDM was preferred compared to other methods as their output often yield irregular ranking orders.

AHP is a well-established method of MCDM, which deals with convoluted problems in intricate environments (Ren, Yusuf & Burns, 2005). The driving factors for adopting AHP revolves around knowledge and insights sharing and acknowledging the preference of stakeholders from a different perspective. In fact, the AHP method has gained wide positive endorsement from the decision maker's perspective. Furthermore, AHP is robust to overcome the structural complexity of a given situation as understanding towards creating a suitable hierarchy framework could be developed with ease as it requires no formal training. AHP analysis requires the problem to be broken down into tree-like structural hierarchies, which are followed by establishing hierarchies with mutual influences.

AHP uses judgments of the ratios of each pair of factors in the hierarchy to derive (rather than assign) ratio scale measures to maintain simplicity in the evaluation. Ratio scale priorities are needed as the priorities (or weights) of the elements at any level of the hierarchy are determined by multiplying the priorities of the elements in that level by the priorities of the parent element. AHP is a preferred method in any complex situation that requires structuring, measurement, and/or synthesis. In addition, AHP used for complex and crucial decision-making situations, where the element of synthesis become the main stimulant in combining parts into a whole. As such, the important function of AHP is its ability to measure and synthesize the multitude of factors in a hierarchy.

AHP has advantages over other multi-criteria methods in terms of its stability and flexibility over any changes in the hierarchy, intuitive appeal to the decision-makers as it provides a good picture of universities linkage options and its ability to check inconsistencies (Brent, et al., 2007;Abbaszadeh, Moradi & Mehrabankhou, 2013). Additionally, the decision maker does not require prior knowledge of either mathematics or decision analysis to perform option selections.

3.6.2.1 Establish a Hierarchical Relational Framework

The research process for this study is illustrated in **Figure 3.3**, which started with gathering elements from reliable sources. The pre-existing theory is the key element in the formation of hypotheses about relationships that might exist in relation to a particular group, topic, or situation. Hence, this study commenced by developing theoretical works by reviewing reliable sources that are directed towards fostering the partnership between university and industry on a different perspective-interaction between the teaching and learning processes of engineering education.

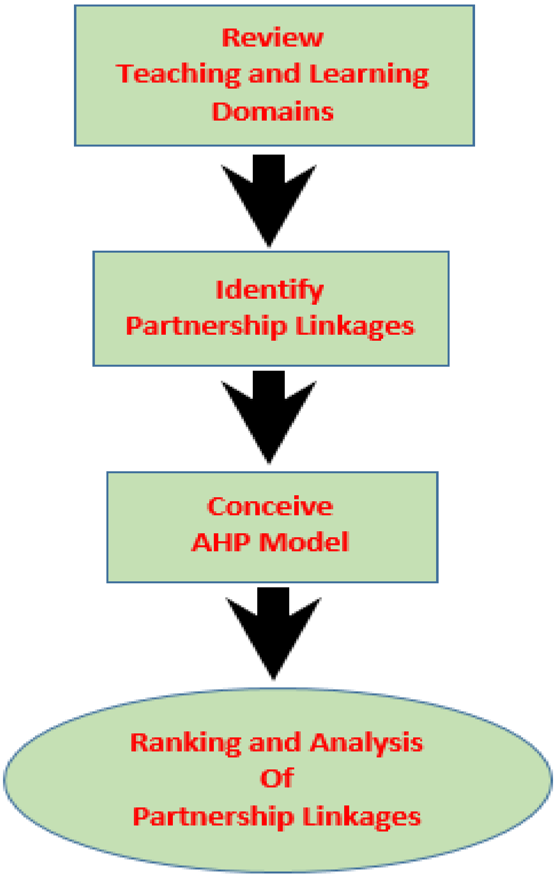


Figure 3.3 Research Process for Rank Order

(Source: (Gosh, 2011; Ishizaka and Labib, 2011))

The next stage involves the identification of the partnership linkages formed by the university that attempts to attract greater interaction of industry. Values, beliefs, and perceptions are the main factors influence the decision-making activities. Industry's opinions of different demographics were collected by administering the questionnaire on a pairwise comparison of decision elements using AHP technique to evaluate the theoretical framework (Ishizaka and Labib, 2011; Onder & Dag, 2013).

The main objectives of the study involve decision-making about ranking the preference of type of linkages to foster university-industry partnership. A typical four-level hierarchy was applied where a hierarchical tree structure was developed with the focus was at the top-level and the alternatives were at the lowest level. If any of the sub-attributes further divided into sub-sub-attributes, the sub-sub-attributes would have constituted a new level. Thus, the problem was divided into its constituent sections, starting from large elements to small elements within the hierarchy. In addition, the structure aimed to clarify the problem and provide the contribution of each of the element for the final decision.

In this study, the adoption of analytical hierarchy process (AHP) requires identification of the objectives. Thus, the set of criteria that affects the objectives and the alternatives (Saaty, 1990) are described below:

(i) The objective is to select the preferred type of academic-led linkage that industry would like to foster the partnership with the university.
(ii) The criteria involving the domains of teaching and learning outcome activities.
(iii) The alternatives involve the linkages that pivot on the basis of knowledge transfer type of university-industry partnership.

3.6.2.2 Formation of Pairwise Comparison Matrix

AHP optimizes a pairwise comparison method in addressing the decision-making involving multiple criteria system of many levels. The general approach of the AHP involves dividing the problems into pairwise comparisons of all elements (attributes, alternatives, etc.) on a given level with respect to the level above. Pairwise comparison generally refers to any process of comparing entities in pairs to judge, which of each pair is preferred or has a greater amount of some quantitative property. Generally, data input for pairwise comparison is straightforward and convenient. In addition, when answering a pairwise comparison question, the decision maker estimates the true but unknown weights based on insight and experience relative to the multi-criteria decision problem.

The degree of preference or intensity of the decision maker for each pairwise comparison was quantified on a scale of 1 to 9, also called "Saaty's fundamental scale" as highlighted in **Table 3-3.**

Table 3-3: Saaty's Fundamental Scale of Judgment and its Description

(Source: Kumar, Parashar & Haleem, 2009; Safian & Nawawi, 2011)

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favouring one activity over another
5	Strong importance	Experience and judgment strongly favouring one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	Sometimes one need to interpolate compromise judgement numerically

According to Belton & Stewart (2002), once the elements are determined, the number of comparisons to be made is defined by:

$$n * (n - 1)/ 2 \text{ } (n \text{ is the number of elements}).$$

For instance, if there are 4 requirements to be compared, there are 6 comparisons (4 * (4 −1)/ 2 = 6).

Therefore, as this study involves 4 domains and 6 links thus, 6 and 15 comparisons were needed respectively. **Table 3-4** indicates the number of comparisons based on the number of elements that are involved in a particular study.

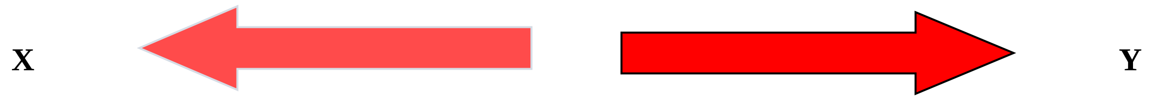
Table 3-4: Number of Comparisons based on Number of Elements in the Study

Number of Domains/Links	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Number of Comparisons	0	1	3	6	10	15	21	28	36

Pairwise comparisons of the elements (usually, alternatives and attributes) can be established using a scale as indicated in **Table 3-5.** Thus, it forms as an easy and most accurate mode in expressing one's opinion using only two alternatives than simultaneously on all the alternatives (Ho, Higson & Dey, 2007, Vaidya & Kumar, 2006; Brent, et al., 2007; Alam, et al., 2012; Prusak, et al., 2013).

Table 3-5: Scoring Pattern in Pairwise Comparison Judgment between Domain vs. Domain

Domain A	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Domain B



Several basic rules must be obeyed to determine and calculate the numbers and weightage.

In this case when:

X to Y = 1, they are of equal importance

X to Y = 3, X is moderately favoured

X to Y = 5, X is strongly favoured

X to Y = 7, X is clearly dominant

X to Y = 9, X is super dominant

As such, when X to Y = 3, it implies that Y to X = 1/3.

Consequently, in this section, the formation of comparison matrix is the resultant of comparing pairs of criteria or alternatives. The pairwise comparison allows the experts to independently judge the contribution of each criterion related to the objective.

Using Saaty's concept, a single number drawn from the fundamental 1-9 scale of absolute numbers was assigned. This scaling process subsequently can be translated into priority weights (scores) for comparison of alternatives. The descriptions of the alternatives are presented and all information is provided.

In this pursuit, the ranking question required respondents to compare the items to each other by placing them in the order of preference. Nonetheless, the sample frame in this study includes respondents from eight industries of various demographic located in Malaysia. The decision to collaborate or affiliate with the university was the responsibility of the mid-level managers. The data used in this study was collected from the senior engineers/technical managers using the questionnaire, which was adapted from Saaty's preference scale. Firstly, the respondents ranked which teaching and learning activity domains were most important to them. This information contains the description of the reviewed criterion and the characteristics of each linkage type on this criterion. Secondly, expert from the industry ranked their preferences on the ranking of the linkage type on each alternative. Subsequently, using the provided information, decision-making will be performed.

The relative values are inserted in a matrix n x n, where n is the number of the elements. Generally, the comparison is performed with the element in the column, on the left, against an element in the row, on top. For instance, in **Table 3.6**, the comparisons were performed as the pairs: domain A with domain B, domain A with domain C, domain A with domain D, until the end of the first row. This is a recommendation for the execution of the comparisons, to make the process easier and ordered.

Table 3-6: Primary Questionnaire Design for Importance of Domain (Respondent 1)

Domain A	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Domain B
Domain A	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Domain C
Domain A	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Domain D

3.6.2.3 Calculation of Priority Vector

A comparison matrix *A*, of dimensions *n X n*, where *n* is the number of alternatives in the particular level. This indicated filling every element *aij* as the result of a pairwise comparison denoting the dominance of element *i* relative to element j. Thus, the manner of the comparison matrix *A*, as introduced by Saaty, is outlined as below:

Let *C1*, *C2*,…, *Cn* denote the set of elements, while *aij* represents a quantified judgment on a pair of elements *Ci*, *Cj*.

An n-by-n matrix *A* as follows:

$$A = [aij] = \begin{array}{c} \\ C1 \\ C2 \\ \vdots \\ Cn \end{array} \begin{array}{c} \begin{array}{cccc} C1 & C2 & \cdots & C3 \end{array} \\ \begin{bmatrix} 1 & a12 & \cdots & an \\ 1/a12 & 1 & \cdots & a2n \\ \vdots & \vdots & \ddots & \vdots \\ 1/a1n & 1/a2n & \cdots & 1 \end{bmatrix} \end{array}$$

Consequently, according to (Gosh, 2011), the decision made based on these pairwise comparisons are transformed into a suitable scale and a sample of comparison as shown in **Table 3.7a**.

Table 3.7a: Insertion of Pairwise Comparisons

Element	C1	C2	C3
C1	1		
C2		1	
C3			1

For instance, in this study, four knowledge transfer teaching and learning criteria were considered to be relevant to the following activity: cooperation in education (CE), mobility of people (MP), knowledge up-gradation (KU), and intellectual enhancement (IE). Consequently, industry provided their own remarks based on the pairwise comparison matrix for the teaching and learning domain.

The input of the pairwise was calculated by summing each column according to equation (Eq.1):

$$\sum_{i} C_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \text{(Eq.1)}$$

Thus, the result of this summation process is shown in **Table 3.7b**

Table 3.7b: Pair-wise Rating of Selection Domain

Sector: Power Electrical   Field Engineer: 1

Domain	**CE**	**MP**	**KU**	**IE**
CE	1	9	9	9
MP	0.111111	1	0.1250	0.1111
KU	0.111111	8	1	9
IE	0.111111	9	0.111111	1
Sum, ∑	**1.333333**	**27**	**10.2361**	**19.1111**

The next step involves calculation of the Eigen value and Eigen vector for the rating. To estimate the vector of priorities, the elements in each row should be summed and the summed value should be normalized by dividing each sum by the total of all sums. The results of all sums should add up to unity. The first entry of the resulting vector is the priority of the first activity; the second entry is the priority of the second activity, and so on.

Therefore, to standardize each cell, X_{ij} and to calculate in obtaining the weight, W, equations (Eq.2), (Eq. 3) and (Eq.4) are used as below:

$$X_{ij} = \frac{C_{ij}}{\sum_i C_{ij}} \quad \text{.................. (Eq. 2)}$$

followed by the summation of row and average (weight) by the following equations respectively:

$$R_i = \sum_j X_{ij} \quad \text{............................ (Eq. 3)}$$

$$W_i = \frac{R_i}{n} \quad \text{........................... (Eq. 4)}$$

where W_i is the rank and n is the number of domains (in this case, n= 4 domains)

Subsequently, calculation of priority vector was performed, where Vi = A●W_i, for i = 1, 2 …n. This was done by combining the normalized local priority weights of the alternatives, sub-criteria and criteria levels through successive multiplication. The new composite weights were normalized. The magnitude, Vi indicates the relative preference of the decision element.

The decision element that receives the highest value reflects the optimal choice as shown in **Table 3.7c**

Table 3.7c: Normalized Pair-wise Rating with Priority Calculation of Selection Domain

Domain	**CE**	**MP**	**KU**	**IE**	**Sum,∑**	**Average weight, W_i**	**Priority Vector, V_i**
CE	0.7500	0.333333	0.87924	0.47093	2.4335	0.608376	**0.73274**
MP	0.083333	0.0370	0.012212	0.005814	0.1384	0.034599	**0.05557**
KU	0.083333	0.296296	0.097693	0.47093	0.9483	0.237063	**0.1406**
IE	0.083333	0.333333	0.010855	0.052326	0.4798	0.119962	**0.07108**
∑	1.0000	1.000	1.0000	1.0000			

The calculated numerical priorities for the decision domains represents the domain's relative ability to achieve the decision goal. The domain with the highest coefficient value was chosen as the best alternative (Vaidya and Kumar, 2006; Gosh, 2011; Abbaszadeh, Moradi and Mehrabankhou, 2013). Thus, this allows diverse and common incommensurable elements to be compared to one another in a rational and consistent way.

As indicated earlier, the respondents are required to respond to a series of redundant pairwise comparisons in AHP. Nevertheless, to maintain the confidentiality level of respondents and the organization's name, the data sets obtained from this survey exercise may reflect each respondent's subjective judgment, which serves as an ideal actual sample. Therefore, to resolve the dilemma of determining the choice of the industry from the given options, the respondents' input based on the assigned criteria to each decision element, were tagged as power electrical experts no. 1-6 from the electrical power industry 1-6 and so on for respondents from other industry.

3.7 Summary

In this study, the relative significance of industry in the teaching and learning domain as a gap analysis effort was performed to bridge the gap between theory and practice by fostering partnership. Moreover, the emphasis was given to adopting suitable approach towards supporting the sound theory from the existing literature.

The methodological basis of this study includes both qualitative and quantitative approaches to tackle the two indicated research questions. The research design outlines the development of the questionnaire, where usage of SEM and AHP were described. The levels of readability and reliability associated with the survey instrument used in the study are acceptable.

Chapter 4
RESULT ANALYSIS

This chapter presents the results and discussion of the study. The chapter is divided into two section:

(i) Analysis of the hypothesized SEM and the results of the SEM analysis

(ii) Decision-making by the industry members for ranking preferred linkage type in establishing partnerships with universities.

4.0 Characteristics of the Targeted Sample

4.0.1 Response Rate

A total of 290 questionnaires were distributed to the shortlisted field engineers who are currently actively employed. After a period of seven months, out of the 290 engineers surveyed in the sample, 219 of them successfully completed and returned the questionnaires. The collected responds were verified for any detectable error for exclusion and available subjects were included the study. The final sample size was 212, where the response rate recorded was 73.1%. The outcome of response rate is presented in **Table 4-1**.

Table 4-1 Response Rate of the Study Participants

Targeted Sample Size	**290**
Respondents	**219**
Valid Sample	**212**
Valid Response Rate	**73.1%**

4.0.2 Distribution of Geographical Region

Malaysia is located in the region of Southeast Asia, comprises of Peninsular Malaysia and the states of Sabah and Sarawak. Sabah and Sarawak are located in the northern part of the island of Borneo, which is separated by 500 kilometres of the South China Sea from Peninsular Malaysia. The industrial zones are earmarked in various regions based on their geographical region within Malaysia. This was done to assure an effective outcome of the study. Intensification and size of industrial zones and engineering strength vary based on the economic policies and priority of policymakers in each state. **Table 4-2** demonstrates the sample size and number of questionnaires that were distributed across different geographical regions within Malaysia.

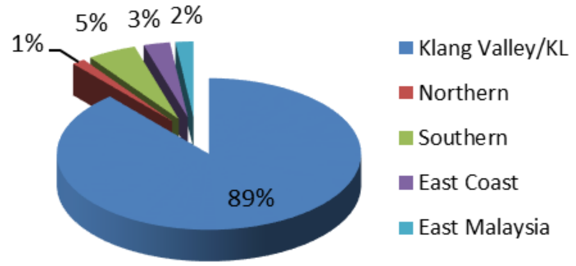
Table 4-2: Sample Size and Questionnaire Distributed According to the Geographical Region

Geographical Region	Sample Questionnaire Distributed
Northern Zone (4 states)	**25**
Central Zone (3 states)	**210**
Southern Zone (2 states)	**25**
East Coast Zone (3 states)	**15**
Sabah & Sarawak Zone (2 states)	**15**
Total Distribution of questionnaire	**290**

The industries participated are actively involved in the engineering-based activities in Malaysia. The distribution of the total 212 survey response was evaluated in terms regional zone in Malaysia. The responders were asked to specify their company's location (region) and the outcome was summarized in Table 4-3. It was found that the responders are predominantly located in Klang Valley/Kuala Lumpur (89%), 5% are located in Southern, 3% are located in East Coast, 2% are located in East Malaysia and the remaining 1% are located in the Northern region.

Table 4-3: Classification of Companies by Their Regional Location

Group	Frequency (No.)	Percentage (%)
Klang Valley/KL	188	88.7
Northern	3	1.4
Southern	11	5.2
East Coast	6	2.8
East Malaysia	4	1.9

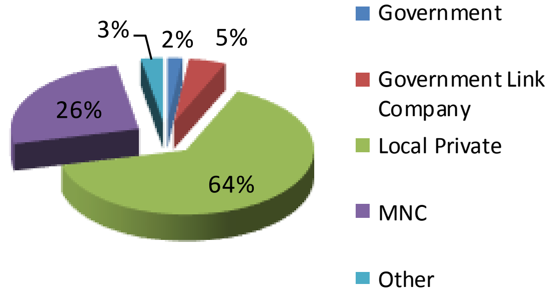


4.0.3 Profile of Ownership of Organization

While demographic information has no impact on the level of analysis of this study, the results may provide a generalized view on the cluster of ownership of the participated organization. The ownership status of the industry participated in this study is shown in **Table 4-4**. The findings revealed that both local and foreign companies are fairly engaged to gain a holistic approach to this intended research.

Table 4-4: Characteristics of Ownership of the Companies

Group	Frequency (No.)	Percentage (%)
Government	4	1.9
Government Linked Company	10	4.7
Local Private	137	64.6
MNC	55	25.9
Other	6	.8



In terms of ownership of the participated companies, 64% are local private, 26% are MNC, 5% are the government-linked company, 2% are government and the remaining 3% are from the other sectors. Therefore, it is clear that majority of the respondents of this study are from local private companies where the outcomes of the survey may mainly reflect the views of this particular ownership.

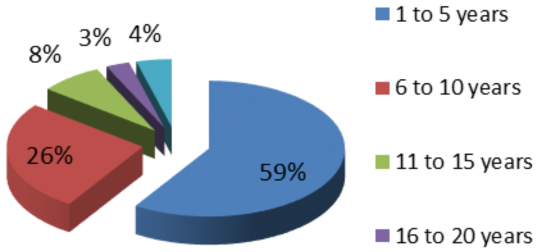
4.0.4 Profile of the Target Respondents

The targeted population for this study is professionals, particularly the field engineers who are actively involved in technical development. All study participants stay with their company for longer than three years. A majority of respondents identified hold strong credibility, where they actively involved in engineering activities as their main source of business. This reflects the sample of industries, which is crucial for the objective of the study to understand the dynamics of the partnership between industry and academia.

Table 4-5 demonstrates the duration of work experience of the study participants in their current organization. The results demonstrate that majority of respondents (59%) have 1 to 5 years of experience. Only a minority of respondents (3%) have 16 to 20 years of experience. Moreover, out of the total study respondents, 26% have 6 to 10 years of experience, 8% have 11 to 15 years of experience and 4% have more than 20 years of experience.

Table 4-5 Duration of Work Experience of Study Respondents in their Current Organization

Group	**Frequency (No.)**	**Percentage (%)**
1 to 5	125	59.0
6 to 10	56	26.4
11 to 15	16	7.5
16 to 20	6	2.8
More than 20 years	9	4.2

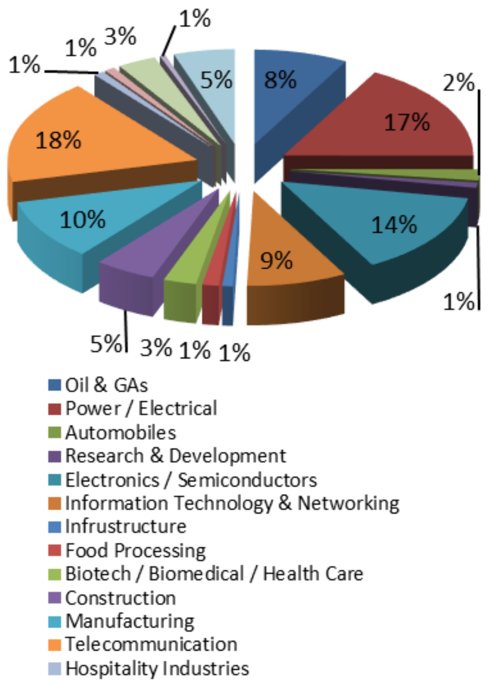


4.0.5 Profile of Industry Sector

The target respondents of this research include industry as the crucial stakeholders where the survey covers almost 20 sectors of industries within Malaysia. Hence, the unit of analysis of this study comprises primarily various types of industries that are strongly associated with engineering activities in Malaysia. It should be noted that these characteristics are an integral part of the analysis to classify the participating industry sector. **Table 4-6** demonstrates the characteristics of industry sectors participated in this study.

Table 4-6: Characteristics of Company's Sector

Group	Frequency (No.)	Percentage (%)
Oil & GAs	17	8.0
Power /	36	17.0
Automobiles	4	1.9
Research &	2	.9
Electronics /	30	14.2
Information	18	8.5
Infrastructure	2	.9
Food	3	1.4
Biotech /	6	2.8
Construction	11	5.2
Manufacturin	22	10.4
Telecommuni	38	17.9
Hospitality	2	.9
Mechanical	2	.9
Training &	7	3.3
Aviation	1	.5
Other Sector	11	5.2



Majority of the study participants are from telecommunication sector (17.9%). Only a small percentage of the participants are from construction sector (5.2%). Out of the total participants, 17.0% are from power and electrical related sectors, 14.2% are from electronics and semiconductor sector, 10.4% are from the manufacturing-related sector, 8.5% are from information and technology sector and 8% are from oil and gas sector. While there was no hypothesized relationship between industrial sectors and teaching and learning domain in this study, the findings partially support the theoretical judgment of sectors involved in the collaborative venture between university and industry.

Overall, the respondents are from a wide range sectors of industries, regions and with relevant work experience, which suggest that the results are relatively representative.

4.1 Examination of Data

4.1.1 Outliers: Univariate and Multivariate

Standardised (z) score of each variable was measured in addition to examination of both histograms and box-plots. The standardised (z) scores of all cases are summarized for the items in each construct as shown in Appendix J-1. Absolute (z) > 4 indicates an extreme observation for larger sample size Hair (1998). The outcome of the test reflects that the standardised (z) scores of the research variables scale were from -3.879 to 2.196. Since none of the variables exceeded the threshold of ±4, there was no univariate outlier detected among the cases.

The data was further subjected to multivariate detection. In this study, Mahalanobis distance was calculated to identify the multivariate outliers. Mahalanobis D-squared distances were generated for each case using AMOS regression with the case number as the dependent variable and all non-demographic measures as independent variables. D^2 / df value greater than 3.5 represents potential multivariate outlier (Hair, et al., 1998). As shown in Appendix C, the results indicated high value of D^2, which was 140.393. Therefore, for 202 exogenous and endogenous variables with their relative estimation errors in this study (Appendix B), the maximum D^2 / df was equal to 0.695 (140.393 / 202), which was far below the cut-off of 3.5. Consequently, there were no multivariate outliers. Thus, all observations were retained for analysis.

4.1.2 Assessment of the Data Normality

The normality test was conducted as the main pre-assumption of maximum likelihood estimation to assess the normal distribution of the data of constructs. The result of normality test for all 87 items in the model indicated that the skew and kurtosis values were between ±2 and ±7 respectively. The skew ranged from -0.509 to 0.113 and the kurtosis ranged from -1.16 to -0.304. Therefore, the data was normally distributed. Summary of the normality test is shown in Appendix J-2.

4.2 Measurement Model (CFA) – Stage 1 of SEM

Operationalisation of constructs is a crucial step to ensure accuracy where the SEM analysis was used to measure the constructs in this study (Hair, et al., 1998).

This study comprised five of individual CFA models and five second-order constructs including, cooperation in education, mobility of people, intellectual enhancement, partnership, and improvement. The overall measurement model for the individual CFA models comprised of knowledge up-gradation as the first-order construct. The following section describes the development of each measurement model and the outcome of testing of the uni-dimensionality of each construct are presented.

4.2.1 A CFA Model for Cooperation in Education (CE)

In this study, 21 items were used to measure two first-order constructs for cooperation in education including curriculum content development (CC) and skills dialogues (SD). The initial cooperation in education model with all 21 items is presented in Appendix D.

4.2.1.1 Standardized Loadings of the Model's Items

The result indicated that the factor loading of 6 items (i.e., CC3, CC7, CC10, SD2, SD5, and SD9) were below the cut-off of 0.5. Therefore, these items were removed from the model. The revised model with 15 remaining items was again tested to examine the stability of the factor structure. It was found that the second standardised factor loading for all items and constructs were more than 0.5, ranged from 0.792 to 0.860. Appendix J-3 presents the deleted items from the model and the recalculated factor loadings for the remaining items.

4.2.1.2 Goodness-of-Fit Indices

The overall results of the CFA indicate that the second measurement model for cooperation in education (CE) adequately fitted the data with remaining 15 items. The results of the GOF indices are represented in **Table 4-7**.

Table 4-7: GOF Indices of Modified Measurement Model for Cooperation in Education

Fit index	Modified Model	Recommended values	Source
Df	89		
CMIN (χ^2)	112.226		
p-value	0.048	> 0.05	
χ^2/df	1.261	≤ 5.00	Bagozzi and Yi, (1988)
GFI	0.938	≥ 0.90	Hoyle, (1995)
AGFI	0.916	≥ 0.80	Chau and Hu, (2001)
CFI	0.991	≥ 0.90	Bagozzi and Yi, (1988); Byrne, 1998
TLI	0.990	≥ 0.90	Hair et al., (1998); Ho, (2006)
IFI	0.992	≥ 0.90	Hair et al., (1998); Ho, (2006)
RMSEA	0.035	≤ 0.10	Schumacker and Lomax, (2010)

AGFI: Adjusted goodness of fit; CFI: comparative fit index; CMIN: chi-square; Df: Degree of Freedom; GFI: Goodness-of-fit index; IFI: Incremental fit index; RMSEA: Root mean square error of approximation

As shown in **Table 4-7**, the chi-square was significant (χ^2= 112.226; df = 89; p= 0.048) indicating the modified measurement model for cooperation in education was significant. Nevertheless, the absolute fit index of minimum discrepancy chi-square can be ignored if the sample size obtained for the study is greater than 200 (Hair et al., 1995; Joreskog & Sorbom, 1986). In addition, the GFI was 0.938, which was above the cut-off of 0.9 as recommended by Hoyle (1995). After adjustment for the degrees of freedom relative to the number of variables, the adjusted GFI (AGFI) was 0.916, which was above the cut-off of 0.80 as recommended by (Chau and Hu, 2001). The results indicated that the model predicts 91% of the variances and covariance in the survey data. The values of

CFI, TLI, and IFI were 0.991, 0.990 and 0.992 respectively, which were above the cut-off of 0.9 (Bagozzi and Yi., 1988); Byrne., 1998; Hair et al., 1998; Ho., 2006). The RMSEA was 0.035, which was below the threshold of 0.1 as recommended by (Schumacker and Lomax, 2010). Furthermore, the relative CMIN/df (1.261) was less than 5 indicating that the model has a good fit (Bagozzi and Yi, 1988).

4.2.1.3 Reliability and Convergent Validity

Various criteria such as Cronbach's alpha, construct reliability (CR) and average variance extracted (AVE) were used to assess the reliability. Meanwhile, validity was measured using construct, including convergent and discriminant. Table 4-8 represents the result of Cronbach alpha and convergent validity for the modified measurement model for CE with 15 remaining items.

Table 4-8: Results of Cronbach Alpha and Convergent Validity for Cooperation in Education (CE) CFA Model

Construct	**Item /Construct**	**Internal Reliability (Cronbach Alpha)**	**Convergent validity**		
			Second Factor Loading	**Average Variance Extracted (AVE)[a]**	**Composite Reliability (CR)[b]**
Curriculum Content Development (CC)	CC1	0.944	0.856	0.681	0.945
	CC2		0.831		
	CC3		0.383[c]		
	CC4		0.836		
	CC5		0.836		
	CC6		0.792		
	CC7		0.311[c]		
	CC8		0.808		
	CC9		0.837		
	CC10		0.374[c]		
	CC11		0.804		
Skills Dialogues (SD)	SD1	0.946	0.86	0.716	0.946
	SD2		0.396[c]		
	SD3		0.856		
	SD4		0.844		
	SD5		0.373[c]		
	SD6		0.844		
	SD7		0.824		
	SD8		0.856		
	SD9		0.302[c]		
	SD10		0.839		

[a]*: Average Variance Extracted = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}.*
[b]*: Composite reliability = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.*
[c]*: denotes for a discarded item due to insufficient factor loading below the cut-off of 0.5*

Table 4-8 demonstrates the AVE assessment criteria. The results indicate the overall amount of variance in the indicators accounted by the latent constructs for curriculum content development (CC) and skills dialogues (SD) were 0.681 and 0.716 respectively. These values were above the cut-off of 0.5 as suggested by (Nunnally & Bernstein, 1994).

The composite reliability value, which reflects the degree to which the construct indicators indicate the latent constructs were 0.945 and 0.946 for curriculum content development (CC) and skills dialogues (SD) respectively. These values exceeded the recommended value of 0.6 by (Bagozzi and Yi, 1988). The values of Cronbach alpha for curriculum content development (CC) and skills dialogues (SD) were 0.944 and 0.946 respectively. These values were above the cut-off of 0.7 as recommended (Nunnally and Bernstein, 1994). Therefore, high Cronbach's alpha for all constructs might reflect a high internal consistency.

4.2.1.4 Discriminant validity

The discriminant validity was examined to assess the degree of difference observed in a construct from other constructs. In this study, as recommended by (Kline, 2005), the correlations between factors in the measurement model were below the threshold value of 0.85. The validity was checked based on the comparisons of the correlations between constructs and the square root of the average variance extracted for a construct (Fornell and Larcker, 1981).

Table 4-9 demonstrates the discriminant validity of the measurement model for cooperation in education (CE).

Table 4-9: Discriminant Validity of Measurement Model for Cooperation in Education

	CC	**SD**
Curriculum Content Development (CC)	**0.825**	
Skills Dialogues (SD)	0.756	**0.846**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

As shown in Table 4-9, the inter-correlations between curriculum content development (CC) and skills dialogues (SD) as the two sub-constructs in cooperation in education was 0.756. This value was lower than the threshold of 0.85, which was satisfactory. Furthermore, the correlation was lower than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between these factors (Kline, 2005). The results of the goodness of fit, convergent validity and discriminant validity of the measurement model, indicated that the final measurement scale to assess the constructs and their relative items in cooperation in education (CE) construct was reliable and valid.

Figure 4-1 depicts the final measurement model for cooperation in education (CE) with standardized factor loadings for the 15 remaining items.

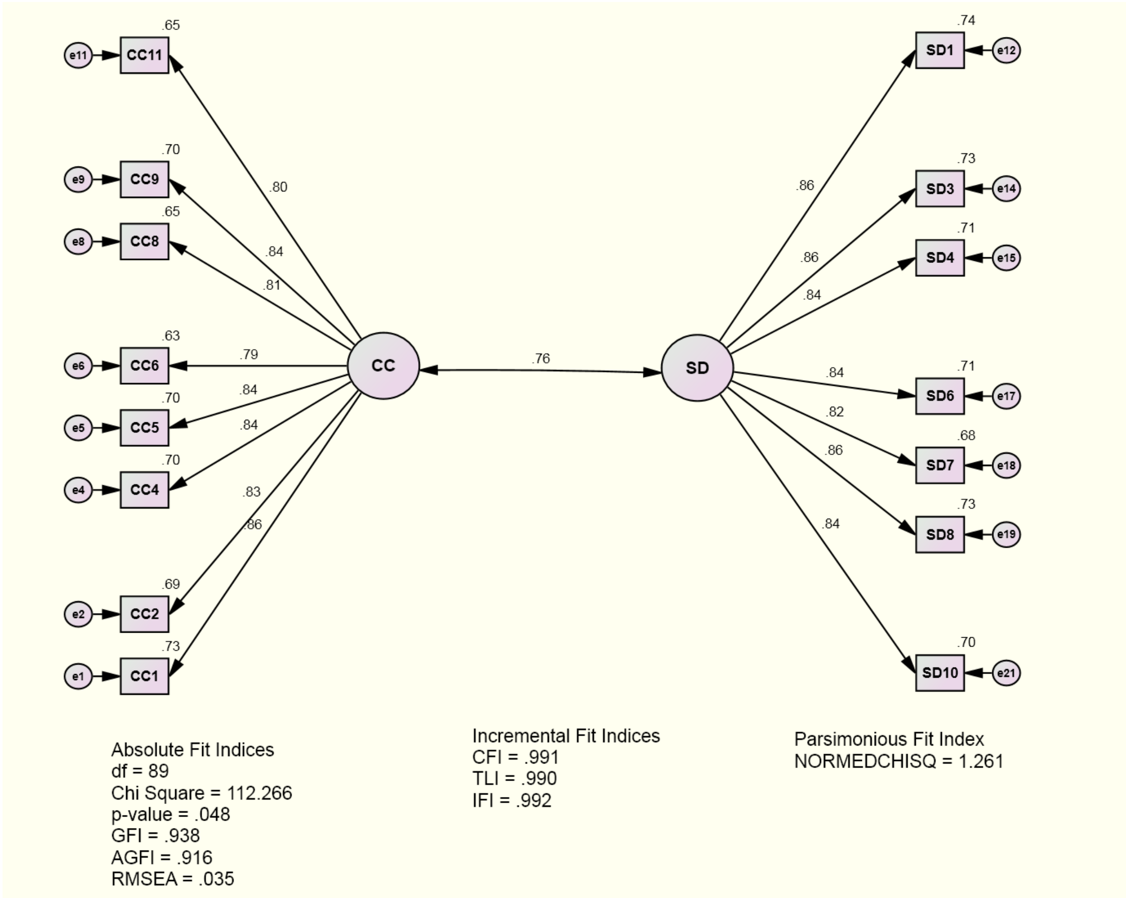


Figure 4-1: Final Measurement Model for Cooperation in Education with Remaining 15 Items

4.2.2 A CFA Model for Mobility of People (MP)

In this study, 17 items were used to measure two first-order constructs in mobility of people (MP): internship programme (IP) and graduate employment (EM)). The initial MP model with all 17 items was portrayed in Appendix E.

4.2.2.1 Standardized Loadings of the Model's Items

The result indicated that the factor loading of 4 items (i.e., IP4, IP8, EM3, and EM6) were below the cut-off of 0.5. Therefore, these items were removed from the model. The revised model with 13 remaining items was again tested to ensure whether the factor structure remained stable. It was observed that the second standardised factor loading for all items and constructs were more than 0.5, ranged from 0.836 to 0.888. As such, some items were deleted from the model and the recalculated factor loadings for the remaining items are presented in Appendix J-4.

4.2.2.2 Goodness-of-Fit Indices

The overall results of the CFA indicate that the second measurement model for mobility of people adequately fitted the data with remaining 13 items. The chi-square was not significant (χ^2= 77.244; df = 64; p= 0.124). In addition, the GFI was 0.945, which was above the cut-off of 0.9 as recommended by Hoyle (1995). The AGFI was 0.922, which was above the cut-off of 0.80 as recommended by Chau and Hu (2001). The values of CFI, TLI, and IFI were 0.995, 0.994 and 0.995 respectively, which were above the cut-off of 0.9 (Bagozzi and Yi., 1988; Byrne, 1998; Hair et al., 1998; Ho, 2006). In addition, as recommended by Schumacker and Lomax (2010), the RMSEA was 0.031, which was below the threshold of 0.1. Additionally, the relative CMIN/df (1.207) was lower than 5 indicating that the model has a good fit (Bagozzi and Yi, 1988).

4.2.2.3 Reliability and Convergent Validity

As shown in Table 4-10, the AVE assessment criteria for internship programme (IP) and graduate employment (EM) were 0.759 and 0.734 respectively. These values were above the cut-off of 0.5 as suggested by (Nunnally & Bernstein, 1994). In addition, the composite reliability values were 0.957 and 0.943 for internship programme (IP) and graduate employment (EM) respectively. Both values exceeded the recommended value of 0.6 (Bagozzi and Yi, 1988). In addition, the values of Cronbach’s alpha assessment criteria for internship programme (IP) and graduate employment (EM) were 0.956 and 0.943 respectively, which were above the cut-off of 0.7 as suggested by (Nunnally and Bernstein, 1994). Therefore, high Cronbach’s alpha for all constructs might reflect a high internal consistency.

Table 4-10 represents the result of Cronbach alpha and convergent validity for the modified measurement model for mobility of people (MP) with 13 remaining items.

Table 4-10: Results of Cronbach's Alpha and Convergent Validity for Mobility of People CFA Model

Construct	**Item /Construct**	**Internal Reliability Cronbach Alpha**	**Convergent validity**		
			Second Factor Loading	**Average Variance Extracted (AVE)[a]**	**Composite Reliability (CR)[b]**
Internship Programme (IP)	IP1	0.956	0.87	0.759	0.957
	IP2		0.848		
	IP3		0.876		
	IP4		0.352[c]		
	IP5		0.873		
	IP6		0.888		
	IP7		0.856		
	IP8		0.356[c]		
	IP9		0.885		
Graduate Employment (EM)	EM1	0.943	0.836	0.734	0.943
	EM2		0.837		
	EM3		0.364[c]		
	EM4		0.853		
	EM5		0.873		
	EM6		0.38[c]		
	EM7		0.873		
	EM8		0.868		

[a]: *Average Variance Extracted = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}.*

[b]: *Composite reliability = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.*

[c]: *denotes for a discarded item due to insufficient factor loading below the cut-off of 0.5*

4.2.2.4 Discriminant validity

Discriminant validity was examined where the correlations between factors in the measurement model were below the threshold value of 0.85 as recommended by (Kline, 2005). **Table 4-11** demonstrates the discriminant validity of the measurement model for mobility of people (MP).

Table 4-11: Discriminant Validity of Measurement Model for Mobility of People

	IP	EM
Internship Programme (IP)	**0.871**	
Graduate Employment (EM)	0.688	**0.857**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

As shown in Table 4-11, the inter-correlations between internship programme (IP) and graduate employment (EM) as the two sub-constructs in mobility of people was 0.688, this value was lower than the threshold of 0.85 indicating a satisfactory result. Furthermore, the correlation was lower than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between IP and EM (Kline, 2005).

The results of the goodness of fit, convergent validity and discriminant validity of the measurement model, implied that the final measurement scale to assess the constructs and their relative items in mobility of people construct was reliable and valid.

Figure 4-2 demonstrates the final measurement model for mobility of people with standardized factor loadings for the 13 remaining items.

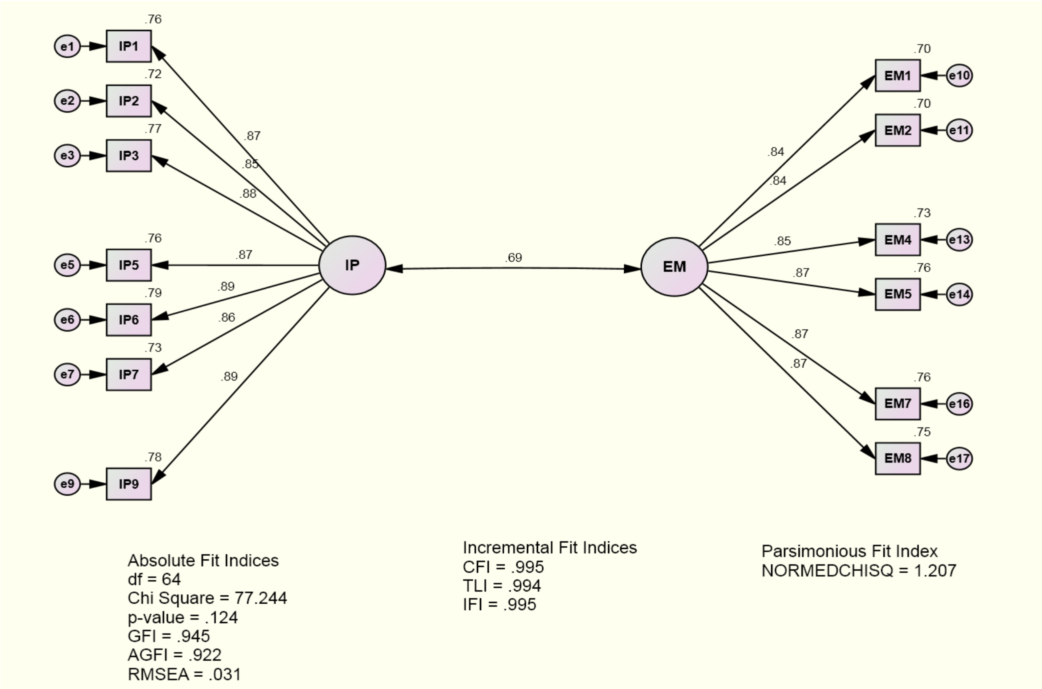


Figure 4-2: Final Measurement Model for Mobility of People with Remaining 13 Items

4.2.3 A CFA Model for Intellectual Enhancement (IE)

A total of 13 items were used to measure two first-order constructs in intellectual enhancement (IE): idea on new projects/knowledge (IK) and academic publications (PB). The initial intellectual enhancement model with all 13 items is shown in Appendix F.

4.2.3.1 Standardized Loadings of the Model's Items

The result indicated that the factor loading of 2 items (i.e., KI1 and KI7) were below the cut-off of 0.5. Therefore, KI1 and KI7 were excluded from the model. The revised model with 11 remaining items was again tested to verify whether the factor structure remained stable. The results demonstrated that the second standardised factor loading for all items and constructs were more than 0.5, ranged from 0.853 to 0.906. As such, some items were deleted from the model and the recalculated factor loadings for the remaining items are presented in Appendix J-5.

4.2.3.2 Goodness-of-Fit Indices

The overall results of the CFA indicate that the second measurement model for intellectual enhancement (IE) adequately fitted the data with remaining 11 items (χ^2=76.061; df = 43; p= 0.001). In addition, the GFI was 0.941, which was above the cut-off of 0.9 as recommended by (Hoyle, 1995). The AGFI was 0.910, which was above the cut-off of 0.80 as recommended by (Chau and Hu, 2001). The values of CFI, TLI and IFI were 0.986, 0.982 and 0.986 respectively, which were above the cut-off of 0.9 (Bagozzi and Yi., 1988; Byrne., 1998; Hair et al., 1998; Ho., 2006). Furthermore, the RMSEA was 0.060, which was below the threshold of 0.1 as recommended by (Schumacker and Lomax, 2010). Additionally, the relative CMIN/df (1.769) was lower than 5 indicating the good fit of the model (Bagozzi and Yi, 1988).

4.2.3.3 Reliability and Convergent Validity

The results of reliability and convergent validity for the modified measurement model for intellectual enhancement (IE) with 11 remaining items is shown in Table 4-12. The AVE values for idea on new projects/knowledge (IK) and academic publications (PB) were 0.756 and 0.794 respectively. These values were above the cut-off of 0.5 as recommended by (Nunnally & Bernstein, 1994). The composite reliability values were 0.949 and 0.951 for idea on new projects/knowledge (IK) and academic publications (PB) respectively. Both values were higher than the recommended value of 0.6 (Bagozzi and Yi, 1988).

Table 4-12 represents the result of Cronbach alpha and convergent validity for the modified measurement model for intellectual enhancement with 11 remaining items.

Table 4-12: Results of Cronbach's Alpha and Convergent Validity for Intellectual Enhancement CFA Model

Construct	**Item /Construct**	**Internal Reliability (Cronbach Alpha)**	**Convergent validity**		
			Second Factor Loading	**Average Variance Extracted (AVE)[a]**	**Composite Reliability (CR)[b]**
Idea on New Projects/Knowledge(IK)	IK1	0.949	0.457 [c]	0.756	0.949
	IK2		0.853		
	IK3		0.878		
	IK4		0.877		
	IK5		0.882		
	IK6		0.865		
	IK7		0.392[c]		
	IK8		0.863		
Academic Publications (PB)	PB1	0.950	0.894	0.794	0.951
	PB2		0.885		
	PB3		0.906		
	PB4		0.886		
	PB5		0.885		

[a]: Average Variance Extracted = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}.

[b]: Composite reliability = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.

[c]: denotes for a discarded item due to insufficient factor loading below the cut-off of 0.5

The values of Cronbach's alpha for idea on new projects/knowledge (IK) and academic publications (PB) were 0.949 and 0.950 respectively. As recommended by (Nunnally and Bernstein, 1994), these values were above the cut-off of 0.7. Therefore, high Cronbach's alpha for all constructs might reflect a high internal consistency.

4.2.3.4 Discriminant validity

The correlations between factors in the measurement model were below the cut-off of 0.85 for the verification of discriminant validity as recommended by (Kline, 2005). The validity was verified based on the comparisons of the correlations between constructs and the square root of the average variance extracted (AVE) for a construct (Fornell and Larcker, 1981). Table 4-13 represents the discriminant validity of the measurement model for intellectual enhancement.

Table 4-13: Discriminant Validity of Measurement Model for Intellectual Enhancement

	IK	PB
Idea on New Projects/Knowledge(IK)	**0.869**	
Academic Publications (PB)	0.735	**0.891**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

As shown in **Table 4-13**, the inter-correlations between idea on new projects/knowledge (IK) and academic publications (PB) as the two sub-constructs in intellectual enhancement (IE) was 0.735. This value was lower than the threshold of 0.85, which was satisfactory. Furthermore, the correlation was lower than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between these factors (Kline, 2005). The overall results of the goodness of fit, convergent validity and discriminant validity of the measurement model implied that the final measurement scale to assess the constructs and their relative items in intellectual enhancement construct was reliable and valid.

Figure 4-3 demonstrates the final measurement model for intellectual enhancement with standardized factor loadings for the 11 remaining items.

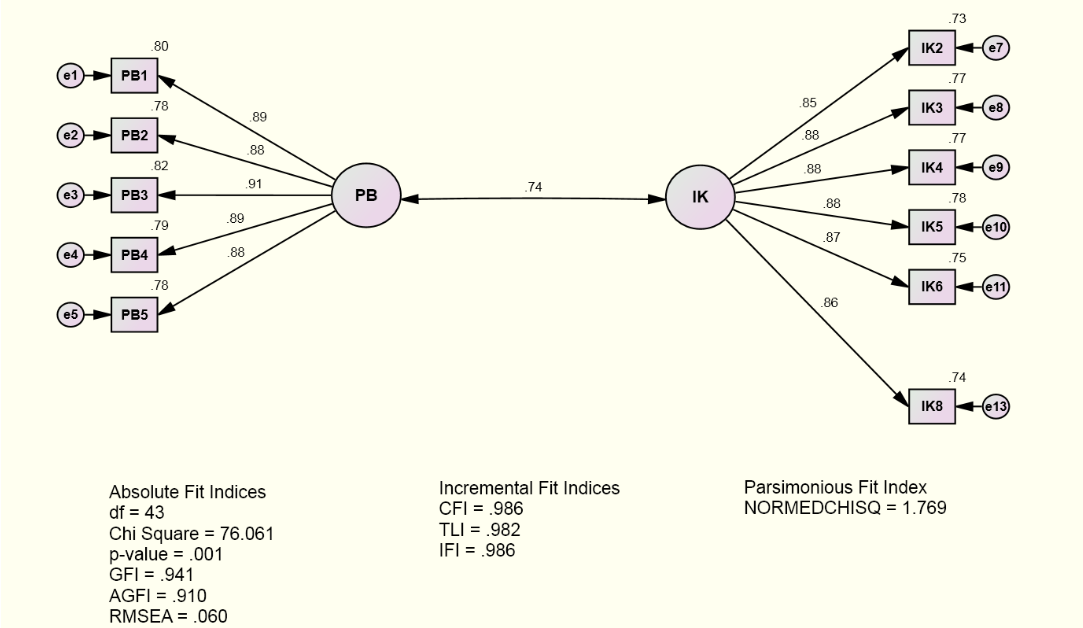


Figure 4-3: Final Measurement Model for Intellectual Enhancement with Reminder 11 Items

4.2.4 A CFA Model for Partnership (PR)

In this study, 14 items were used to measure three first-order constructs in partnership: promote product/expertise (PP), best-fit talent (BT) and social obligation & opportunities (SO). The initial partnership model with all 14 items is shown in Appendix G.

4.2.4.1 Standardized Loadings of the Model's Items

The result indicated that the factor loading of one item (i.e., BT3) was 0.399, which was lower than the cut-off of 0.5. Therefore, this item was removed from the model. The revised model with 13 remaining items was again tested to ensure whether the factor structure remained stable. In addition, the second standardised factor loading for all items and constructs were more than 0.5, ranged from 0.862 to 0.914. As such, some items were deleted from the model and recalculated factor loadings for the remaining items are presented in Appendix. J-6

4.2.4.2 Goodness-of-Fit Indices

The overall results of the CFA indicate that the second measurement model for partnership adequately fitted the data with remaining 11 items. The chi-square was not significant (χ^2= 60.894; df = 62; p= 0.516). In addition, the GFI was 0.957, which was above the cut-off of 0.9 as recommended by Hoyle (1995). The AGFI was 0.937, which was above the cut-off of 0.80 as recommended by (Chau and Hu, 2001). The value of CFI, TLI and IFI was 1.00, above the cut-off of 0.9. (Bagozzi and Yi., 1988; Byrne., 1998; Hair et al., 1998; Ho., 2006). In addition, the RMSEA was 0.000, which was far below the threshold of 0.1 as recommended by Schumacker and Lomax (2010). Additionally, the relative CMIN/df (0.982) was lower than 5 indicating the good fit of the model (Bagozzi and Yi, 1988).

4.2.4.3 Reliability and Convergent Validity

Once the uni-dimensionality of the constructs was achieved, each of the construct was assessed for the reliability and validity. **Table 4-14** demonstrates the result of Cronbach's alpha and convergent validity for the modified measurement model for partnership with 13 remaining items.

Table 4-14: Results of Cronbach's Alpha and Convergent Validity for Partnership CFA Model

Construct	**Item /Construct**	**Internal Reliability Cronbach Alpha**	**Convergent validity**		
			Second Factor Loading	**Average Variance Extracted (AVE)[a]**	**Composite Reliability (CR)[b]**
Promote Product/Expertise (PP)	PP1 PP2 PP3 PP4	0.933	0.871 0.914 0.871 0.871	0.778	0.933
Best Fit Talent (BT)	BT1 BT2 BT3 BT4 BT5 BT6	0.943	0.881 0.875 0.399[c] 0.871 0.871 0.883	0.768	0.943
Social Obligation & Opportunities (SO)	SO1 SO2 SO3 SO4	0.937	0.894 0.901 0.896 0.862	0.789	0.937

[a]: Average Variance Extracted = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}.

[b]: Composite reliability = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.

[c]: denotes for a discarded item due to insufficient factor loading below the cut-off of 0.5

As shown in **Table 4-14**, the AVE values for promote product/expertise (PP), best fit talent (BT) and social obligation & opportunities (SO) were 0.778, 0.768 and 0.789 respectively. These values were above the cut-off of 0.5 as suggested by (Nunnally & Bernstein, 1994). The composite reliability values were 0.933, 0.943 and 0.937 for promote product/expertise (PP), best fit talent (BT) and social obligation & opportunities (SO) respectively. These values exceeded the recommended value of 0.6 (Bagozzi and Yi, 1988). Moreover, the values of Cronbach's alpha for promote product/expertise (PP), best fit talent (BT) and social obligation & opportunities (SO) were 0.933, 0.943 and 0.937 respectively. As suggested by (Nunnally and Bernstein, 1994), all of these values were above the cut-off of 0.7. Therefore, high Cronbach's alpha for all constructs might reflect a high internal consistency.

4.2.4.4 Discriminant validity

In the case of discriminant validity, the correlations between factors in the measurement model were below the threshold value of 0.85 as recommended by (Kline, 2005). The validity was checked based on comparisons of the correlations between constructs and the square root of the average variance extracted (AVE) for a construct (Fornell and Larcker, 1981). **Table 4-15** demonstrates the discriminant validity of the measurement model for partnership. As shown in Table 4-15, the inter-correlations between promote product/expertise (PP), best fit talent (BT) and social obligation & opportunities (SO) as the three sub-constructs in the partnership were ranged from 0.701 to 0.745.

Table 4-15: Discriminant validity of Measurement Model for Partnership

	PP	BT	SO
Promote Product/Expertise (PP)	**0.882**		
Best Fit Talent (BT)	0.701	**0.876**	
Social Obligation & Opportunities (SO)	0.708	0.745	**0.888**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

All of these relationships were below the threshold value of 0.85, which were satisfactory. Furthermore, the correlations were lower than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between these factors (Kline, 2005). The results of goodness to fit, convergent validity and discriminant validity of the measurement model demonstrated that the final measurement scale to assess the constructs and their relative items in partnership construct was reliable and valid. **Figure 4-4** illustrates the final measurement model for partnership with standardized factor loadings for the 13 remaining items.

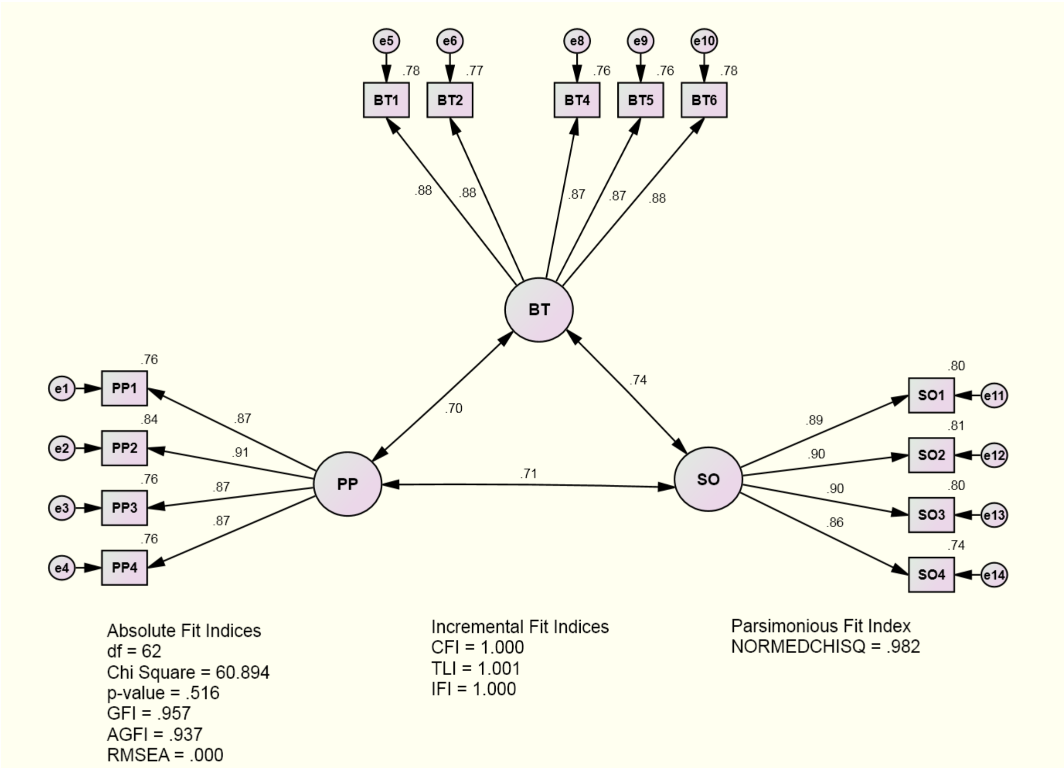


Figure 4-4: Final Measurement Model for Partnership with Remaining 13 Items

4.2.5 A CFA Model for Improvement (IM)

In this study, 12 items were used to measure two first-order constructs in improvement: educational outcomes (EO) and work quality (WQ). The initial improvement model with all 12 items was portrayed in Appendix H.

4.2.5.1 Standardized Loadings of the Model's Items

The result indicated that the factor loading of 2 items (i.e., EO2 and WQ4) were below the cut-off of 0.5. Therefore, these items were removed from the model. The revised model with 10 remaining items was again tested to ensure whether the factor structure remained stable. Additionally, the second standardised factor loading for all items and constructs was more than 0.5, ranged from 0.841 to 0.993. As such, some items were deleted from the model and the recalculated factor loadings for the remaining items are shown in Appendix J-7.

4.2.5.2 Goodness-of-Fit Indices

The overall results of the CFA indicate that the second measurement model for improvement adequately fitted the data with remaining 11 items. The chi-square was not significant (χ^2= 34.012; df = 34; p= 0.467). The GFI was 0.970, which was above the cut-off of 0.9 as recommended by (Hoyle, 1995). The AGFI was 0.952, which was above the cut-off of 0.80 as recommended by (Chau and Hu, 2001). The value of CFI, TLI, and IFI was 1.00, which was above the cut-off of 0.9 (Bagozzi and Yi, 1988; Byrne, 1998; Hair et al., 1998; Ho, 2006). The RMSEA was 0.001, which was far below the threshold of 0.1 as recommended by (Schumacker and Lomax, 2010). Furthermore, the relative CMIN/df (1.000) was less than 5 demonstrated the good fit of the model (Bagozzi and Yi, 1988).

4.2.5.3 Reliability and Convergent Validity

Once the uni-dimensionality of the constructs was achieved, each of the construct was assessed for their reliability and validity. **Table 4-16** represents the result of Cronbach alpha and convergent validity for the modified measurement model for improvement with 11 remaining items.

Table 4-16: Results of Cronbach's Alpha and Convergent Validity for Improvement CFA Model

Construct	**Item /Construct**	**Internal Reliability Cronbach Alpha**	**Convergent validity**		
			Second Factor Loading	**Average Variance Extracted (AVE)[a]**	**Composite Reliability (CR)[b]**
Educational Outcomes(EO)	EO1 EO2 EO3 EO4 EO5 EO6	0.945	0.893 0.447[c] 0.884 0.874 0.883 0.872	0.777	0.946
Work Quality (WQ)	WQ1 WQ2 WQ3 WQ4 WQ5 WQ6	0.933	0.848 0.88 0.841 0.414[c] 0.879 0.844	0.737	0.933

[a]: Average Variance Extracted = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}.

[b]: Composite reliability = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.

[c]: denotes for a discarded item due to insufficient factor loading below the cut-off of 0.5

As shown in **Table 4-16**, the AVE values for educational outcomes (EO) and work quality (WQ) were 0.777 and 0.737 respectively. These values were above the cut-off of 0.5 as suggested by (Nunnally & Bernstein, 1994). In addition, the composite reliability values were 0.946 and 0.933 for educational outcomes (EO) and work quality (WQ) respectively. Both values exceeded the recommended value of 0.6 (Bagozzi and Yi, 1988). The values of Cronbach's alpha for educational outcomes (EO) and work quality

(WQ) were 0.945 and 0.933 respectively. These values were above the cut-off of 0.7 as suggested by (Nunnally and Bernstein, 1994). The high Cronbach's alpha for all constructs might reflect a high internal consistency.

4.2.5.4 Discriminant validity

Table 4-17 represents the discriminant validity of the measurement model for improvement. The inter-correlations between educational outcomes (EO) and work quality (WQ) as the two sub-constructs in improvement was 0.694. The value was lower than the threshold of 0.85, which was satisfactory. Furthermore, the correlation was lower than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between these factors (Kline, 2005). The results of the goodness of fit, convergent validity and discriminant validity of the measurement model demonstrated that the final measurement scale to assess the constructs and their relative items in improvement construct was reliable and valid.

Table 4-17: Discriminant Validity of Measurement Model for Improvement

	EO	WQ
Educational Outcomes(EO)	**0.881**	
Work Quality (WQ)	0.694	**0.858**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

Figure 4-5 demonstrates the final measurement model for improvement with standardized factor loadings for the 10 remaining items.

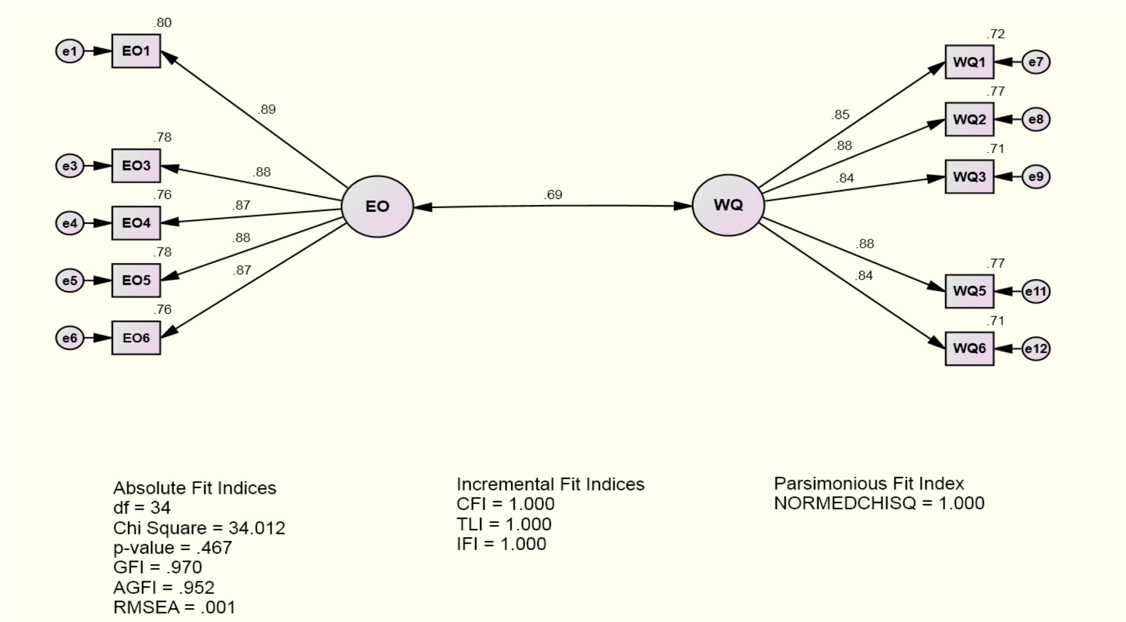


Figure 4-5: Final Measurement Model for Improvement with Remaining 10 Items

4.2.6 The Overall Measurement Model

Confirmatory factor analysis (CFA) was used to assess the overall measurement model for cooperation in education (CE), mobility of people (MP), intellectual enhancement (IE), partnership (PR), improvement (IM) and knowledge up-gradation (KU). The overall measurement model included all latent constructs with their respective measured indicators specified in the previous individual CFA models.

4.2.6.1 Standardized Loadings of the Model's Items

The CFA model was conducted for all the constructs in the overall measurement model (refer to Appendix H-1). **Table 4-18** demonstrates the deleted items from the model and recalculated factor loadings for the remaining items and constructs. The results of assessing the standardized loadings of the model's items indicated that the factor loadings of three items (i.e., KU3, KU5 and KU8) were 0.386, 0.395 and 0.322 respectively. All of these values were below the cut-off of 0.5. Hence, the decision was made to discard KU3, KU5, and KU8 from their relative construct (i.e., knowledge up-gradation). The revised model was again tested to ensure whether the factor structure remained stable (refer to Appendix H-2). As the result, the second standardised factor loadings for all items were more than 0.5, ranged from 0.806 to 0.892.

Table 4-18: Discarded Items Due to Insufficient Factor Loadings in Overall CFA Model

Construct	Item / Construct	First Factor Loading	Item Deleted	Second Factor Loading
Cooperation in Education (CE)	Curriculum Content Development	0.857		0.857
	Skills Dialogues (SD)	0.882		0.882
Mobility of People (MP)	Internship Programme (IP)	0.805		0.806
	Graduate Employment (EM)	0.854		0.854
Intellectual Enhancement (IE)	Idea on New	0.869		0.867
	Academic Publications (PB)	0.846		0.848
Partnership (PR)	Promote Product/Expertise (PP)	0.81		0.81
	Best Fit Talent (BT)	0.856		0.856
	Social Obligation & Opportunities	0.875		0.875
Improvement (IM)	Educational Outcomes (EO)	0.808		0.809
	Work Quality (WQ)	0.859		0.858
Knowledge Up-Gradation (KU)	KU1	0.888		0.889
	KU2	0.854		0.854
	KU3	0.386	Deleted	
	KU4	0.893		0.892
	KU5	0.395	Deleted	
	KU6	0.873		0.874
	KU7	0.842		0.84
	KU8	0.322	Deleted	
	KU9	0.877		0.878
	KU10	0.889		0.893

4.2.6.2 Goodness-of-Fit Indices

The measurement model for knowledge up-gradation demonstrated a poor fit for the second overall measurement model even after removal of the items with insufficient factor loadings (refer to Appendix H-2). The chi-square was significant (χ^2 = 2819.773; df = 2252; p< 0.001). Furthermore, the GFI was 0.745, lower than the cut-off of 0.9. Additionally, the AGFI of 0.727 was lower than the cut-off of 0.8 as recommended by (Chau and Hu, 2001). Therefore, the detailed examination was carried out by analysing the modification indices and standardized residual covariance. Residuals having the value of ± 2.58 indicates a specification error in the model whereas the modification index measures how much of chi-square is expected to decrease if a particular parameter is set free and the model is re-estimated (Hair, et al., 1998; Kline, 2010).

The result indicated that several items had the high discrepancy of covariance between their related errors (M.I. above 15), indicating the presence of redundant items in the model. For instance, the M.I value of covariance between the errors of 'IP3' and 'IP9' was 15.793. This implies that if the analysis is repeated, the discrepancy will be reduced to at least 15.793 by treating the covariance between the error of these two items as a free parameter. When two items loaded on the same construct (i.e., internship programme), the covariance between their errors known as within-construct error covariance, which becomes threats to construct validity (DeVellis, 2016). Drawing the correlation paths between these errors and allowing these paths to be estimated (freeing them) will lead to the reduction in the χ^2 and improvement of the model fit (Hair, et al., 1995). Therefore, the decision of modifying the model was to draw a correlation path between these items' errors.

Furthermore, the model indicated covariance between the error terms of indicator variables loading on different constructs. Here, the high M.I covariance value of the error of 'IK4' with the items' errors of other constructs refers to between-construct error covariance. Significant between-construct error covariance suggests that the items are associated with the error term are strongly related to each other than the original measurement model predicts. Such phenomenon indicates the presence of significant cross loading in the model, which can cause a lack of discriminant validity (Bentler, 1980). Therefore, the decision of modifying the model was to discard this item from the model rather than drawing correlation path between the items' errors (Zainudin, 2012).

Examination of standardized residual covariance indicated that one item (i.e, PB5) had unacceptably high absolute value above 2.58 with other items in the model. Therefore, the decision was to discard this item from the model as recommended by (Hair, et al., 1998; Kline, 2010). After iteratively removing these items, the overall CFA model was performed once again.

The results of the goodness-of-fit indices of the modified overall measurement model are presented in **Table 4-19.**

Table 4-19: GOF Indices of Modified Overall Measurement Model

Fit index	**Modified Model**	**Recommended values**	**Source**
df	2118		
CMIN (χ^2)	2579.002		
p-value	**<0.000**	> 0.05	
χ^2/df	1.218	≤ 5.00	Bagozzi and Yi (1988)
GFI	0.856	≥ 0.90	Hoyle (1995)
AGFI	0.838	≥ 0.80	Chau and Hu (2001)
CFI	0.968	≥ 0.90	Bagozzi and Yi (1988); Byrne, 1998
TLI	0.966	≥ 0.90	Hair et al., (1998); Ho, (2006)
IFI	0.968	≥ 0.90	Hair et al., (1998); Ho, (2006)
RMSEA	0.032	≤ 0.10	Schumacker and Lomax, 2010

AGFI: Adjusted goodness of fit; CFI: comparative fit index; CMIN: chi-square; Df: Degree of Freedom; GFI: Goodness-of-fit index; IFI: Incremental fit index; RMSEA: Root mean square error of approximation

The results of the GOF demonstrates that the chi-square was significant (p<0.000). The GFI was 0.856, which was slightly lower than the cut-off of 0.9 as recommended by Hoyle (1995) but still above the threshold of 0.85. Normally, GFI is strongly influenced by a relatively small sample size (below 300), as recommended by (Byrne, 1998) while the CFI is more appropriate when the sample size is small. Therefore, the obtained GFI was satisfactory as the recommended the value for GFI range between 0.85 and 0.9 as recommended by (Gefen, 2000).

After adjustment for the degrees of freedom relative to the number of variables, the adjusted GFI (AGFI) was 0.838, which was above the cut-off of 0.80 as recommended by (Chau and Hu, 2001). This denotes that the model predicts 83% of the variances and covariance in the survey data. Based on the CFI, TLI, and IFI indices with values more than the cut-off of 0.9, the model had a good fit of data (Bagozzi and Yi, 1988; Byrne, 1998; Hair, et al., 1998; Ho, 2006). The RMSEA was 0.032, which was far below the threshold of 0.1 as recommended by Schumacker and Lomax (2010). Additionally, the relative CMIN/df (1.218) was lower than 5, which indicates the good fit of the model (Bagozzi and Yi, 1988). As the modified overall measurement model fits the data adequately, no further adjustments were required.

4.2.6.3 Reliability and Convergent Validity

Table 4-20 demonstrates the result of Cronbach alpha and convergent validity for the modified overall measurement model. In this study, AVE values were above the cut-off of 0.5 for all constructs as suggested by (Nunnally & Bernstein, 1994), ranged from 0.690 to 0.764. The composite reliability values exceeded the recommended value of 0.6 for all constructs as recommended by (Bagozzi and Yi, 1988), ranging from 0.817 to 0.958. The Cronbach's alpha values range from 0.785 to 0.958, which were above the threshold of 0.7 as recommended previously (Nunnally and Bernstein, 1994). Therefore, high Cronbach's alpha for all constructs in this study might reflect a high internal consistency.

Table 4-20: Results of Cronbach's Alpha and Convergent Validity for Overall Measurement Model

Construct	Item / Construct	Internal Reliability Cronbach Alpha	Convergent validity		
			Third Factor Loading	Average Variance Extracted (AVE)[a]	Composite Reliability (CR)[b]
Cooperation in Education	Curriculum Content	0.833	0.857	0.756	0.861
	Skills Dialogues (SD)		0.882		
Mobility of People (MP)	Internship Programme	0.790	0.807	0.690	0.817
	Graduate Employment		0.854		
Intellectual Enhancement	Idea on New	0.823	0.888	0.726	0.841
	Academic Publications		0.815		
Partnership (PR)	Promote	0.859	0.811	0.719	0.884
	Best Fit Talent (BT)		0.856		
	Social Obligation &		0.875		
Improvement (IM)	Educational Outcomes	0.785	0.808	0.695	0.820
	Work Quality (WQ)		0.859		
Knowledge Up-Gradation (KU)	KU1	0.958	0.889	0.764	0.958
	KU2		0.854		
	KU3		0.386 [c]		
	KU4		0.892		
	KU5		0.395 [c]		
	KU6		0.874		
	KU7		0.839		
	KU8		0.322[c]		
	KU9		0.878		
	KU10		0.893		

[a]: Average Variance Extracted = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}.

[b]: Composite reliability = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.

[c]: denotes for a discarded item due to insufficient factor loading below the cut-off of 0.5

4.2.6.4 Discriminant validity

Table 4-21 demonstrates the discriminant validity of the modified overall measurement model. The inter-correlations between the six constructs in overall measurement model ranged from 0.487 to 0.780, which were below the threshold of 0.85. Furthermore, the correlations were lower than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between these factors (Kline, 2005). The results of the goodness of fit, convergent validity and discriminant validity of the modified overall measurement model, demonstrate that the final modified measurement scale to assess the constructs and their relative items was reliable and valid.

Table 4-21: Discriminant validity of Modified Overall Measurement Model

	CE	MP	IE	PR	IM	KU
Cooperation in Education (CE)	**0.870**					
Mobility of People (MP)	0.755	**0.831**				
Intellectual Enhancement (IE)	0.487	0.531	**0.852**			
Partnership (PR)	0.679	0.705	0.583	**0.848**		
Improvement (IM)	0.777	0.780	0.583	0.768	**0.834**	
Knowledge Up-Gradation (KU)	0.699	0.696	0.581	0.566	0.648	**0.874**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

Figure 4-6 depicts the modified overall measurement model with standardized factor loadings.

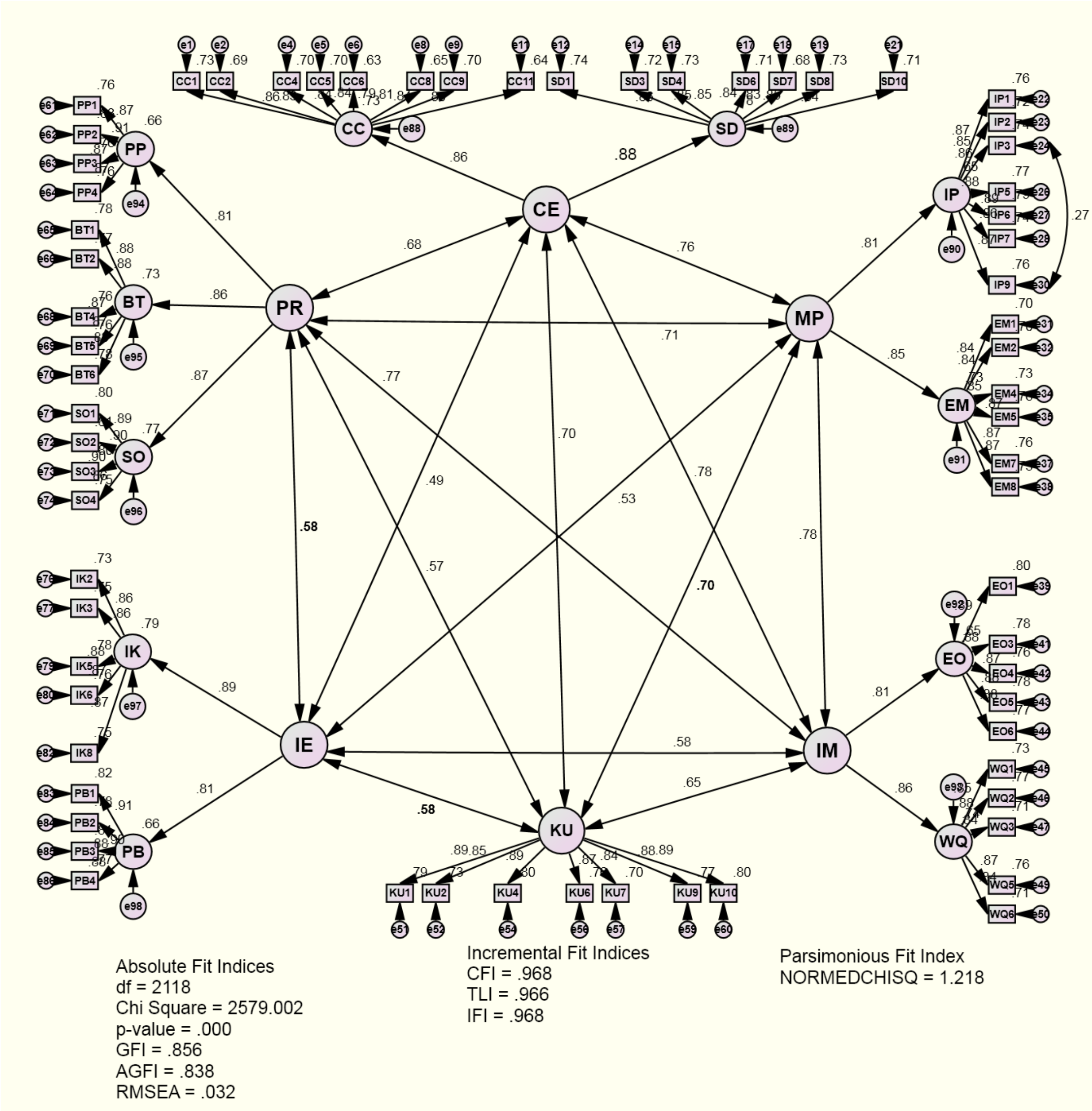


Figure 4-6: Overall Measurement Model

4.2.7 Descriptive Analysis

In this analysis, covariance matrix method was used to calculate the descriptive function to allow all variables to be included in the analysis. The composite scores of the variables were computed by parcelling the original measurement item scores. Parcels are sum or averages of several individual indicators or items based on their factor loadings on the construct (Coffman & Maccallum, 2005; Hair, et al., 1998).

Table 4-22 displays the means and standard deviation of the constructs, assessed on a 10-point Likert scale. The mean was applied as a measure of central tendency. The means of all variables were above their midpoint level (5.5), which implies that the consensus respondents' perceptions toward these variables were above the average. The highest mean rating corresponded to educational outcomes (EO) with the mean value of 7.20. The lowest mean rating corresponded to academic publications (PB) with the mean value of 6.97.

Table 4-22: Results of Descriptive Statistic for the First-Order Constructs

Variable	**Mean (M)**	**Std. Deviation (SD)**
Cooperation in Education (CE)	7.16	1.16
Mobility of People (MP)	7.20	1.20
Intellectual Enhancement (IE)	7.06	1.22
Partnership (PR)	7.06	1.17
Improvement (IM)	7.17	1.17
Knowledge Up-Gradation (KU)	7.06	1.41
Curriculum Content Development (CC)	7.18	1.21
Skills Dialogues (SD)	7.15	1.30
Internship Programme (IP)	7.20	1.36
Graduate Employment (EM)	7.20	1.27
Idea on New Projects/Knowledge(IK)	7.16	1.30
Academic Publications (PB)	6.97	1.34
Promote Product/Expertise (PP)	7.07	1.35
Best Fit Talent (BT)	7.12	1.29
Social Obligation & Opportunities (SO)	6.99	1.34
Educational Outcomes (EO)	7.20	1.36
Work Quality (WQ)	7.15	1.22

The standard deviation (SD) was used as a dispersion index to indicate the degree to which individuals within each variable differ from the variable mean. Among the studied variables, the individual value of knowledge up-gradation (KU) largely deviated from its mean (SD = 1.41). This SD suggested that there was relatively high variability in respondents' willingness to declare their perception toward knowledge up-gradation. In addition, the results imply that the survey participants were significantly different from each other in this variable. Contrarily, the lowest deviation from the mean corresponded to cooperation in education (CE) with the standard deviation of 1.16.

Figure 4-7 provides a good illustration for the mean of all constructs with their standard deviations.

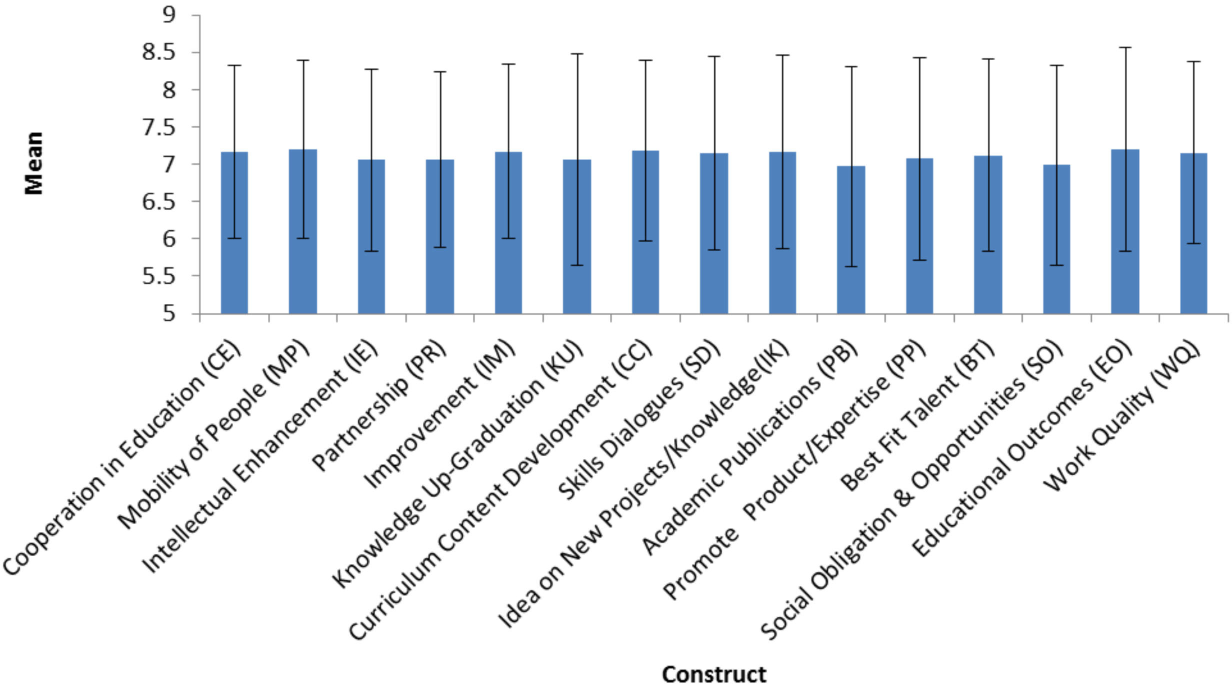


Figure 4-7: Means and Standard Variations of All Constructs

4.3 Structural Model - Stage 2 of SEM

Firstly, the evaluation of the structural model focuses on the overall model fit, followed by the size, direction, and significance of the hypothesized parameter estimates, as shown by the one-headed arrows in the path diagrams (Hair, et al., 1998). The final part involved the confirmation of the structural model of the study, which was based on the proposed relationship between the variables identified and assessed.

In the structural model, the relationships between cooperation in education (CE), mobility of people (MP), knowledge up-gradation (KU), intellectual enhancement (IE), partnership (PR) and improvement (IM) were examined. Furthermore, the mediating effects of partnership (PR) on the effects of cooperation in education (CE), mobility of people (MP), knowledge up-gradation (KU) and intellectual enhancement (IE) on the improvement (IM) were evaluated. A total of 13 research hypotheses were examined in the structural model. The codes and description of these hypotheses are presented in **Table 4-23.**

Table 4-23: Examined Hypotheses in Structural Model

Code	Description	Path
Direct Effects of the Variables		
H1.a	Cooperation in Education (CE) has a positive effect on Partnership	CE → PR
H2.a	Mobility of People (MP) has a positive effect on Partnership (PR)	MP → PR
H3.a	Knowledge Up-Gradation (KU) has a positive effect on Partnership (PR)	KU → PR
H4.a	Intellectual Enhancement (IE) has a positive effect on Partnership (PR)	IE → PR
H1.b	Cooperation in Education (CE) has a positive effect on Improvement (IM)	CE → IM
H2.b	Mobility of People (MP) has a positive effect on Improvement (IM)	MP → IM
H3.b	Knowledge Up-Gradation (KU) has a positive effect on Improvement (IM)	KU → IM
H4.b	Intellectual Enhancement (IE) has a positive effect on Improvement (IM)	IE → IM
H5	Partnership (PR) has a positive effect on Improvement (IM)	PR → IM
Indirect Effects of the Variables (Mediation Effects)		
H1.c	Partnership (PR) mediates the relationship between Cooperation in Education (CE) and Improvement (IM)	CE → PR → IM
H2.c	Partnership (PR) mediates the relationship between Mobility of People (MP) and Improvement (IM)	MP → PR → IM
H3.c	Partnership (PR) mediates the relationship between Knowledge Up-Gradation (KU) and Improvement (IM)	KU → PR → IM
H4.c	Partnership (PR) mediates the relationship between Intellectual Enhancement (IE) and Improvement (IM)	IE → PR → IM

The research structural model of this study and the standardized regression weights is portrayed in **Figure 4-8**.

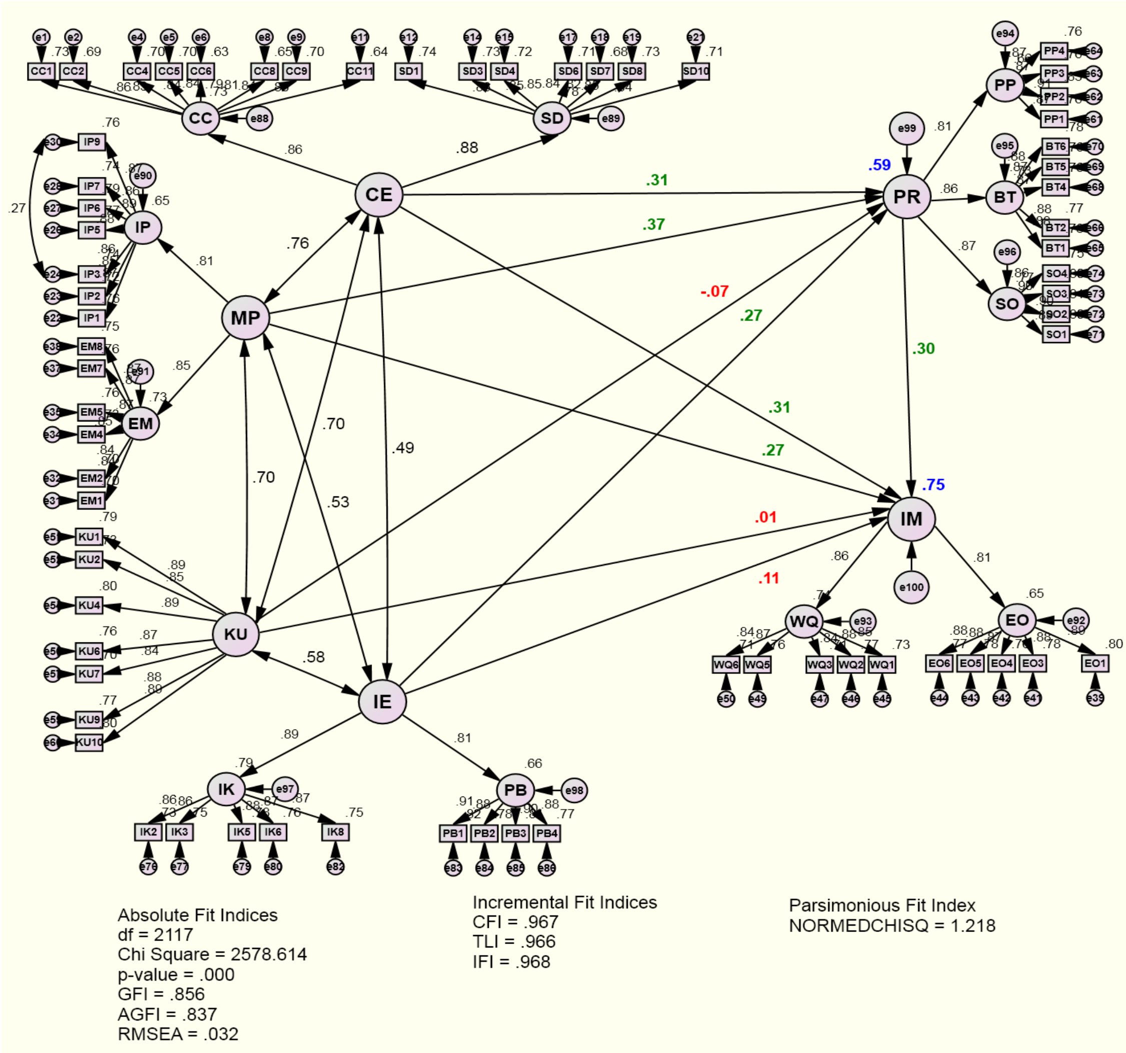


Figure 4-8: Research Structural Model

An examination of goodness-of-fit indices indicates that the research structural model (Figure 4-8) was adequately fitted the data (χ^2 = 2578.614; df = 2117; p< 0.001, GFI = 0.856; AGFI = 0.837; CFI = 0.967; TLI = 0.966; IFI = 0.968; RMSEA = 0.032; χ^2/df= 1.218). Although the chi-square statistic was statistically significant, it was not deemed unusual given the large sample size (Bagozzi, Yi, and Phillips, 1991).

The values of R^2 for partnership (PR) and improvement (IM) were 0.59 and 0.75 respectively. This indicates, for example, the error variance of improvement (IM) approximately 75% of the variance of improvement itself. This denotes 75% of variations in improvement (IM) were explained by its 5 predictors (i.e., cooperation in education, mobility of people, knowledge up-gradation, intellectual enhancement, and partnership). Overall findings demonstrated that both scores of R^2 values were within the cut-off value of 0.30 as recommended by (Quaddus and Hofmeyer, 2007).

4.3.1 Direct Effects of the Variables

The coefficient parameters estimates were examined to test the hypothesized direct effects of the variables, which are shown in **Table 4-23**. The standardised regression weight and the results of examining hypothesized direct effects of the variables are shown in **Table 4-24**.

Table 4-24: Examining Results of Hypothesized Direct Effects of the Variables (Path Analysis)

Path	Unstandardized Estimate		Standardised Estimate	C.R.	P-value	Hypothesis Result
	Estimate	S.E.	Beta			
CE → PR	0.345	0.137	0.315*	2.519	0.012	H1.a) Supported
MP → PR	0.365	0.129	0.373**	2.828	0.005	H2.a) Supported
KU → PR	-0.055	0.074	-0.074	-0.743	0.458	H3.a) Rejected
IE → PR	0.257	0.082	0.274**	3.142	0.002	H4.a) Supported
CE → IM	0.339	0.134	0.309*	2.533	0.011	H1.b) Supported
MP → IM	0.266	0.13	0.271*	2.052	0.04	H2.b) Supported
KU → IM	0.009	0.071	0.012	0.132	0.895	H3.b) Rejected
IE → IM	0.102	0.08	0.109	1.283	0.2	H4.b) Rejected
PR → IM	0.298	0.109	0.297**	2.736	0.006	H5) Supported

**. Contribution is significant at the 0.05 level (2-tailed)*

***. Contribution is significant at the 0.01 level (2-tailed)*

C.R. : Construct Reliability ; S.E. : Standard error

As shown in **Table 4-24**, the influences of some predictors on their relative predicted variables were statistically significant, whilst the other influences were not statistically significant. The results indicated that the hypotheses H1.a, H2.a, H4.a, H1.b, H2.b, and H5 were supported as their p-values were below 0.05, while the hypotheses H3.a, H3.b and H4.b were rejected, as their p-values were more than 0.05. The following section discusses the results of the path analysis in relation to the above hypotheses in the research structural model.

H1.a) Cooperation in Education (CE) has a positive effect on Partnership (PR) (CE → PR)

As shown in Table 4-24, the C.R and p-values of cooperation in education (CE) used in predicting partnership (PR) were 2.519 and 0.012 respectively. This means that the probability of getting a critical ratio as large as 2.519 in absolute value was 0.012. In other words, the regression weight for cooperation in education (CE) in the prediction of partnership (PR) was significantly different from zero at the 0.05 level (two-tailed). Thus, H1.a was supported. Furthermore, the standardized estimate of beta was 0.315, indicating a positive relationship. This means, when cooperation in education (CE) increased by 1 SD, partnership (PR) increased by 0.315 SD.

H2.a) Mobility of People (MP) has a positive effect on Partnership (PR) (MP → PR)

As shown in Table 4-24, the C.R and p-values of mobility of people (MP) in predicting partnership (PR) were 2.828 and 0.005 respectively. It means that the probability of getting a critical ratio as large as 2.828 in absolute value was 0.005. In other words, the regression weight for mobility of people (MP) in the prediction of partnership (PR) was significantly different from zero at the 0.01 level (two-tailed). Thus, H2.a was supported. Furthermore, the standardized estimate of beta was 0.373, indicating a positive relationship. It means, when mobility of people (MP) increased by 1 SD, partnership (PR) increased by 0.373 SD. Furthermore, amongst the four predictors of partnership (PR), mobility of people (MP) was found as the most important influential factor, with the standardized estimate of 0.373.

H3.a) Knowledge Up-Gradation (KU) has a positive effect on Partnership (PR) (KU → PR)

The results indicated no significant association between the knowledge up-gradation (KU) and partnership (PR) (β = -0.074; C.R. = -0.743; p= 0.458). Thus, H3.a was rejected.

H4.a) Intellectual Enhancement (IE) has a positive effect on Partnership (PR) (IE → PR)

As shown in Table 4-24, the C.R and p-values of intellectual enhancement (IE) in predicting partnership (PR) were 3.142 and 0.002 respectively. It means that the probability of getting a critical ratio as large as 3.142 in absolute value was 0.002. In other words, the regression weight for intellectual enhancement (IE) in the prediction of partnership (PR) was significantly different from zero at the 0.01 level (two-tailed). Thus, H4.a was supported. Furthermore, the standardized estimate of the beta was 0.274, indicating a positive relationship. It means, when intellectual enhancement (IE) increased by 1 SD, partnership (PR) increased by 0.274 SD.

H1.b) Cooperation in Education (CE) has a positive effect on Improvement (IM) (CE → IM)

As shown in Table 4-24, the C.R and p-values of cooperation in education (CE) in predicting improvement (IM) were 2.533 and 0.011 respectively. It means that the probability of getting a critical ratio as large as 2.533 in absolute value was 0.011. In other words, the regression weight for cooperation in education (CE) in the prediction of improvement (IM) was significantly different from zero at the 0.05 level (two-tailed). Thus, H1.b was supported. Furthermore, the standardized estimate of the beta was 0.309, indicating a positive relationship. It means, when cooperation in education (CE) increased by 1 SD, improvement (IM) increased by 0.309 SD. Furthermore, amongst the four predictors of improvement (IM), cooperation in education (CE) was found as the most important influential factor, with the standardized estimate of 0.309.

H2.b) Mobility of people (MP) has a positive effect on improvement (IM) (MP → IM)

As shown in Table 4-24, the C.R and p-values of mobility of people (MP) in improvement (IM) were 2.052 and 0.04 respectively. It means that the probability of getting a critical ratio as large as 2.052 in absolute value was 0.04. In other words, the regression weight for mobility of people (MP) in the prediction of improvement (IM) was significantly different from zero at the 0.05 level (two-tailed). Thus, H2.b was supported. Furthermore, the standardized estimate of the beta was 0.271, indicating a positive relationship. It means, when mobility of people (MP) increased by 1 SD, improvement (IM) increased by 0.271 SD.

H3.b) Knowledge up-gradation (KU) has a positive effect on improvement (IM) (KU → IM)

As shown in Table 4-24, the analysis between the knowledge up-gradation (KU) and improvement (IM) yielded β = 0.012, C.R. = 0.132 and p= 0.895. The results demonstrated no significant association between the knowledge up-gradation (KU) and improvement (IM). Thus, H3.b was rejected.

H4.b) Intellectual Enhancement (IE) has a positive effect on Improvement (IM) (IE → IM)

The analysis between the intellectual enhancement (IE) and improvement (IM) yielded β = 0.109, C.R. = 1.283 and p= 0.200. The results indicated no significant relationship between the intellectual enhancement (IE) and improvement (IM). Thus, H4.b was rejected.

H5) Partnership (PR) has a positive effect on improvement (IM) (PR → IM)

As shown in Table 4-24, the C.R and p-values of partnership (PR) in improvement (IM) were 2.736 and 0.006 respectively. It means that the probability of getting a critical ratio as large as 2.736 in absolute value was 0.006. In other words, the regression weight for partnership (PR) in the prediction of improvement (IM) was significantly different from zero at the 0.01 level (two-tailed). Thus, H5 was supported. Furthermore, the standardized estimate of the beta was 0.297, indicating a positive relationship. It means, when partnership (PR) increased by 1 SD, improvement (IM) increased by 0.297 SD.

4.3.2 Indirect Effects of the variables (mediation effects)

The mediation analysis was used to determine the mediation effects of partnership (PR) as mediating variable on the effects of cooperation in education (CE), mobility of people (MP), knowledge up-gradation (KU) and intellectual enhancement (IE) as independent variables and improvement (IM) as the dependent variables (i.e., H8, H9 and H10 respectively). Furthermore, the indirect effects of independent variables on the dependent variable through the mediation variable were also examined.

The statistics of mediation is based on the correlation. A study suggested a decision tree framework to examine the covariance relationships among three variables: an independent variable (IV), a potential mediating variable (M) and a dependent variable (DV) (Mathieu & Taylor, 2006). Illustration of this framework is shown in **Figure 4-9.** Based on this framework, the most important precondition that must be met to achieve significant mediation is that all three correlations among the three variables (paths a, b & c) must be statistically significant. If one of the three correlations is not significant, then there would be no significant mediation (Baron & Kenny, 1986; Mathieu & Taylor, 2006). The mediating variable act as a full mediator if the direct effect of IV on DV in the multiple regression (path a') is not statistically significant. Otherwise, the mediation can be considered as partial mediation. In absence of full or partial mediation, the relationships between IV and DV comprise to direct, indirect or no any relationship. In addition, independent variable has a non-significant indirect effect on the dependent variable through mediating variable in the absence of significant effect in path "a" and indicates significant effects in path "b" and "c".

On the other hand, the independent variable has only a direct effect on the dependent variable in the presence of a significant effect in path "a" and a non-significant effect in path "b" or "c". Hence, there would be no association between the independent and dependent variables in the absence of a significant association in path "a" and the absence of a significant association in the paths "b" or "c".

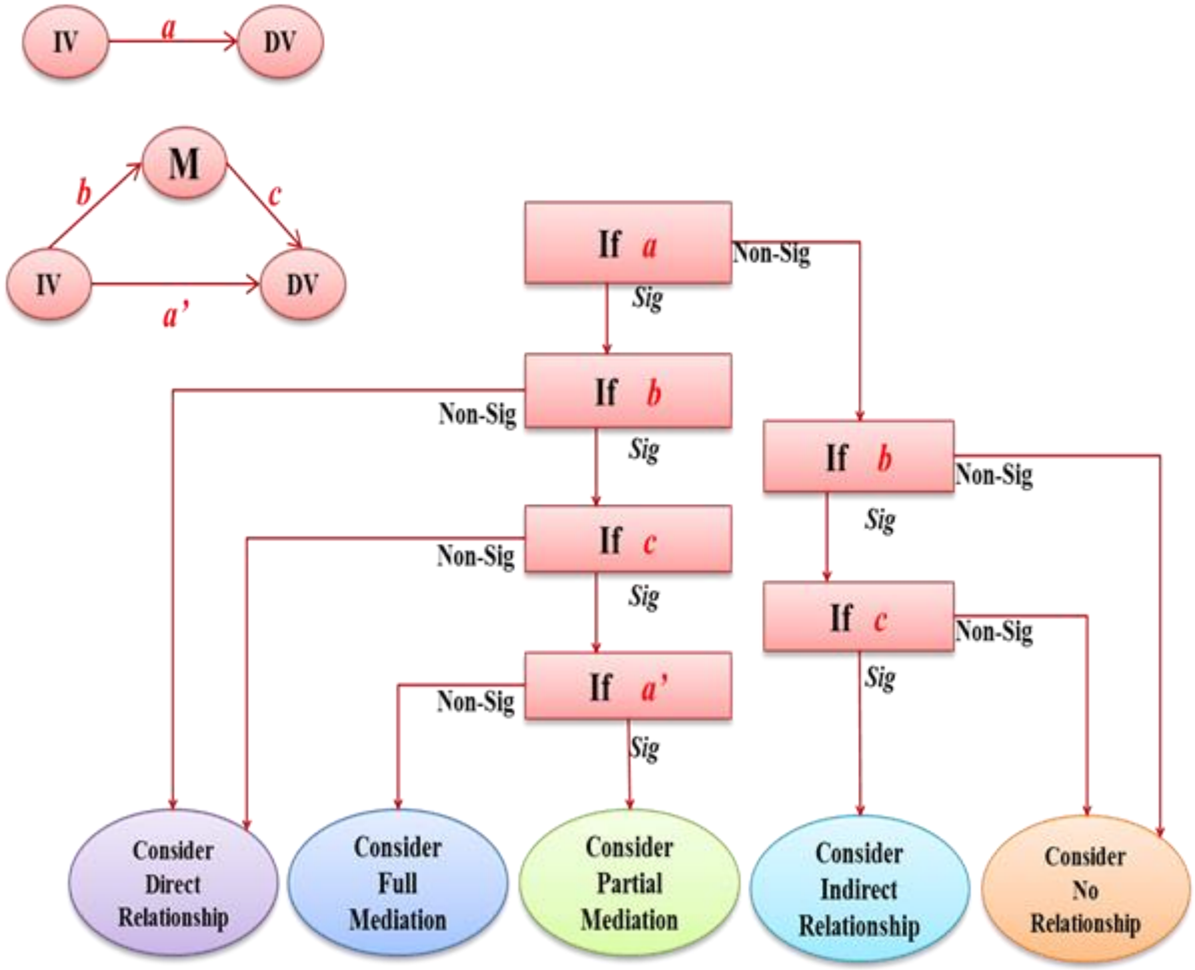


Figure 4-9: Decision Tree for Evidence Supporting Different Intervening Effects
(Source: Mathieu & Taylor, 2006)

The significance of the regression coefficients between cooperation in education (CE), mobility of people (MP), knowledge up-gradation (KU) and intellectual enhancement (IE) as IVs, partnership (PR) as M and improvement (IM) as DV were examined to determine the presence of the mediation effect and its mediating degree. Thus, four hypotheses (i.e., H1.c, H2.c, H3.c and H4.c) depicted in Table 4-23 were examined in this section. The outcomes of examination on these hypotheses are exhibited in **Table 4-25** with the standardized effects of different paths.

Table 4-25: Results of Examining Mediation Effects and Indirect Effects

DV = Improvement (IM) M = Partnership (PR)	**Independent Variable (IV)**			
	Cooperation in Education (CE)	**Mobility of People (MP)**	**Knowledge Up-Gradation (KU)**	**Intellectual Enhancement (IE)**
Total Effect of IV on DV	.403**(sig:0.001)	.382*(sig:0.010)	-.009(sig:0.911)	.190*(sig:0.030)
Direct Effect of IV on DV with	.309*(sig:0.011)	.271*(sig:0.040)	.012(sig:0.895)	.109(sig:0.200)
Indirect Effect of IV on DV	.094*(sig:0.032)	.111*(sig:0.015)	-0.022(sig:0.354)	.081*(sig:0.017)
Effect of IV on M	.315*(sig:0.012)	.373**(sig:0.005)	-.074(sig:0.458)	.274**(sig:0.002)
Effect of M on DV	.297**(sig:0.006)	.297**(sig:0.006)	.297**(sig:0.006)	.297**(sig:0.006)
Mediation Path	CE→PR→IM	MP→PR→IM	KU→PR→IM	IE→PR→IM
Mediation Effect	Yes	Yes	No	Yes
Degree of Mediation	Partial	Partial	---	Full
Hypothesis Result	H1.c) Supported	H2.c) Supported	H3.c) Rejected	H4.c) Supported

**. Contribution is significant at the 0.05 level (2-tailed)*

***. Contribution is significant at the 0.01 level (2-tailed)*

****. Contribution is significant at the 0.001 level (2-tailed)*

As shown in **Table 4-25**, partnership (PR) mediated the effects of cooperation in education (CE), mobility of people (MP) and intellectual enhancement (IE) on the improvement (IM). Thus hypotheses H1.c, H2.c and H4.c, were supported. Contrarily, the mediation effect of partnership (PR) on the relationship between knowledge up-gradation (KU) and improvement (IM) was not supported. Thus, the hypothesis H3.c was rejected. The following section discusses the results of the mediation analysis and indirect effects.

H1.c) Partnership (PR) mediates the relationship between Cooperation in Education (CE) and Improvement (IM) (Path: CE → PR → IM)

As shown in Table 4-25, there was a significant association between cooperation in education (CE) and improvement (IM) in the absence of partnership (PR), with the standardized total effect of 0.403 and the P-value of 0.001. Thus, the total effect of cooperation in education (CE) as IV on improvement (IM) as DV without the inclusion of partnership (PR) as M was statistically significant at 0.01 level. Moreover, the association remains significant even after inclusion of partnership (PR) into the model, with the standardized direct effect of 0.309 and the P-value of 0.011. Thus, the direct effect of cooperation in education (CE) as IV on improvement (IM) as DV with the inclusion of partnership (PR) as M was statistically significant at 0.05 level.

As depicted in **Table 4-25**, the effects of cooperation in education (CE) as IV on partnership (PR) as M (path b) was statistically significant at 0.05 level, with the standardized effects of 0.315. In contrast, the effects of partnership (PR) as M on improvement (IM) as DV (path c) was statistically significant at 0.01 level with the standardized effects of 0.297.

These results indicated that partnership (PR) mediates the relationship between cooperation in education (CE) and improvement (IM). The degree of mediation was partial since the paths a, a', b and c were all statistically significant. The phenomenon supported the hypothesis H1.c. Furthermore, the result revealed that cooperation in education (CE) had a significant indirect positive effect on improvement (IM) through partnership (PR) with the standardized indirect effect of 0.094 and the P-value of 0.032.

H2.c) Partnership (PR) mediates the relationship between Mobility of People (MP) and Improvement (IM) (Path: MP → PR → IM)

The significance of the regression coefficients between cooperation in education (CE), mobility of people (MP), knowledge up-gradation (KU) and intellectual enhancement (IE) as IVs, partnership (PR) as M and improvement (IM) as DV were examined to determine the presence of the mediation effect and its mediating degree. Thus, four hypotheses (i.e., H1.c, H2.c, H3.c and H4.c) depicted in Table 4-23 were examined in this section. The outcomes of examination on these hypotheses are exhibited in Table 4-25 with the standardized effects of different paths.

Table 4-25, there was a significant association between mobility of people (MP) and improvement (IM) in the absence of partnership (PR), with the standardized total effect of 0.382 and the P-value of 0.010. Thus, the total effect of mobility of people (MP) as IV on improvement (IM) as DV without the inclusion of partnership (PR) as M was statistically significant at 0.05 level.

This association remains significant even after inclusion partnership (PR) into the model, with the standardized direct effect of 0.271 and the P-value of 0.040. Thus, the direct effect of mobility of people (MP) as IV on improvement (IM) as DV with the inclusion of partnership (PR) as M was statistically significant at 0.05 level. As depicted in **Table 4-25**, the effects of mobility of people (MP) as IV on partnership (PR) as M (path b) was statistically significant at 0.01 level, with the standardized effects of 0.373. On the other hand, the effects of partnership (PR) as M on improvement (IM) as DV (path c) was statistically significant at 0.01 level with the standardized effects of 0.297.

These results indicated that partnership (PR) mediates the relationship between mobility of people (MP) and improvement (IM). The degree of mediation was partial since the paths a, a', b and c were all statistically significant. The phenomenon supported the hypothesis H2.c. Furthermore, the result revealed that mobility of people (MP) had a significant indirect positive effect on improvement (IM) through partnership (PR) with the standardized indirect effect of 0.111 and the P-value of 0.015.

H3.c) Partnership (PR) mediates the relationship between Knowledge Up-Gradation (KU) and Improvement (IM) (Path: KU → PR → IM)

As shown in **Table 4-25**, the result indicated that there was no significant association between knowledge up-gradation (KU) and improvement (IM) in the absence of partnership (PR), with the standardized total effect of -0.009 and the P-value of 0.911. Thus, the total effect of knowledge up-gradation (KU) as IV on improvement (IM) as DV without the inclusion of partnership (PR) as M was statistically not significant. This association remains not significant even after the inclusion of partnership (PR) into the model, with the standardized direct effect of 0.012 and the P-value of 0.895. Thus, the direct effect of knowledge up-gradation (KU) as IV on improvement (IM) as DV with the inclusion of partnership (PR) as M was statistically not significant.

As depicted in **Table 4-25**, the effects of knowledge up-gradation (KU) as IV on partnership (PR) as M (path b) was statistically not significant, with the standardized effects of -0.074 and p-value of 0.558. In contrast, the effects of partnership (PR) as M on improvement (IM) as DV (path c) was statistically significant at 0.01 level with the standardized effects of 0.338. These results indicated that partnership (PR) could not mediate the relationship between knowledge up-gradation (KU) and improvement (IM). The phenomenon rejected the hypothesis H3.c. Consequently, the result revealed that knowledge up-gradation (KU) had insignificant indirect effect on improvement (IM) through partnership (PR) with the standardized indirect effect of -0.022 and the P-value of 0.354.

H4.c) Partnership (PR) mediates the relationship between Intellectual Enhancement (IE) and Improvement (IM) (Path: IE → PR → IM)

As shown in **Table 4-25**, there was a significant association between intellectual enhancement (IE) and improvement (IM) in the absence of partnership (PR), with the standardized total effect of 0.190 and the P-value of 0.030. Thus, the total effect of intellectual enhancement (IE) as IV on improvement (IM) as DV without the inclusion of partnership (PR) as M was statistically significant at 0.05 level. Nonetheless, this association becomes not significant after the inclusion of partnership (PR) into the model, with the standardized direct effect of 0.109 and the P-value of 0.200. Thus, the direct effect of intellectual enhancement (IE) as IV on improvement (IM) as DV with the inclusion of partnership (PR) as M was statistically not significant. Furthermore, the effects of intellectual enhancement (IE) as IV on partnership (PR) as M (path b) was statistically significant at 0.01 level, with the standardized effects of 0.274.

In contrast, the effects of partnership (PR) as M on improvement (IM) as DV (path c) was statistically significant at 0.01 level with the standardized effects of 0.297. These results indicated that partnership (PR) mediates the relationship between intellectual enhancement (IE) and improvement (IM). The degree of mediation was full since the paths a, b and c were statistically significant but path a' was not significant. The phenomenon supported the hypothesis H4.c. Furthermore, the result revealed that intellectual enhancement (IE) had a significant indirect positive effect on improvement (IM) through partnership (PR) with the standardized indirect effect of 0.081 and the P-value of 0.017.

4.3.3 Summary of Results

SEM analysis revealed a plausible model that provided relationship assessments of four latent variables associated with teaching and learning activities towards stimulating partnership between university and industry in view of improving the talent pool for the workforce. The results indicated that the hypotheses H1.a, H2.a, H4.a, H1.b, H2.b, and H5 were supported as their p-values were below 0.05, while the hypotheses H3.a, H3.b, and H4.b were rejected as their p-values were above 0.05.

From the Malaysia perspective, the positive significant relationship between the partnership and industry illustrates that respondents are aware of the shortcomings of curriculum contents, the technology and changing trends of industrial landscape and skills sets of the graduates. Therefore, cooperation in education involving industry or supported by industry has great potential to develop new ideas or input to align the contents in-depth and breadth that meets the evolving trends of technology. Thus, this positively promotes the university-industry partnerships. As such, the hypothesis (H1a) was supported, where cooperation in education (CE) had a positive effect on partnership (PR) (CE → PR).

The Science & Business Commission report on university-industry partnership by (Edmondson, et al.,2012) indicates that many industries have established partnerships with the university in view of supporting their goals (i.e. the breeding and training of

graduates needed in the engineering and technological fields) which could best use of their knowledge, skills, and abilities to achieve success and growth (2012).
In this relation, the hypothesis (H2a) was supported, where mobility of people (MP) had a positive effect on partnership (PR) (MP → PR).

Knowledge up-gradation (KU) focuses to innovate curriculum through enrichment educational activities that supplement theoretical knowledge in view of stimulating students' learning curve towards engineering practice and development in industry. In this regards, there are substantial grounds for believing that there is a relationship between knowledge up-gradation and partnership. This was in agreement with findings from other studies indicated a correlation between the enrichment activities outside the classroom and students' learning outcomes (Smith, et al., 2005; Vogt, 2008 Vasileiou, 2009; Prasad, Subbaiah, & Padmavathi, 2012; Kakepoto, et al, 2013).

However, this research did not fully support the hypothesis (H3a), where knowledge up-gradation (KU) had a positive effect on partnership (PR) (KU → PR). From the Malaysia perspective, this domain was rejected, as it is too often the case that the respondents involved have the perception that working with universities in this teaching domain is not part of the mainstream activities in their respective industry. Thus, they viewed this domain has lack of impact to bolster their competitiveness.

Conducting academic-led projects in partnership with industry has been suggested as one of the critical principles of good practice in teaching and learning (Kantonidou, 2010; Moalosi, Oladivan & Uziak, 2012; Schubert, 2012). In response to this notion, empirical evidence confirmed that intellectual enhancement (IE) had a significant relationship on the partnership in the teaching and learning activity.

As highlighted by reviews (O. Brien, 2011; Sthapak, 2012; Schubert, 2012), this study demonstrated an existing demand among industry pertaining to the need of engaging students in innovative projects related to the real-world engineering practice. However, this activity is generally common for science-based technology where product innovation is dependent on the discovery. As such, in this perspective, a majority of the respondents were keen on basic academic knowledge and research scope that limits on findings solution to technical problems. Thus, the hypothesis (H4a) was supported, where intellectual enhancement (IE) had a positive effect on the partnership (PR) (IE → PR).

The importance of partnership and the significance of improvement well documented in the literature (Patil, Nair & Codner, 2008; Onwuka, 2009; Shah and Nair, 2011; Thune, 2011). Thus, industry should establish partnerships with the university as an improvement measure to particularly overcome the chronic complaints on teaching and learning processes, which have direct impacts on nurturing the desirable workability of the engineering graduates. As such, the hypothesis (H5) was supported, where partnership (PR) had a positive effect on improvement (IM) (PR → IM).

The focus on the need for university graduates to be equipped with relevant knowledge with appropriate skill sets for the modern industries has been well documented. Nonetheless, critical success factor of this endeavour is dependent on enhancing the engineering curriculum contents and its associated educational mission on a periodical manner by engaging relevant communities of industry (Onwuka, 2009; Shah and Nair, 2011; Rose and Stiefer, 2013). As such, the hypothesis (H1b) was supported, where cooperation in education (CE) had a positive effect on improvement (IM) (CE → IM).

The competency level and acquisition of new skill sets of present-day graduates needs to be enhanced specifically the generic skills. This is crucial, as the industries require the new generation of graduates to have contemporary workplace professional attitudes, understanding and skills. As such, providing relatively good understanding and appreciation of the profession by interacting with field engineers ultimately improve the students' learning experience (Yusoff, et al., 2008; Zaharim, et al., 2009; Yuzainee, Zaharim and Omar, 2011). As such, the hypothesis (H2b) was supported, where mobility of people (MP) had a positive effect on improvement (IM) (MP → IM).

In-depth analysis of the dataset indicates that knowledge up-gradation (KU) and intellectual enhancement (IE) had no significant association with improvement (IM) as the p-values were 0.895 and 0.2 respectively. Moreover, a negative association was found between knowledge up-gradation (KU) and improvement (IM). This was contradictory to the findings of the existing literature that demonstrated coordination and providing value-added enrichment activities in partnership with industry improves the skills of talent pool as this endeavour viewed to narrow the gap between theory and practice (Vasileiou, 2009; Prasad, Subbaiah, & Padmavathi, 2012; Kakepoto, et al., 2013).

Nonetheless, by deductive reasoning, it is cautiously surmised that there may exist concern among field engineers to perceive value-added enrichment activities such as partnering and sponsoring may arise challenges including high cost, geographical proximity, tight work and operational schedule, time constraint, and reluctant to participate. As such, the hypothesis (H3b) was not supported, where knowledge up-gradation (KU) had a positive effect on improvement (IM) (KU → IM).

Intellectual enhancement is emerging as a key factor in improving students' learning experience via engagement with industry. This relationship provides students the opportunity to develop solutions through the element of design in capstone and final year projects that emphasize on real-world problems. Thus, there is a growing need for the university to provide innovative offerings as part of improvement strategies to bridge the gap between theory and engineering practice (Kantonidou, 2010; Moalosi, Oladivan & Uziak, 2012; Schubert, 2012).

This research found a negative relationship between intellectual enhancement (IE) and improvement (IM) measure for students. Additionally, consensus suggested that academic-led research activities have minimal impact on the work nature of field engineers and thus, not a favourable endeavour. Consequently, respondents felt that their involvement in this domain would not be constructive in improving the talent pool. As such, this hypothesis (H4b) was not supported, where intellectual enhancement (IE) had a positive effect on improvement (IM) (IE → IM).

4.4 Survey outcome for rank of preference

The survey instruments were administered to technical and engineering related field engineers from the selected industry sectors with the aim of investigating the preference of industry on the type of linkage to establish the collaborative partnership with universities. Thus, a hierarchical model was developed based on the AHP to enable the industry to rank the type of linkages from a given set of the alternative. The survey was administered to 48 industry subject matter experts where the response rate for participation was 100 %.

The study participants were asked to compare the relative importance of each link in the question in order to use the AHP to assign weights. Thus, the decision structure was built systematically, reflecting the links that are perceived to be relevant towards a decision-making in fostering university-industry partnership. From the results of this survey, statistically based weights were assigned to each question. To fulfill the purpose of this study, the target population was determined subjectively and purposively. It should be noted that the respondents were made up of 22 industrial sectors that optimize technical expertise for their business operation.

An extract of the MITI report (2016) and Productivity report (2017) indicated that Malaysia in its pursuit to sustain a rapidly developing economy with a thriving business environment in 2015/2016, has identified four main economic sectors namely, agriculture, manufacturing, construction, and service to boost its productivity. In addition, the oil and gas, semiconductor, electrical and electronic were identified as the sub-sectors under manufacturing while information technology and networking, and telecommunication were identified as the sub-sectors of service sectors. Thus, these sectors including power electrical (PE), construction (CT), telecommunication (Telco), semiconductor (Semi), oil and gas (OG), electronic (ELE), manufacturing (MFG), and IT and networking (ITN) were selected as the target group for this study. The agriculture sector was excluded from the list.

In this survey, the respondents were asked to rank the important link type to gauge the level of involvement and commitment supported by normal operations of their respective sectors. The academic-led linkage types included were advisory on curriculum & skills development, internship programme, support learning enrichment activities, retraining programme for academics, publications activities, and consultancy work with academics.

The data were analyzed manually by counting and the use of frequency distribution. Once the survey data entered into the excel spreadsheet, the numerical values for each of the question were averaged among the survey participants. Subsequently, a reciprocal matrix was created to calculate the new weights using all of the pairwise comparisons. The size of the reciprocal matrix was determined using the number of pairwise comparisons made. For the teaching and learning domain, there were 4 domains that were subjected to the pairwise comparison.

As shown in **Table 4-26,** the 4 x 4 reciprocal matrix was built using the averaged responses of the decision-makers (respondents). The diagonal elements of the matrix were all equal to 1, as it was assumed that when a question is compared to itself, the relative importance is always equal. The values on the upper part of the diagonal within the matrix are the averaged values from the survey participants. The values on the lower part of the diagonal within the matrix are the reciprocal values of the upper part of the diagonal. Below the matrix, the sums of each column are shown in red. These values were used in the next step of the analysis for normalizing the reciprocal matrix.

Table 4-26: Reciprocal Matrix for the Teaching and Learning domain

Domain	**CE**	**MP**	**KU**	**IE**
CE	1	9	9	9
MP	0.111111	1	0.1250	0.1111
KU	0.111111	8	1	9
IE	0.111111	9	0.111111	1
∑, SUM	**1.333333**	**27**	**10.2361**	**19.1111**

Subsequently, the matrix shown in Table 4-26 was normalized using basic linear algebra concepts. This was accomplished by dividing each value of the reciprocal matrix by the sum of the column that the value was in. Therefore, the sum of the normalized matrix was equal to 1, which allowed the values within each column to be compared. The outcome of computation is shown in **Table 4-27**. As shown, the sum of each of the columns now was equal to 1.

Table 4-27: Normalized Reciprocal Matrix for the teaching and learning domain

Domain	**CE**	**MP**	**KU**	**IE**
CE	0.7500	0.333333	0.87924	0.47093
MP	0.083333	0.0370	0.012212	0.005814
KU	0.083333	0.296296	0.097693	0.47093
IE	0.083333	0.333333	0.010855	0.052326
∑, SUM	**1.0000**	**1.000**	**1.0000**	**1.0000**

The final step in computing the weights using the AHP was to calculate the principal eigenvector of the normalized matrix. The principal eigenvector is also known as the priority vector and is calculated by considering the average of each row of the normalized reciprocal matrix. **Table 4-28** demonstrates the principal eigenvector or priority vector for the pairwise comparison for teaching and learning domain.

Table 4-28: Principal Eigenvector on Teaching and Learning Domain by Power Expert

Domain	Average	Priority Vector
CE	0.608376	**0.73274**
MP	0.034599	**0.05557**
KU	0.237063	**0.1406**
IE	0.119962	**0.07108**
SUM		**1.000**

Table 4-29 demonstrates the final results, based on the statistical concepts that involve input from the power electrical sector as shown in the principal eigenvector.

Table 4-29: Priority Vector of Teaching and Learning Domain by Power Electrical Sector

Power Electrical Sector	CE	MP	KU	IE
Expert 1	0.73274	0.05572	0.14060	0.07108
Expert 2	0.07064	0.70632	0.13897	0.08407
Expert 3	0.02437	0.34225	0.3374	0.29598
Expert 4	0.11291	0.45941	0.24537	0.1823
Expert 5	0.63956	0.09579	0.2016	0.06305
Expert 6	0.09291	0.68676	0.16083	0.0595

Similarly, the composite priorities, which are priorities for the domain, were computed for each of the industrial sectors. The comprehensive composite priorities for all the groups, with respect to the various alternatives, are presented in Appendix K.

The outcome of this study demonstrates that the communities of the industry were significantly receptive towards fostering partnerships with the university within the teaching and learning domains as this enables them to obtain solutions to their problems, gain insight from the research and solutions provided by the students and provide a better understanding of the educational institutions and student expectations. In agreement to these findings, a substantial body of literature highlighted the positive relevance of industry in supporting the teaching and learning domain towards enhancing students' learning experience of engineering practice (Patil, Nair & Codner, 2008; Zaharim, et al., 2010; Shah and Nair, 2011; Alexander et al. 2012; Pinelli, Hall and Brush, 2013).

In this study, the option considered in using the information derived from the rankings was by selecting each teaching and learning activity from the surveyed sectors with the highest priority. As such, outcome of investigation towards the perceived ranking of each teaching and learning domain of the academic development by the respondents (local field engineers); the most important (Rank1) and least important (Rank4) domain were identified.

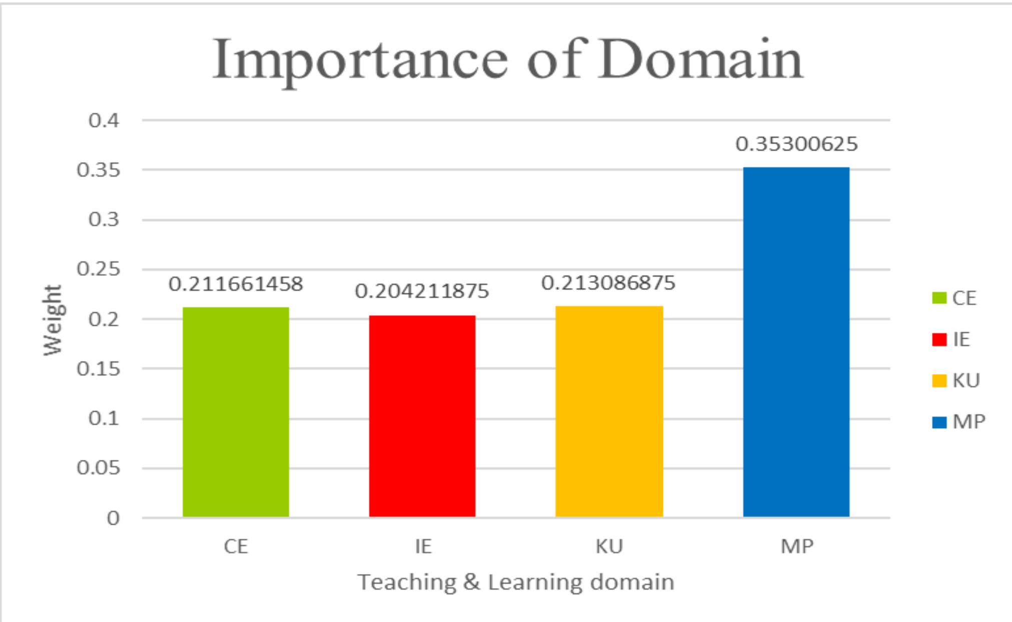


Figure 4-10: Rank of Importance of Teaching and Learning Domain by Industry Members

As illustrated in **Figure 4-10**, the result indicates that the mobility of people (MP) in teaching and learning activities were ranked as the most important domain by the industrial members. Moreover, knowledge up-gradation (KU) was considered as the second important domain compared to the cooperation in education (CE). Overall, intellectual enhancement (IE) was perceived to be of lowest appeal by all the engineers.

As Malaysia propels towards the advancement of science and technology, the need for better work quality talent is becoming more prevalent, which is strongly felt by the industry. In this context, mobility of people (MP) had the highest weightage of 0.353. Consequently, the community of industries shared a strong sentiment that the education process represents the central importance of the higher education institutions, which produces highly competent and skillful students and graduates for the workforce. The results were in agreement with the Science & Business Commission report on the university-industry partnership, by (Edmondson, et al., 2012) which indicated that many industries formed partnerships with the university in view of supporting their aims including the breeding and training of graduates to best use their knowledge, skills, and abilities to benefit many industries (2012).

In this study, the second-ranked domain was knowledge up-gradation (KU) with a weightage of 0.213. Industry acknowledged that interaction with field engineers through enrichment activities is valuable for students in terms engineering practice and professional relevance. Moreover, industry perceived partnerships as a pathway to develop a two-way exchange mechanism to build a substrate of academics who understand the industry needs (Shah and Nair, 2011; Felder, et al., 2012). In this regards, this domain was given importance as industry aware that university must realize its role to respond to sudden changes and eventually to undergo a radical change in providing better training “incubator” for learners. Therefore, this entails the university to encourage participation in academic centric efforts of industry, including inviting field engineers to share and teach in the professional engineering education.

Generally, the impact of industry can add value to the relatively conventional class dynamics for improving the learning opportunities of learners (Alexander, et al., 2012; Pinelli, Hall and Brush, 2013). Contrarily, the hypothetical study indicates that engagement towards knowledge up-gradation had a negative effect on sustainable partnership. This possibly due to the fact that in Malaysia, typically the majority of engineering companies focus on business growth to sustain competitive edge. Thus, the companies exhibit minimal initiative to formulate a “social responsibility” agenda to share or engage the university in the teaching and learning activities. This is potentially due to the uncertainty in believing that the partnership is doable and actionable. Moreover, this is evident from the belief that university and industry do not align with each other or are not capable or ready to foster the partnership based on the strategic priority.

Cooperation in education (CE) was ranked as the third important link with a weightage of 0.211. CE focuses to innovate and reform curricula, contents, and technology that aligns towards the needs of evolving industrial landscape. It should be noted that studies conducted in Malaysia revealed that deficiencies in the teaching and learning in the curriculum was the main reason for the existence of the gap between the theory and practice (Zaharim, et al., 2009; Yuzainee, Zaharim and Omar, 2011). Nonetheless, in the context of Malaysia, communities of industry ranked CE as the third important domain because some of the surveyed companies are small companies. Thus, they may lack adequate knowledge, suitable manpower or appropriate resources towards the curriculum development and its associated needs.

Intellectual enhancement (IE) was perceived to have the lowest appeal by the engineers with weightage of 0.204. Generally, IE focuses to innovate curriculum on joint initiatives and projects that integrate research and education, which leads to academic publication as the output of real-world setting. As such, industry is well aware that research, which is an original investigation is capable to produce new and valid knowledge in the scientific field. Nonetheless, it was observed to be the least preferred endeavour among the industry in Malaysia despite its core interest among the academicians.

The representatives of selected companies participated in this study supported the concept of greater inclusive representation of the industry in the teaching and learning activities and thus, ranked the crucial domain in renewal and redirection of professional engineering education. In this regards, the benefit of this domain to the university is through real-world industry projects that support the teaching and learning activities.

Thus, paves the way for interaction between the students and field engineers that helps to reduce the gap that exists between them. This subsequently familiarizes the students with their future workforce community.

Figure 4-11 summarizes ranking of the teaching and learning activities (academic domain) as perceived by specific industrial sectors among 8 different sectors. The results indicate that each industrial sector shared a common mean of overall dimension level of preferences due to the ratio nature of the data. Furthermore, the overall output suggests that over 87.5% of respondents ranked mobility of people (MP) as the important teaching and learning domain. In addition, a total of 5 industrial sectors rated the intellectual enhancement (IE) as the least important domain with a score of 62.5%.

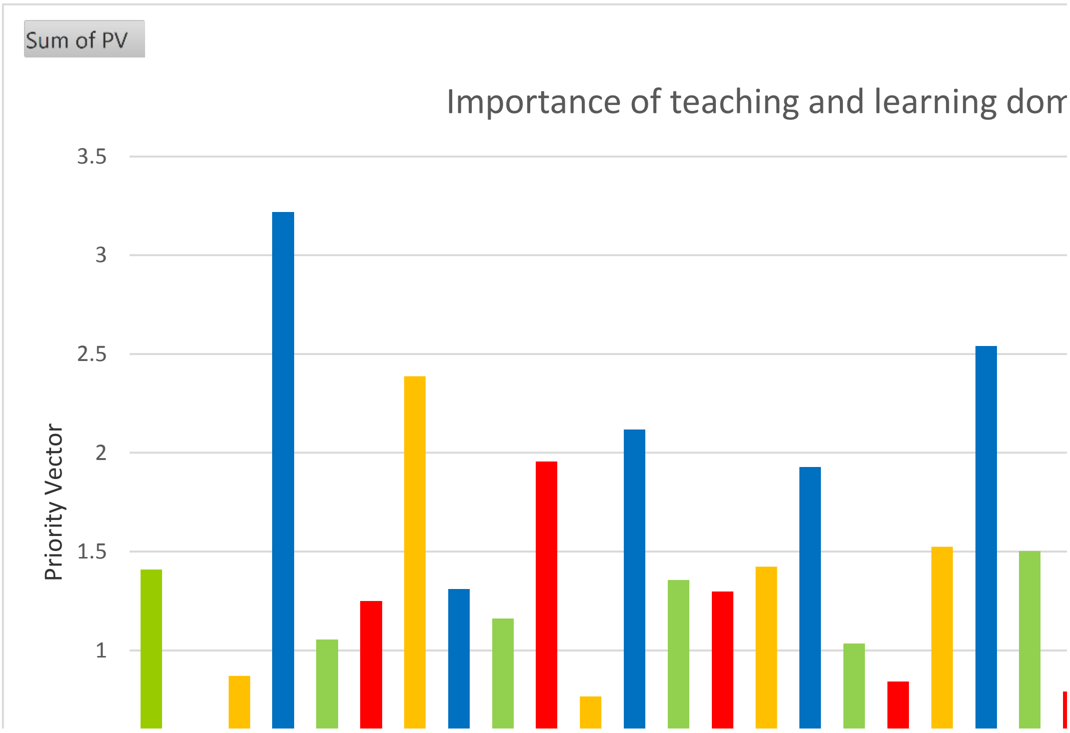


Figure 4-11: Rank of Important Teaching and Learning Domain by Industrial Sectors

In this study, three sectors ranked mobility of people (MP) as an important domain to foster partnerships. These sectors are construction (CT), oil and gas (OG) and information technology and networking (ITN) with weightage of 3.35, 2.55 and 2.15 respectively. MP is a crucial domain for these sectors primarily because it benefits the industries in terms of providing higher recruitment rate of graduates every year.

However, in this context, the industry might play multiple roles and be embedded in a variety of mechanisms in the form of linkages. The common type of involvement in this domain is industrial training, which gravitates around a regular university course under the professional engineering education. Previous studies indicated that industry tends to work closely with the university through internship programme (IP) for nurturing critical attributes in the graduates (Yusoff, et al., 2008; Zaharim, et al., 2009; Yuzainee, Zaharim and Omar, 2011). Thus, it is clear that CT, OG and ITN sectors acknowledged the opportunity to apply the concepts and theories learned in the classroom into practice, which adds a new and valuable "real-world" dimension to the learning process. Moreover, the partnership through this domain helps to foster their brand name in the higher engineering education marketplace.

Electronics (ELE), telecommunication (TELCO) and power electrical (PE) ranked the knowledge up-gradation domain as an important domain to foster partnerships with weightage of 2.45, 1.85 and 1.60 respectively. These sectors viewed knowledge up-gradation domain as an important element that leads to excellence in engineering related academic programmes. Moreover, studies demonstrated that knowledge up-gradation domain allows students to establish the connection with industry and theoretical knowledge to obtain a good understanding of the basic engineering principles (Diamond, Walleley & Forber, 2011; Prasad, Subbaiah, & Padmavathi, 2012; Kakepoto, et al., 2013).

Among the 8 sectors surveyed, power electrical (PE), construction (CT) and telecommunication (TELCO) sectors ranked cooperation in education (CE) as a moderately important domain with weightage of 1.50, 1.45 and 1.40 respectively. This implies that industry aware of the importance of quality teaching in universities in Malaysia. Moreover, CE is directly related to policy, which has direct implication in sustaining relevancy of contents and technology to cope with the needs of the modern industry. In fact, the significance of CE is well-established towards supporting the need for better understanding and integrating needs of industry into the curriculum development (Onwuka, 2009; Yuzainee, Zaharim and Omar, 2011; Shah and Nair, 2011).

Despite its significance, CE domain was ranked relatively low as the respondents had the perception that this domain is not a part of their mainstream activity and lack of expertise on the educational background. Furthermore, Science & Business Commission report on the university-industry partnership by (Edmondson, et al., 2012) indicated that engagement involving multinational organizations such as Intel, Shell and Microsoft Corporation dominantly dictate their needs be prioritized by the university (2012). Similarly, in Malaysia, this scenario was raised by the study's respondents, where the curriculum development of the university is shaped mainly to fulfill the needs of large industries, which are perceived as stable and reliable. On the other hand, the existence of mismatch between teaching and practice may not be the prime concern of the small entrepreneurial companies where they rely heavily on the regional workforce.

Information technology and networking (ITN), semiconductor (SEMI) and manufacturing (MFG) sectors ranked intellectual enhancement (IE) as an important domain to foster partnerships effort with a weightage of 2.98, 1.70 and 1.38 respectively. University programmes should be strongly orientated toward building abilities in graduates to cope with the scientific and technological challenges that industries are concern about. In this regards, industry fosters partnership through student mentorship and/or provides funding for the projects and provides the sponsored projects for the students (Moalosi, Oladivan & Uziak, 2012). Nonetheless, the students' learning experience and creativity might be restrained by economic or manufacturing restrictions imposed by their project partner/industry, which results in relatively low perception by the field engineers from the 8 surveyed sectors in this domain.

Table 4-30 demonstrates the end results, shown in the principal eigenvector, which is based on statistical concepts that involve input from the power electrical sector. The same methodology (as described above) was applied for the six different links involving the 8 industrial sectors. The resulting weights for each category were then compared to understand the preference of important link present between the eight different groups.

Table 4-30: Priority Vector of Link Type by Power Electrical Sector

Power electrical sector	**ACD**	**IP**	**SLA**	**STP**	**PA**	**CW**
Expert 1	0.598725	0.16506	0.091288	0.146528	0.062458	0.04577
Expert 2	0.04595	0.60296	0.16894	0.35198	0.04205	0.07999
Expert 3	0.0229	0.34423	0.28249	0.29204	0.12736	0.19839
Expert 4	0.09073	0.30356	0.20849	0.28751	0.0935	0.14436
Expert 5	0.56308	0.06075	0.16563	0.05277	0.04832	0.12261
Expert 6	0.24613	0.21597	0.0902	0.17662	0.01795	0.33163

Similarly, the composite priorities or priorities for the link type were computed for each of the industrial sectors. The comprehensive composite priorities for all groups, with respect to the various link types, are presented in Appendix K.

The most important (Rank 1) linkage preferred by all respondents (industry members) were identified based on the ranking assigned to each linkage type in fostering the partnership between university-industry. The results are presented in **Figure 4-12.**

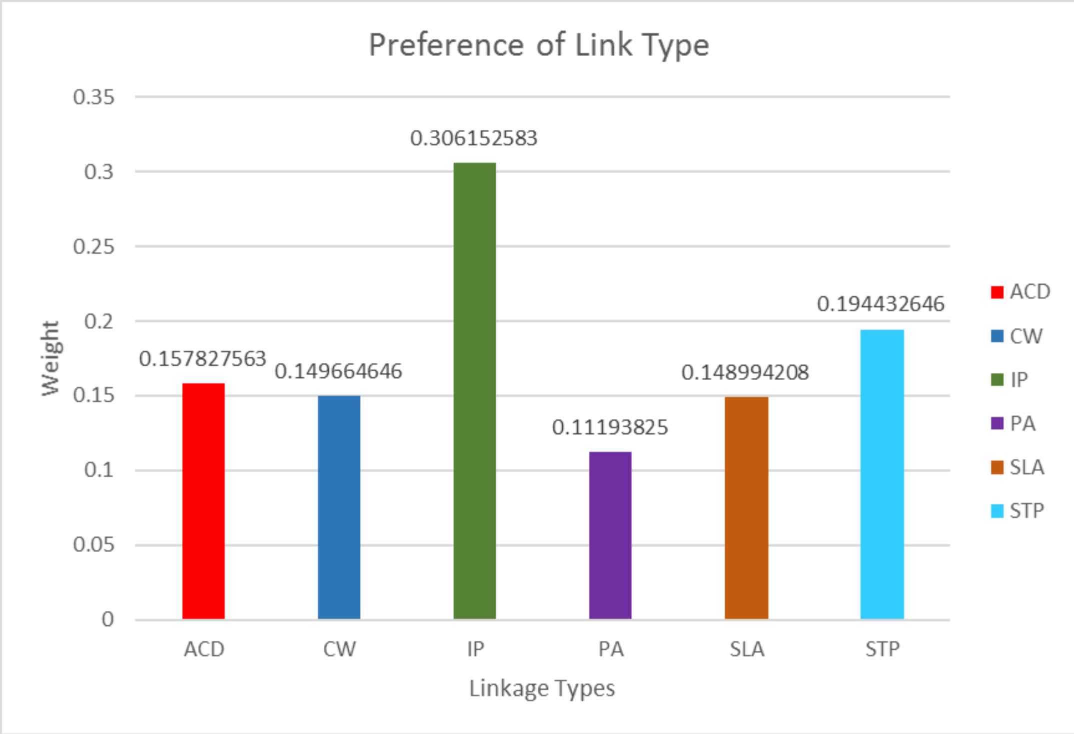


Figure 4-12: Rank Preference of Type of Linkage by Field Engineers

As illustrated in **Figure 4-12**, it is interesting to note that the decision-makers ranked internship programme (IP) as the most important link with a score of 0.3061, which was expected because industrial training forms as the common link that fosters partnership. In addition, the engineers from industry indicated that staff training programme (STP), academic curriculum development (ACD) and consultancy work (CW) as their choice of preferred linkage in forming the partnership with universities. Nevertheless, the results indicate that least preferred linkage types were student learning activity (SLA) and publication activities (PA).

The industrial training is the highly preferred linkage among the local industrial sectors due to the professional nature of the most professional engineering programmes. This was in agreement with many studies indicated that engagement with the university through industrial training was the common concern of industry as is supported by the policy of the majority of the company to provide placement for the students (Haddara & Skanes, 2007; Pinnelli, Hall & Brush, 2013). Nonetheless, the success of this partnership depends on industry to continuously provide the source of training placement for budding graduates in exploiting their workability and skills as they navigate the industry within the stipulated period (Yuzainee, Zaharim and Omar, 2011; Rodzalan & Saat, 2012).

In this regards, decision-makers felt that training needs and scheduled periods of training requirement of the industry should be monitored and supported. This should be a high priority of universities as it is crucial to ensure the projects are executed in a timely manner with sufficient manpower resources. Hence, the findings indicated a significant association between mobility of people and the university-industry partnership.

Decision-makers felt that universities are often criticised that their educators are lack of knowledge on the technological innovations that incorporated into the industrial landscape. Consequently, the respondents ranked staff training programme (STP) as the second important link with a score of 0.1944. In light of positive significance towards partnerships, it is clear that field engineers in this study appreciated the significance of greater inclusiveness of educators with research experience in the industry towards sustaining their intellectual curiosity for continuous learning. Furthermore, decision-makers felt that STP would assist in improving educators' knowledge of technological and technical innovation in the industry. Therefore, it was perceived that the upskilling and training initiatives through engagement of industry by providing access to their technical infrastructure and technology would be a good choice. This was in agreement with findings from studies by (Onwuka, 2009; Shah and Nair, 2011) indicated that STP is necessary towards supporting the students' learning experience and drive to align engineering education with industry's needs as part of maintaining the quality of engineering provision.

The decision-makers ranked academic curriculum development (ACD) as the third important link with a score of 0.1578. They felt that achieving partnership through ACD appears to be the new trend towards narrowing the gap between the theory and practice. Therefore, the decision-makers felt that the involvement of the advisory members especially in the engineering education in terms of providing insights, recommendation, and advice would critically assist universities to design curriculum and skills development of engineering education that meets the demands of the industrial landscape. Thus, this link improves the collaborative relationship between universities and industry.

The decision-makers felt that there should be constant yearning for improving production of goods and services, especially to face competition and environmental changes to sustain the development of technology. In fact, the industry has a wide spectrum of specific technical issues, which are critically required to be solved.

The decision-makers ranked consultancy work (CW) as the fourth important link with a score of 0.1496. CT was viewed as an influential factor to successfully solve the technical issues. Moreover, several decision-makers believed that consultancy work is a key enabler to leverage the capacity and capabilities of educators to exploit their knowledge and expertise to solve the technical issues in the industry. In addition, the industry felt that their involvement in supporting multiple projects for their organization leads to lack of time to explore the solution for the technical problems within a short time frame.

Decision-makers rated student-learning activity (SLA) as the second lowest important link towards fostering the better partnership between university and industry with a score of 0.1489. Generally, the results revealed that SLA benefits only a small number of activities. In addition, communities of the industry felt that supporting this link requires them to frequently reschedule or disrupt their own task at the workplace, schedule several meetings with educators to plan relevant activities, and overcome barriers in the policy of organizations. Furthermore, they believed that involvement in the link requires consistent support and commitment, which creates a huge challenge for the industry to sustain.

Decision-makers rated publication activities (PA) as the least important link with a weightage score of 0.1119. This implies strong variability in view of the communities of industry on the importance of PA. The decision-makers who felt that PA as a low priority link argued that contribution of PA has a little impact towards recognition and promotion initiative in their organization unlike policy in universities. Furthermore, they believed that work performance is measured through overall contribution in successfully fulfilling the work requirement, which has the direct effect on sustaining good career advancement in their organization. Nevertheless, decision-makers indicated that the output of publication was mooted by educators as they were able to better determine the novelty and originality of work emerged from final year projects or capstone design projects. Thus, collaboration through this link was rated low because of the company policies that unable to support the academic publication initiatives despite its importance in academia.

The study presented the perspective of eight industry sectors in regards to the six academic-led linkages. Overall, the results revealed variation in the perceptions of the eight industry sectors in Malaysia in engaging university through academic-led linkages.

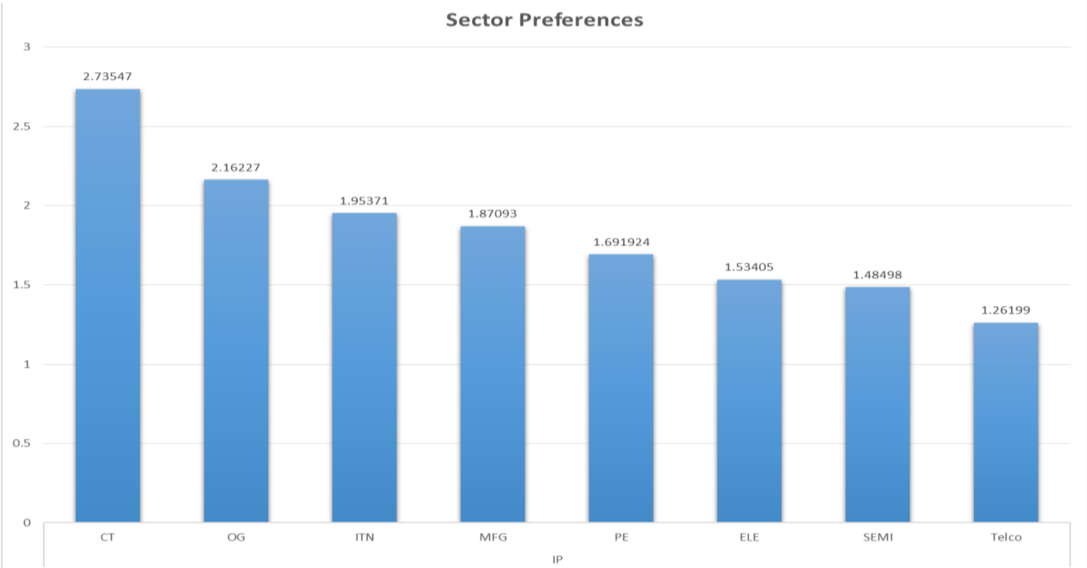


Figure 4-13 (a) Industry Sector Preference on Internship Placement (IP)

According to Productivity report for the period of 2015/2016, the construction (CT) sector has proven to be one of the resilient industries in driving the economic growth of Malaysia. This is due to the strong demand for good quality infrastructure (Malaysia Productivity Corporation, 2017). In this study, the CT ranked internship programme (IP) as the most preferred linkage with a weightage of 2.735 as indicated in Fig 4-13 (a). This was in agreement with studies conducted by (Yuzainee, Zaharim and Omar, 2011; Rodzalan & Saat, 2012; Pinnelli, Hall & Brush, 2013). In general, CT is relatively labour intensive, which uses a larger number of the workforce compared to other sectors. Thus, IP provides a platform for the industry to recruit technical employees by being the common type of linkage that merges education and engineering practice.

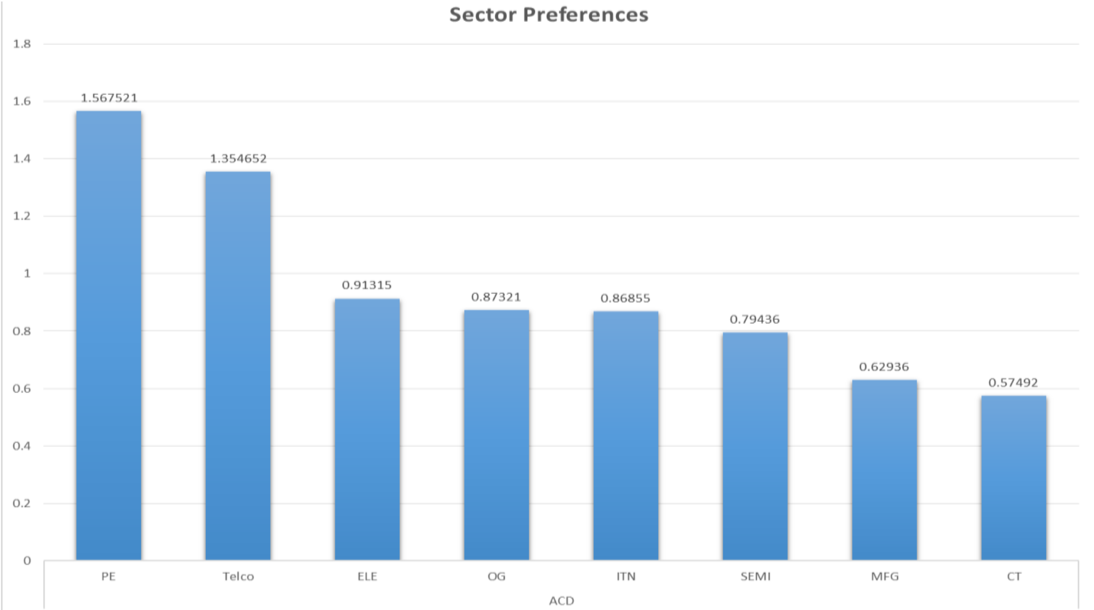


Figure 4-13(b): Industry Sector Preference on Academic Curriculum Development (ACD)

Fig 4-13 (b) demonstrates the preference of industry sectors on academic curriculum development. Power electrical (PE) sector ranked academic curriculum development (ACD) as highly preferred linkage with weightage of 1.567. Impact of Malaysia's modernization efforts has pushed the industry, particularly electrical and renewable energy to import technologies from the West. Thus, the university has an essential role to produce the talent pool, which is adaptive towards utilizing the imported technology by enhancing their academic structure and curriculum.

The success of PE sector is influenced by efforts of the university to prioritize the relevance of engineering education to cope with the demands of the industry rather than developing undergraduate programmes, which only deal with their own requirements and policies, which are far from addressing the industry's requirements. Therefore, a curriculum that is designed to produce graduates who are able to meet the work demands of the industry is vital in addressing the gap between the theory and practice (Froyd, Layne & Watson, 2006; Olorunfemi & Ashaolu, 2008; Childs & Gibson, 2010).

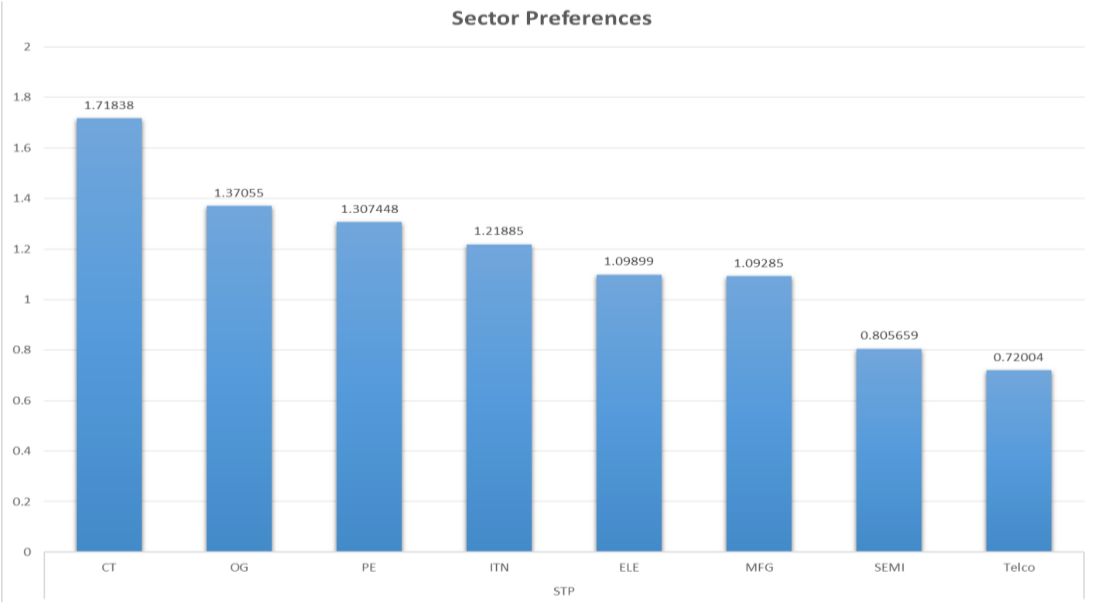


Figure 4-13 (c): Industry Sector Preference on Staff Training Programme (STP)

Construction (CT) sector ranked staff training programme (STP) as the most preferred linkage with a weightage of 1.718 as shown in Fig 4-13 (c). According to productivity report for the period of 2015/2016, building information modeling (BIM) has gradually replaced the computer-aided design and drafting (CAD) and adoption of industrialised building system (IBS) technology in the construction sector (2017). In addition, there is an increased demand for high-quality construction mega-projects urging CT to adopt and utilize the advanced construction technology and techniques such as 3D printing, BIM and the integration of design and off-site component-based assembly. Thus, this might have typically prompted the construction sector for an outreach effort through STP by engaging and facilitating educators and engineering professionals to train on this new system. Moreover, growing evidence also suggests that engineering educators need to be conversant with existing practices in industry while also playing the role of agents to bring in innovation and improvement in the teaching and learning domains (Heesom, et al., 2008; Onwuka, 2009; Schubert and Andersen, 2012; Howard & Campbell, 2013).

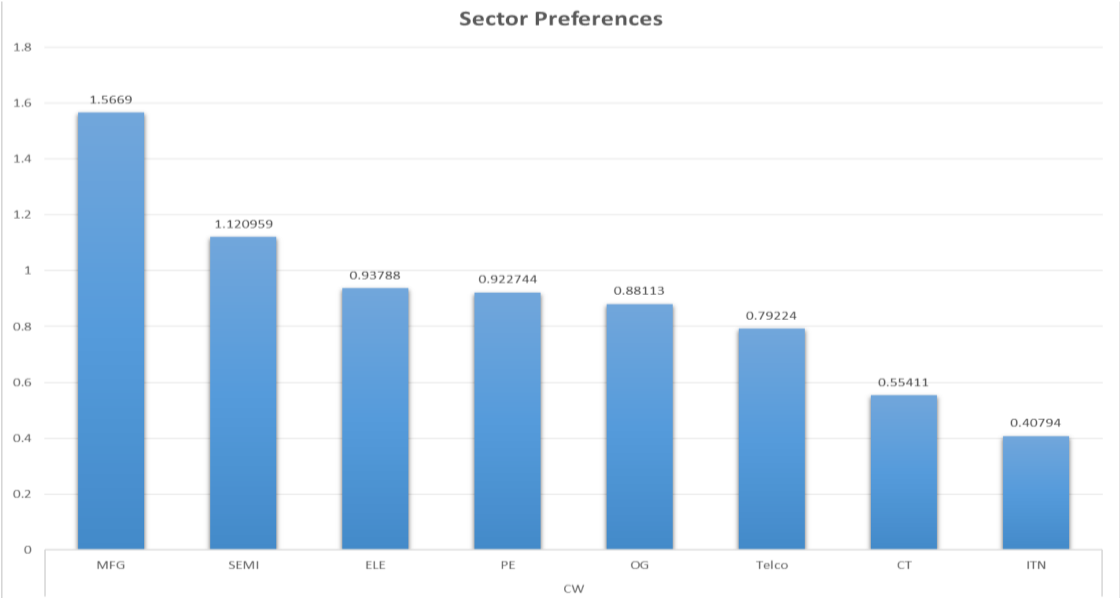


Figure 4-13 (d): Industry Sector Preference on Consultancy Work (CW)

Manufacturing (MFG) sector ranked consultancy work (CW) as the most preferred linkage with a weightage of 1.566 as shown in Fig 4-13 (d). As MFG is a highly dynamic sector, it emphasises on the "survival of the fittest" attitude, where the industry often seeks expert opinion and collaboration from the university to provide solutions for their pressing technical problems and challenges. Furthermore, the report by Ministry of International Trade and Industry (MITI) in Malaysia outlined that strong manufacturing foundation coupled with developed infrastructure and connectivity remains steadfast to leverage on this sector to become a high-income nation. In 2015, however, the local manufacturers faced the challenging issues related to the relative reticence to invest in modern technology, lack of skilled manpower and high production costs, which impeded the strategies towards sustaining during the fourth wave of revolution or industry (2016).

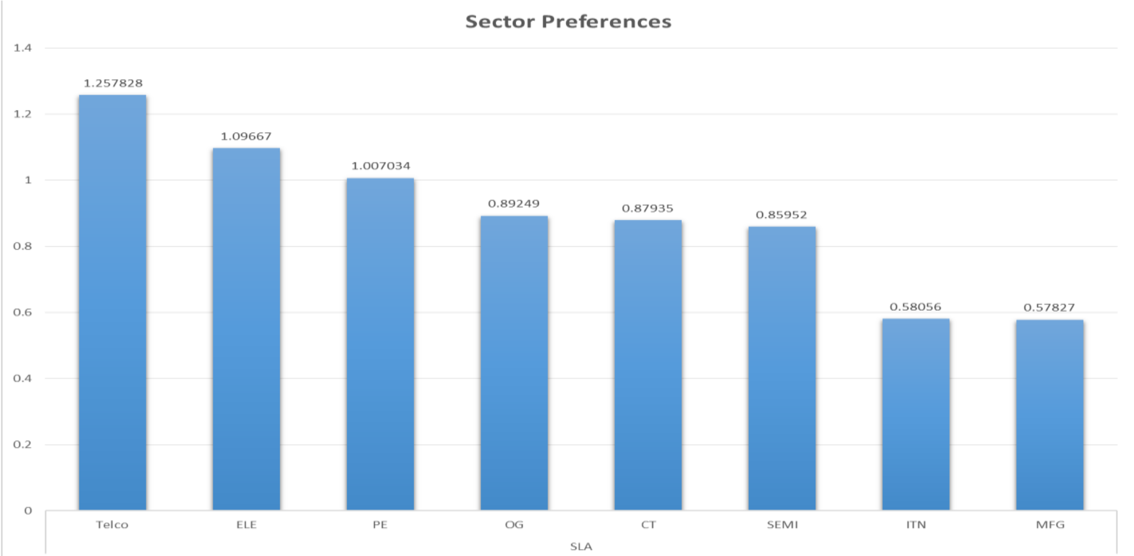


Figure 4-13 (e): Industry Sector Preference on Student Learning Activity (SLA)

Telecommunication (TELCO) sector ranked student-learning activity (SLA) as the most preferred linkage with a weightage of 1.2578 as shown in Fig 4-13 (e). This is to open up its doors to provide opportunities for the students to utilize modern infrastructure, provide the first-hand experience on the technology and the industry's direction for supplementing their knowledge in real-life business environments and learn best practices. Furthermore, Productivity report reflecting performance in 2015/2016, indicated that there is a need to formalize partnerships between industry and university towards creating the knowledge-based talent pool to support the services sector especially the information and communication technology (ICT) sub-sectors, which includes telecommunication. The reason being is for paving way for the economic growth, which is gradually shifting towards digital and technology-driven approach from labour intensity (Malaysia Productivity Corporation, 2017). Hence, SLA is a linkage, which has positive significant towards students' learning curve, as this will boost their confidence in terms of keeping abreast of current technological developments (Vest, 2005; Morell, 2008; Kumar and Iman, 2010).

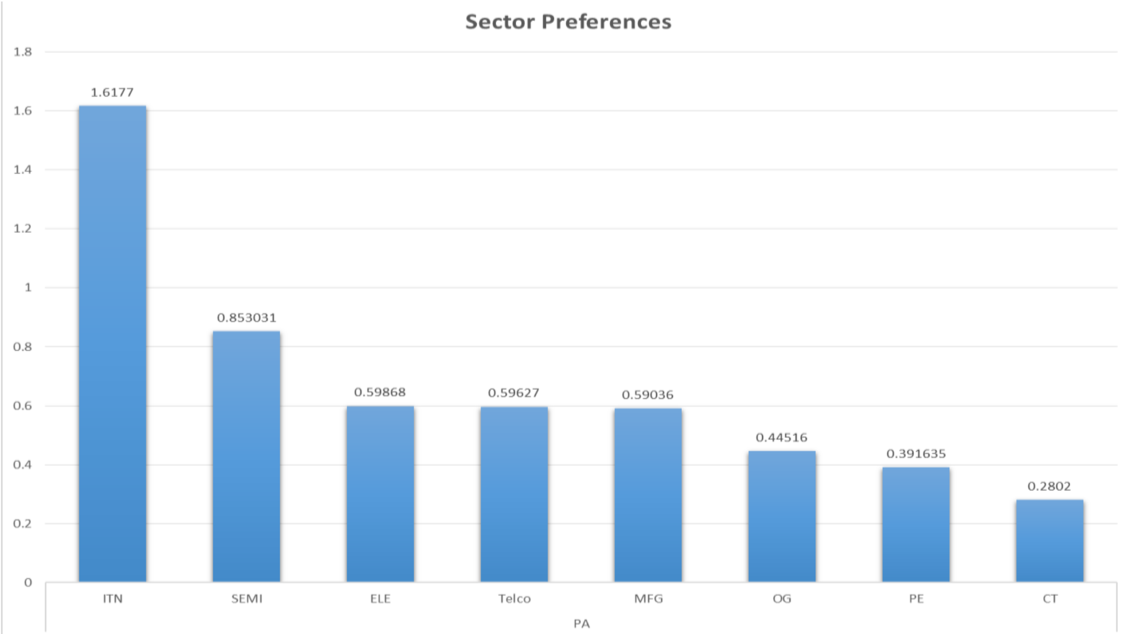


Figure 4-13 (f): Industry Sector Preference on Publication Activity (PA)

Information technology and networking (ITN) sector ranked publication activity (PA) as the most preferred linkage with a weightage of 1.6177 as shown in Fig 4-13 (f). In this regards, the new technological shift in ICT has shown to create new discoveries, which would be valuable contributions to the researchers, educators, and community. Consequently, (Schubert & Andersen, 2012) indicated that prevailing partnership via ITN would increase the publications outcomes that support the application of latest technology transpiring at work front. Thus, it indirectly improves the reputation of the university, the reputation of the industry and contributes towards research culture. In should be noted that according to Productivity report on the performance of service sectors for the period of 2015/2016, information technology and networking sector that forms as part of information and communication technology sub-sectors, experienced a drastic upbeat evolution. This was mainly due to the expansion of new Internet-based applications and the rising demand for reliable and high-speed internet, including 4G long-term evolution (LTE) network and fibre optics (Malaysia Productivity Corporation, 2017).

4.5 Chapter Summary

An investigation to capture the perspectives of industries on the university-industry partnership is vital as industries are the driving force behind the success of this cause-effect model. In this study, a total of 13 research hypotheses were examined to validate the conceptual model of the cause-effect of the study. The results revealed that nine out of the thirteen hypotheses (69.2 %) were significant including six direct and three indirect paths in the cause-effect model.

Overall, as reflected by the datasets, the findings of this study are in agreement with several studies conducted previously in supporting the greater representation of industry in the teaching and learning (Patil, Nair and Codner, 2008; Onwuka, 2009; Zaharim et al. 2009; Shah and Nair, 2011; Yuzainee, Zaharim and Omar, 2011). Furthermore, the aim of the research was achieved by developing a hierarchical model that provided a locus for respondents to select academic-led linkages based on their perceived preferences. The findings of AHP indicate that internship programme (IP) was the most preferred academic-led linkage, followed by staff training programme (STP), academic curriculum development (ACD), consultancy work (CW), student-learning activity (SLA) and the least preferred was publication activity (PA).

In addition, analysis of the perception of sectors on the six academic-led linkages demonstrated that construction (CT) sector ranked IP and STP as their preferred linkage. This is because a majority of the respondents are from relatively large construction companies, which are characterized to have adequate resources specifically the trained technical manpower, technical “know-how” and appropriate technology. Thus, CT perceived to have strong ability to provide adequate support to universities through these linkages in the field of electrical, civil, and mechanical.

Power Electrical (PE) sector perceived that curriculum development (ACD), which involves curriculum design of the contents and appropriate skill-sets to be important. This is indicatory evidence of consensus as Malaysia has huge potential renewable energy resources in the form of biomass, solar, and hydro. Thus, demands of new area and scope of study require inputs and recommendations in supporting universities to design electrical and renewable related undergraduate programmes and its associated contents.

In contrast, the research findings in this study indicate that the information technology and networking sector perceived publication activity (PA) to be important. The respondents perceived that impact on current development in the area of computing such as big data, cloud computing, and internet of things could trigger discovery of new breakthroughs, which can be translated into series of publications. Since partnership involves the integration of working and learning relationship, respondents are confident on the feasibility of fostering industry-university partnership to support the university in their quest to narrow the gap between theory and practice and adapting the "outcomes" concept in professional engineering education in Malaysia.

Chapter 5
CONCLUSION

5.0 Overview of Study

Impact to modernize the teaching and learning activity with the greater inclusive representation of the industry in the professional engineering education has brought university-industry partnerships to the forefront interest of many universities. This is largely influenced by the substantial criticism especially from industry regarding the structure and delivery of the undergraduate professional engineering education in terms of the engineering practice. Thus, the conceptual model guiding this study was conceived to establish the relationship between teaching and learning outcomes activities and partnership and improvement. The AHP was useful in allowing participants to make good decisions in terms of selecting academic-led linkage on their perceived preferences. The identified preference of field engineers from various sectors on the academic-led linkages will aid in fostering the partnerships towards narrowing the gap between theory and practice.

5.1 Review of Stated Research Questions

This section summarizes the outcomes of the study that pivot on the pedagogical reform, specifically teaching and learning activities based on the purpose and research questions as described below:

1. To carry out scholarly review that provides collective insights towards significance of industry's inclusive representation in bolstering quality teaching and learning in shaping good work quality of the talent pool

The theory of quality teaching in engineering education has been explored through many publications and reviews citing that solution to remedy the gap between theory and practice requires the greater interaction of industry in the learning domain. In the interest of this, an extensive literature review conducted in this study serves an important function in the formation of the research problem and provides a locus to explore new areas of research within bodies of knowledge. Although the literature review typically accounts for a larger coverage of this dissertation, eventually it enables to draw a specific boundary of the intended scope within this research literature activity. As such, the scope is defined within the professional engineering education specifically the academic development criterion of the outcome-based accreditation framework of Engineering Accreditation Council (EAC), Malaysia.

According to many published studies, universities are encouraged to develop an outreach strategy to foster the partnership with industry as part of the solution to reduce the gap between theory and practice. This involves critical initiatives in various aspects of teaching specifically on the programmes and its relevance to technical manpower needs. The outreach strategy should also concentrate on the contents of the engineering programme and its educational mission on par with the current practice and technology. Moreover, nurturing the desired skill sets and professional outlook of the students should be the focus of the outreach strategy (Patil, Nair & Codner, 2008; Zaharim, et al., 2010; Shah and Nair, 2011; Morell & Trucco, 2012; Yusoff, Omar & Zaharim, 2012).

This stage instigates the much required discriminatory ability to assess the theoretical underpinnings of published work in pursuit of crafting frameworks for this research study. As such, exploring well- documented literature materials often improve the ability to analyse reviews, increased the ability to conceptualize and express own reviews of literature as an end product. Thus, entails the study to conceive and investigate a cause-effect model that hypothesised correlation of teaching and learning activities to establish partnerships with industry. Nonetheless, statistical investigation relies heavily on the published and documented work to identify judgements or arguments, which critically forms the prime focus in designing effective yet reliable questionnaire for this research study.

The process of conducting the scholarly review is helpful in examining whether the retrieved articles are appropriate for addressing the research objectives of the current study (Zainudin, 2012). In fact, this would be the basis to identify various constructs to conceive a cause-effect model; in this case, that hypothesised correlation of teaching and learning activities to establish partnerships with industry. This entails the creation of the questionnaire using a suitable Likert scale. Nonetheless, refining statements with the open-ended statements are crucial in the development phase of the questionnaire, which largely dependent on the investigation of extensive scholarly review.

This dissertation has demonstrated that exploring the related literature of published work derives various multi-item constructs to conceive and investigate a cause-effect model. This will subsequently aid in identifying critical academic-led linkages to engage respondents on their perceived preference on academic-led linkages to the foster partnership with the university.

2. To investigate the university-industry partnerships using a cause-effect approach that pivots on triangulation from data of published domains and industry's input.

The goal of the study is to investigate a conceived research model that hypothesised correlation between teaching and learning activities and partnerships. Consequently, four latent constructs of teaching and learning activities involving cooperation in education **(CE)**, mobility of people **(MP)**, knowledge up-gradation **(KU)** and intellectual knowledge **(IE)** were hypothesised to directly stimulate partnership **(PR)** effects in influencing improvement **(IM)** on students' learning experience towards generating good quality talent pool. The direction of all the constructs affecting the partnership is clearly indicated on the existence of the correlation.

Therefore, the following section will describe the summary of the three research questions developed in this study:

- Overall, does the research structural equation model (SEM) created indicates a satisfactory degree of fit to the observed data?

  A total of 13 research hypotheses were examined to investigate a conceived research model that hypothesised correlation between teaching and learning activities and partnerships. The structured equation modeling procedure revealed a plausible model that provided evidence of four latent variables associated with teaching and learning activities in stimulating the partnership between university and industry in view of improving the talent pool for the workforce.

- Does the teaching and learning activities have statistically significant effects on the partnership with industry?

A total of 13 research hypotheses were examined to validate the conceptual model of the cause-effect of study. The results indicated that the hypotheses of direct path H1.a, H2.a, H4.a, H1.b, H2.b, and H5 were supported as their p-values were below 0.05, while the hypotheses H3.a, H3.b, and H4.b were rejected as their p-values were above 0.05. Partnership (PR) mediated the effects of cooperation in education (CE), mobility of people (MP) and intellectual enhancement (IE) on the improvement (IM). Thus, hypotheses H1.c, H2.c, and H4.c were supported. Conversely, the mediation effect of partnership (PR) on the relationship between knowledge up-gradation (KU) and improvement (IM) was not supported. Thus, the hypothesis H3.c was rejected.

The relationship analysis of the model revealed that nine out of the thirteen hypotheses were significant in which six direct and three indirect paths in the cause-effect model were supported. Overall, 69.2% of the relationship was supported. Thus, it was found that the findings emerged from this study were consistent with prior literature reports.

3. To investigate the influence of subjective preference of industry towards establishing successful university-industry partnership using multiple criteria decision-making (MCDM) theory.

In this study, AHP enabled the communities of the industry to perform good decision-making in selecting six academic-led linkages for fostering partnership based on their perceived preferences. Thus, the study reveals that the changing opinions and experiences of industries represent an important input that assists in fostering collaborative partnership. In Malaysia perspective, the university-industry partnership is viewed as both a working and learning relationship. Moreover, the respondents are confident about the feasibility of fostering partnership to support the university in their efforts to narrow the gap between theory and practice and adapting the “outcomes” concept in professional engineering education.

- What is the preference of the communities of industry on the academic-led linkage that could narrow the gap between the theory and practice in stimulating students' learning experience?

The research findings of AHP indicate that internship Programme (IP) was the most preferred academic-led linkage. Furthermore, the industrial members widely acknowledged that sufficient exposure towards engineering practice is highly beneficial to enhance the students' learning curve towards building good work quality graduates. In addition, staff training programme (STP), academic curriculum development (ACD), consultancy work (CW), student-learning activity (SLA) and publication activity (PA) were also perceived as preferred academic-led linkage by the industry.

In addition, the findings on the perception of industry sectors on the six academic-led linkages revealed that construction (CT) sector ranked IP and STP as their preferred linkages. The outcome of this investigation supports the theory that industrial communities were mutually agreed that collaboration between universities and industry in the teaching and learning activities has a positive impact especially in internship programme (IP).

5.2 Research Summary and Contribution

This study was carried out to conceive and evaluate the cause-effect model that foster university-industry partnership to improve the quality of teaching and learning activities. It timely and important that the professional engineering accreditation body's accrediting principle emphasises the improvement measures related to teaching and learning activities with greater engagement of industry.

As the outcome of this study emphasised the academic development domain of engineering education, the implications of research findings for universities are as follows:

i) The findings provide evidence for seeking greater support from industry to improve the quality output for higher learning institutions. Importantly, the industry members emphasised the importance of three teaching domains involving cooperation in education (CE), mobility of people (MP) and intellectual enhancement (IE) with respect to professional engineering education in Malaysia. As such, this suggests that majority of teaching and learning outcomes activities in the academic development criterion are crucial in stimulating the university-industry partnership towards improving the students' learning experience. In Malaysia perspective, the above findings indicate that field engineers are receptive towards being part of the solution to narrow the gap between theory and practice. On the other hand, the element of knowledge up-gradation lacks appeal on the university-industry partnership.

ii) As partnership is both a working and learning relationship, respondents asserted to engage with the university through top three important academic-led linkages such as internship programme (IP), staff training programme (STP) and academic curriculum development (ACD). Additionally, an interesting finding confirms that industry players prefer to engage educators in their quest to improve quality of teaching.

iii) In Malaysia perspective, the perception of industry sectors on the six academic-led linkages revealed that only the construction (CT) sector ranked IP and STP as their preferred linkage. The benefits of these linkages for CT including recruitment of interns, acquiring good quality work talent, and development of new technology.

The study contributes to additional knowledge and understanding of the university-industry partnership in a number of ways as elaborated below:

(i) **Valid and Reliable Instrument for Measurement of University-Industry Partnership**

The study demonstrated the benefits of utilizing a second-generation statistical technique to validate published work of the theoretical underpinnings of teaching and learning activities in terms of industry-university partnerships. The reviewed materials were transformed into a cause-effect model to generate statistical datasets to ascertain the validity of these claims and arguments. The study provides a valid and reliable measurement for the teaching and learning construct where the scale has been tested using rigorous statistical methodologies including pre-test, confirmatory factor analysis, uni-dimensionality, reliability, and validation of second-order construct. The scale was shown to meet the requirements for reliability and validity. Thus, it might be useful for future research. The development of these measurements tools will greatly stimulate and facilitate the theory development in professional engineering education.

(ii) **Theoretical Framework**

This research provides a theoretical framework that characterizes the teaching and learning outcome activities of engineering education. Collaboration between the university and industry plays a key role in achieving responsiveness. Moreover, the outcome of this research may facilitate the formation of new constructs to provide an in-depth understanding of inclusive cooperation between industry and university towards enhancing the learning experience of the undergraduate engineering students.

(iii) **Refinement of Model**

This study provides a list of recommendations for future research. The findings revealed that knowledge up-gradation (KU) activity had no significant impact on the partnership. Thus, this recommends further exploration of KU as enrichment activity involving industry. Secondly, the three least popular linkages including consultancy work (CW), student learning activity (SLA) and the publication activity (PA) as ranked by the industry members should be explored further for its usefulness in the industry-university partnership in future. Thirdly, the perception of sectors on the six academic-led linkages could be further explored on the internship programme (IP), which was ranked as the least important linkage by the semiconductor (SEMI) and telecommunication (TELCO) sectors.

Importantly, the industrial training remains on top as the common type of linkage that merges education and practice towards enhancing the students' learning experience in the professional engineering education in Malaysia.

Appendix

APPENDIX A-1

Thu 26/5/2016 10:11 PM

Sarah Agnew

Ethics Approval - Investigating University-Industry partnership of Higher Engineering Education using Cause-Effect analysis and Multi-criteria Decision making: A Malaysian Perspective

To 'Sivajothi a/l Paramasivam'

Cc Kian Tan; Paul Greenhalgh; EE PGR Administration

You forwarded this message on 6/3/2017 6:38 PM.

Dear Siva

I am pleased to inform you that your ethics application has been approved today, 26/05/16.

As you have not registered the project on the online system, you will not have a reference number to use in your Annual Progression forms. I would suggest that you enter the phrase 'not applicable' when it asks for a reference number, and you will then be able to enter the date of approval (26/05/16).

If you have any queries about how to complete the Annual Progression paperwork, then please contact Stuart in the PGR Graduate School (his email address is copied into this email).

Kind regards
Sarah

Sarah Agnew
Research Administrator (Ethics), Research and Business Services

northumbria UNIVERSITY NEWCASTLE

T: +44 (0) 191 227 3656
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Follow Northumbria University's Research Support Blog

Room B106 Ellison Building, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom

APPENDIX A-2

30th July 2013

Dear Respondent,

RE: Survey Questionnaire for Doctoral Studies

My name is Sivajothi Paramasivam, I am a doctoral candidate at the Northumbria University of Newcastle of Advance Mechanical Engineering with emphasis on quality control and assurance in engineering education. I am currently attached with the School of Engineering as a full time educator and strongly involved in areas such as teaching and learning, curriculum development, research as well as industrial collaboration. Industry, as a key stakeholder in this context of engineering higher education is crucially needed and valued to complete my study in order to gauge industry's perception of their involvement through providing insights, advice and recommendation in areas pertaining to academic development domains of engineering degree programmes by fostering close and active partnership with academia

This questionnaire will take you approximately forty-five minutes to complete as a holistic investigative study is undertaken here. It is also expected that your participation will help ensure an accurate determination level of involvement and sustainability of industry with academia base on industry's preferred activity of collaboration within domains of academic development.

I sincerely appreciate your willingness to participate in this study. The responses you provide will remain confidential and no names or company/organizations will be associated with the findings of this study. Again thank you for your valued input as greater voice of industry is highly sought with regards to this study and would greatly beneficial in our attempt to provide students with high quality of education so that these budding graduates in turn would able to be the prime source of talented human capital that able to positively impact business dominance of your organization.

Sincerely,

Sivajothi Paramasivam, CEng. (UK), MIET

Survey Questionnaire

On

Sustainable of University-Industry Partnership Through Academic Development

PART A: BACKGROUND INFORMATION & PARTICIPATION IN COLLABORATIVE ACTIVITY

Instruction: Fill in the selected value into the assigned box within each Question. Each box only one value

Section 1: Demographic of Industry

A. What is the Ownership structure of your current company/organization?	B.Which area is your company located in Malaysia?	C. What type of company it is classified to?	D.What is the main activity your engineers involved in?
1.Government 2.Government Link Company 3.Local Private 4.MNC 5.Other (Specify)_____________	1. Klang Valley/KL 2. Northern 3. Southern 4. East Coast 5. East Malaysia	1. Manufacturing 2. Service sector 3. SME/SMI 4. Agricultural 5. Others(please specify _______________	1.System design 2. Repair service 3.Project Mgmt 4.Sales/Tenders 5.Other(Specify)
☐	☐	☐	☐

E. What is your job title?	F. How many years have you served in current company?	G. Years spent in Management role?
1. CEO / COO / CTO 2. Gen. Manager of technical department 3.Sr. Engineer of engineering department 4.Jr. engineer of technical services 5.Head / Manager of Human Resource department 6.Other (please specify)___________________________	1. 1 to 5 years 2. 6 to 10 years 3. 11 to 15 years 4. 16 to 20 years 5. more than 20 years	1. 1 to 5 years 2. 6 to 10 years 3. 11 to 15 years 4. 16 to 20 years 5. more than 20 years
☐	☐	☐

H. Which sector does your company/firm/organizationbelong to?

1. Oil & Gas
2. Power/Electrical
3. Automobiles
4. Research & Development
5. Pharmaceuticals
6. Electronics/Semiconductors
7. Information Technology& Networking
8. Infrastructure
9. Food Processing
10. Biotech / Biomedical/Health care
11. Construction
12. Manufacturing
13. Transportation
14. Telecommunication
15. Hospitality Industries
16. Mechanical
17. Refinery, Chemicals
18. Defence &Marine-time
19. Training and Development service activities
20. Aviation industry
21. Other sector (please specify)

____

☐

Section 2: Employment Distribution

Q1. Which level of engineering qualification would be mostly recruited by your company? Graduates of: 1. Bachelors Degree 2. Masters Degree 3. PhD Degree ☐	**Q2.What is the most preferred engineering graduate employed from?** 1.Public IHL – 4 year degree 2. Private IHL – 4 years degree 3. Overseas IHL – 4 years degree/ equivalent 4.Other (please specify -------------------- ☐	**Q3. The engineering related work force highly needed by your organization is:** 1. Engineers (Bachelor of Engineering Graduates) 2. Technologies (Bachelor of TechnologyGraduates) 3. Technical Assistant (Diploma in Engineering) 4. Technician (Certificate in Engineering) ☐	**Q4. Which engineering fields do you mostly recruit graduates for employment?** 1.Electrical 2.Mechanical 3.Chemical 4.Civil 5.Electronic 6. Telecommunication 7.Information Tech. 8.Others (specify) ……………………………. ☐
Q5. Do you agree that fresh graduates are technically competent to be employed today? 1. Yes 2. No 3. Sometimes ☐	**Q6. Do you agree that improvement is needed among new hires of engineers on soft skills ability?** 1. Yes 2. No 3. Not Sure ☐	**Q7. Do you agree courses of engineering degree relevant towards industry need?** 1. Yes 2. No 3. Not sure ☐	**Q8. Do you agree that students and educators are not well aware of changing trends in engineering practice?** 1. Yes 2. No 3. Not sure ☐

Q9. What are the greatest challenges you face in filling the vacancies of engineering graduates today?

1. Shortage of applicants with the right skills and capabilities
2. Limited resources to market graduate vacancies adequately
3. Offering a competitive starting salary
4. Graduate candidates withdraw applications because hiring process slow
5. Graduate candidate not interested on work requirement of applied job
6. Shortage of applicants due to skill labour issue

☐

Q10. Do you require fresh bachelor's degree engineers to be registered with Board of Engineers?

1. Yes
2. No

☐

Q11. Do you agree that work experience is a crucial asset for new hires?

1. Yes
2. No

☐

Section 3: Academia-Industry Collaborative

Q1. Do you think that industry should establish working ties with academia? 1. Yes 2. No 3. Don't Know ☐	**Q2. Is your organization,you or other staff(s) of engineering department involved in collaborative work with academia?** 1. Yes 2. No 3. Don't Know ☐	**Q3. Number of working ties currently activewith academia (s)** 1. 1-3 partner 2. 4-6 partners 3. 7-10partners 4. more than 11 ☐	**Q4. Number of years your organization has working ties academia** 1. 0 to 3 years 2. 4 to 8years 3. 9 to 12 years 4. 13 or more ☐
Q5. Do you support academic curriculum collaborative with academia to be beneficial besides traditional R&D? 1. Yes 2. No 3. Not sure ☐	**Q6. Rate the status of your/company's input/voice towards development of engineering education as a stakeholder in the higher education system?** 1.Strongly heard 2.Moderately heard 3.Weakly heard 4.Totally unheard 5.Others(please specify) …………………………………… ☐	**Q7. Do you think the academia-industry relationship is working well within Malaysia engineering education context?** 1.Yes 2.No 3.Don't Know ☐	**Q8. Does academia establish contact with industry to seek assistance on enriching engineering education needs?** 1.Yes 2.No 3. Don't Know ☐

Q9. Listed below are 12 types of activities that have been considered as important for industry to establish collaborative/partnership with university/academia (IHL- Institution of Higher Learning).

Please rank these 12 activities in order of importance according your opinion that may impact your organization's involvement in this partnership. (1 being the most and 12 being least important)

It is vital that you rank ALL 12 and that you do not give any activities equal ranking

Type of activity industry involve with academic	RANKING
1.Support on cooperation in education (curriculum contents & skills) of engineering programmes	
2.Support on internship programme of engineering schools	
3.Support on recruitment of high quality graduates (eg. Graduates with 1st Class and 2nd upper classification ONLY)	
4.Collaborative venture on joint academic publications for Symposium or conference etc.	
5.Support continuing education of staff from academia	
6.Support as guest lectures from industry to teach on the programme base on related expertise	
7.Support on Final Year Project s (FYP) – Capstone projects of real world for students/educators to collaborate	
8.Support as industry representative in university committee for quality improvement	
9. Supports learning activities such plant visits/talks/special workshops/training programme /product development kits	
10. Corporate Social Responsibility Activities such as Scholarships/National competitions/Career Fairs	
11. Corporate joint research and innovation activities with university Academics	
12. Corporate in engaging academic staff(s) on consultancy work base on related expertise	

Q10. Please circle or bold only a value in each row base on the importance of the academic dimensions on a pair-wise comparison between each dimensions. (Input on role and activities of EACH dimensions is inserted to give better understanding to make a reliable comparison for your particular industry)

Criteria	More Importance Than								Equal	Less Important Than								Criteria
Cooperation in Education *Activity involves:* *-be part of advisory committee representing industry in academic meetings* *- Provide advice, recommendation on curriculum contents development on new/existing degree programmes on relevancy and industry needs* *- Provide advice, insights on skills & competency needed by*	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Mobility of People** *Activity involves:* *-Support internship programme* *- Provide employment opportunity to graduates of high talent*

graduates																		
Cooperation in Education ***Activity involves:*** ***-be part of advisory committee representing industry in academic meetings*** ***- Provide advice, recommendation on curriculum contents development on new/existing degree programmes on relevancy and industry needs*** ***- Provide advice, insights on skills & competency needed by graduates***	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Knowledge Up-Gradation** ***Activity involves:*** *-Support learning activities via plant visits, guest lectures/seminars* *-Support career fairs/competitions of universities* *-Support workshop of industrial based skills/products as teaching aid at universities.* *-Support &develop retraining programmes for academic staffs*
Cooperation in Education ***Activity involves:*** ***-be part of advisory committee representing industry in academic meetings*** ***- Provide advice, recommendation on curriculum contents development on new/existing degree programmes on relevancy and industry needs*** ***- Provide advice, insights on skills & competency needed by graduates***	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Intellectual Enhancement** ***Activity involves:*** *- Support on Capstone/ Final Year projects* *-Pursuit academic publications on new knowledge with universities* *-Collaborate on consultancy work with academics on industrial base technical issues*
Mobility of People ***Activity involves:*** ***-Support internship programme*** ***-Provide employment opportunity to graduates of high talent***	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Knowledge Up-Gradation** ***Activity involves:*** *-Support learning activities via plant visits, guest lectures/seminars* *-Support career fairs/competitions of universities* *-Support workshop of industrial based skills/products as teaching aid at universities.* *-Support &develop retraining programmes for academic staffs*
Mobility of People ***Activity involves:*** ***-Support internship programme*** ***- Provide employment opportunity to graduates of high talent***	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Intellectual Enhancement** ***Activity involves:*** *- Support on Capstone/ Final Year projects* *-Pursuit academic publication on new knowledge with universities* *-Collaborate on consultancy work with academics on industrial based technical issues*
Knowledge Up-Gradation ***Activity involves:*** ***-Support learning activities via plant visits, guest lecture, seminars*** ***-Support career fairs/competitions of universities*** ***-Support workshop of industrial based skills /products as teaching***	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Intellectual Enhancement** *Activity involves:* *- Support on Capstone/ Final Year projects* *-Pursuit academic publication on new knowledge with*

aid at universities. ***-Support & develop retraining programmes for academic staffs***																		*universities* *-Collaborate on consultancy work with academics on industrial based technical issues*

Q11. **Please circle or bold only <u>a value</u> in each row your preference base on your industry's expertise/strength on the type of linkage industry prefer to partner with university which is listed in pair-wise comparison basis.**

Alternatives	**More Preference Than**								**Equal**	**Less Preference Than**								**Alternatives**
Advisory on curriculum & skills development	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Internship programme
Advisory on curriculum & skills development	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Support learning enrichment activities
Advisory on curriculum & skills development	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Continuing training for academicians
Advisory on curriculum & skills development	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Publications activities of new knowledge
Advisory on curriculum & skills development	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Consultancy work with academicians
Internship programme	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Support learning enrichment activities
Internship programme	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Continuing training for academicians
Internship programme	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Publications activities of new knowledge
Internship programme	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Consultancy work with academicians
Support learning enrichment activities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Continuing training for academicians
Support learning enrichment activities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Publications activities of new knowledge
Support learning enrichment activities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Consultancy work with academicians
Continuing training for academicians	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Publications activities of new knowledge
Continuing training for academicians	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Consultancy work with academicians
Publications activities of new knowledge	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Consultancy work with academicians

PART B: PERCEPTION OF INDUSTRY TOWARDS ENGINEERING ACADEMIC DEVELOPMENT

Section 1: Cooperation in Education

This scope is to seek industry's perspective towards cooperation in education in issues related to curriculum content and skills dialogues of engineering programmes at degree level in Institute of Higher Learning (IHL).
Please indicate how strongly you agree or disagree with the statements. You can mark your sincere response anywhere from 1 to 10; Score 1 indicates Strongly Disagree, while Score 10 indicates Strongly Agree. Please circle only **one response per statement**

No	Statement	Strongly Disagree									Strongly Agree
		1	2	3	4	5	6	7	8	9	10
CC1	Industry's involvement on need analysis has the ability for IHL to develop relevant new engineering course(s) to meet workforce demand	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC2	Industry's involvement in curriculum development has the ability to influence IHL to infuse potential technical knowledge into engineering course(s)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC3	Industry's involvement in curriculum development has the ability to advice IHL on the demand of the proposed field across other similar industries.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC4	Industry's involvement in curriculum development has the ability to advice IHL to prepare and produce graduates of balanced skills of both knowledge specific and soft-skills	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC5	Industry's involvement in curriculum development has the ability to influence IHL to infuse broader range of knowledge for graduates to contribute in different areas of worksites	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC6	Industry's involvement in curriculum development has the ability to advice IHL to emphasize on elements such as economic, business, quality management, entrepurealship that are currently expected from graduates.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Industry's involvement in curriculum										

CC7	development has the ability to highlight IHL to place emphasize on collaborative learning environment in class to drive teamwork culture needed at worksites	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC8	Industry's involvement in curriculum development has ability to advice on trends of industrial landscape that creates gap between need of industry and that delivered by IHL	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC9	Industry's inputs has the ability to influence IHL to overhaul existing curriculum to address changing trends in engineering practice	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC10	Industry's involvement in curriculum has the ability to influence IHL to teach graduates to meet current needs of industry and engineering practice	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CC11	Industry's involvement on the need analysis has the ability to give insight to IHL on potential new programme(s) that could be developed in the new future.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD1	Industry's involvement in skills dialogues with IHL has the ability to provide input on quality and insight of skills needed by industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD2	Industry's involvement has the ability for IHL to be aware of business mergers trends that need graduates with new set of broader skills	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD3	Industry's involvement has the ability to guide IHL to produce graduate with professional practice (soft-skills) for engineering businesses.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD4	Industry's involvement has the ability to guide IHL to place emphasize to develop graduates of multi diverse ability for labour market	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD5	Industry's involvement has the ability to influence IHL to address skills deficiencies of engineering graduates	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD6	Industry's involvement has the ability to advice IHL on the competence and	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

	skills of relevant at work practice										
SD7	Industry's involvement has the ability to stress on specific transferable skills (communication, teamwork, responsibility time management, etc.) that lacks among graduates entering workforce	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD8	Industry's involvement has the ability to influence IHL to infuse specific technical skills/knowledge to meet demands of technology across similar industry settings	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD9	Industry's involvement has the ability to boast students satisfaction on relevancy of knowledge/skills acquired from programme	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SD10	Industry's involvement has the ability to influence strengthening relationship between current educational outcome and labour market needs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Section 2: Mobility of People

This scope seeks perspective of industry on issues related to industrial training and employability of both potential engineering graduates and entry level graduates for a successful employment that meets industry's aspiration. Please indicate how strongly you agree or disagree with the statements. You can mark your sincere response anywhere from 1 to 10; Score 1 indicates Strongly Disagree, while Score 10 indicates Strongly Agree. Please circle only **one response per statement**											
NO	**Statements**	**Strongly Disagree**									**Strongly Agree**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP1	Industry's involvement has the ability to infuse internship Programme into academic curriculum to complement students classroom experience/learning	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP2	Industry's involvement in internship programme has the ability to provide feedbacks to IHL on quality of potential graduates for future workforce	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP3	Industry's support in internship programme has the ability to provide exposure to interns of real world issues of the industrial landscape	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP4	Industry's support towards internship programme has the ability for interns to use discipline-specific knowledge and skills attained in class to contribute at work place	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP5	Industry's involvement in internship programme has the ability to stimulate interns to appreciate that knowledge gained in class differs to those demanded in worksites	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP6	Industry's support towards internship programme has the ability to influence interns on credible realistic engineering role models to be successful at work	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP7	Industry's involvement in internship programme has the ability to leverage on to tap potential talents for future recruitment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IP8	Industry's support towards internship able interns to acquire beneficial skills	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

IP9	Industry's support towards internship programme able to harness transferable skills (communication, teamwork, responsibility etc.) among interns	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM1	Industry's support on employment of new engineering graduates has the ability to gauge employability rate in domestic market.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM2	Industry's support on employment has the ability to advice IHL on relevancy of course and competence to sustain employability rate.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM3	Industry's involvement in employability activity has the ability to advice IHL that academic performance alone is not the criteria for employment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM4	Industry's involvement in employability activity has the ability to influence IHL to provide exposure on demands of engineering jobs to student to impress potential employers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM5	Industry's involvement in employability activity has the ability to influence IHL to produce talents of broader job requirement to overcome addressable issues (such as legislation, environment, safety) at workplace	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM6	Industry's involvement in employability activity has the ability to influence IHL to produce talent robust towards adaptability of new technologies and business environment due to commercial pressure	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM7	Industry's involvement in employability activity has the ability to provide adequate concerns on recruiting desirable talent from the local market	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EM8	Industry's involvement in employability activity has ability to influence IHL on employability rate of graduates	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Section 3: Knowledge Up-gradation

This scope seeks perspective of industry on their involvement and support on enrichment activities with IHL that able to further enhance learning curve of engineering students via a much closer collaboration.
Please indicate how strongly you agree or disagree with the statements. You can mark your sincere response anywhere from 1 to 10; Score 1 indicates Strongly Disagree, while Score 10 indicates Strongly Agree. Please circle only **one response per statement**

NO	Statements	Strongly Disagree									Strongly Agree
		1	2	3	4	5	6	7	8	9	10
KU1	Industry's support towards knowledge enrichment of students learning curve has the ability to establish working ties with IHL	1	2	3	4	5	6	7	8	9	10
KU2	Industry's support in enrichment activities (e.g. seminars, guest lectures, career talks/fair, plant visits, workshops) able to boast understanding of industry demand and needs among students	1	2	3	4	5	6	7	8	9	10
KU3	Industry's support in enrichment activities has the ability to stimulate need of industry that may not be stressed in classroom environment	1	2	3	4	5	6	7	8	9	10
KU4	Industry's support in enrichment activities with IHL has the ability to foster working relationship between students & industry before graduation	1	2	3	4	5	6	7	8	9	10
KU5	Industry's support in enrichment activities with IHL has the ability to provide opportunity to field engineer(s) to share aspiration, knowledge & skills of own industry to students	1	2	3	4	5	6	7	8	9	10
KU6	Industry's support on enrichment activities with IHL has the ability to influence inclusion of specific skills/training into programme of study as value added to students	1	2	3	4	5	6	7	8	9	10
KU7	Industry's support on enrichment activities with IHL has the ability to influence exposure of industrial skills (e.g. PMP, 6σ, 5S, CISCO, PLC, TRIZ. etc) for students while in pursuit of the	1	2	3	4	5	6	7	8	9	10

	course of study.										
KU8	Industry's support on enrichment activities with IHL able students to make baseline assessment of current practice towards that being pursuit in the programme of study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
KU9	Industry's support on enrichment activities with IHL able to provide insight of operational, actual equipment and technologies used in worksites to supplement class room knowledge	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
KU10	Industry's support on enrichment activities with IHL able to boast respect and appreciation of role of engineers towards society and development to sustain students interest	1	2	3	4	5	6	7	8	9	10

Section 4: Intellectual Enhancement

This scope seeks perspective on industry of its involvement of supporting project design and development that stimulates scholarly and publication activities with undergraduate level. Please indicate how strongly you agree or disagree with the statements. You can mark your sincere response anywhere from 1 to 10; Score 1 indicates Strongly Disagree, while Score 10 indicates Strongly Agree. Please circle only **one response per statement**											
NO	**Statement**	**Strongly Disagree**									**Strongly Agree**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE1	Industry's support in intellectual enhancement via ideas/projects has the ability to establish working ties with academia	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE2	Industry's support in intellectual enhancement has the ability to advice IHL of knowledge/technologies of tackling real world issues	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE3	Industry's support in enhancement has the ability to provide opportunity for open communication channel between stakeholders (student, staff and industry)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE4	Industry's support in intellectual enhancement has the ability to engage students/educators in projects/knowledge in providing solution to address design issues	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE5	Industry's support in intellectual enhancement on partial mentoring on projects able to gauge students talent/strength as feedback to IHL	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE6	Industry's support in intellectual enhancement such as capstone-projects has the ability to harness student's transferable skills.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE7	Industry's support in intellectual enhancement with IHL able to provide students insights of design, integration & practice culture in engineering jobs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IE8	Industry's support in intellectual enhancement with IHL has the ability to provide students the value of	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

	meeting customer satisfaction as a comprehensive outcome										
PB1	Industry's support in intellectual enhancement with IHL has the ability of harnessing ideas/projects outcomes into joint academic publication(s) at conference	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PB2	Industry's support in intellectual enhancement with IHL has the ability to sustain continuous learning mind-set as a result of joint discovery work	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PB3	Industry's support in intellectual enhancement with IHL has the ability to expose journal familiarity and its constraints on novelty approach among field engineers(industry)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PB4	Industry's support in intellectual enhancement has the ability to foster networking on specific field of expertise via conference related activities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PB5	Industry's involvement in intellectual enhancement has the ability to boast confidence to joint academic publication with educators	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Section 5: Sustain Partnership

This scope seeks perspective of industry on justification towards maintaining a working partnership with academia (IHL) especially in academic development domains. Please indicate how strongly you agree or disagree with the statements. You can mark your sincere response anywhere from 1 to 10; Score 1 indicates Strongly Disagree, while Score 10 indicates Strongly Agree.Please circle only **one response per statement**

NO	**Statement**	**Strongly Disagree**									**Strongly Agree**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BT1	Sustaining partnership with IHL has the ability to tap on a constant source of talent pool for the organization.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BT2	Sustaining partnership with IHL has the ability on gaining confidence of securing work savvy graduates.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BT3	Sustaining partnership with IHL has the ability to tap on specific skill/talents (SCADA, PLC, 6σ, PMP, etc) that meets specific need of industry.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BT4	Sustaining partnership with IHL has the ability for talents hired to utilize innovative tool and technologies in meeting customers aspiration	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BT5	Sustaining partnership with IHL has the ability to promote recruitment drive of graduates needs through academia portals/websites.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BT6	Sustaining partnership with IHL has the ability for talents of new hires to understand the cultural expectation and organizational pressure of job vacancies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PP1	Sustaining partnership with IHL has the ability to promote expertise of similar interest to collaborate effectively	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PP2	Sustaining partnership with IHL has the ability to allows products developed of technological innovation to be introduced as teaching aid for students	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

PP3	Sustaining partnership with IHL has the ability to influence field engineer to conduct training for both student and educators on product	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PP4	Sustaining partnership with IHL has the ability to potentially assist on setting of work/lab environment on promotion of products sponsored/sold to IHL	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SO1	Sustaining partnership with IHL has the ability to boost image (industry's) on socially responsible towards promoting excellence in engineering education	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SO2	Sustaining partnership with IHL has the ability to boost reputation of its field engineers to collaborate with other IHL on academic publications	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SO3	Sustaining partnership with IHL has the ability to influence offering of bursary/grants scholarships/assistance as part of social obligation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SO4	Sustaining partnership with IHL has the ability to drive on exploration of future commercialization joint ventures	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Section 6: Improvement

This scope seeks perspective of industry towards improvement activities as a result of strong partnership with academia on a mutually beneficial manner. Please indicate how strongly you agree or disagree with the statements. You can mark your sincere response anywhere from 1 to 10; Score 1 indicates Strongly Disagree, while Score 10 indicates Strongly Agree.Please circle only **one response per statement**											
NO	**Statement**	**Strongly Disagree**									**Strongly Agree**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
WQ 1	Strong partnership has the ability to improve on work quality of talents hired from source of partnership	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
WQ 2	Strong partnership has the ability to improve on matters meeting customer's deliverables in a satisfactory level	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
WQ 3	Strong partnership has the ability to improve on attracting clients as marketing initiatives due to quality of graduates from source of partnership	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
WQ 4	Strong partnership has the ability to improve in innovating new product /design for business growth of industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
WQ 5	Strong partnership has the ability to improve on demonstrating transferable skills of satisfactory level at workplace	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
WQ 6	Strong partnership has the ability to reduce re-skilling and re-training programme of graduates on new hire	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EO1	Strong partnership has the ability to improve deficiencies of knowledge and competence graduates for the workforce	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EO2	Strong partnership has the ability to improve in providing quality graduates from quality education system	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EO3	Strong partnership has the ability to improve knowledge of community of educators on latest technology and	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

	trends in industry.										
EO4	Strong partnership has the ability to improve on employability of graduates joining the workforce	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EO5	Strong partnership has the ability to improve educational ranking of IHL as marketing initiative	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EO6	Strong partnership has the ability to improve on accreditation evaluation of programme(s)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

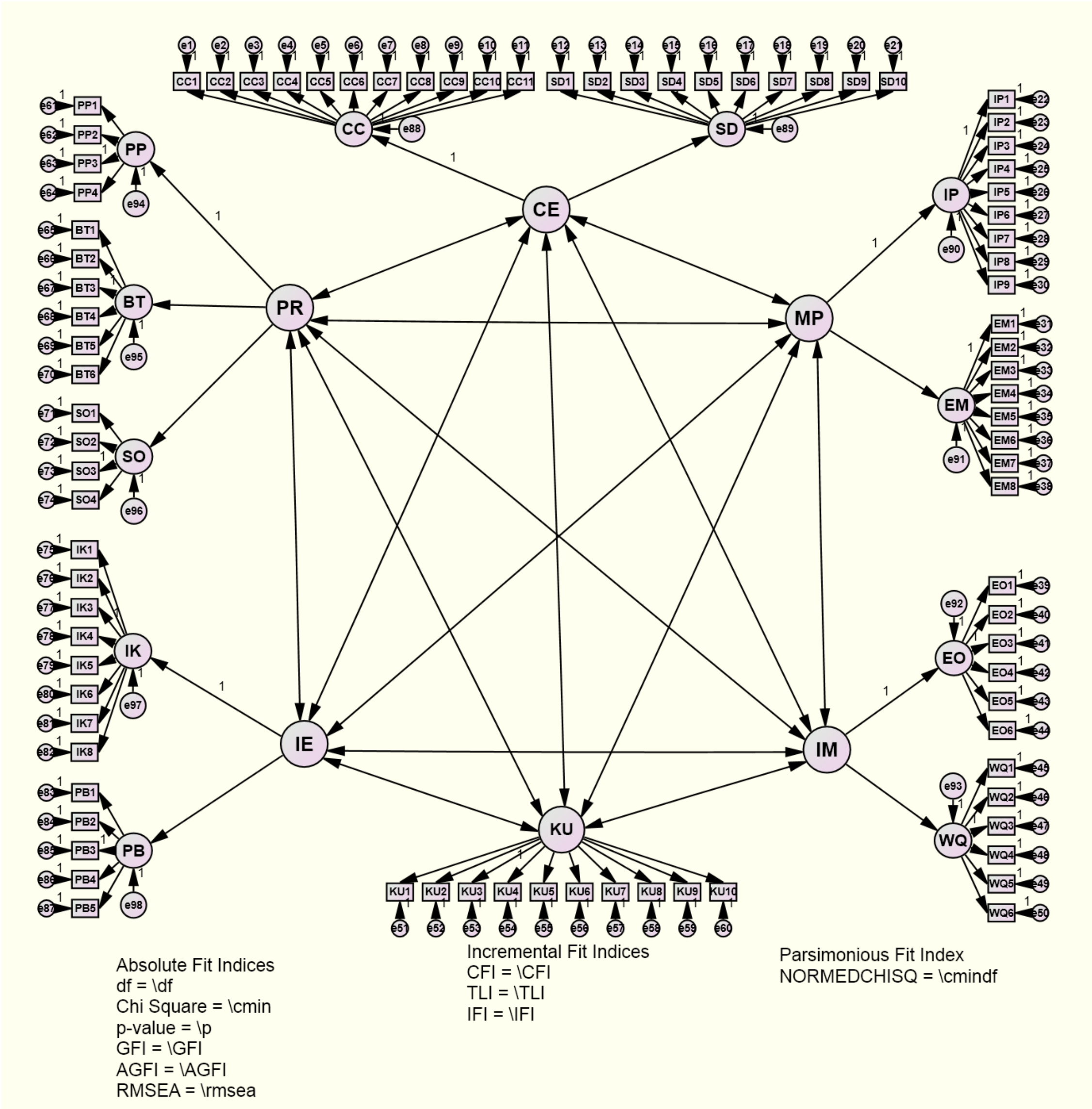
Thank you for participating in this session

Company Stamp/Respondent Stamp:

……
…

APPENDIX B

All exogenous and endogenous variables together with their relative estimation errors (87 items)



APPENDIX C

Observations farthest from the centroid (Mahalanobis distance)

Number of variables in the model = 202

Max (D^2) / (no. variables) = 140.393 / 202 = 0.695 which is < 3.5 → No Multivariate Outliers

Observation number	Mahalanobis d-squared	p1	p2
43	140.393	.000	.052
206	132.693	.001	.026
62	126.492	.004	.044
93	125.268	.005	.017
65	124.880	.005	.004
167	122.063	.008	.007
94	121.442	.009	.003
121	121.394	.009	.001
48	120.508	.010	.000
57	119.997	.011	.000
53	117.864	.015	.001
31	116.006	.021	.002
86	115.792	.021	.001
55	109.417	.052	.225
69	109.348	.053	.156
96	109.198	.054	.112
28	108.526	.059	.124
24	108.017	.063	.123
188	107.222	.070	.158
71	107.149	.070	.112
46	107.045	.071	.080
128	106.836	.073	.063
10	105.836	.083	.112
124	105.826	.083	.075
42	105.820	.083	.048

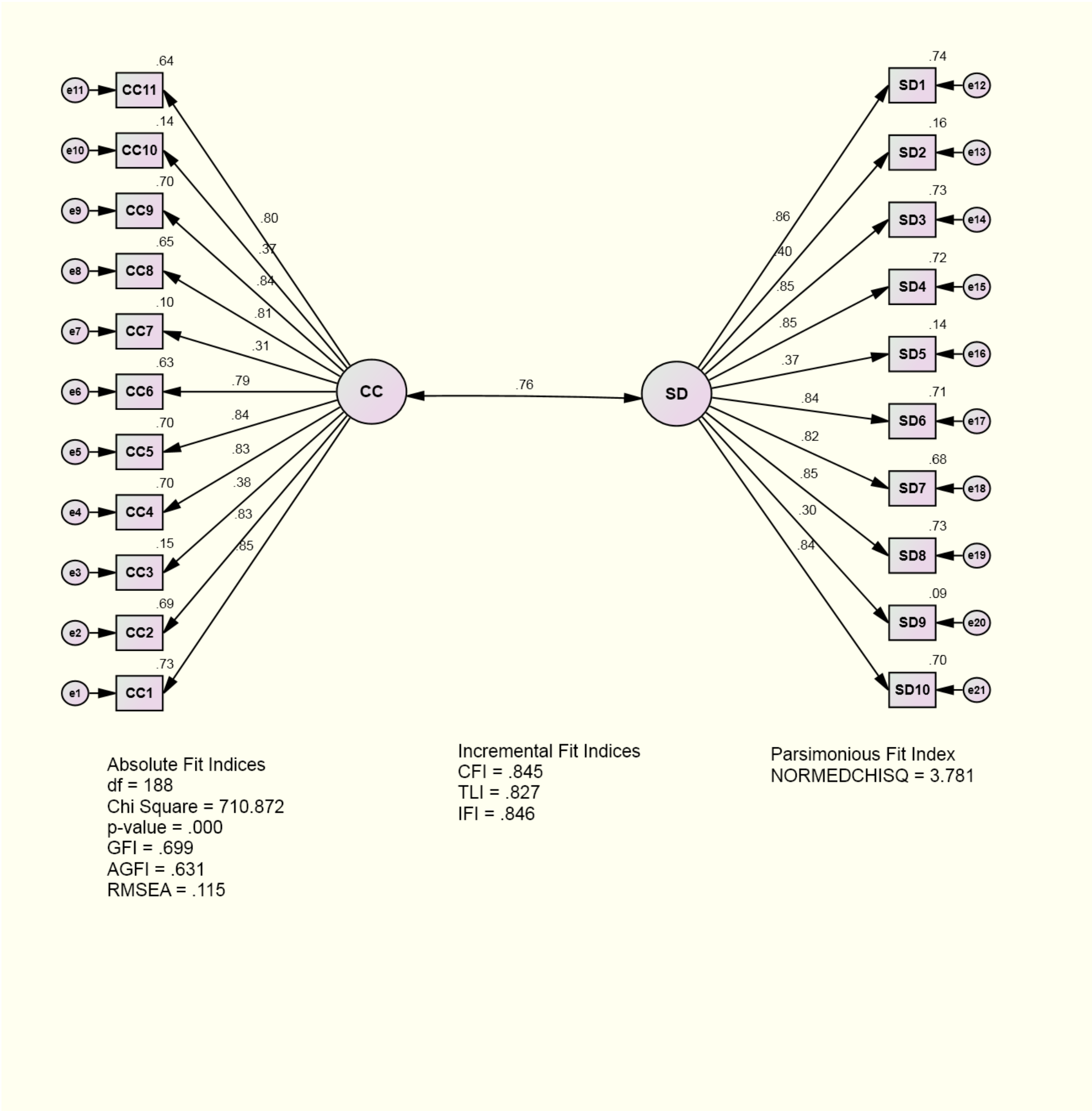
Observation number	Mahalanobis d-squared	p1	p2
29	105.396	.087	.050
37	105.208	.089	.040
6	105.194	.090	.025
74	105.023	.091	.019
155	104.216	.101	.036
25	102.125	.128	.240
2	102.062	.129	.194
184	101.482	.137	.246
148	101.205	.142	.242
19	101.038	.144	.218
177	100.171	.158	.348
40	98.499	.188	.716
147	98.370	.190	.685
209	98.197	.194	.664
77	98.129	.195	.617
127	97.970	.198	.593
162	97.859	.200	.556
142	97.727	.203	.525
14	97.623	.205	.487
179	97.576	.206	.433
16	97.498	.207	.390
47	97.345	.210	.368
4	96.706	.224	.487
92	96.621	.225	.447
39	96.604	.226	.388
34	96.536	.227	.346
64	96.276	.233	.358
33	96.068	.237	.357
207	96.022	.238	.312
158	95.076	.260	.529
13	95.000	.261	.490

Observation number	Mahalanobis d-squared	p1	p2
154	94.658	.269	.533
50	94.654	.270	.473
11	93.532	.297	.745
17	93.070	.308	.809
104	92.852	.314	.815
133	92.800	.315	.785
152	92.244	.330	.862
67	92.183	.332	.839
156	92.126	.333	.813
8	91.962	.337	.809
81	91.347	.354	.891
122	91.244	.357	.879
60	90.940	.365	.899
44	90.790	.369	.895
23	90.752	.370	.874
21	90.532	.377	.881
72	90.516	.377	.854
5	90.459	.379	.831
56	90.440	.379	.796
90	90.406	.380	.763
178	90.316	.383	.741
82	90.268	.384	.708
157	90.218	.385	.672
194	90.021	.391	.682
1	89.923	.394	.660
52	89.815	.397	.642
176	89.791	.398	.597
192	89.272	.412	.708
205	88.986	.421	.743
181	88.833	.425	.740
3	88.818	.426	.698

Observation number	Mahalanobis d-squared	p1	p2
141	88.808	.426	.651
114	88.501	.435	.696
59	88.421	.437	.671
164	87.959	.451	.760
129	87.958	.451	.715
12	87.706	.459	.742
193	87.526	.464	.748
41	87.486	.465	.714
109	87.452	.466	.677
204	87.359	.469	.656
182	87.099	.477	.689
187	87.051	.478	.655
174	86.947	.481	.637

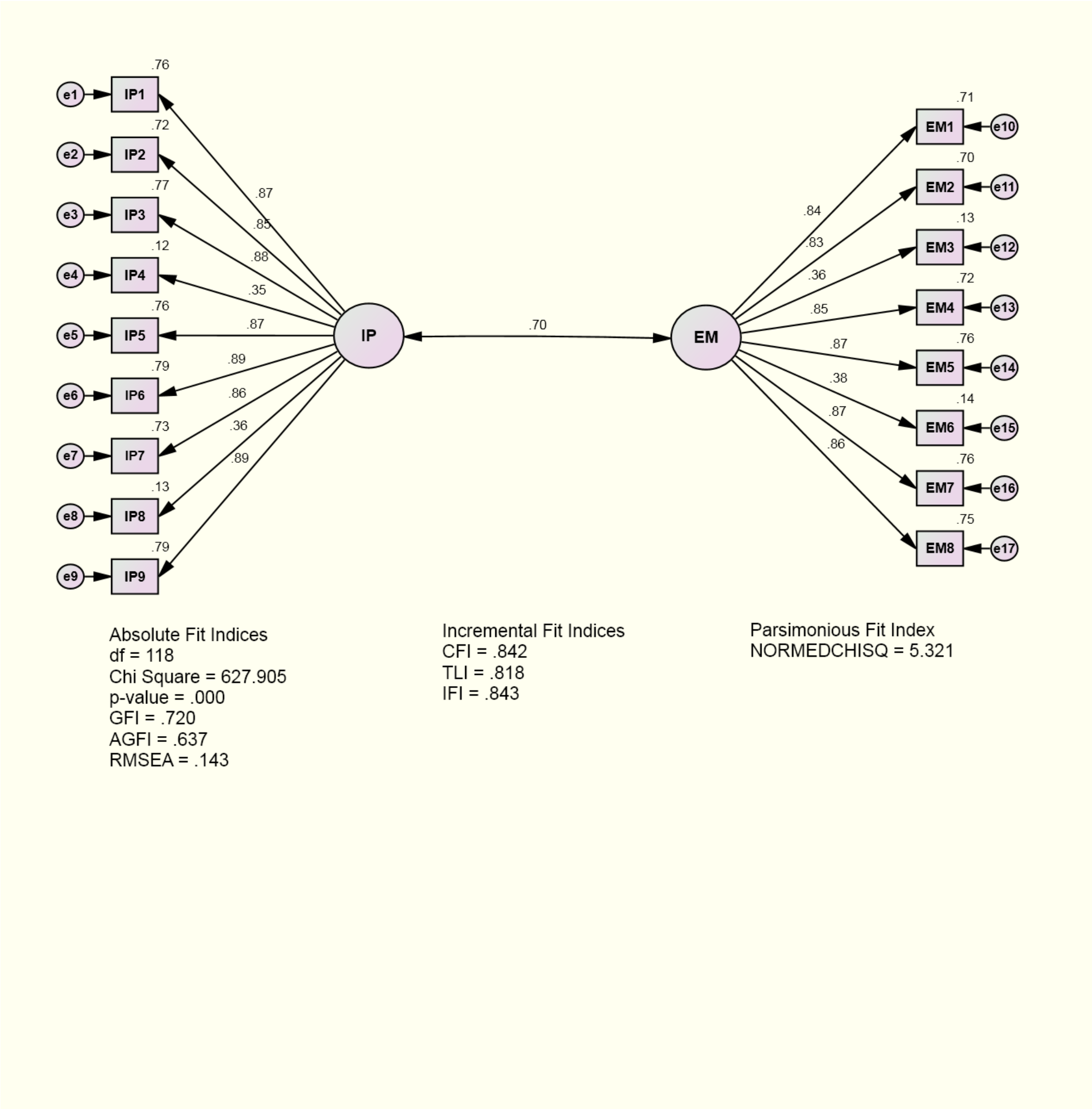
APPENDIX D

Initial First CFA model for Cooperation in Education with all 21 items



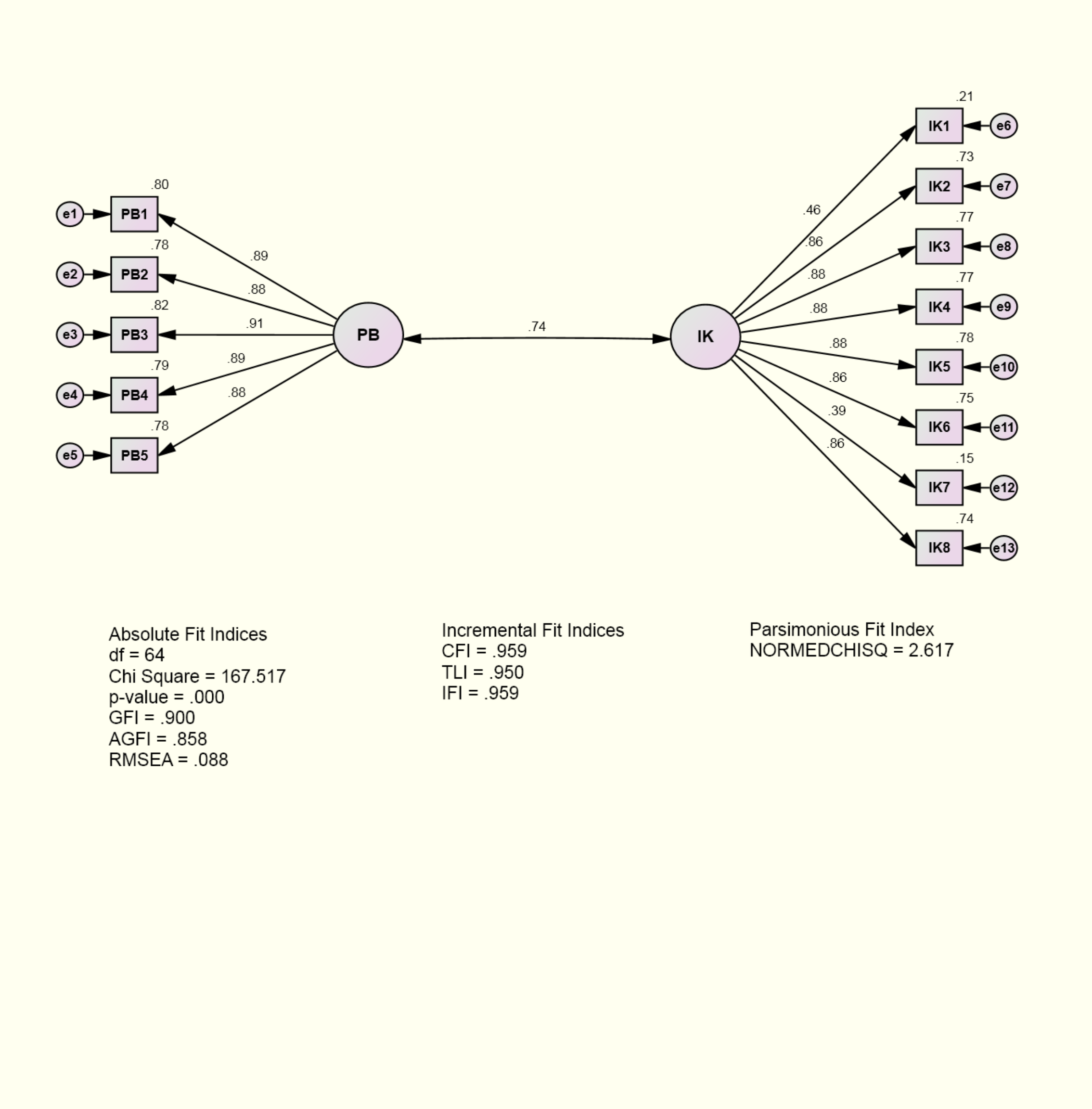
APPENDIX E

Initial First CFA model for Mobility of People with all 17 items



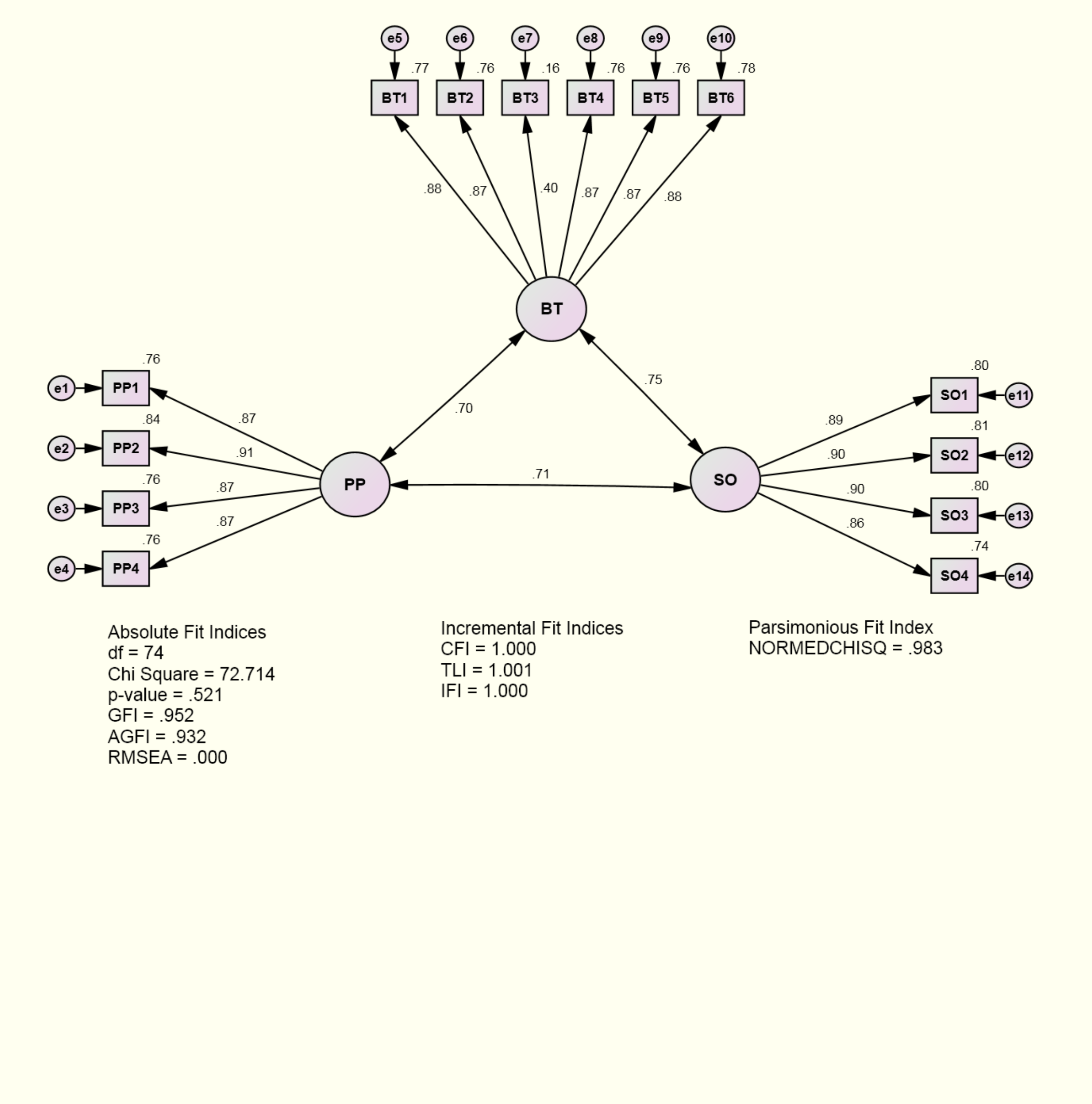
APPENDIX F

Initial First CFA model for Intellectual Enhancement with all 13 items



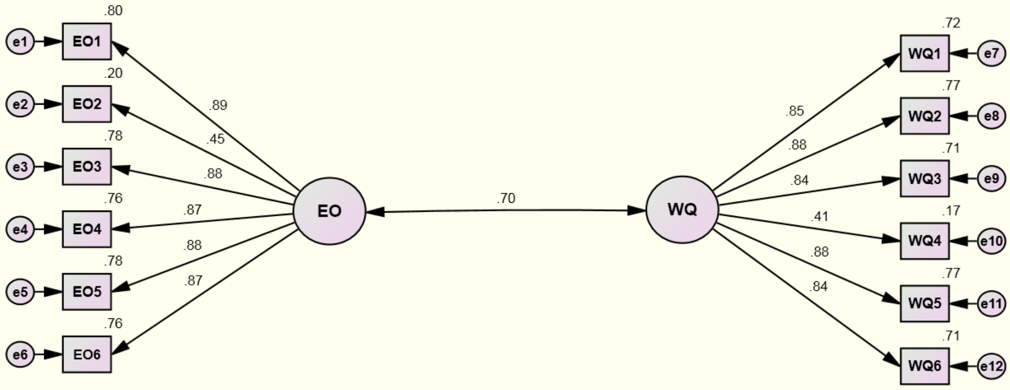
APPENDIX G

Initial First CFA model for Partnership with all 14 items



APPENDIX H-1

Initial First CFA model for Improvement with all 12 items



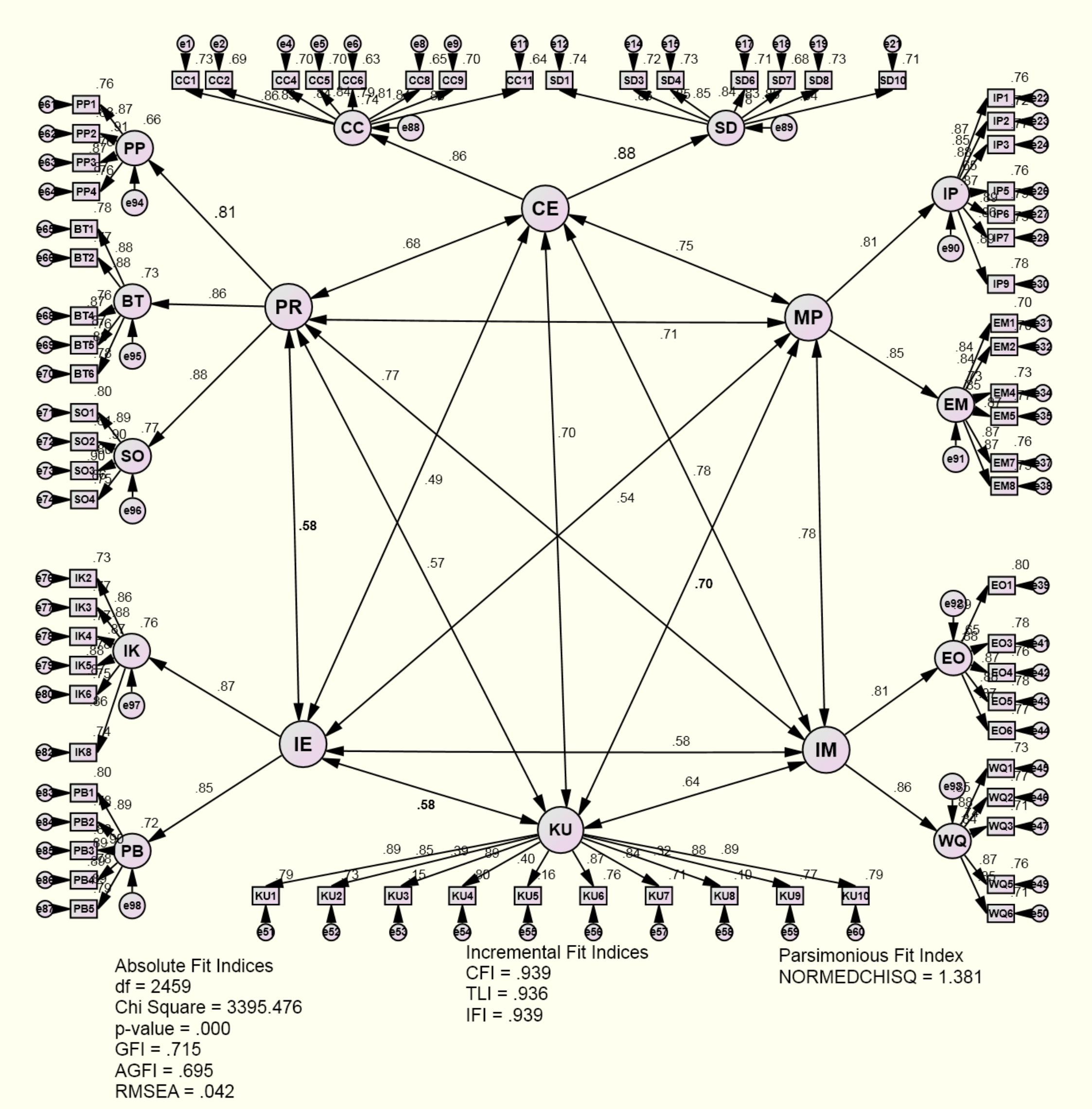
Absolute Fit Indices
df = 53
Chi Square = 192.518
p-value = .000
GFI = .895
AGFI = .846
RMSEA = .112

Incremental Fit Indices
CFI = .935
TLI = .919
IFI = .935

Parsimonious Fit Index
NORMEDCHISQ = 3.632

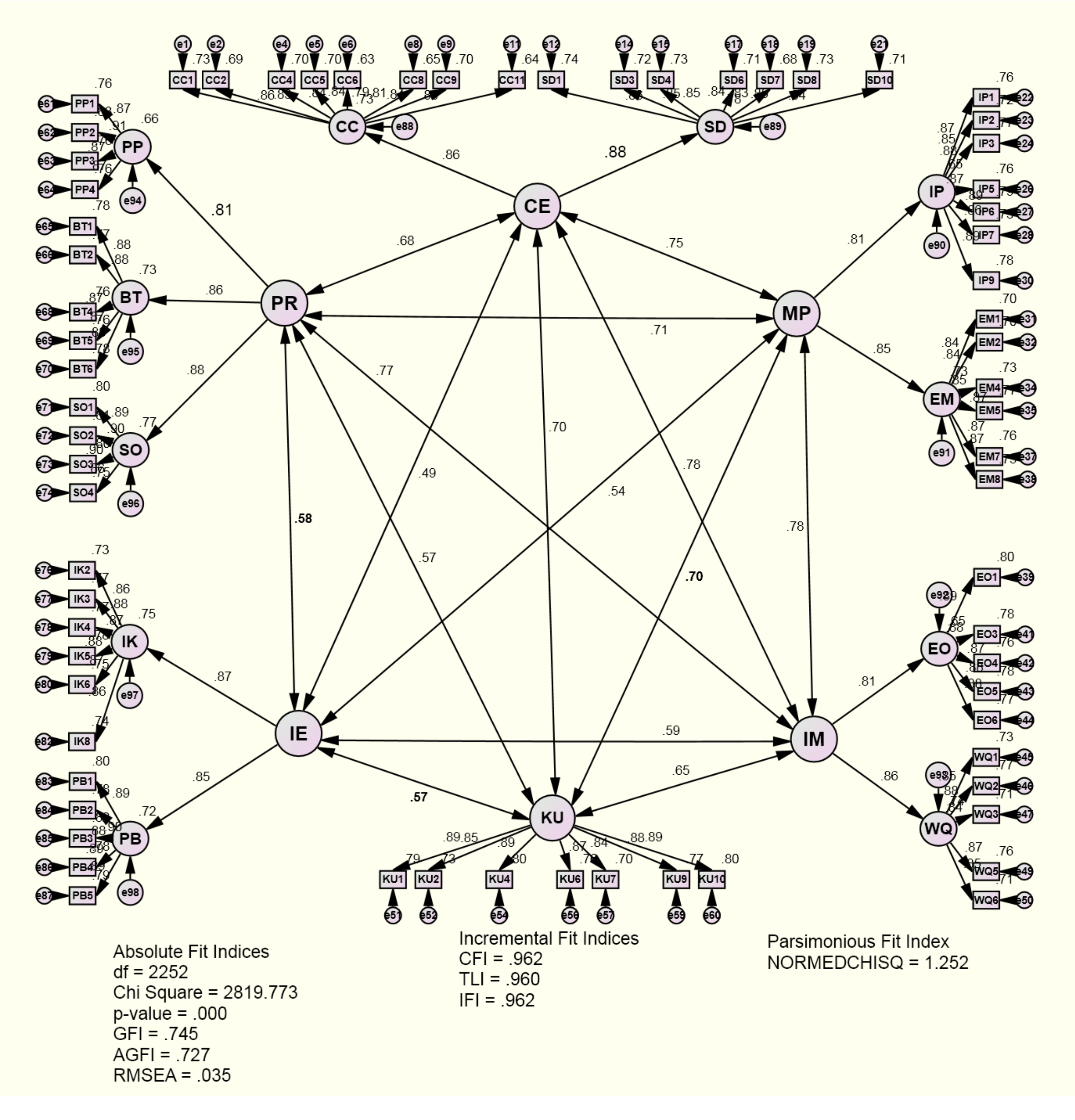
APPENDIX H-2

Initial First Overall Measurement Model



APPENDIX H-3

Initial Second Overall Measurement Model after discarding 3 items with insufficient factor loadings below 0.5



APPENDIX J-1

Result of Univariate Outlier Based on Standardized values

Construct	*Item*	**Standardized value (Z-Score)**	
		Lower Bound	**Upper Bound**
Curriculum Content Development (CC)	CC1	-2.125	1.879
	CC2	-3.074	2.098
	CC3	-3.222	1.607
	CC4	-2.858	1.902
	CC5	-2.963	1.922
	CC6	-3.047	1.955
	CC7	-3.141	1.653
	CC8	-2.947	2.057
	CC9	-2.772	1.973
	CC10	-2.835	1.573
	CC11	-2.972	2.051
Skills Dialogues (SD)	SD1	-2.711	1.908
	SD2	-2.686	1.675
	SD3	-2.713	1.899
	SD4	-2.843	1.903
	SD5	-2.660	1.580
	SD6	-2.830	1.997
	SD7	-2.776	1.863
	SD8	-2.050	1.931
	SD9	-3.053	1.671
	SD10	-2.820	1.820
Internship Programme (IP)	IP1	-2.766	1.872
	IP2	-2.661	1.957
	IP3	-2.896	1.750
	IP4	-2.670	1.676
	IP5	-2.703	1.860
	IP6	-3.221	1.786
	IP7	-3.668	1.896
	IP8	-2.638	1.539
	IP9	-3.879	1.707
Graduate Employment (EM)	EM1	-2.980	2.051
	EM2	-2.683	1.469
	EM3	-2.855	1.976
	EM4	-2.991	1.914
	EM5	-2.923	1.945
	EM6	-2.697	1.599
	EM7	-2.938	1.950
	EM8	-2.780	1.794
Idea on New Projects/Knowledge(IK)	IK1	-3.052	1.859
	IK2	-2.723	1.859
	IK3	-1.632	1.691
	IK4	-2.621	1.871
	IK5	-1.618	1.699
	IK6	-2.529	1.805
	IK7	-3.250	1.812
	IK8	-2.522	1.880
Academic Publications (PB)	PB1	-2.613	1.881
	PB2	-2.457	1.905
	PB3	-3.135	1.792
	PB4	-2.390	2.048

	PB5	-2.176	1.980
Promote Product/Expertise (PP)	PP1	-2.092	1.922
	PP2	-2.688	1.871
	PP3	-2.171	2.045
	PP4	-3.054	1.570
Best Fit Talent (BT)	BT1	-2.870	1.889
	BT2	-2.063	1.925
	BT3	-2.673	2.033
	BT4	-2.075	2.196
	BT5	-2.032	2.144
	BT6	-2.605	2.047
Social Obligation & Opportunities (SO)	SO1	-2.126	2.009
	SO2	-2.714	1.894
	SO3	-2.069	2.005
	SO4	-2.752	2.036
Educational Outcomes(EO)	EO1	-2.841	1.939
	EO2	-2.268	2.184
	EO3	-2.989	1.498
	EO4	-2.905	2.028
	EO5	-2.178	2.019
	EO6	-2.791	1.910
Work Quality (WQ)	WQ1	-2.777	2.060
	WQ2	-2.659	1.978
	WQ3	-2.720	2.097
	WQ4	-2.783	2.098
	WQ5	-2.754	1.869
	WQ6	-2.898	1.522
Knowledge Up-Graduation (KU)	KU1	-2.138	1.964
	KU2	-2.728	1.801
	KU3	-2.218	1.918
	KU4	-2.824	1.828
	KU5	-2.501	2.150
	KU6	-2.337	2.041
	KU7	-2.956	2.145
	KU8	-3.079	1.636
	KU9	-2.927	2.118
	KU10	-2.880	1.906

APPENDIX J-2

Assessment of Normality for Measurement Model

Construct	Item	Skewness	c.r.	Kurtosis	c.r.	Distribution Statues
Curriculum Content Development (CC)	CC1	-0.155	-0.922	-0.396	-1.178	Normal
	CC2	-0.155	-0.921	0.099	0.294	Normal
	CC3	-0.421	-2.501	0.03	0.09	Normal
	CC4	-0.299	-1.78	-0.448	-1.33	Normal
	CC5	-0.155	-0.921	-0.25	-0.743	Normal
	CC6	-0.207	-1.23	-0.323	-0.96	Normal
	CC7	-0.396	-2.357	0.266	0.79	Normal
	CC8	-0.386	-2.294	-0.184	-0.546	Normal
	CC9	-0.128	-0.762	-0.345	-1.025	Normal
	CC10	-0.395	-2.346	-0.309	-0.917	Normal
	CC11	-0.317	-1.884	-0.229	-0.679	Normal
Skills Dialogues (SD)	SD1	-0.291	-1.728	-0.178	-0.528	Normal
	SD2	-0.331	-1.97	-0.407	-1.208	Normal
	SD3	-0.331	-1.965	-0.341	-1.013	Normal
	SD4	-0.132	-0.782	-0.235	-0.699	Normal
	SD5	-0.342	-2.035	-0.487	-1.447	Normal
	SD6	-0.237	-1.411	-0.234	-0.696	Normal
	SD7	-0.157	-0.932	-0.386	-1.146	Normal
	SD8	-0.144	-0.858	-0.649	-1.93	Normal
	SD9	-0.333	-1.981	-0.412	-1.224	Normal
	SD10	-0.122	-0.728	-0.65	-1.933	Normal
Internship Programme (IP)	IP1	-0.331	-1.97	-0.145	-0.43	Normal
	IP2	-0.318	-1.89	-0.048	-0.142	Normal
	IP3	-0.357	-2.123	0.065	0.193	Normal
	IP4	-0.316	-1.88	-0.596	-1.77	Normal
	IP5	-0.373	-2.218	-0.355	-1.056	Normal
	IP6	-0.128	-0.761	-0.501	-1.488	Normal
	IP7	-0.371	-2.207	0.135	0.402	Normal
	IP8	-0.382	-2.273	-0.715	-2.124	Normal
	IP9	-0.41	-2.438	0.304	0.903	Normal
Graduate Employment (EM)	EM1	-0.167	-0.994	0.044	0.132	Normal
	EM2	-0.333	-1.98	-0.112	-0.333	Normal
	EM3	-0.414	-2.461	-0.665	-1.976	Normal
	EM4	-0.304	-1.805	-0.022	-0.066	Normal
	EM5	-0.262	-1.56	-0.151	-0.448	Normal
	EM6	-0.295	-1.754	-0.716	-2.127	Normal
	EM7	-0.203	-1.205	-0.215	-0.638	Normal
	EM8	-0.267	-1.585	-0.122	-0.364	Normal
Idea on New Projects/Knowledge(IK)	IK1	-0.424	-2.519	0.181	0.538	Normal
	IK2	0.002	0.011	-0.543	-1.614	Normal
	IK3	-0.144	-0.857	-0.739	-2.195	Normal
	IK4	-0.031	-0.183	-0.864	-2.569	Normal
	IK5	-0.159	-0.948	-0.72	-2.14	Normal
	IK6	0	0	-0.687	-2.041	Normal
	IK7	-0.345	-2.054	-0.383	-1.138	Normal
	IK8	-0.055	-0.328	-0.469	-1.394	Normal
Academic Publications (PB)	PB1	-0.035	-0.207	-0.399	-1.187	Normal
	PB2	-0.011	-0.068	-0.517	-1.538	Normal
	PB3	0.089	0.532	-0.612	-1.819	Normal
	PB4	0.054	0.323	-0.28	-0.832	Normal
	PB5	-0.123	-0.73	-0.58	-1.723	Normal
Promote Product/Expertise	PP1	-0.083	-0.493	-0.681	-2.024	Normal
	PP2	-0.265	-1.575	-0.379	-1.126	Normal

(PP)	PP3	0.026	0.152	-0.577	-1.715	Normal
	PP4	-0.05	-0.297	-0.463	-1.377	Normal
Best Fit Talent (BT)	BT1	-0.27	-1.606	-0.356	-1.057	Normal
	BT2	-0.022	-0.128	-0.808	-2.402	Normal
	BT3	-0.509	-3.026	-0.327	-0.971	Normal
	BT4	-0.307	-1.826	-0.251	-0.746	Normal
	BT5	0.113	0.669	-0.391	-1.161	Normal
	BT6	-0.104	-0.618	-0.623	-1.853	Normal
Social Obligation & Opportunities (SO)	SO1	-0.183	-1.09	-0.532	-1.58	Normal
	SO2	-0.057	-0.34	-0.556	-1.652	Normal
	SO3	-0.234	-1.389	-0.689	-2.048	Normal
	SO4	-0.109	-0.648	-0.259	-0.769	Normal
Educational Outcomes(EO)	EO1	-0.437	-2.598	-0.176	-0.523	Normal
	EO2	-0.341	-2.029	-0.382	-1.135	Normal
	EO3	-0.167	-0.992	-0.718	-2.134	Normal
	EO4	-0.142	-0.843	-0.598	-1.776	Normal
	EO5	-0.129	-0.77	-0.647	-1.923	Normal
	EO6	-0.087	-0.519	-0.569	-1.69	Normal
Work Quality (WQ)	WQ1	-0.175	-1.039	-0.027	-0.081	Normal
	WQ2	-0.358	-2.127	-0.478	-1.421	Normal
	WQ3	-0.179	-1.066	-0.077	-0.229	Normal
	WQ4	-0.308	-1.83	-0.374	-1.112	Normal
	WQ5	-0.163	-0.97	-0.193	-0.575	Normal
	WQ6	-0.216	-1.286	-0.238	-0.706	Normal
Knowledge Up-Graduation (KU)	KU1	-0.126	-0.748	-0.31	-0.922	Normal
	KU2	-0.032	-0.189	-0.639	-1.9	Normal
	KU3	-0.216	-1.281	-0.328	-0.975	Normal
	KU4	-0.082	-0.486	-1.089	-3.238	Normal
	KU5	-0.156	-0.93	-0.593	-1.762	Normal
	KU6	0.028	0.165	-1.16	-3.448	Normal
	KU7	-0.124	-0.739	-0.64	-1.901	Normal
	KU8	-0.204	-1.215	-0.307	-0.912	Normal
	KU9	-0.234	-1.393	-0.782	-2.323	Normal
	KU10	-0.276	-1.642	-0.538	-1.598	Normal

APPENDIX J-3

Discarded Items Due to Insufficient Factor Loadings in Cooperation in Education CFA Model

Construct	***Item***	**First Factor Loading**	**Item Deleted**	**Second Factor Loading**
Curriculum Content Development (CC)	CC1	0.851		0.856
	CC2	0.831		0.831
	CC3	0.383	Deleted	
	CC4	0.834		0.836
	CC5	0.838		0.836
	CC6	0.791		0.792
	CC7	0.311	Deleted	
	CC8	0.807		0.808
	CC9	0.837		0.837
	CC10	0.374	Deleted	
	CC11	0.803		0.804
Skills Dialogues (SD)	SD1	0.86		0.86
	SD2	0.396	Deleted	
	SD3	0.854		0.856
	SD4	0.846		0.844
	SD5	0.373	Deleted	
	SD6	0.841		0.844
	SD7	0.822		0.824
	SD8	0.852		0.856
	SD9	0.302	Deleted	
	SD10	0.839		0.839

APPENDIX J-4

Discarded Items Due to Insufficient Factor Loadings in Mobility of People CFA Model

Construct	*Item*	First Factor Loading	Item Deleted	Second Factor Loading
Internship Programme (IP)	IP1	0.87		0.87
	IP2	0.847		0.848
	IP3	0.875		0.876
	IP4	0.352	Deleted	
	IP5	0.87		0.873
	IP6	0.887		0.888
	IP7	0.857		0.856
	IP8	0.356	Deleted	
	IP9	0.887		0.885
Graduate Employment (EM)	EM1	0.84		0.836
	EM2	0.834		0.837
	EM3	0.364	Deleted	
	EM4	0.851		0.853
	EM5	0.873		0.873
	EM6	0.38	Deleted	
	EM7	0.872		0.873
	EM8	0.864		0.868

APPENDIX J-5

Discarded Items Due to Insufficient Factor Loadings in Intellectual Enhancement CFA Model

Construct	*Item*	First Factor Loading	Item Deleted	Second Factor Loading
Idea on New Projects/Knowledge(IK)	IK1	0.457	Deleted	
	IK2	0.856		0.853
	IK3	0.88		0.878
	IK4	0.877		0.877
	IK5	0.881		0.882
	IK6	0.864		0.865
	IK7	0.392	Deleted	
	IK8	0.858		0.863
Academic Publications (PB)	PB1	0.894		0.894
	PB2	0.885		0.885
	PB3	0.906		0.906
	PB4	0.886		0.886
	PB5	0.885		0.885

APPENDIX J-6

Discarded Items Due to Insufficient Factor Loadings in Partnership CFA Model

Construct	*Item*	**First Factor Loading**	**Item Deleted**	**Second Factor Loading**
Promote Product/Expertise (PP)	PP1	0.871		0.871
	PP2	0.914		0.914
	PP3	0.871		0.871
	PP4	0.872		0.871
Best Fit Talent (BT)	BT1	0.88		0.881
	BT2	0.874		0.875
	BT3	0.399	Deleted	
	BT4	0.873		0.871
	BT5	0.871		0.871
	BT6	0.883		0.883
Social Obligation & Opportunities (SO)	SO1	0.894		0.894
	SO2	0.901		0.901
	SO3	0.896		0.896
	SO4	0.863		0.862

APPENDIX J-7

Discarded Items Due to Insufficient Factor Loadings in Improvement CFA Model

Construct	*Item*	**First Factor Loading**	**Item Deleted**	**Second Factor Loading**
Educational Outcomes(EO)	EO1	0.892		0.893
	EO2	0.447	Deleted	
	EO3	0.884		0.884
	EO4	0.874		0.874
	EO5	0.881		0.883
	EO6	0.873		0.872
Work Quality (WQ)	WQ1	0.847		0.848
	WQ2	0.88		0.88
	WQ3	0.843		0.841
	WQ4	0.414	Deleted	
	WQ5	0.879		0.879
	WQ6	0.842		0.844

APPENDIX K

Calculation for Priority Vector for industry sector

K-1(a-f): Power Electrical Sectors

TABLE 1: Pair-wise rating of selection domain

Domain	CE	MP	KU	IE
CE	1	9	9	9
MP	0.111111	1	0.1250	0.1111
KU	0.111111	8	1	9
IE	0.111111	9	0.111111	1
∑	**1.333333**	**27**	**10.2361**	**19.1111**

Table 2: Normalized pair-wise rating of selection domain

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.7500	0.333333	0.87924	0.47093	2.4335	0.608376	**0.73274**
MP	0.083333	0.0370	0.012212	0.005814	0.1384	0.034599	**0.05557**
KU	0.083333	0.296296	0.097693	0.47093	0.9483	0.237063	**0.1406**
IE	0.083333	0.333333	0.010855	0.052326	0.4798	0.119962	**0.07108**
∑	1.0000	1.000	1.0000	1.0000			

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**9**	**9**	**9**	8	8
IP	0.111111	1	8	8	8	8
SLA	0.111111	0.125	1	8	8	8
STP	0.111111	0.125	0.125	1	0.1111	0.1111
PA	0.125	0.125	0.125	9	1	9.0000
CW	0.125	0.125	0.125	9	0.111111	1
∑	**1.5833**	**10.5000**	**18.3750**	**44.0000**	25.2222	34.1111

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.631579	0.857143	0.489796	0.204545	0.317181	0.234528	2.734771	0.4558	**0.598725**
IP	0.070175	0.095238	0.435374	0.181818	0.317181	0.234528	1.334314	0.2224	**0.16506**
SLA	0.070175	0.011905	0.054422	0.181818	0.317181	0.234528	0.870028	0.1450	**0.091288**
STP	0.070175	0.011905	0.006803	0.022727	0.004405	0.003257	0.119273	0.0199	**0.146528**
PA	0.078947	0.011905	0.006803	0.204545	0.039648	0.263844	0.605692	0.1009	**0.062458**
CW	0.078947	0.011905	0.006803	0.204545	0.004405	0.029316	0.335922	0.0560	**0.04577**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1429	0.1667	0.2500
MP	7.00035	1	8.0000	7.0000
KU	6.00024	0.125	1	6
IE	4	0.142857	0.166667	1
∑	**18.00059**	**1.410707**	**9.3333**	**14.2500**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0556	0.101261	0.017856	0.017544	0.1922	0.048054	**0.07064**
MP	0.388896	0.7089	0.857143	0.491228	2.4461	0.611533	**0.70632**
KU	0.333336	0.088608	0.107143	0.421053	0.9501	0.237535	**0.13897**
IE	0.222215	0.101266	0.017857	0.070175	0.4115	0.102878	**0.08407**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.1250	0.1250	0.1428	5	0.16666
IP	8	1	8	8	8	8
SLA	8	0.125	1	8	8	8
STP	7.002801	0.125	0.125	1	6	0.200
PA	0.200	0.125	0.125	0.166667	1	0.2000
CW	6.00024	0.125	0.125	5	5	1
∑	**30.2030**	**1.6250**	**9.5000**	**22.3095**	33.0000	17.5667

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.033109	0.076923	0.013158	0.006401	0.151515	0.009487	0.290594	0.0484	**0.045947**
IP	0.264874	0.615385	0.842105	0.358592	0.242424	0.455408	2.778788	0.4631	**0.602956**
SLA	0.264874	0.076923	0.105263	0.358592	0.242424	0.455408	1.503485	0.2506	**0.168939**
STP	0.231857	0.076923	0.013158	0.044824	0.181818	0.011385	0.559966	0.0933	**0.351978**
PA	0.006622	0.076923	0.013158	0.007471	0.030303	0.011385	0.145862	0.0243	**0.042046**
CW	0.198663	0.076923	0.013158	0.22412	0.151515	0.056926	0.721306	0.1202	**0.079988**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.2000	0.1428
MP	7.002801	1	0.2000	7.0000
KU	5	5	1	0.2000
IE	7.002801	0.142857	5	1
∑	20.0056	6.285657	6.4000	8.3428

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0500	0.022718	0.03125	0.017117	0.1211	0.030268	0.02437
MP	0.350042	0.1591	0.03125	0.839047	1.3794	0.344858	0.34225
KU	0.24993	0.795462	0.15625	0.023973	1.2256	0.306404	0.3374
IE	0.350042	0.022727	0.78125	0.119864	1.2739	0.318471	0.29598

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	1	0.1428	0.2000	5	0.1428	0.1428
IP	7.002801	1	0.2000	5	7	7
SLA	5	5	1	3	0.2	0.2
STP	0.2	0.2	0.333333	1	0.2	0.2
PA	7.002801	0.142857	5	5	1	0.2000
CW	7.002801	0.142857	5	5	5	1
∑	27.2084	6.6285	11.7333	24.0000	13.5428	8.7428

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.036753	0.021543	0.017045	0.208333	0.010544	0.016333	0.310553	0.0518	0.022898
IP	0.257376	0.150863	0.017045	0.208333	0.51688	0.800659	1.951157	0.3252	0.344229
SLA	0.183767	0.754317	0.085227	0.125	0.014768	0.022876	1.185955	0.1977	0.282494
STP	0.007351	0.030173	0.028409	0.041667	0.014768	0.022876	0.145243	0.0242	0.29204
PA	0.257376	0.021552	0.426136	0.208333	0.07384	0.022876	1.010114	0.1684	0.12736
CW	0.257376	0.021552	0.426136	0.208333	0.3692	0.11438	1.396978	0.2328	0.19839
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.500	0.200	1
MP	2	1	5.0000	1.0000
KU	5	0.200	1	5
IE	1	1	0.2	1
∑	**9**	**2.7**	**6.4000**	**8.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1111	0.185185	0.03125	0.125	0.4525	0.113137	**0.11291**
MP	0.222222	0.3704	0.78125	0.125	1.4988	0.374711	**0.45941**
KU	0.555556	0.074074	0.15625	0.625	1.4109	0.35272	**0.24537**
IE	0.111111	0.37037	0.03125	0.125	0.6377	0.159433	**0.1823**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.3333**	**0.2**	**1**	1	1
IP	3.0003	1	5	1	1	1
SLA	5	0.2	1	1	5	3
STP	1	1	1	1	3	1
PA	1	1	0.2	0.333333	1	0.3333
CW	1	1	0.333333	1	3.0003	1
∑	**12.0003**	**4.5333**	**7.7333**	**5.3333**	14.0003	7.3333

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.083331	0.073523	0.025862	0.1875	0.071427	0.136364	0.578007	0.0963	**0.09073**
IP	0.250019	0.22059	0.646552	0.1875	0.071427	0.136364	1.512452	0.2521	**0.303564**
SLA	0.416656	0.044118	0.12931	0.1875	0.357135	0.409093	1.543813	0.2573	**0.208486**
STP	0.083331	0.22059	0.12931	0.1875	0.214281	0.136364	0.971377	0.1619	**0.287507**
PA	0.083331	0.22059	0.025862	0.0625	0.071427	0.04545	0.50916	0.0849	**0.093499**
CW	0.083331	0.22059	0.043103	0.1875	0.214303	0.136364	0.928295	0.1547	**0.144362**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	6	4	8
MP	0.166667	1	0.2000	5.0000
KU	0.25	5	1	4
IE	0.125	0.2	0.25	1
∑	**1.541667**	**12.2**	**5.4500**	**18.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.6486	0.491803	0.733945	0.444444	2.3188	0.57971	**0.63956**
MP	0.108108	0.0820	0.036697	0.277778	0.5046	0.126138	**0.09579**
KU	0.162162	0.409836	0.183486	0.222222	0.9777	0.244427	**0.2016**
IE	0.081081	0.016393	0.045872	0.055556	0.1989	0.049725	**0.06305**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**8**	**6**	**9**	7	4
IP	0.125	1	0.200	6	5	0.2500
SLA	0.166667	5	1	7	8	3
STP	0.111111	0.166667	0.142857	1	1	0.200
PA	0.142857	0.2	0.125	1	1	0.2500
CW	0.25	4	0.333333	5	4	1
∑	**1.7956**	**18.3667**	**7.8012**	**29.0000**	26.0000	8.7000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.556906	0.435572	0.769113	0.310345	0.269231	0.45977	2.800937	0.4668	**0.56308**
IP	0.069613	0.054446	0.025637	0.206897	0.192308	0.028736	0.577637	0.0963	**0.060751**
SLA	0.092818	0.272232	0.128186	0.241379	0.307692	0.344828	1.387135	0.2312	**0.165628**
STP	0.061878	0.009074	0.018312	0.034483	0.038462	0.022989	0.185198	0.0309	**0.052772**
PA	0.079558	0.010889	0.016023	0.034483	0.038462	0.028736	0.20815	0.0347	**0.048318**
CW	0.139227	0.217786	0.042729	0.172414	0.153846	0.114943	0.840943	0.1402	**0.122608**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.16666	0.1428	6
MP	6.00024	1	7.0000	8.0000
KU	7.002801	0.142857	1	6
IE	0.166667	0.125	0.166667	1
∑	**14.16971**	**1.434517**	**8.3095**	**21.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0706	0.116178	0.017185	0.285714	0.4897	0.122413	**0.09291**
MP	0.423455	0.6971	0.842413	0.380952	2.3439	0.58598	**0.68676**
KU	0.494209	0.099586	0.120345	0.285714	0.9999	0.249963	**0.16083**
IE	0.011762	0.087137	0.020057	0.047619	0.1666	0.041644	**0.0595**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1666**	**0.1428**	**0.2000**	5	6
IP	6.002401	1	7	7	6	0.1666
SLA	7.002801	0.142857	1	**0.2500**	5	**0.2500**
STP	5	0.142857	4	1	5	0.2
PA	0.2	0.166667	0.2	0.2	1	0.1666
CW	0.166667	6.002401	4	5	6.002401	1
∑	**19.3719**	**7.6214**	**16.3428**	**13.6500**	28.0024	7.7832

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.051621	0.02186	0.008738	0.014652	0.178556	0.770891	1.046318	0.1744	**0.246134**
IP	0.309851	0.13121	0.428323	0.512821	0.214267	0.021405	1.617877	0.2696	**0.215967**
SLA	0.361493	0.018744	0.061189	0.018315	0.178556	0.03212	0.670418	0.1117	**0.090197**
STP	0.258106	0.018744	0.244756	0.07326	0.178556	0.025696	0.799119	0.1332	**0.176618**
PA	0.010324	0.021868	0.012238	0.014652	0.035711	0.021405	0.116199	0.0194	**0.017951**
CW	0.008604	0.787574	0.244756	0.3663	0.214353	0.128482	1.750069	0.2917	**0.331628**
	1	1	1	1	1.0000	1			

K-2(a-f): Construction Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1666	0.1428	6
MP	6.002401	1	7.0000	8.0000
KU	7.002801	0.142857	1	6
IE	0.166667	0.125	0.166667	1
∑	**14.17187**	**1.434457**	**8.3095**	**21.0000**

Table 2: Normalized pair wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0706	0.116141	0.017185	0.285714	0.4896	0.122401	**0.09289**
MP	0.423543	0.6971	0.842413	0.380952	2.3440	0.586009	**0.68679**
KU	0.494134	0.09959	0.120345	0.285714	0.9998	0.249946	**0.16082**
IE	0.01176	0.087141	0.020057	0.047619	0.1666	0.041644	**0.0595**

Table 3: Pair-wise rating for alternatives

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	**0.125**	**0.1428**	**6**	4	6
IP	8	1	8	7	8	7
LEA	7.002801	0.125	1	8	7	6
CTA	0.166667	0.142857	0.125	1	4.0000	0.2500
PA	0.25	0.125	0.142857	0.25	1	0.2000
CW	0.166667	0.142857	0.166667	4	5	1
∑	**16.5861**	**1.6607**	**9.5773**	**26.2500**	29.0000	20.4500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.060291	0.075269	0.01491	0.228571	0.137931	0.293399	0.810371	0.1351	**0.085715**
IP	0.482331	0.602151	0.835306	0.266667	0.275862	0.342298	2.804615	0.4674	**0.595605**
LEA	0.422208	0.075269	0.104413	0.304762	0.241379	0.293399	1.44143	0.2402	**0.162617**
CTA	0.010049	0.086022	0.013052	0.038095	0.137931	0.012225	0.297373	0.0496	**0.290561**
PA	0.015073	0.075269	0.014916	0.009524	0.034483	0.00978	0.159044	0.0265	**0.042983**
CW	0.010049	0.086022	0.017402	0.152381	0.172414	0.0489	0.487167	0.0812	**0.06184**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1666	6.0000	5.0000
MP	6.002401	1	9.0000	9.0000
KU	0.166667	0.111111	1	3
IE	0.2	0.111111	0.333333	1
∑	**7.369068**	**1.388822**	**16.3333**	**18.0000**

Table 2: Normalized pair wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1357	0.119958	0.367347	0.277778	0.9008	0.225196	**0.15117**
MP	0.81454	0.7200	0.55102	0.5000	2.5856	0.646399	**0.71728**
KU	0.022617	0.080004	0.061224	0.166667	0.3305	0.082628	**0.0695**
IE	0.02714	0.080004	0.020408	0.055556	0.1831	0.045777	**0.06206**

Table 3: Pair-wise rating for alternatives

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.1111	6.0000	0.250	6	0.250
IP	9.0009	1	9	9	9	9
SLA	0.166667	0.111111	1	0.16666	3	0.200
STP	4	0.111111	6.00024	1	6	0.200
PA	0.167	0.111111	0.333333	0.166667	1	0.1428
CW	4	0.111111	5	5	7.002801	1
∑	**18.3342**	**1.5555**	**27.3336**	**15.5833**	32.0028	10.7928

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.054543	0.071422	0.21951	0.016043	0.187484	0.023164	0.572165	0.0954	**0.062519**
IP	0.490934	0.642862	0.329265	0.57754	0.281225	0.833889	3.155716	0.5260	**0.633605**
SLA	0.00909	0.071429	0.036585	0.010695	0.093742	0.018531	0.240072	0.0400	**0.047011**
STP	0.218171	0.071429	0.219519	0.064171	0.187484	0.018531	0.779305	0.1299	**0.307047**
PA	0.00909	0.071429	0.012195	0.010695	0.031247	0.013231	0.147888	0.0246	**0.043519**
CW	0.218171	0.071429	0.182925	0.320856	0.218818	0.092654	1.104854	0.1841	**0.129822**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.125	1.0000	1
MP	8	1	7.0000	7.0000
KU	1	0.142857	1	0.1250
IE	1	0.142857	8	1
∑	11	1.410714	17.0000	9.1250

Table 2: Normalized pair wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0909	0.088608	0.058824	0.109589	0.3479	0.086982	0.09089
MP	0.727273	0.7089	0.411765	0.767123	2.6150	0.653755	0.70205
KU	0.090909	0.101266	0.058824	0.013699	0.2647	0.066174	0.08065
IE	0.090909	0.101266	0.470588	0.109589	0.7724	0.193088	0.12641

Table 3: Pair-wise rating for alternatives

Link	ACD	IP	SLA	STP	PA	CW
ACD	1	0.1111	8.0000	0.125	7	7
IP	9.0009	1	6.0000	7	7	7
SLA	0.125	0.166667	1	0.16666	7	6
STP	8	0.142857	6.00024	1	5	6
PA	0.142857	0.142857	0.142857	0.2	1	4.0000
CW	0.142857	0.142857	0.166667	0.166667	0.25	1
∑	18.4116	1.7063	21.3098	8.6583	27.2500	31.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.054314	0.06511	0.375415	0.014437	0.256881	0.225806	0.991963	0.1653	0.097989
IP	0.488871	0.58605	0.281561	0.80847	0.256881	0.225806	2.64764	0.4413	0.561021
SLA	0.006789	0.097675	0.046927	0.019249	0.256881	0.193548	0.621069	0.1035	0.070676
STP	0.434508	0.083721	0.281572	0.115496	0.183486	0.193548	1.292333	0.2154	0.330369
PA	0.007759	0.083721	0.006704	0.023099	0.036697	0.129032	0.287013	0.0478	0.049092
CW	0.007759	0.083721	0.007821	0.019249	0.009174	0.032258	0.159983	0.0267	0.044481
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.125	4.000	6.000
MP	8	1	9.0000	8.0000
KU	0.25	0.111	1	0.3333
IE	0.166667	0.125	3.0003	1
∑	**9.416667**	**1.361111**	**17.0003**	**15.3333**

Table 2: Normalized pair wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1062	0.091837	0.23529	0.391305	0.8246	0.206157	**0.12786**
MP	0.849558	0.7347	0.529402	0.52174	2.6354	0.658849	**0.72999**
KU	0.026549	0.081633	0.058822	0.021737	0.1887	0.047185	**0.06394**
IE	0.017699	0.091837	0.176485	0.065218	0.3512	0.08781	**0.07821**

Table 3: Pair-wise rating for alternatives

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1428**	**4**	**0.3333**	4	0.1428
IP	7.002801	1	8	9	8	7
SLA	0.25	0.125	1	0.200	0.3333	0.1428
STP	3.0003	0.111111	5	1	5	0.1428
PA	0.25	0.125	3.0003	0.2	1	0.1250
CW	7.002801	0.142857	7.002801	7.002801	8	1
∑	**18.5059**	**1.6468**	**28.0031**	**17.7361**	26.3333	8.5534

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.054037	0.086715	0.142841	0.018792	0.151899	0.016695	0.47098	0.0785	**0.063764**
IP	0.378409	0.60725	0.285683	0.50744	0.303798	0.818388	2.900967	0.4835	**0.644045**
SLA	0.013509	0.075906	0.03571	0.011276	0.012657	0.016695	0.165754	0.0276	**0.045513**
STP	0.162127	0.067472	0.178552	0.056382	0.189874	0.016695	0.671101	0.1119	**0.366088**
PA	0.013509	0.075906	0.107142	0.011276	0.037975	0.014614	0.260422	0.0434	**0.047968**
CW	0.378409	0.08675	0.250072	0.394833	0.303798	0.116913	1.780847	0.2968	**0.170604**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	8	6	8
MP	0.125	1	0.1428	0.5000
KU	0.166667	7.002801	1	6
IE	0.125	2	0.166667	1
∑	**1.416667**	**18.0028**	**7.3095**	**15.5000**

Table 2: Normalized pair wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.7059	0.444375	0.820853	0.516129	2.4872	0.62181	**0.70912**
MP	0.088235	0.0555	0.019536	0.032258	0.1956	0.048894	**0.06493**
KU	0.117647	0.388984	0.136809	0.387097	1.0305	0.257634	**0.15516**
IE	0.088235	0.111094	0.022801	0.064516	0.2866	0.071662	**0.0708**

Table 3: Pair-wise rating for alternatives

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	**8**	**7**	**0.125**	9	8
IP	0.125	1	0.125	0.1428	0.3333	0.2000
SLA	0.142857	8	1	0.1666	7	7
STP	8	7.002801	6.002401	1	8	7.000
PA	0.111111	3.0003	0.142857	0.125	1	0.2500
CW	0.125	5	0.142857	0.142857	4	1
∑	**9.5040**	**32.0031**	**14.4131**	**1.7023**	29.3333	23.4500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.105219	0.249976	0.485669	0.073432	0.306819	0.341151	1.562266	0.2604	**0.181744**
IP	0.013152	0.031247	0.008673	0.083889	0.011363	0.008529	0.156852	0.0261	**0.043565**
SLA	0.015031	0.249976	0.069381	0.09787	0.238637	0.298507	0.969402	0.1616	**0.095941**
STP	0.841754	0.218816	0.416454	0.587455	0.272728	0.298507	2.635714	0.4393	**0.264217**
PA	0.011691	0.09375	0.009912	0.073432	0.034091	0.010661	0.233537	0.0389	**0.041467**
CW	0.013152	0.156235	0.009912	0.083922	0.136364	0.042644	0.442229	0.0737	**0.054427**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.3333	5
MP	7.002801	1	8.0000	5.0000
KU	3.0003	0.125	1	3
IE	0.2	0.2	0.333333	1
∑	**11.2031**	**1.4678**	**9.6666**	**14.0000**

Table 2: Normalized pair wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0893	0.097288	0.034479	0.357143	0.5782	0.144543	**0.10249**
MP	0.625077	0.6813	0.827589	0.357143	2.4911	0.622775	**0.67663**
KU	0.26781	0.085161	0.103449	0.214286	0.6707	0.167676	**0.12302**
IE	0.017852	0.136258	0.034483	0.071429	0.2600	0.065005	**0.09786**

Table 3: Pair-wise rating for alternatives

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.200**	**0.2500**	**5.0000**	4	0.5
IP	5	1	0.3333	8	5	7
SLA	4	3.0003	1	**4.0000**	5	**5.0000**
STP	0.2	0.125	0.25	1	0.3333	0.1428
PA	0.25	0.2	0.2	3.0003	1	0.1666
CW	2	0.142857	0.2	7.002801	6.002401	1
∑	**12.4500**	**4.6682**	**2.2333**	**28.0031**	21.3357	13.8094

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.080321	0.042843	0.111942	0.178552	0.187479	0.036207	0.637345	0.1062	**0.083193**
IP	0.401606	0.214217	0.149241	0.285683	0.234349	0.506901	1.791997	0.2987	**0.257627**
SLA	0.321285	0.642716	0.447768	0.142841	0.234349	0.362072	2.151032	0.3585	**0.457591**
STP	0.016064	0.026777	0.111942	0.03571	0.015622	0.010341	0.216456	0.0361	**0.160691**
PA	0.02008	0.042843	0.089554	0.107142	0.04687	0.012064	0.318553	0.0531	**0.055167**
CW	0.160643	0.030602	0.089554	0.250072	0.281331	0.072414	0.884617	0.1474	**0.092944**
	1	1	1	1	1.0000	1			

K-3(a-f): Telecommunication Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	2	1	1
MP	0.5	1	0.3333	0.5000
KU	1	3.0003	1	0.3333
IE	1	2	3.0003	1
∑	**3.5**	**8.0003**	**5.3336**	**2.8333**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.2857	0.249991	0.187491	0.352945	1.0761	0.269035	**0.28186**
MP	0.142857	0.1250	0.062491	0.176473	0.5068	0.126704	**0.13338**
KU	0.285714	0.375023	0.187491	0.117637	0.9659	0.241466	**0.19082**
IE	0.285714	0.249991	0.562528	0.352945	1.4512	0.362795	**0.37242**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**2**	**1**	**0.5**	2	2
IP	0.5	1	0.5	0.5	0.5	1
SLA	1	2	1	2	1	2
STP	2	2	0.5	1	2.0000	2.0000
PA	0.5	2	1	0.5	1	2.0000
CW	0.5	1	0.5	0.5	0.5	1
∑	**5.5000**	**10.0000**	**4.5000**	**5.0000**	7.0000	10.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.181818	0.2	0.222222	0.1000	0.285714	0.2000	1.189755	0.1983	**0.192366**
IP	0.090909	0.1	0.111111	0.1	0.071429	0.1	0.573449	0.09557	**0.096139**
SLA	0.181818	0.2	0.222222	0.4	0.142857	0.2	1.346898	0.2245	**0.237627**
STP	0.363636	0.2	0.111111	0.2	0.285714	0.2	1.360462	0.2267	**0.159777**
PA	0.090909	0.2	0.222222	0.1	0.142857	0.2	0.955988	0.1593	**0.151578**
CW	0.090909	0.1	0.111111	0.1	0.071429	0.1	0.573449	0.09557	**0.096139**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	8.0000	0.1250	0.2500
MP	0.125	1	0.1250	0.1666
KU	8	8	1	8
IE	4	6.002401	0.125	1
∑	**13.125**	**23.0024**	**1.3750**	**9.4166**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0762	0.34779	0.090909	0.026549	0.5414	0.13536	**0.08702**
MP	0.009524	0.0435	0.090909	0.017692	0.1616	0.0404	**0.06401**
KU	0.609524	0.34779	0.727273	0.849564	2.5341	0.633537	**0.28795**
IE	0.304762	0.260947	0.090909	0.106195	0.7628	0.190703	**0.12964**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.1250	0.1250	0.125	0.125	0.1111
IP	8	1	0.1428	0.1428	0.1428	0.125
SLA	8	7.002801	1	0.125	8	9
STP	8	7.002801	8	1	8	0.125
PA	8.000	7.002801	0.125	0.125	1	0.1250
CW	9.0009	8	0.111111	8	8	1
∑	**42.0009**	**30.1334**	**9.5039**	**9.5178**	25.2678	10.4861

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.023809	0.004148	0.013152	0.013133	0.004947	0.010595	0.069785	0.0116	**0.011436**
IP	0.190472	0.033186	0.015025	0.015003	0.005651	0.011921	0.271259	0.0452	**0.016196**
SLA	0.190472	0.232393	0.10522	0.013133	0.316608	0.858279	1.716106	0.2860	**0.322423**
STP	0.190472	0.232393	0.841759	0.105066	0.316608	0.011921	1.698219	0.2830	**0.025202**
PA	0.190472	0.232393	0.013152	0.013133	0.039576	0.011921	0.500648	0.0834	**0.026968**
CW	0.214303	0.265486	0.011691	0.84053	0.316608	0.095364	1.743983	0.2907	**0.309877**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	1	1.0000	7
MP	1	1	7.0000	7.0000
KU	1	0.142857	1	7.0000
IE	0.142857	0.142857	0.142857	1
∑	**3.142857**	**2.285714**	**9.1429**	**22.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.3182	0.4375	0.109375	0.318182	1.1832	0.29581	**0.33086**
MP	0.318182	0.4375	0.765625	0.318182	1.8395	0.459872	**0.46346**
KU	0.318182	0.0625	0.109375	0.318182	0.8082	0.20206	**0.18661**
IE	0.045455	0.0625	0.015625	0.045455	0.1690	0.042259	**0.04727**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	7	1.0000	**7**	7	1
IP	0.142857	1	7.0000	7	7	1
SLA	1	0.142857	1	7	7	1
STP	0.142857	0.142857	0.142857	1	7	1
PA	0.142857	0.142857	0.142857	0.142857	1	0.1428
CW	1	1	1	1	7.002801	1
∑	**3.4286**	**9.4286**	**10.2857**	**23.1429**	36.0028	5.1428

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.291667	0.742424	0.097222	0.302469	0.194429	0.194447	1.822658	0.3038	**0.354069**
IP	0.041667	0.106061	0.680556	0.302469	0.194429	0.194447	1.519628	0.2533	**0.223448**
SLA	0.291667	0.015152	0.097222	0.302469	0.194429	0.194447	1.095385	0.1826	**0.169872**
STP	0.041667	0.015152	0.013889	0.04321	0.194429	0.194447	0.502793	0.0838	**0.200423**
PA	0.041667	0.015152	0.013889	0.006173	0.027776	0.027767	0.132423	0.0221	**0.024451**
CW	0.291667	0.106061	0.097222	0.04321	0.194507	0.194447	0.927113	0.1545	**0.171172**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	5.000	6
MP	7.002801	1	6.0000	8.0000
KU	0.2	0.167	1	3
IE	0.166667	0.125	0.333333	1
∑	**8.369468**	**1.434467**	**12.3333**	**18.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1195	0.099549	0.405405	0.333333	0.9578	0.239442	**0.14506**
MP	0.836708	0.6971	0.486486	0.444444	2.4648	0.616191	**0.69814**
KU	0.023896	0.116187	0.081081	0.166667	0.3878	0.096958	**0.13518**
IE	0.019914	0.08714	0.027027	0.055556	0.1896	0.047409	**0.06372**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.125**	**6**	**7**	8	7
IP	8	1	8	7	8	7
SLA	0.166667	0.125	1	6	3	4
STP	0.142857	0.142857	0.166667	1	5	2
PA	0.125	0.125	0.333333	0.2	1	0.3333
CW	0.142857	0.142857	0.25	0.5	3.0003	1
∑	**9.5774**	**1.6607**	**15.7500**	**21.7000**	28.0003	21.3333

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.104413	0.075269	0.380952	0.322581	0.285711	0.328126	1.497051	0.2495	**0.156532**
IP	0.835301	0.602151	0.507937	0.322581	0.285711	0.328126	2.881806	0.4803	**0.60735**
SLA	0.017402	0.075269	0.063492	0.276498	0.107142	0.1875	0.727303	0.1212	**0.080718**
STP	0.014916	0.086022	0.010582	0.046083	0.17857	0.09375	0.429922	0.0717	**0.154759**
PA	0.013052	0.075269	0.021164	0.009217	0.035714	0.015623	0.170038	0.0283	**0.044453**
CW	0.014916	0.086022	0.015873	0.023041	0.107152	0.046875	0.309753	0.0516	**0.05407**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1111	0.1428	1
MP	9.0009	1	1.0000	1.0000
KU	7.002801	1	1	1
IE	1	1	1	1
∑	18.0037	3.1111	3.1428	4.0000

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0555	0.035711	0.045437	0.25	0.3867	0.096673	0.09137
MP	0.499947	0.3214	0.318188	0.25	1.3896	0.347391	0.32077
KU	0.388965	0.32143	0.318188	0.25	1.2786	0.319645	0.31887
IE	0.055544	0.32143	0.318188	0.25	0.9452	0.23629	0.27781

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1111**	**0.1428**	**9**	1	9
IP	9.0009	1	1.000	7	1	1.0000
SLA	7.002801	1	1	5	1	5
STP	0.111111	0.142857	0.2	1	0.2000	1.000
PA	1	1	1	5	1	1.0000
CW	0.111111	1	0.2	1	1	1
∑	18.2259	4.2540	3.5428	28.0000	5.2000	18.0000

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Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.054867	0.026117	0.040307	0.321429	0.192308	0.5	1.135027	0.1892	0.119903
IP	0.493852	0.235075	0.282263	0.25	0.192308	0.055556	1.509053	0.2515	0.272274
SLA	0.384222	0.235075	0.282263	0.178571	0.192308	0.277778	1.550217	0.2584	0.270373
STP	0.006096	0.033582	0.056453	0.035714	0.038462	0.055556	0.225862	0.0376	0.129328
PA	0.054867	0.235075	0.282263	0.178571	0.192308	0.055556	0.998639	0.1664	0.186542
CW	0.006096	0.235075	0.056453	0.035714	0.192308	0.055556	0.581202	0.0969	0.113596
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	8	0.3333	4
MP	0.125	1	0.1428	0.1250
KU	3.0003	7.002801	1	1
IE	0.25	8	1	1
∑	**4.3753**	**24.0028**	**2.4761**	**6.1250**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.2286	0.333294	0.134607	0.653061	1.3495	0.33738	**0.29778**
MP	0.028569	0.0417	0.057671	0.020408	0.1483	0.037078	**0.03834**
KU	0.685736	0.291749	0.403861	0.163265	1.5446	0.386153	**0.29623**
IE	0.057139	0.333294	0.403861	0.163265	0.9576	0.23939	**0.22667**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**8**	**5**	**7.0000**	3	7
IP	0.125	1	0.1428	1	0.125	4
SLA	0.2	7.002801	1	**6.0000**	2	**6.0000**
STP	0.142857	1	0.166667	1	0.125	1
PA	0.333333	8	0.5	8	1	5.0000
CW	0.142857	0.25	0.166667	1	0.2	1
∑	**1.9440**	**25.2528**	**6.9761**	**24.0000**	6.4500	24.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.514391	0.316797	0.716729	0.291667	0.465116	0.291667	2.596366	0.4327	**0.520325**
IP	0.064299	0.0396	0.02047	0.041667	0.01938	0.166667	0.352081	0.0587	**0.046577**
SLA	0.102878	0.277308	0.143346	0.25	0.310078	0.25	1.333609	0.2223	**0.176816**
STP	0.073484	0.0396	0.023891	0.041667	0.01938	0.041667	0.239688	0.0399	**0.050552**
PA	0.171464	0.316797	0.071673	0.333333	0.155039	0.208333	1.256638	0.2094	**0.1622**
CW	0.073484	0.0099	0.023891	0.041667	0.031008	0.041667	0.221616	0.0369	**0.047388**
	1	1	1	1	1.0000	1			

K-4(a-f): Semiconductor Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	1	1	1
MP	1	1	1.0000	1.0000
KU	1	1	1	1
IE	1	1	1	1
∑	4	4	4.0000	4.0000

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.2500	0.25	0.25	0.25	1.0000	0.25	0.25
MP	0.25	0.2500	0.25	0.25	1.0000	0.25	0.25
KU	0.25	0.25	0.25	0.25	1.0000	0.25	0.25
IE	0.25	0.25	0.25	0.25	1.0000	0.25	0.25

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	1	0.2	5	4	4	5
IP	5	1	6	6	6	6
SLA	0.2	0.166667	1	3	5	4
STP	0.25	0.166667	0.333333	1	0.2500	0.2500
PA	0.25	0.166667	0.2	4	1	4.0000
CW	0.2	0.166667	0.25	4	0.25	1
∑	6.9000	1.8667	12.7833	22.0000	16.5000	20.2500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.144928	0.107143	0.391134	0.181818	0.242424	0.246914	1.314361	0.2191	0.179714
IP	0.724638	0.535714	0.469361	0.272727	0.363636	0.296296	2.662373	0.4437	0.526045
SLA	0.028986	0.089286	0.078227	0.136364	0.30303	0.197531	0.833423	0.1389	0.103935
STP	0.036232	0.089286	0.026076	0.045455	0.015152	0.012346	0.224545	0.0374	0.177149
PA	0.036232	0.089286	0.015645	0.181818	0.060606	0.197531	0.581118	0.0969	0.075051
CW	0.028986	0.089286	0.019557	0.181818	0.015152	0.049383	0.38418	0.0640	0.060119
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.2000	0.5000	0.1666
MP	5	1	6.0000	3.0000
KU	2	0.166667	1	0.2000
IE	6.002401	0.333333	5	1
∑	**14.0024**	**1.700**	**12.5000**	**4.3666**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0714	0.117647	0.04	0.038153	0.2672	0.066804	**0.08252**
MP	0.357082	0.5882	0.48	0.687033	2.1124	0.528088	**0.59384**
KU	0.142833	0.098039	0.08	0.045802	0.3667	0.091669	**0.0830**
IE	0.428669	0.196078	0.4	0.229011	1.2538	0.31344	**0.24063**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.1666	0.5000	0.1428	0.1666	0.250
IP	6.002401	1	4	0.1666	0.2000	0.1428
SLA	2	0.25	1	0.1428	0.1666	4
STP	7.002801	6.002401	7.002801	1	6	7.000
PA	6.002	5	6.002401	0.166667	1	6.0000
CW	4	7.002801	0.25	0.142857	0.166667	1
∑	**26.0076**	**19.4218**	**18.7552**	**1.7617**	7.6999	18.3928

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.03845	0.008578	0.026659	0.081057	0.021637	0.013592	0.189974	0.0317	**0.046813**
IP	0.230794	0.051489	0.213274	0.094566	0.025974	0.007764	0.623862	0.1040	**0.078123**
SLA	0.076901	0.012872	0.053319	0.081057	0.021637	0.217476	0.463261	0.0772	**0.073806**
STP	0.26926	0.309055	0.373379	0.567626	0.779234	0.380584	2.679138	0.4465	**0.106122**
PA	0.230794	0.257443	0.320039	0.094604	0.129872	0.326215	1.358967	0.2265	**0.167676**
CW	0.153801	0.360564	0.01333	0.081089	0.021645	0.054369	0.684799	0.1141	**0.090705**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.3333	0.2000	0.3333
MP	3.0003	1	0.3333	1.0000
KU	5	3.0003	1	3.0000
IE	3.0003	1	0.333333	1
∑	**12.0006**	**5.3336**	**1.8666**	**5.3333**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0833	0.062491	0.107145	0.062494	0.3155	0.078865	**0.08733**
MP	0.250013	0.1875	0.178557	0.187501	0.8036	0.20089	**0.18778**
KU	0.416646	0.562528	0.535724	0.562504	2.0774	0.51935	**0.5371**
IE	0.250013	0.187491	0.178575	0.187501	0.8036	0.200895	**0.18779**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.3333	0.2000	**1**	0.3333	1
IP	3.0003	1	0.3333	3	1	3
SLA	5	3.0003	1	3	3	3
STP	1	0.333333	0.333333	1	1	1
PA	3.0003	1	0.333333	1	1	1.0000
CW	1	0.333333	0.333333	1	1	1
∑	**14.0006**	**6.0003**	**2.5333**	**10.0000**	7.3333	10.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.071426	0.055548	0.078948	0.1	0.04545	0.1	0.451372	0.0752	**0.072947**
IP	0.214298	0.166659	0.131568	0.3	0.136364	0.3	1.248889	0.2081	**0.179176**
SLA	0.357128	0.500028	0.394742	0.3	0.409093	0.3	2.26099	0.3768	**0.39707**
STP	0.071426	0.055553	0.131581	0.1	0.136364	0.1	0.594924	0.0992	**0.145301**
PA	0.214298	0.166659	0.131581	0.1	0.136364	0.1	0.848902	0.1415	**0.139519**
CW	0.071426	0.055553	0.131581	0.1	0.136364	0.1	0.594924	0.0992	**0.105644**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	7.000	4.000	1
MP	0.142857	1	0.2500	0.1666
KU	0.25	4.000	1	1
IE	1	6.002401	1	1
∑	**2.392857**	**18.0024**	**6.2500**	**3.1666**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.4179	0.388837	0.64	0.315796	1.7625	0.440636	**0.42963**
MP	0.059701	0.0555	0.04	0.052612	0.2079	0.051965	**0.05336**
KU	0.104478	0.222193	0.16	0.315796	0.8025	0.200617	**0.18656**
IE	0.41791	0.333422	0.16	0.315796	1.2271	0.306782	**0.33045**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**1**	**1**	**4**	1	0.500
IP	1	1	1	3	1	1
SLA	1	1	1	3	0.3333	1
STP	0.25	0.333333	0.333333	1	0.200	0.1666
PA	1	1	3.0003	5	1	0.5000
CW	2	1	1	6.002401	2	1
∑	**6.2500**	**5.3333**	**7.3336**	**22.0024**	5.5333	4.1666

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.16	0.1875	0.136358	0.181798	0.180724	0.120002	0.966382	0.1611	**0.159167**
IP	0.16	0.1875	0.136358	0.136349	0.180724	0.240004	1.040935	0.1735	**0.190216**
SLA	0.16	0.1875	0.136358	0.136349	0.060235	0.240004	0.920446	0.1534	**0.164419**
STP	0.04	0.0625	0.045453	0.04545	0.036145	0.039985	0.269532	0.0449	**0.149202**
PA	0.16	0.1875	0.409115	0.227248	0.180724	0.120002	1.284589	0.2141	**0.203052**
CW	0.32	0.1875	0.136358	0.272807	0.361448	0.240004	1.654475	0.2757	**0.260808**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.200	0.1428	0.3333
MP	5	1	0.2000	0.2000
KU	7.002801	5	1	0.2
IE	3.0003	5	5	1
∑	**16.0031**	**11.2**	**6.3428**	**1.7333**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0625	0.017857	0.022514	0.192292	0.2952	0.073788	**0.10968**
MP	0.312439	0.0893	0.031532	0.115387	0.5486	0.137161	**0.10209**
KU	0.43759	0.446429	0.157659	0.115387	1.1571	0.289266	**0.1968**
IE	0.187482	0.446429	0.788295	0.576934	1.9991	0.499785	**0.59144**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.200**	**0.1428**	**0.200**	0.333	0.200
IP	5	1	0.200	**0.1428**	0.1428	0.2000
SLA	7.002801	5	1	0.2000	0.200	0.200
STP	5	7.002801	5	1	0.200	0.200
PA	3.003003	7.002801	5	5	1	0.2000
CW	5	5	5	5	5	1
∑	**26.0058**	**25.2056**	**16.3428**	**11.5428**	6.8758	2.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.038453	0.007935	0.008738	0.017327	0.048431	0.1	0.220883	0.0368	**0.056166**
IP	0.192265	0.039674	0.012238	0.012371	0.020768	0.1	0.377316	0.0629	**0.057047**
SLA	0.269278	0.198369	0.061189	0.017327	0.029088	0.1	0.67525	0.1125	**0.0781**
STP	0.192265	0.277827	0.305945	0.086634	0.029088	0.1	0.991759	0.1653	**0.072023**
PA	0.115474	0.277827	0.305945	0.43317	0.145438	0.1	1.377855	0.2296	**0.200435**
CW	0.192265	0.198369	0.305945	0.43317	0.727188	0.5	2.356937	0.3928	**0.488989**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.200	7	5
MP	5	1	7.0000	6.0000
KU	0.142857	0.142857	1	0.200
IE	0.2	0.166667	5	1
∑	**6.342857**	**1.509524**	**20.0000**	**12.2000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1577	0.132492	0.35	0.409836	1.0500	0.262496	**0.18194**
MP	0.788288	0.6625	0.35	0.491803	2.2926	0.573138	**0.66093**
KU	0.022523	0.094637	0.05	0.016393	0.1836	0.045888	**0.06439**
IE	0.031532	0.11041	0.25	0.081967	0.4739	0.118477	**0.09274**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.500**	**8**	**7.0000**	5	4
IP	2	1	9	7	6	4
SLA	0.125	0.111111	1	**7.0000**	0.250	**0.1666**
STP	0.142857	0.142857	0.142857	1	0.3333	0.1428
PA	0.2	0.166667	4	3.0003	1	0.3333
CW	0.25	0.25	6.002401	7.002801	3.0003	1
∑	**3.7179**	**2.1706**	**28.1453**	**32.0031**	15.5836	9.6427

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.268972	0.230347	0.28424	0.218729	0.32085	0.414822	1.73796	0.2897	**0.279556**
IP	0.537944	0.460695	0.31977	0.218729	0.38502	0.414822	2.336979	0.3895	**0.454366**
SLA	0.033622	0.051188	0.03553	0.218729	0.016043	0.017277	0.372388	0.0621	**0.042192**
STP	0.038425	0.065814	0.005076	0.031247	0.021388	0.014809	0.176758	0.0295	**0.15587**
PA	0.053794	0.076782	0.14212	0.09375	0.06417	0.034565	0.465182	0.0775	**0.067293**
CW	0.067243	0.115174	0.213265	0.218816	0.192529	0.103705	0.910733	0.1518	**0.114688**
	1	1	1	1	1.0000	1			

K-6(a-f): Electronic Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	8	6	3
MP	0.125	1	0.1428	0.1250
KU	0.166667	7.002801	1	0.1666
IE	0.333333	8	6.002401	1
∑	**1.625**	**24.0028**	**13.1452**	**4.2916**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.6154	0.333294	0.45644	0.69904	2.1042	0.52604	**0.60965**
MP	0.076923	0.0417	0.010863	0.029127	0.1586	0.039644	**0.05244**
KU	0.102564	0.291749	0.076073	0.03882	0.5092	0.127302	**0.08712**
IE	0.205128	0.333294	0.456623	0.233013	1.2281	0.307015	**0.25079**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**9**	**6**	**8**	5	7
IP	0.111111	1	0.125	0.2000	0.2000	0.250
SLA	0.166667	8	1	6	4	3
STP	0.125	5	0.166667	1	0.2500	0.5000
PA	0.2	5	0.25	4	1	5.0000
CW	0.142857	4	0.333333	2	0.2	1
∑	**1.7456**	**32.0000**	**7.8750**	**21.2000**	10.6500	16.7500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.572857	0.28125	0.761905	0.377358	0.469484	0.41791	2.880765	0.4801	**0.569148**
IP	0.063651	0.03125	0.015873	0.009434	0.018779	0.014925	0.153913	0.0257	**0.039193**
SLA	0.095476	0.25	0.126984	0.283019	0.375587	0.179104	1.310171	0.2184	**0.16438**
STP	0.071607	0.15625	0.021164	0.04717	0.023474	0.029851	0.349516	0.0583	**0.04622**
PA	0.114571	0.15625	0.031746	0.188679	0.093897	0.298507	0.883651	0.1473	**0.111763**
CW	0.081837	0.125	0.042328	0.09434	0.018779	0.059701	0.421985	0.0703	**0.064202**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.250	0.2000	0.16666
MP	4	1	0.1111	0.1667
KU	5	9.0009	1	4.0000
IE	6.00024	6.00024	0.25	1
∑	**16.00024**	**16.25114**	**1.5611**	**5.3333**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0625	0.015384	0.128115	0.031249	0.2372	0.059312	**0.08612**
MP	0.249996	0.0615	0.071168	0.031249	0.4139	0.103487	**0.06988**
KU	0.312495	0.553863	0.640574	0.750002	2.2569	0.564233	**0.64201**
IE	0.375009	0.36922	0.160143	0.1875	1.0919	0.272968	**0.20199**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	3	0.2000	**0.1666**	0.1428	0.1428
IP	0.333333	1	0.1666	0.2000	0.250	0.3333
SLA	5	6.002401	1	2	0.250	0.16666
STP	6.002401	5	0.5	1	0.125	0.1111
PA	7.002801	4	4	8	1	0.1111
CW	7.002801	3.0003	6.00024	9.0009	9.0009	1
∑	**26.3413**	**22.0027**	**11.8668**	**20.3675**	10.7687	1.8650

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.037963	0.136347	0.016854	0.00818	0.013261	0.07657	0.289174	0.0482	**0.048925**
IP	0.012654	0.045449	0.014039	0.00982	0.023215	0.178717	0.283894	0.0473	**0.091762**
SLA	0.189816	0.272803	0.084268	0.098196	0.023215	0.089364	0.757662	0.1263	**0.088488**
STP	0.22787	0.227245	0.042134	0.049098	0.011608	0.059572	0.617527	0.1029	**0.110736**
PA	0.265848	0.181796	0.337074	0.392783	0.092862	0.059572	1.329935	0.2217	**0.152012**
CW	0.265848	0.136361	0.505631	0.441925	0.835839	0.536205	2.721808	0.4536	**0.557107**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	8.000	0.333	5
MP	0.125	1	0.1250	1.0000
KU	3.0003	8.000	1	8
IE	0.2	1	0.125	1
∑	**4.3253**	**18**	**1.5833**	**15.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.2312	0.444444	0.21051	0.333333	1.2195	0.304871	**0.23787**
MP	0.0289	0.0556	0.078949	0.066667	0.2301	0.057518	**0.06159**
KU	0.693663	0.444444	0.631592	0.533333	2.3030	0.575758	**0.63367**
IE	0.04624	0.055556	0.078949	0.066667	0.2474	0.061853	**0.06687**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**4**	**0.3333**	**0.200**	6	3
IP	0.25	1	0.200	0.200	0.3333	0.3333
SLA	3.0003	5	1	1	4	2
STP	5	5	1	1	5	5
PA	0.166667	3.0003	0.25	0.2	1	0.2500
CW	0.333333	3.0003	0.5	0.2	4	1
∑	**9.7503**	**21.0006**	**3.2833**	**2.8000**	20.3333	11.5833

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.102561	0.190471	0.101514	0.071429	0.295082	0.258994	1.02005	0.1700	**0.131655**
IP	0.02564	0.047618	0.060914	0.071429	0.016392	0.028774	0.250767	0.0418	**0.052285**
SLA	0.307714	0.238088	0.304572	0.357143	0.196722	0.172662	1.576901	0.2628	**0.30319**
STP	0.512805	0.238088	0.304572	0.357143	0.245902	0.431656	2.090166	0.3484	**0.143067**
PA	0.017093	0.142867	0.076143	0.071429	0.04918	0.021583	0.378296	0.0630	**0.05988**
CW	0.034187	0.142867	0.152286	0.071429	0.196722	0.086331	0.836107	0.1394	**0.101123**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1666	0.125	0.1666
MP	6.002401	1	7.0000	0.2000
KU	8	0.142857	1	5
IE	6.002401	5	0.2	1
∑	**21.0048**	**6.309457**	**8.3250**	**6.3666**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0476	0.026405	0.015015	0.026168	0.1152	0.028799	**0.02321**
MP	0.285763	0.1585	0.840841	0.031414	1.3165	0.329128	**0.34544**
KU	0.380865	0.022642	0.12012	0.785349	1.3090	0.327244	**0.30498**
IE	0.285763	0.792461	0.024024	0.15707	1.2593	0.31483	**0.32636**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1428**	**0.125**	**7**	0.200	6
IP	7.002801	1	7.000	5	6	4.0000
SLA	8	0.142857	1	7	0.2	7
STP	0.142857	0.2	0.142857	1	0.1428	0.167
PA	5	0.166667	5	7.002801	1	6.0000
CW	0.166667	0.25	0.142857	6.002401	0.166667	1
∑	**21.3123**	**1.9023**	**13.4107**	**33.0052**	7.7095	24.1666

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.046921	0.075066	0.009321	0.212088	0.025942	0.248277	0.617615	0.1029	**0.065577**
IP	0.32858	0.525673	0.521971	0.151491	0.778264	0.165518	2.471496	0.4119	**0.524032**
SLA	0.37537	0.075096	0.074567	0.212088	0.025942	0.289656	1.052719	0.1755	**0.113568**
STP	0.006703	0.105135	0.010652	0.030298	0.018523	0.006894	0.178205	0.0297	**0.317673**
PA	0.234606	0.087612	0.372836	0.212173	0.129711	0.248277	1.285214	0.2142	**0.176074**
CW	0.00782	0.131418	0.010652	0.181862	0.021618	0.041379	0.394751	0.0658	**0.069562**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1111	0.1428	4
MP	9.0009	1	9.0000	9.0000
KU	7.002801	0.111111	1	5
IE	0.25	0.111111	0.2	1
∑	**17.2537**	**1.333322**	**10.3428**	**19.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0580	0.083326	0.013807	0.210526	0.3656	0.091404	**0.07165**
MP	0.521679	0.7500	0.870171	0.473684	2.6155	0.653885	**0.74291**
KU	0.405872	0.083334	0.096686	0.263158	0.8490	0.212262	**0.12328**
IE	0.01449	0.083334	0.019337	0.052632	0.1698	0.042448	**0.06215**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1111**	**0.2**	**0.2500**	2	3
IP	9.0009	1	9	9	9	9
SLA	5	0.111111	1	**7.0000**	7	**6.0000**
STP	4	0.111111	0.142857	1	2	4
PA	0.5	0.111111	0.142857	0.5	1	2.0000
CW	0.333333	0.111111	0.166667	0.25	0.5	1
∑	**19.8342**	**1.5555**	**10.6524**	**18.0000**	21.5000	25.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.050418	0.071422	0.018775	0.013889	0.093023	0.12	0.367527	0.0613	**0.054809**
IP	0.453806	0.642862	0.844882	0.5	0.418605	0.36	3.220154	0.5367	**0.644888**
SLA	0.252089	0.071429	0.093876	0.388889	0.325581	0.24	1.371864	0.2286	**0.135397**
STP	0.201672	0.071429	0.013411	0.055556	0.093023	0.16	0.59509	0.0992	**0.32276**
PA	0.025209	0.071429	0.013411	0.027778	0.046512	0.08	0.264338	0.0441	**0.050164**
CW	0.016806	0.071429	0.015646	0.013889	0.023256	0.04	0.181026	0.0302	**0.046551**
	1	1	1	1	1.0000	1			

K-6(a-f): Oil and Gas Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	7.0000	9.0000	9.0000
MP	0.142857	1	8.0000	8.0000
KU	0.111111	0.125	1	3
IE	0.111111	0.125	0.333333	1
∑	1.365079	8.25	18.3333	21.0000

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.7326	0.848485	0.490909	0.428571	2.5005	0.625131	0.7327
MP	0.104651	0.1212	0.436364	0.380952	1.0432	0.260795	0.14456
KU	0.081395	0.015152	0.054545	0.142857	0.2939	0.073487	0.06464
IE	0.081395	0.015152	0.018182	0.047619	0.1623	0.040587	0.0581

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	1	7.0000	9.0000	6	9	8
IP	0.142857	1	9	8	9	8
SLA	0.111111	0.111111	1	6	7	6
STP	0.166667	0.125	0.166667	1	5	8.000
PA	0.111	0.111111	0.142857	0.2	1	2.0000
CW	0.125	0.125	0.166667	0.125	0.5	1
∑	1.6567	8.4722	19.4762	21.3250	31.5000	33.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.603593	0.82623	0.462103	0.28136	0.285714	0.242424	2.701423	0.4502	0.592751
IP	0.086228	0.118033	0.462103	0.375147	0.285714	0.242424	1.569648	0.2616	0.183484
SLA	0.067066	0.013115	0.051345	0.28136	0.222222	0.181818	0.816926	0.1362	0.079017
STP	0.100599	0.014754	0.008557	0.046893	0.15873	0.242424	0.571958	0.0953	0.162936
PA	0.067066	0.013115	0.007335	0.009379	0.031746	0.060606	0.189246	0.0315	0.038044
CW	0.075449	0.014754	0.008557	0.005862	0.015873	0.030303	0.150798	0.0251	0.040816
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	1	6.0000	0.200
MP	1	1	6.0000	1.0000
KU	0.166667	0.166667	1	0.2500
IE	5	1	4	1
∑	**7.166667**	**3.166667**	**17.0000**	**2.4500**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1395	0.315789	0.352941	0.081633	0.8899	0.222475	**0.18178**
MP	0.139535	0.3158	0.352941	0.408163	1.2164	0.304107	**0.31704**
KU	0.023256	0.052632	0.058824	0.102041	0.2368	0.059188	**0.06693**
IE	0.697674	0.315789	0.235294	0.408163	1.6569	0.41423	**0.43425**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.200	0.2000	**0.1666**	0.250	1
IP	5	1	1.0000	1	1	0.200
SLA	5	1	1	4	5	4
STP	6.002401	1	0.25	1	4	5
PA	4	1	0.2	0.25	1	0.2500
CW	1	5	0.25	0.2	4	1
∑	**22.0024**	**9.2000**	**2.9000**	**6.6166**	15.2500	11.4500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.04545	0.021739	0.068966	0.025179	0.016393	0.087336	0.265063	0.0442	**0.050092**
IP	0.227248	0.108696	0.344828	0.151135	0.065574	0.017467	0.914947	0.1525	**0.180966**
SLA	0.227248	0.108696	0.344828	0.60454	0.327869	0.349345	1.962525	0.3271	**0.360092**
STP	0.272807	0.108696	0.086207	0.151135	0.262295	0.436681	1.317821	0.2196	**0.182979**
PA	0.181798	0.108696	0.068966	0.037784	0.065574	0.021834	0.484651	0.0808	**0.064599**
CW	0.04545	0.543478	0.086207	0.030227	0.262295	0.087336	1.054993	0.1758	**0.156263**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.125	0.500
MP	7.002801	1	0.1428	0.3333
KU	8	7.002801	1	0.3333
IE	2	3.0003	3.0003	1
∑	**18.0028**	**11.1459**	**4.2681**	**2.1666**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0555	0.012812	0.029287	0.230776	0.3284	0.082106	**0.10651**
MP	0.388984	0.0897	0.033458	0.153836	0.6660	0.166499	**0.11851**
KU	0.444375	0.628285	0.234296	0.153836	1.4608	0.365198	**0.28607**
IE	0.111094	0.269184	0.702959	0.461553	1.5448	0.386197	**0.48891**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.125**	**0.1111**	**0.125**	0.3333	0.2000
IP	8	1	0.1111	0.125	0.3333	0.2000
SLA	9.0009	9.0009	1	0.1111	0.3333	0.200
STP	8	8	9.0009	1	0.3333	0.2000
PA	3.0003	3.0003	3.0003	3.0003	1	0.2000
CW	5	5	5	5	5	1
∑	**34.0012**	**26.1262**	**18.2234**	**9.3614**	7.3332	2.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.029411	0.004784	0.006097	0.013353	0.045451	0.1	0.199095	0.0332	**0.050842**
IP	0.235286	0.038276	0.006097	0.013353	0.045451	0.1	0.438462	0.0731	**0.060121**
SLA	0.264723	0.344516	0.054875	0.011868	0.045451	0.1	0.821432	0.1369	**0.089836**
STP	0.235286	0.306206	0.49392	0.106822	0.045451	0.1	1.287684	0.2146	**0.079701**
PA	0.088241	0.114839	0.16464	0.320497	0.136366	0.1	0.924583	0.1541	**0.162469**
CW	0.147054	0.191379	0.274373	0.534108	0.681831	0.5	2.328744	0.3881	**0.470185**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.125	0.2
MP	7.002801	1	8.0000	7.0000
KU	8	0.125	1	8
IE	5	0.142857	0.125	1
∑	**21.0028**	**1.410657**	**9.2500**	**16.2000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0476	0.101229	0.013514	0.012346	0.1747	0.043675	**0.06618**
MP	0.333422	0.7089	0.864865	0.432099	2.3393	0.584819	**0.70558**
KU	0.380902	0.088611	0.108108	0.493827	1.0714	0.267862	**0.1486**
IE	0.238063	0.10127	0.013514	0.061728	0.4146	0.103644	**0.07964**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.125**	**0.1666**	**0.200**	5	0.1666
IP	8	1	8	8	7	6
SLA	6.002401	0.125	1	8	7	7
STP	5	0.125	0.125	1	6	5
PA	0.2	0.142857	0.142857	0.166667	1	0.2500
CW	6.002401	0.166667	0.142857	0.2	4	1
∑	**26.2048**	**1.6845**	**9.5773**	**17.5667**	30.0000	19.4166

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.038161	0.074205	0.017395	0.011385	0.166667	0.00858	0.316393	0.0527	**0.046849**
IP	0.305288	0.59364	0.835307	0.455408	0.233333	0.309014	2.73199	0.4553	**0.58426**
SLA	0.229057	0.074205	0.104413	0.455408	0.233333	0.360516	1.456933	0.2428	**0.171004**
STP	0.190805	0.074205	0.013052	0.056926	0.2	0.257512	0.792499	0.1321	**0.341708**
PA	0.007632	0.084806	0.014916	0.009488	0.033333	0.012876	0.163051	0.0272	**0.045987**
CW	0.229057	0.09894	0.014916	0.011385	0.133333	0.051502	0.55405	0.0923	**0.070634**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.1428	0.1428
MP	7.002801	1	7.0000	7.0000
KU	7.002801	0.142857	1	7
IE	7.002801	0.142857	0.142857	1
∑	**22.0084**	**1.428514**	**8.2857**	**15.1428**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0454	0.099964	0.017235	0.00943	0.1721	0.043017	**0.06556**
MP	0.318188	0.7000	0.844833	0.462266	2.3253	0.581329	**0.69004**
KU	0.318188	0.100004	0.12069	0.462266	1.0011	0.250287	**0.15998**
IE	0.318188	0.100004	0.017241	0.066038	0.5015	0.125368	**0.08442**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1428**	**0.1428**	**0.1428**	0.1428	7
IP	7.002801	1	7.000	7	7	7.0000
SLA	7.002801	0.142857	1	0.1428	7	7
STP	7.002801	0.142857	7.002801	1	7	7.000
PA	7.002801	0.142857	0.142857	0.142857	1	7.0000
CW	0.142857	0.142857	0.142857	0.142857	0.142857	1
∑	**29.1541**	**1.7142**	**15.4313**	**8.5713**	22.2857	36.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.034301	0.083303	0.009254	0.01666	0.006408	0.194444	0.34437	0.0574	**0.04884**
IP	0.2402	0.583353	0.453623	0.816678	0.314103	0.194444	2.602401	0.4337	**0.56241**
SLA	0.2402	0.083336	0.064803	0.01666	0.314103	0.194444	0.913547	0.1523	**0.099324**
STP	0.2402	0.083336	0.453805	0.116668	0.314103	0.194444	1.402557	0.2338	**0.345536**
PA	0.2402	0.083336	0.009258	0.016667	0.044872	0.194444	0.588777	0.0981	**0.064448**
CW	0.0049	0.083336	0.009258	0.016667	0.00641	0.027778	0.148349	0.0247	**0.043048**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.125	1
MP	7.002801	1	0.1666	9.0000
KU	8	6.002401	1	8
IE	1	0.111111	0.125	1
∑	**17.0028**	**7.256312**	**1.4166**	**19.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0588	0.019679	0.088239	0.052632	0.2194	0.054841	**0.06516**
MP	0.411862	0.1378	0.117606	0.473684	1.1410	0.285241	**0.15865**
KU	0.470511	0.827197	0.705916	0.421053	2.4247	0.606169	**0.71229**
IE	0.058814	0.015312	0.088239	0.052632	0.2150	0.053749	**0.06391**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.125**	**0.1428**	**1.0000**	0.500	3
IP	8	1	9	9	8	7
SLA	7.002801	0.111111	1	**1.0000**	1	**1.0000**
STP	1	0.111111	1	1	1	0.3333
PA	2	0.125	1	1	1	0.2000
CW	0.333333	0.142857	1	3.0003	5	1
∑	**19.3361**	**1.6151**	**13.1428**	**16.0003**	16.5000	12.5333

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.051717	0.077396	0.010865	0.062499	0.030303	0.239362	0.472142	0.0787	**0.083838**
IP	0.413733	0.619165	0.684786	0.562489	0.484848	0.558512	3.323533	0.5539	**0.591025**
SLA	0.362161	0.068796	0.076087	0.062499	0.060606	0.079787	0.709937	0.1183	**0.093218**
STP	0.051717	0.068796	0.076087	0.062499	0.060606	0.026593	0.346298	0.0577	**0.257677**
PA	0.103433	0.077396	0.076087	0.062499	0.060606	0.015957	0.395979	0.0660	**0.06962**
CW	0.017239	0.088452	0.076087	0.187515	0.30303	0.079787	0.752111	0.1254	**0.100178**
	1	1	1	1	1.0000	1			

K-7(a-f): Manufacturing Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	7.000	8	3
MP	0.142857	1	0.1666	7.0000
KU	0.125	6.002401	1	7.0000
IE	0.333333	0.142857	0.142857	1
∑	**1.60119**	**14.14526**	**9.3095**	**18.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.6245	0.494865	0.859341	0.166667	2.1454	0.536352	**0.63169**
MP	0.089219	0.0707	0.017896	0.388889	0.5667	0.141675	**0.09045**
KU	0.078067	0.42434	0.107418	0.388889	0.9987	0.249678	**0.15692**
IE	0.208178	0.010099	0.015345	0.055556	0.2892	0.072295	**0.12094**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1428**	**6**	**1**	2	1
IP	7.002801	1	6	1	7	1
SLA	0.166667	0.166667	1	0.2000	5	0.250
STP	1	1	5	1	6.0000	1.0000
PA	0.5	0.142857	0.2	0.166667	1	0.2000
CW	1	1	4	1	5	1
∑	**10.6695**	**3.4523**	**22.2000**	**4.3667**	26.0000	4.4500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.093725	0.041363	0.27027	0.229008	0.076923	0.224719	0.936009	0.1560	**0.143618**
IP	0.65634	0.28966	0.27027	0.229008	0.269231	0.224719	1.939228	0.3232	**0.318651**
SLA	0.015621	0.048277	0.045045	0.045802	0.192308	0.05618	0.403232	0.0672	**0.049278**
STP	0.093725	0.28966	0.225225	0.229008	0.230769	0.224719	1.293107	0.2155	**0.230882**
PA	0.046863	0.04138	0.009009	0.038168	0.038462	0.044944	0.218825	0.0365	**0.03998**
CW	0.093725	0.28966	0.18018	0.229008	0.192308	0.224719	1.2096	0.2016	**0.222022**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1666	5.0000	3.0000
MP	6.002401	1	4.0000	6.0000
KU	0.2	0.25	1	1
IE	0.333333	0.166667	1	1
∑	**7.535734**	**1.583267**	**11.0000**	**11.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1327	0.105225	0.454545	0.272727	0.9652	0.2413	**0.15771**
MP	0.796525	0.6316	0.363636	0.545455	2.3372	0.584305	**0.63973**
KU	0.02654	0.157901	0.090909	0.090909	0.3663	0.091565	**0.11452**
IE	0.044234	0.105268	0.090909	0.090909	0.3313	0.08283	**0.08804**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.2000	5.0000	1	4	0.2
IP	5	1	4	3	5	1
SLA	0.2	0.25	1	0.1666	1	0.5
STP	1	0.333333	6.002401	1	4	1.000
PA	0.250	0.2	1	0.25	1	0.5000
CW	5	1	2	1	2	1
∑	**12.4500**	**2.9833**	**19.0024**	**6.4166**	17.0000	4.2000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.080321	0.067039	0.263125	0.155846	0.235294	0.047619	0.849244	0.1415	**0.103013**
IP	0.401606	0.335196	0.2105	0.467537	0.294118	0.238095	1.947052	0.3245	**0.337925**
SLA	0.016064	0.083799	0.052625	0.025964	0.058824	0.119048	0.356323	0.0594	**0.067867**
STP	0.080321	0.111732	0.315876	0.155846	0.235294	0.238095	1.137164	0.1895	**0.219934**
PA	0.02008	0.067039	0.052625	0.038961	0.058824	0.119048	0.356577	0.0594	**0.06546**
CW	0.401606	0.335196	0.10525	0.155846	0.117647	0.238095	1.35364	0.2256	**0.262113**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.125	0.1428	5
MP	8	1	7.0000	7.0000
KU	7.002801	0.142857	1	8.0000
IE	0.2	0.142857	0.125	1
∑	**16.2028**	**1.410714**	**8.2678**	**21.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0617	0.088608	0.017272	0.238095	0.4057	0.101423	**0.07401**
MP	0.493742	0.7089	0.846658	0.333333	2.3826	0.595649	**0.70615**
KU	0.432197	0.101266	0.120951	0.380952	1.0354	0.258842	**0.15226**
IE	0.012344	0.101266	0.015119	0.047619	0.1763	0.044087	**0.06758**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.1666	0.1250	**0.2000**	5	4
IP	6.002401	1	7.0000	7	8	6
LEA	8	0.142857	1	8	8	7
CTA	5	0.142857	0.125	1	5	4
PA	0.2	0.125	0.125	0.2	1	0.2500
CW	0.25	0.166667	0.142857	0.25	4	1
∑	**20.4524**	**1.7440**	**8.5179**	**16.6500**	31.0000	22.2500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.048894	0.095529	0.014675	0.012012	0.16129	0.179775	0.512175	0.0854	**0.065133**
IP	0.293481	0.573401	0.821803	0.42042	0.258065	0.269663	2.636833	0.4395	**0.574787**
SLA	0.391152	0.081914	0.1174	0.48048	0.258065	0.314607	1.643619	0.2739	**0.183946**
STP	0.24447	0.081914	0.014675	0.06006	0.16129	0.179775	0.742185	0.1237	**0.354609**
PA	0.009779	0.071675	0.014675	0.012012	0.032258	0.011236	0.151635	0.0253	**0.039242**
CW	0.012224	0.095567	0.016771	0.015015	0.129032	0.044944	0.313553	0.0523	**0.055104**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	7.000	0.250	6
MP	0.142857	1	5.0000	7.0000
KU	4	0.200	1	6
IE	0.166667	0.142857	0.166667	1
∑	**5.309524**	**8.342857**	**6.4167**	**20.0000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.1883	0.839041	0.038961	0.3	1.3663	0.341586	**0.35333**
MP	0.026906	0.1199	0.779221	0.35	1.2760	0.318997	**0.29855**
KU	0.753363	0.023973	0.155844	0.3	1.2332	0.308295	**0.32237**
IE	0.03139	0.017123	0.025974	0.05	0.1245	0.031122	**0.02575**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1666**	**6**	**6**	4	6
IP	6.002401	1	5	6	7	6
SLA	0.166667	0.2	1	5	4	6
STP	0.166667	0.166667	0.2	1	3	0.2
PA	0.25	0.142857	0.25	0.333333	1	0.2500
CW	0.166667	0.166667	0.166667	5	4	1
∑	**7.7524**	**1.8428**	**12.6167**	**23.3333**	23.0000	19.4500

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.128992	0.090406	0.475561	0.257143	0.173913	0.308483	1.434499	0.2391	**0.190434**
IP	0.774263	0.542655	0.396301	0.257143	0.304348	0.308483	2.583194	0.4305	**0.531799**
SLA	0.021499	0.108531	0.07926	0.214286	0.173913	0.308483	0.905972	0.1510	**0.110473**
STP	0.021499	0.090443	0.015852	0.042857	0.130435	0.010283	0.311368	0.0519	**0.157133**
PA	0.032248	0.077522	0.019815	0.014286	0.043478	0.012853	0.200203	0.0334	**0.047508**
CW	0.021499	0.090443	0.01321	0.214286	0.173913	0.051414	0.577974	0.0963	**0.067949**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.2000	0.2000	0.2000
MP	5	1	0.1428	0.1428
KU	5	7.002801	1	0.1111
IE	5	7.002801	9.0009	1
∑	**16**	**15.2056**	**10.3437**	**1.4539**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0625	0.013153	0.019335	0.137561	0.2325	0.058137	**0.08998**
MP	0.3125	0.0658	0.013806	0.098219	0.4903	0.122572	**0.08673**
KU	0.3125	0.460541	0.096677	0.076415	0.9461	0.236533	**0.14202**
IE	0.3125	0.460541	0.870182	0.687805	2.3310	0.582757	**0.68127**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	0.2000	0.2000	0.2000	0.2000	0.2000
IP	5	1	0.143	0.2000	0.143	0.2000
SLA	5	7.002801	1	0.1428	0.1111	0.1428
STP	5	5	7.002801	1	0.1428	0.200
PA	5	7.002801	9.0009	7.002801	1	0.200
CW	5	5	7.002801	5	5	1
∑	**26.0000**	**25.2056**	**24.3493**	**13.5456**	6.5967	1.9428

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.038462	0.007935	0.008214	0.014765	0.030318	0.102944	0.202637	0.0338	**0.052741**
IP	0.192308	0.039674	0.005865	0.014765	0.021647	0.102944	0.377202	0.0629	**0.057364**
SLA	0.192308	0.277827	0.041069	0.010542	0.016842	0.073502	0.61209	0.1020	**0.062636**
STP	0.192308	0.198369	0.287598	0.073825	0.021647	0.102944	0.87669	0.1461	**0.067341**
PA	0.192308	0.277827	0.369657	0.51698	0.151591	0.102944	1.611307	0.2686	**0.217726**
CW	0.192308	0.198369	0.287598	0.369124	0.757955	0.514721	2.320073	0.3867	**0.504821**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	0.2000	0.3333
MP	7.002801	1	0.1428	0.2000
KU	5	7.002801	1	0.2000
IE	3.0003	5	5	1
∑	**16.0031**	**13.1456**	**6.3428**	**1.7333**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0625	0.010863	0.031532	0.192292	0.2972	0.074294	**0.10816**
MP	0.43759	0.0761	0.022514	0.115387	0.6516	0.16289	**0.10696**
KU	0.312439	0.532711	0.157659	0.115387	1.1182	0.279549	**0.20982**
IE	0.187482	0.380355	0.788295	0.576934	1.9331	0.483267	**0.57507**

Table 3: Pair wise rating of alternative

Link	ACD	IP	SLA	STP	PA	CW
ACD	**1**	**0.1428**	**0.2000**	**0.2000**	0.3333	0.3333
IP	7.002801	1	0.1428	0.1428	0.2000	0.1428
SLA	5	7.002801	1	**0.2000**	0.2	**0.3333**
STP	5	7.002801	5	1	0.3333	0.2000
PA	3.0003	5	5	3.0003	1	0.2000
CW	3.0003	7.002801	3.0003	5	5	1
∑	**24.0034**	**27.1512**	**14.3431**	**9.5431**	7.0666	2.2094

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	SLA	STP	PA	CW	∑	Average	Priority Vector
ACD	0.041661	0.005259	0.013944	0.020958	0.047166	0.150855	0.279843	0.0466	**0.074433**
IP	0.291742	0.036831	0.009956	0.014964	0.028302	0.064633	0.446428	0.0744	**0.050405**
SLA	0.208304	0.257919	0.06972	0.020958	0.028302	0.150855	0.736058	0.1227	**0.104061**
STP	0.208304	0.257919	0.3486	0.104788	0.047166	0.090522	1.057298	0.1762	**0.062964**
PA	0.124995	0.184154	0.3486	0.314395	0.141511	0.090522	1.204176	0.2007	**0.18044**
CW	0.124995	0.257919	0.209181	0.523939	0.707554	0.452612	2.276198	0.3794	**0.456717**
	1	1	1	1	1.0000	1			

K-8(a-f): Information Technology & Network Sector

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.125	0.1428	0.16666
MP	8	1	7.0000	8.0000
KU	7.002801	0.142857	1	7
IE	6.00024	0.125	0.142857	1
∑	**22.00304**	**1.392857**	**8.2857**	**16.1667**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0454	0.089744	0.017235	0.010309	0.1627	0.040684	**0.06151**
MP	0.363586	0.7179	0.844833	0.494846	2.4212	0.605303	**0.70982**
KU	0.318265	0.102564	0.12069	0.43299	0.9745	0.243627	**0.15223**
IE	0.2727	0.089744	0.017241	0.061856	0.4415	0.110385	**0.07645**

Table 3: Pair wise rating of alternative

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	**0.1111**	**0.125**	**0.2000**	0.2000	4
IP	9.0009	1	7	8	5	9
LEA	8	0.142857	1	7	6	8.0000
CTA	5	0.125	0.142857	1	0.5000	5.0000
PA	5	0.2	0.166667	2	1	6.0000
CW	0.25	0.111111	0.125	0.2	0.166667	1
∑	**28.2509**	**1.6901**	**8.5595**	**18.4000**	12.8667	33.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.035397	0.065737	0.014604	0.01087	0.015544	0.121212	0.263363	0.0439	**0.04192**
IP	0.318606	0.591692	0.817803	0.434783	0.388601	0.272727	2.824211	0.4707	**0.594873**
LEA	0.283177	0.084527	0.116829	0.380435	0.466321	0.242424	1.573713	0.2623	**0.174222**
CTA	0.176986	0.073962	0.01669	0.054348	0.03886	0.151515	0.51236	0.0854	**0.34496**
PA	0.176986	0.118338	0.019471	0.108696	0.07772	0.181818	0.683029	0.1138	**0.09105**
CW	0.008849	0.065744	0.014604	0.01087	0.012953	0.030303	0.143322	0.0239	**0.038291**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1666	6.0000	0.1250
MP	6.002401	1	6.0000	0.1428
KU	0.166667	0.166667	1	0.1250
IE	8	7.002801	8	1
∑	**15.16907**	**8.336068**	**21.0000**	**1.3928**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0659	0.019985	0.285714	0.089747	0.4614	0.115343	**0.07948**
MP	0.3957	0.1200	0.285714	0.102527	0.9039	0.225976	**0.14799**
KU	0.010987	0.019993	0.047619	0.089747	0.1683	0.042087	**0.06313**
IE	0.527389	0.84006	0.380952	0.717978	2.4664	0.616595	**0.7094**

Table 3: Pair wise rating of alternative

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	0.1666	6.0000	0.1428	0.1111	7
IP	6.002401	1	7	0.2000	0.1428	8
LEA	0.166667	0.142857	1	0.1666	0.1428	5
CTA	7.002801	5	6.002401	1	0.1666	5.000
PA	9.001	7.002801	7.002801	6.002401	1	8.0000
CW	0.142857	0.125	0.2	0.2	0.125	1
∑	**23.3156**	**13.4373**	**27.2052**	**7.7118**	1.6883	34.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.04289	0.012398	0.220546	0.018517	0.065806	0.205882	0.566039	0.0943	**0.056814**
IP	0.257441	0.07442	0.257304	0.025934	0.084582	0.235294	0.934975	0.1558	**0.099589**
LEA	0.007148	0.010631	0.036758	0.021603	0.084582	0.147059	0.307782	0.0513	**0.05157**
CTA	0.300348	0.3721	0.220634	0.129671	0.098679	0.147059	1.268491	0.2114	**0.150024**
PA	0.386046	0.521148	0.257407	0.77834	0.592312	0.235294	2.770546	0.4618	**0.574858**
CW	0.006127	0.009302	0.007352	0.025934	0.074039	0.029412	0.152166	0.0254	**0.042822**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1428	5.0000	0.1428
MP	7.002801	1	8.0000	5.0000
KU	0.2	0.125	1	0.1428
IE	7.002801	0.2	7.002801	1
∑	**15.2056**	**1.4678**	**21.0028**	**6.2856**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0658	0.097288	0.238063	0.022719	0.4238	0.105959	**0.07958**
MP	0.460541	0.6813	0.380902	0.795469	2.3182	0.579551	**0.67633**
KU	0.013153	0.085161	0.047613	0.022719	0.1686	0.042161	**0.05894**
IE	0.460541	0.136258	0.333422	0.159094	1.0893	0.272329	**0.18515**

Table 3: Pair wise rating of alternative

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	0.1428	7.0000	**6**	0.1666	7
IP	7.002801	1	9.0000	8	5	9
LEA	0.142857	0.111111	1	0.3333	0.125	4
CTA	0.166667	0.125	3.0003	1	0.1428	5
PA	6.002401	0.2	8	7.002801	1	8.0000
CW	0.142857	0.111111	0.25	0.2	0.125	1
∑	**14.4576**	**1.6900**	**28.2503**	**22.5361**	6.5594	34.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.069168	0.084496	0.247785	0.266239	0.025399	0.205882	0.898969	0.1498	**0.089554**
IP	0.484369	0.591708	0.318581	0.354986	0.762265	0.264706	2.776614	0.4628	**0.583042**
LEA	0.009881	0.065745	0.035398	0.01479	0.019057	0.117647	0.262518	0.0438	**0.042045**
CTA	0.011528	0.073964	0.106204	0.044373	0.02177	0.147059	0.404898	0.0675	**0.272601**
PA	0.415173	0.118342	0.283183	0.310737	0.152453	0.235294	1.515182	0.2525	**0.19439**
CW	0.009881	0.065745	0.008849	0.008875	0.019057	0.029412	0.141819	0.0236	**0.038399**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	3.000	0.1428	0.1111
MP	0.333333	1	0.1428	0.1250
KU	7.002801	7.003	1	0.1428
IE	9.0009	8	7.002801	1
∑	**17.33703**	**19.0028**	**8.2884**	**1.3789**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0577	0.157871	0.017229	0.080571	0.3134	0.078338	**0.06647**
MP	0.019227	0.0526	0.017229	0.090652	0.1797	0.044933	**0.06505**
KU	0.403922	0.368514	0.120651	0.103561	0.9966	0.249162	**0.14325**
IE	0.519172	0.420991	0.844892	0.725216	2.5103	0.627567	**0.72522**

Table 3: Pair wise rating of alternative

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	**0.500**	**0.125**	**0.2500**	0.125	0.2000
IP	2	1	0.125	0.500	0.1428	0.200
LEA	8	8	1	8	0.1666	7
CTA	4	2	0.125	1	0.1428	0.3333
PA	8	7.002801	6.002401	7.002801	1	7.0000
CW	5	5	0.142857	3.0003	0.142857	1
∑	**28.0000**	**23.5028**	**7.5203**	**19.7531**	1.7201	15.7333

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.035714	0.021274	0.016622	0.012656	0.072672	0.012712	0.17165	0.0286	**0.042485**
IP	0.071429	0.042548	0.016622	0.025312	0.08302	0.012712	0.251643	0.0419	**0.050007**
LEA	0.285714	0.340385	0.132974	0.405	0.096857	0.444916	1.705847	0.2843	**0.185781**
CTA	0.142857	0.085096	0.016622	0.050625	0.08302	0.021184	0.399405	0.0666	**0.053835**
PA	0.285714	0.297956	0.798164	0.354517	0.581376	0.444916	2.762643	0.4604	**0.592852**
CW	0.178571	0.212741	0.018996	0.15189	0.083054	0.063559	0.727808	0.1213	**0.075494**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	0.1666	4	0.250
MP	6.002401	1	7.0000	6.0000
KU	0.25	0.142857	1	0.200
IE	4	0.166667	5	1
∑	**11.2524**	**1.476124**	**17.0000**	**7.4500**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.0889	0.112863	0.235294	0.033557	0.4706	0.117646	**0.09853**
MP	0.533433	0.6774	0.411765	0.805369	2.4280	0.607004	**0.67559**
KU	0.022217	0.096779	0.058824	0.026846	0.2047	0.051166	**0.07039**
IE	0.35548	0.112908	0.294118	0.134228	0.8967	0.224183	**0.1555**

Table 3: Pair wise rating of alternative

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	**0.1428**	**5**	**0.200**	0.1666	5
IP	7.002801	1	7.000	6	7	9.0000
LEA	0.2	0.142857	1	**0.200**	0.200	3
CTA	5	0.166667	5	1	5	7.000
PA	6.002401	0.142857	5	0.2	1	8.0000
CW	0.2	0.111111	0.333333	0.142857	0.125	1
∑	**19.4052**	**1.7063**	**23.3333**	**7.7429**	13.4916	33.0000

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.051533	0.08369	0.214286	0.02583	0.012348	0.151515	0.539202	0.0899	**0.064663**
IP	0.360872	0.586066	0.3	0.774908	0.518841	0.272727	2.813415	0.4689	**0.575007**
LEA	0.010307	0.083724	0.042857	0.02583	0.014824	0.090909	0.268451	0.0447	**0.052204**
CTA	0.257663	0.097678	0.214286	0.129151	0.370601	0.212121	1.2815	0.2136	**0.336726**
PA	0.309319	0.083724	0.214286	0.02583	0.07412	0.242424	0.949703	0.1583	**0.099861**
CW	0.010307	0.065118	0.014286	0.01845	0.009265	0.030303	0.147729	0.0246	**0.038253**
	1	1	1	1	1.0000	1			

TABLE 1: Pair-wise rating of selection criteria

Domain	CE	MP	KU	IE
CE	1	9	7	8
MP	0.111111	1	0.2500	0.5000
KU	0.142857	4	1	1
IE	0.125	2	1	1
∑	**1.378968**	**16**	**9.2500**	**10.5000**

Table 2: Normalized pair-wise rating of selection criteria

Domain	CE	MP	KU	IE	∑	Average	Priority Vector
CE	0.7252	0.5625	0.756757	0.761905	2.8063	0.701585	**0.72457**
MP	0.080576	0.0625	0.027027	0.047619	0.2177	0.05443	**0.06868**
KU	0.103597	0.25	0.108108	0.095238	0.5569	0.139236	**0.11132**
IE	0.090647	0.125	0.108108	0.095238	0.4190	0.104748	**0.09543**

Table 3: Pair wise rating of alternative

Link	ACD	IP	LEA	CTA	PA	CW
ACD	**1**	**9**	**8**	**7.0000**	8	4
IP	0.111111	1	0.25	1	0.500	0.25
LEA	0.125	4	1	**2.0000**	1	**0.3333**
CTA	0.142857	1	0.5	1	1	0.1666
PA	0.125	2	1	1	1	0.2500
CW	0.25	4	3.0003	6.002401	4	1
∑	**1.7540**	**21.0000**	**13.7503**	**18.0024**	15.5000	5.9999

Table 4: Normalized pair-wise rating of alternatives

Link	ACD	IP	LEA	CTA	PA	CW	∑	Average	Priority Vector
ACD	0.570136	0.428571	0.581805	0.388837	0.516129	0.666678	3.152156	0.5254	**0.573127**
IP	0.063348	0.047619	0.018181	0.055548	0.032258	0.041667	0.258622	0.0431	**0.051196**
LEA	0.071267	0.190476	0.072726	0.111096	0.064516	0.055551	0.565632	0.0943	**0.074742**
CTA	0.081448	0.047619	0.036363	0.055548	0.064516	0.027767	0.313261	0.0522	**0.060705**
PA	0.071267	0.095238	0.072726	0.055548	0.064516	0.041667	0.400962	0.0668	**0.064706**
CW	0.142534	0.190476	0.218199	0.333422	0.258065	0.166669	1.309365	0.2182	**0.174687**
	1	1	1	1	1.0000	1			

K-9 (a): Consolidated Average Priority Vector for Teaching and Learning Domain

CE	0.211661458
IE	0.204211875
KU	0.213086875
MP	0.35300625

K-9(b): Consolidated Average Priority Vector for Linkage Type

ACD	0.157827563
CW	0.149664646
IP	0.306152583
PA	0.11193825
SLA	0.148994208
STP	0.194432646

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