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Study of the Effectiveness of the Implementation of Washington Accord in Malaysia's Engineering Undergraduate Programme using SEM

Sivajothi Paramasivam^{a*}, Kanesan Mutusamy^b, Kian Tan^c^a*KDU University College, Petaling Jaya, 47400, Malaysia*^b*Open University Malaysia, Kuala Lumpur, 50480, Malaysia*^c*Northumbria University, Newcastle upon Tyne, NE1 8ST, UK*

Abstract

Transformation of engineering undergraduate programs towards global practice of outcomes based accreditation (OBA) entails a huge challenge to universities as there is mounting pressure for infusion of desirable and yet measurable graduate competencies into its offered programs in order to fulfil professional bodies accreditation criteria. Hence, in view of providing a sense of direction to the local engineering education community, Washington Accord (WA) ensures that accredited programmes synonymously mean that its graduates are equipped with 12 professional abilities obtained through an innovative outcomes-based engineering programme. However, further complication unfolds as industries are continuously evolving to meet rapid global demand and practice; hence defining set of competencies that can accurately map attributes outlined by industry with the aim of addressing 'skill-gap' will continue to be a challenging endeavour for higher education sector. This paper intends to investigate the effectiveness of the OBA criteria outlined by WA in terms of attainment of graduate attributes which would enable graduates to take on challenging careers in the industry. Hence, the study will focus on identifying the relationship between the five outcome-based accredited criteria and the attainment of twelve graduate attributes outlined by WA in view of producing a conceptual framework which are then tested using Structural Equation Modelling (SEM).

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* Corresponding author.

E-mail address: siva@kdu.edu.my

1. Introduction

The impact of globalization has changed the landscape of engineering undergraduate education and it has pushed education providers to adopt the standard framework outlined by WA. Thus, this is viewed as an important milestone towards achieving success in producing graduates with a global mentality. This is also in tandem with nation's 20 years plans currently well in place, Malaysia's move towards developing a world-class education hub kick-starts by ensuring that its education system is of reputable quality, which would indirectly determine the quality of the country's future, vis-à-vis in generating a huge pool of work-savvy graduates who possess the ability to be innovative, competitive, and would value unity and harmony (Micheaux, 1997).

Universities are deemed to be the focal point which generates knowledge in abundance and conceives new and innovative ideas that will lead to technological breakthroughs. Hence, the process of teaching and learning focuses on the satisfactory planning of elements such as contents, strategies, assessment and other parameters. This focus has the eventual view and aim of ascertaining the extent and feasibility of the learning curve and the amount of learning that can be achieved by the student. It is an extremely delicate process, and the desirable learning outcomes from the teaching and learning process must be measured in an appropriate manner so that learners are well equipped for the workforce.

Fundamentally engineering education is the building block of knowledge base and set of attributes, however, there are many factors that will affect students' academic performance, ranging from students academic ability, the environment, teaching methodologies and teaching aids used, students' attitudes and the lecturers' involvement in teaching (Arsad, Buniyamin, & Manan, 2011). Thus, generally causing universities to arrive at a crossroad of being unable to complement concerned echoed by government, employers and professional bodies to produce graduates who are competently robust towards rapid change of work environment. It is important that education reforms initiated by university desired to be ahead towards meeting the changing needs of employers and the industry, thus fulfilling the human capital.

2. Graduate Attributes and Its Impact on Employability

Government's continuous initiatives to improve the higher education sector to be a force of global recognition has to be applauded as institutions of higher education are always viewed as important backbone that able to formulate and mobilize strategies covering curriculum development, active learning strategies, human and infrastructure resources as well as quality improvement to transform graduates to meet demands of industry as well as improve national economy in terms of healthy employment rate. Hence, graduate employability forms as an important aspect of higher education industry besides exploring potential new "breakthroughs" in the field of engineering.

As employers form an important stakeholder of institute of higher learning, it is imperative that feedbacks are obtained with regards to the desired key capabilities of graduates in view of meeting changing industry trends in various professions. One of the critical factors is the existence of competency gap and the crucial need of incorporating transferable skills to complement the core modules (Ratneswary & Rasiah, 2009). Industry representatives have stressed that engineering education should prepare students for real-world problem situations. They expect students to be equipped holistically and to have acquired competency in functioning as a team and able to display interaction and interdisciplinary skills (Badiru, 2002). New engineering graduates venturing into the workforce have impressed their employers with their technical competency but fail to shine in the aspect of employability skills which enable them to optimize their technical and knowledge skills effectively. (Yuzainee, et al., 2008). In fact, expectation of Malaysian employers has gone beyond technical knowledge and placed strong emphasize on ability such as excellent communication skills, problem solving excellent teamwork ability and good attitude towards professionalism (Shah & Nair, n.d.; Yuzainee, Omar, & Zaharim, 2011;

Mohaiadin, n.d.). Further complication arises as graduates are found to be not work-savvy as some education system are too prone exam-oriented and offer courses that has no market potential (Khoo, Moar, & Schibeci, 2011).

Education revolution towards graduate capabilities or attributes for university graduates are gaining momentum across the higher education segment primarily to fulfill the expectation of industry of competent graduate (Bosenquet, 2011). Graduate attributes are a set of qualities and skills pre-determined by institution of higher learning that are vital for students to develop and acquire during their tertiary studies which later contribute to their career (Khoo, et al., 2011; Barrie, 2004; Bosenquet, 2011). Engineering employability skills is also known as generic skills and is highly related to non-technical skills or abilities (Zaharim, et al., 2009). Graduate skills aims to enable graduates to be of forward thinking and response swiftly and accordingly as the landscape of employment is constantly subjected to changes due to global impact. The key graduate attributes outlined by WA is shown in Figure 1 (Brodie, Bullen, & Jolly, 2011).

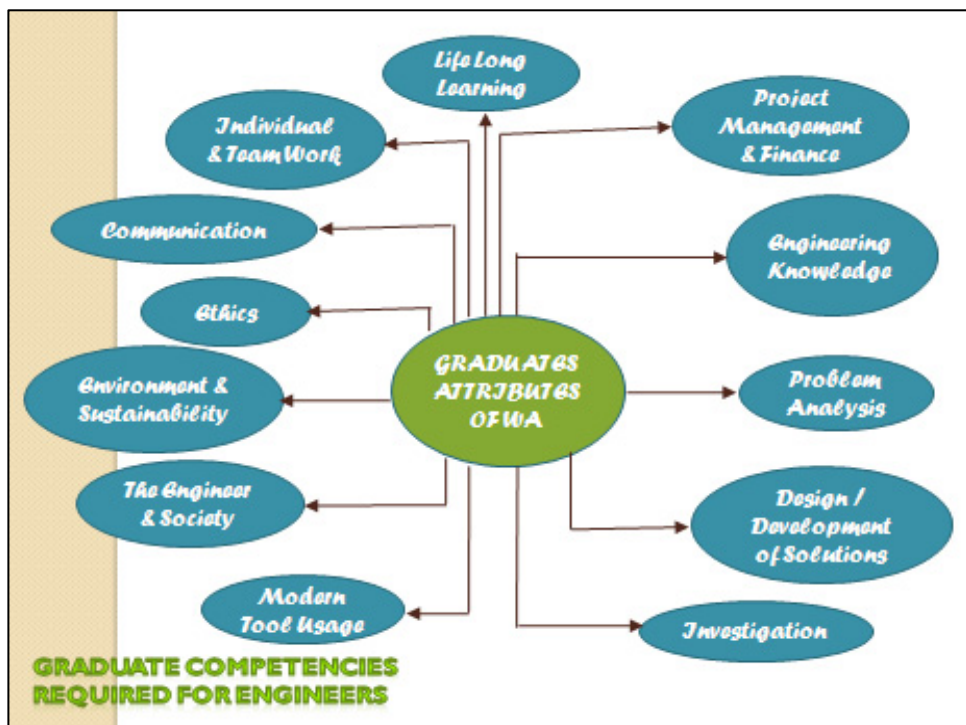


Figure 1: Graduate Attributes Outlined by WA

Even though fulfilling industry expectation forms one of the factors that influence the curriculum development of engineering programs; employability of graduates projects another concern especially given the recent economic climate turmoil. The reason being impact of globalization has created an immense transformation towards the labour market landscape as well as structural change to the economy segment, thus taking a huge toll to the nature of graduate careers (Ratneswary & Rasiah, 2009). Sustainability of business growth during the current global economical climate change has placed tremendous pressure on Malaysian employers to stringently scrutinize engineering graduates in terms of their use of creativity and innovation to solve pressing problems faced at work front (Shah & Nair, n.d.). Universities are encouraged to promote broader career management competence of graduates which would make them appealing to multiple employers across

various demographics. This competency enables graduates to create realistic meaningful career goal and strategize work decision and learning opportunities and strike a healthy balance between work and life (Bridgestock, 2009).

Hence, it's imperative that engineering education reforms initiated by universities are desirable to be aligned towards producing graduates who are capable of facing changing needs of employers as well as knowledge-base human capital that are able to positively contribute to the economic transformation agendas of the nation.

3. Outcome-based Accreditation Criteria

Accreditation is a process of quality assurance, an activity vital for engineering undergraduate programmes. If a programme obtains accreditation based on a stringent set of evaluation, the programme is deemed to have met a certain standard of excellence. A global trend towards outcomes based accreditation has ignited the re-engineering process to focus on key attributes that graduates should attain in order to blend in and contribute efficiently towards challenges at the work front (Palmer & Ferguson, 2008).

Engineering Accreditation Council (EAC) which acts as the appointed marshal for the engineering education in Malaysia has developed a set of graduate competency attributes mirroring Washington Accords guideline and policy that graduates are required to attain during their period of study. In view of meeting these expectations, Washington Accord ensures that accredited programmes synonymously means that its graduates are equipped with 12 professional abilities such as the capability to demonstrate sufficient knowledge in sciences and mathematics, possess design capabilities, able to work in multi-disciplinary teams and demonstrate broader problem solving skills, able to adopt of a lifelong learning approach, and able to work ethically and communicate effectively (Basri, 2009).

The national accreditation process of the undergraduate engineering programme needs to be recognised globally and be in-line with agreed global policies where outcomes-based accreditation is a mandatory requirement towards gaining accreditation. In ensuring that high quality is maintained of the assurance process, rigorous procedures and a set of criteria have been developed and they are to be used as key reference by education providers for adherence towards gaining full accreditation. Criteria such as the presence of academic challenges and rigour, innovative mode of teaching, assessment practices used, calibre of academic staffs, the conduciveness of the learning environment and the infrastructure support available for the programme are often scrutinized, and these criteria in totality is regarded an important yardstick for quality assurance (Engineering Accreditation Council Malaysia, [EAC], 2007).

3.1 Criterion 1: Academic Curriculum

Designing and crafting an engineering curriculum to cater for the rapid evolvement of technological developments is a challenging task which requires a high level of creativity. Elements of competencies are required to be infused into the curriculum as employers are keener on the capabilities of the graduates than the learned contents in the programme. Competencies acquired can encompass the knowledge, skills, abilities, attitudes and other characteristics that enable a person to exhibit and contribute skilfully in a given situation or on the work front (Passow, 2007).

Relevancy of engineering education to the demands of the industry is seen as least in priority as universities tend to develop undergraduate programmes based on their own requirements and policies that do not necessarily blend in with the industry's requirements. This mismatch between the industry's expectations and the education provided by universities has resulted in graduates being ill-prepared for work in the real-world, and bearing degrees that does not include the most current technologies (Song & Balamuralikrishna, 2005).

The curriculum developed emphasized to be of sufficient depth and breadth and must be complete with definition of expectations and assessments that would challenge students learning capacity. The contents of the programme should encompass critical elements of sciences and mathematics, core and elective technical modules

and the internship module in order to cultivate the desired twelve graduate attributes. It is expected that these attributes would allow graduates to suitably demonstrate their capabilities in order to impress potential employers (Martin, Maytham, Case, & Fraser, 2005).

Besides knowledge and skills directly related to the subjects in the programme, infusion of soft skills through workshops and activities are also not neglected; this is in view of providing students with a rich learning experience that will put them on the path of a balanced and holistic development. These workshops are also targeted to help students become more inquisitive, discerning, confident and self-directing, all of which will enable them to become independent life-long learners (Aziz, Megat Mohd Noor, Abang Ali, & Jaafar, 2005).

Teaching and learning methods employed can be varied; both inductive and deductive approaches can be employed. The model of methodology adopted in the programme is based on Outcome-based Education (OBE) with an infusion of Problem-based Learning (PBL), theory of inventive problem solving (TRIZ) and Project based Learning (ProjBL), forming an exciting approach whereby a minimum touch of the traditional teaching method of face-to-face lectures and tutorials is retained.

Engineering education providers are pressured to ensure that graduates are well equipped with the necessary transferable and creative thinking skills that would enable graduates to successfully gain employment. Utilization of appropriate tools for honing innovation and stirring interest in the area are normally not stressed in engineering undergraduate programmes (Kumar & Iman, 2010).

Reinforcing on the idea that there is a critical requirement for hands-on skills and real-life experiences in order to stay afloat in the competitive job market, it was thus suggested that the technical and vocational systems develop some form of partnership with the industrial sector to provide the much sought after exposure for engineering students. With this collaboration it is anticipated that the gap between real world practice and engineering education would be reduced. This idea was brought up because of the limitations in the educational infrastructure to produce the desired outcome for actual industry settings (Badiru, 2002).

OBE is considered an antidote for some of the deficiencies in the engineering education system as it enhances the core competencies of learners in areas such as: improved perception towards acquiring knowledge and skills, enhanced creativity and critical thinking capabilities, instilled sense of responsibility and leadership traits, having developed a global outlook towards technology developments (Malan, 2000).

3.2 Criterion 2: Students' Admission

Students are the main stakeholder of the programme of study in any Institution of Higher Learning (IHL). They form the dominant and important resource in ensuring programme gains popularity and sustainability. Hence, it is imperative that the crafted curriculum and execution of programs has strong employment sentiment at work front which would trigger a greater influx of enrolment.

In order to achieve its objective of ensuring 40% of its population to gain a university education by 2010, Malaysia university education sector has expanded rapidly both in terms of number of universities and student enrolment. However, despite these initiatives, accelerating rate of unemployed graduates was a huge concern to the nation as it reflects a waste of valuable resources in terms of investment as well as triggering potential social issues as erosion of skill due to prolong unemployment (Lim, 2011).

The secondary school qualification forms the primary source of enrolment into the undergraduate programmes. As students are well exposed on rote learning styles and examination oriented education system for almost 11 years, transition to adapt towards an innovative learners centric system of OBE format at tertiary level would cause students to fail to take ownership of their learning curve thus, resulting in high attrition rate at engineering schools.

Universities are constantly challenged to keep tabs on attrition rate on a positive level despite enacting on government policies to recruit high quality engineering students. Hence, it is vital that a proper entry qualification

scheme is developed with the view of controlling the selection process and to preserve the good reputation of the institution (Plattner, 2004).

As universities now routinely offer multiple admission routes into its program which indirectly complicate matters as students enrol on different background, strengths and weaknesses, interest, level of motivation and approach to study. Hence, a shift from traditional engineering pedagogy towards learner centred approach is adopted to meet the learning needs of a greater diversity of learners (Barrie, 2004).

It is imperative to adopt this selection process as IHL is required to monitor progression rate of students. This enables the IHL to project a reasonable relationship between its admission requirements and student retention, student failure and graduation rate (Kaushik & Khanduja, 2010).

3.3 Criterion 3: Academic and Support Staff

The outcome of an educational experience is normally influenced strongly by the professional competence and outlook of the staff. Hence, it is important that staffs are recruited according to their academic qualifications, years of teaching or industry experience, and their attitude and passion for teaching. In view of this, the most efficient and effective recruitment selection methods are deployed to guarantee that those being recruited meet the stringent requirements of the academic institution.

Possession of sound knowledge by engineering educators is crucial towards reaping a harvest of graduates with the desired attributes. In view of this, teaching loads must be set as such that it allows for adequate interaction between staff and students to motivate and spark passion in students as well as to allow staff to part take actively in professional development activities. Development of research strength and sufficient grants are important parameters in attracting excellent staff that are committed to contribute to the advancement in engineering knowledge (Plattner, 2004).

Paradigm shift towards more individualistic styles of pedagogy in tandem with aspiration of OBE which involve students working in small groups in an active mode tends to promote relatively positive learning curve of students in terms of motivation, increased interaction level, better understanding on context and improved sense of resourcefulness (Plattner, 2004). However, as engineering educators strive to master the many teaching and learning pedagogical approaches to stimulate, teach and motivate students and to tap into as much knowledge as possible, it is inevitable that at some point educators will realize that their efforts are in vain as the gap will still persistently exist between students' performance and the industry's expectations (Dee Fink, Ambrose, & Wheeler, 2005).

Community of educators are encouraged to be proactive in research and development as well as collaborative and consultancy activities to positively contribute and share their knowledge, expertise and new discovery as these activities now form as part of their key result area (KRA) in terms of performance. Thus, indirectly improves the image and reputation of the institution and contributes towards nation building (Abang Abdullah, Mohd Ali, & Mokhtar, 1994).

3.4 Criterion 4: Facilities

Services to support the teaching, learning and research activities form an important component of education institutions, and investments in this area must be considered in view of creating conducive learning environment. Hence, it is vital that academic institutions are financially well-positioned to provide optimal resources, be it human capital, physical or infrastructural, for the conduct of its programmes and related activities/events (Plattner, 2004).

An impressive facilities setup is viewed as a dominant marketing tool as it is a positive indicator of the institution's image positioning and branding, and in that way attract international students to join programmes

under its flagship. Hence, huge investments into additional resources are therefore needed to strategically face long term challenges in improving or maintaining the existing standards and to be committed to the country's transformation initiative of converting Malaysia into a central hub for education excellence in the ASEAN region (Mustafa, Basri, Abidin, Ali, Shahabudin, & Hamid, 2012).

3.5 Criterion 5: Quality Management System

Engineering education providers render services not only to students but also to industry players of various demographics that employ graduates. Hence, it is vital that processes are in place to improve and to strive for attainment of good service quality.

The quality culture is one of the most important factors that are to be considered not only for improving the processes in the education system but also to be leveraged on to increase enrolment, to reduce attrition rate as well as to ensure graduates' employability. This is because higher education has become more commercialized and is now treated as a market commodity. As education is becoming more service-oriented, students are viewed as products that are to be groomed well in view that they will be resources tapped by future employers (Kaushik & Khanduja, 2010).

The periodically program review exercise ensures that there is a good balance between academic rigor and the quality of graduates produced for the workforce. It ensures that tailored courses have kept in view the industry's needs and have synergized with developments and trends in technology. This move should provide young graduates the opportunity for better employment and room for development as they will have been prepared to adapt to the impact of rapid globalization, to blend and contribute towards the advancement in technological breakthroughs as well as to intensify the pace of the nation's growth and development (Basri, 2009).

It is vital that tertiary education providers develop a system or tool that ensures that the stated outcomes are achieved and met. The result from the tool should assist the institution to revisit the listed programme objectives for improvements.

4. Research Model and Hypotheses

Rapid changes in global and technical environments, graduating engineers venturing into the workforce face an uphill battle in discharging their functions effectively; a more worrying issue is the impact that these changes have on graduates' ability to display and demonstrate their attained graduate attributes at the work front.

This intended study is therefore to investigate the effectiveness of the OBA on criteria outlined by Washington Accord in terms of attainment of graduate attributes which would enable students to take on challenging careers in the industry.

Identification of competency gaps within the scope of this study is geared to reduce the discrepancies between the level of performance expected by the employer and the level that can be delivered by fresh engineers with regard to their actual capabilities.

Based on the literature gathered above, the following research model (Figure 2) and hypotheses (Table 1) are proposed and would be subjected to an empirical test. The conceptual framework presented in Figure 2 is drawn from the SEM approach.

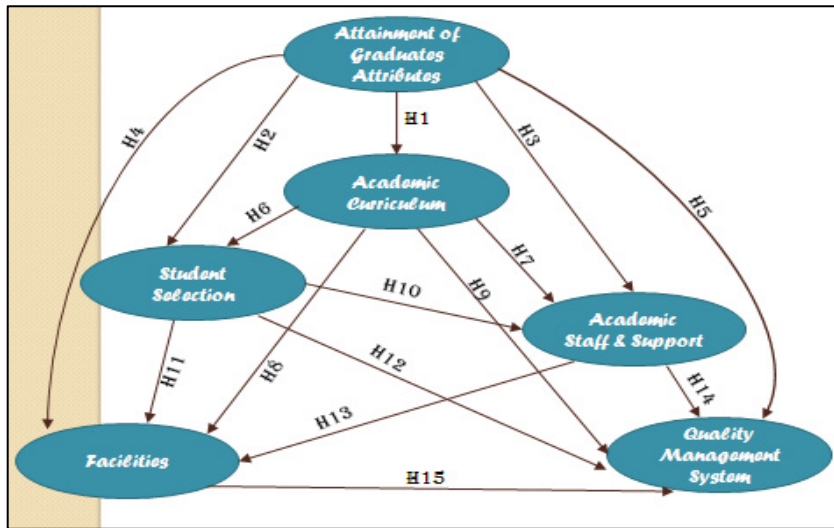


Figure 2: The Proposed Research Model
 (Source: Interpretation of Research Work, Chazoglou et al, 2011)

Table 1: Summary of the Intended Research Hypotheses
 (Source: Interpretation of Research Work, Chazoglou et al, 2011)

Hypothesis	Statement
H1	Graduate attributes positively affect academic curriculum
H2	Graduate attributes positively affect student selection
H3	Graduate attributes positively affect academic and support staff
H4	Graduate attributes positively affect facilities
H5	Graduate attributes positively affect quality management system
H6	Academic curriculum positively affect student selection
H7	Academic curriculum positively affect academic and support staff
H8	Academic curriculum positively affect facilities
H9	Academic curriculum positively affect quality management system
H10	Student selection positively affect academic and support staff
H11	Student selection positively affect facilities
H12	Student selection positively affect quality management system
H13	Academic and support staff positively affect facilities
H14	Academic and support staff positively affect quality management system
H15	Facilities positively affect quality management system

SEM is a statistical method to analyze theoretical constructs represented by the latent factors. This technique provides a very general and convenient framework for analysis as it capable of obtaining more relevant results than traditional method such as regression. SEM enables factor analysis and test analysis of hypothesis to be done with the same analysis. It is often visualized by a graphical path diagram and test of relationships in the proposed model could be carried out with ease (Saghaei & Ghasemi, 2009).

5. Research Methodology

5.1 Measure of concept

The study is designed as an explanatory study using survey method. The target population of this research includes all stakeholders affected by the outcome of this study including IHLs subjected to EAC accreditation process and industry players of various demographics as well as students. Survey questionnaires with a suitable scope and separated into sections, would be developed to capture the observed variable. It will then be administered to all the stakeholders in the Klang Valley through personal contact or electronic mails. An electronic mail system would be deployed along with a website which would enable participants to submit their response without much difficulty.

5.2 Sampling and Data Collection & Analysis

The data in this study is analyzed using Statistical Analysis Software (SAS). The initial process involves filtering out the unwanted gathered parameters in this study. The final data collected would be analyzed in terms of various appropriate segments to draw a reliable and accurate outcome for this study.

The response stored would adopt the predefined 5 point Likert scale using factor analysis the main factors included in the model would be tested for validity and reliability while the hypotheses would be tested using path analysis. Various fit indices would be used to assess the overall fit of the proposed model.

6. Discussion

The research proposed is to validate the effectiveness of the criteria and policy outlined by WA. However, as the questionnaires to address this research are being currently developed, it's expected that sufficient data would be available to draw a comprehensive conclusion on the effectiveness of WA under Malaysian context. The research finding expects to assist universities to re-examine the quality monitoring system of their educational process cycle to address any shortfall in the engineering education system

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