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Commercialisation of University Research into Engineering Education

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Abstract: This study examines the value of integrating exposure to and knowledge of the commercialisation of university research into engineering education. By including courses or programs addressing research commercialisation as offered by Faculty of Engineering, the commercialisation process within the university is both more reliable and better sustained. The literature thus far includes a considerable number of studies of the engineering education process that have examined the best mechanism for commercialisation as well as models for engineering education in Malaysia. As a contribution to this literature, we analyse the current practices of engineering, faculty at Malaysian research universities to determine the extent to which aspects of university research commercialisation are incorporated into their curricula. This study found that commercialisation of university innovations is not a significant component of an engineering education for students in Malaysia. However, integration of the commercialisation of university research into engineering curricula is essential to cultivate a culture of entrepreneurship among engineering students that will eventually assist the university in commercialising its research.

Key words: Engineering education, commercialisation of university research, university technology transfer, entrepreneurship, literature, Malaysia

INTRODUCTION

In Malaysia, the economic situation that developed in 2008 forced the government to limit its contributions to the research budgets of universities in Malaysia. As a result, the majority of Malaysian research universities will need to find alternative funding and adjust their budgets to fund their research activities in the future. Currently, Malaysian authorities are encouraging all Malaysian universities to commercialise their products for sale to the public.

This situation is quite stressful for Malaysian research universities because processes for commercialisation are new and unproven in Malaysia (Yusof *et al*., 2009; Hussain *et al*., 2011). There are five research universities in Malaysia including the Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Sains Malaysia (USM) and Universiti Teknologi Malaysia (UTM). The commercialisation of university research originated in the United States during the cold war when government budget deficits resulted in Federal funding cuts to public universities. The US introduced the Bayh-Dole Act in 1980; this act allowed those institutions that received federal funding to retain control of their intellectual property which promoted the commercialisation process in most US universities (Rasmussen, 2008). This act enables the university to obtain funding from the government more rapidly and assists in patent applications. In 1986, the Federal Technology Transfer Act was introduced to mandate and manage the development of inventions that have commercial value (Rahm, 1994). The growing involvement of universities in technology transfer and commercialisation has raised questions about their nature and mission (Lissoni *et al*., 2007). This study further examines the commercialisation of university research in Malaysia based on a review of the literature and the

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engineering education system in Malaysia. In the field of higher education research, there are many studies concerning the changing roles of the university and pressure from the government (Bok, 2003; Geiger and Sa, 2008; Etzkowitz, 2003; Owen-Smith, 2003; Hussain *et al*., 2011).

An entrepreneurial university can be defined as a university that has developed a comprehensive internal system for the commercialisation and commodification of its knowledge which includes not just structures such as liaison or technology transfer offices which bridge the gap between industry and the academy but also incentives for adjusting lines of study and the allocation of research budgets to the demand in the private and public sectors (Feldman *et al*., 2002).

This research also evaluates the structure of engineering education in Malaysia and we attempt to integrate commercialisation university research subject as a new course into the curriculum offered by engineering faculty. The integration of new courses related to the commercialisation of university research will help Malaysia universities establish platforms for the commercialisation process and will also facilitate the identification of suitable entrepreneurs to aid the commercialisation of university research. This study examines the methodology that was used in these researches and we evaluate the potential for integrating a new course related to the commercialisation of university research into the engineering curriculum that would change students' perspectives and contribute to the higher education system. The limitations of this research and possible future recommendations are suggested to improve the understanding of these issues.

In the early 1990s', there was increasing pressure on universities from industrial and educational leaders to implement significant changes to engineering curricula to better prepare engineers for leadership while providing real-world experience (Todd *et al*., 1995). Implicit in this educational view is that the role of academics is changing. Rather than focusing on blue-skies analysis, academics are increasingly eager to bridge the worlds of research and technology in an entrepreneurial manner by commercialising technologies that emerge from their research (Clark and Montgomery, 1998). Current university policies often require that their academic staff engage with their industrial counterparts. This policy promotes an environment in which the university and industry support each other and helps sustain an economic future. Commercialisation is a significant pressure on universities in the United States due to Federal government budget cuts that directly affect university funding (Cohen, 2005):

> Communities are increasingly looking to their regional governments and universities to implement programs that stimulate the local economy. This community expectation is especially vocal when regions are trying to overcome an economic downturn (e.g., the post dot-com bust) or stimulate a particularly promising industry (e.g., nanotechnology). In response to these heightened outcries, government leaders eagerly assemble a plan corresponding to taxpayer-derived funding. Leveraging universities is frequently a key component of this solution

Siegel *et al*. (2003) also note that the contribution of the commercialisation of university research to economic development is not new. University inventions have clearly contributed to the economic and social development of the country in United States because this area is a high value investment opportunity for investors. Malaysia desires similar development of its national economy thus, it is essential for Malaysia to become involved in the commercialisation process because greater entrepreneurship and impact on economic development will result. This trend has been observed by Mirowski and Sent (2002):

> Something rather drastic and profound has been happening to the social organization of science in America and Europe at the end of this century. In light of a newly globalized economy, those sweeping changes have a lot to do with accountability and impact of public funds

This statement indicates that commercialisation activities are an important feature in developing countries and universities in Malaysia should take serious steps to become involved in this process. The current role of the university is changing; the university is not only a place to perform research and publish but is also a place where revenue and income can be generated (for the university). The commercialisation process was also implemented in the United Kingdom.

However, this process has been much slower than that which occurred in the United States because the university environment in the United Kingdom similar to the environment in Malaysia is focused on research and publication.

The United Kingdom has many inventions that could potentially generate income for the university, however compared to universities in the United States, practically none of the universities in the United Kingdom have the capacity to commercialise their inventions. Recently, the United Kingdom has implemented a few changes

to accelerate this process and Malaysian universities should attempt to benefit from their situation. The commercialisation of university inventions entails an extensive process and numerous people. Transforming research/inventions into profitable businesses requires a proper strategy before revenue can be generated for the university.

Researchers believe that implementing changes to the traditional educational system is a component of this strategy. This approach will aim to increase university and student awareness of commercialisation as well as to prepare them for new roles of the university in the commercialisation process.

Due to the rising trend of globalisation in quality education, there is a rising demand for uniform quality assurance processes at different levels including at the university, professional, regional and international levels (Memon *et al*., 2009). These researchers also noted that engineering education in Pakistan has experienced problems such as low intake, shortages in lab equipment, no student feedback systems, lack of academic counselling and difficult access to scientific tools and materials. Schachterle (1999) asserted that the ability to use techniques, skills and modem engineering tools is necessary for engineering practice. There are many resources available for promoting the development of engineering education; in Malaysia, the educational curriculum has been developed with engineers who must design under and at the same time have knowledge on it (Dym *et al*., 2006). However at this stage, an active and uniform international accreditation agency in engineering education has not been established and successfully operated (Patil and Codner, 2007). Parkinson (2007) discussed what many forward-thinking engineering education institutions are doing to add a global and multi-cultural component to their curricula. The accreditation parameters and detailed criteria discussed in this research are critical components of the certification required by the government, prospective employers and industry to evidence the professional knowledge and skills possessed by engineering graduates.

Some argue that universities and industry are converging into a hybrid entity in which the differences between scholarly and commercial pursuits are becoming blurred (Hussain *et al*., 2011). However, announcements of the entrepreneurial university may be premature and based on an overstated generalisation of insights from the life sciences (Patil and Codner, 2007). To align the commercialisation of a university's research within the university's educational goals, a strategy for addressing commercialisation issues should be developed and implemented from the start of an education program. As described by D'este and Patel (2007), there are many mechanisms that can be used to implement the commercialisation of university research. This study was based on previously published research regarding the commercialisation of Malaysian university research and engineering education. Researchers attempt to identify the potential of integrating new courses related to the commercialisation of university research into the Malaysian university environment. We believe that the incorporation of technology transfer into the engineering education program will facilitate the commercialisation of university research.

However as mentioned by Yusof *et al*. (2009), there is a paucity of research available concerning the commercialisation of university research in the Malaysian context and Dzulkifli has further stated that an entrepreneurial culture should be developed in all Malaysian universities.

As we unanimously concur with Polanyi (1966) who stressed that while information is easily transmissible, information that is more tacit in nature is difficult to transmit from one person to another and the challenge is identifying the right people for accomplishing the right tasks when universities, especially in Malaysia, start to seriously focus on the commercialisation of university research. Thus, engineering faculty in Malaysia should never ignore or give less emphasis to aspects of research commercialisation in their curricula.

Incorporating the commercialisation aspects of university research into engineering education: In a study, entitled Malaysian engineering education model for the next millennium (Johari, 1999), the engineering profession is reportedly not playing a sufficiently important role in the community. As shown in Table 1, the duration for higher education in most engineering programs in Malaysia is 4 years. Table 1 also shows that technology transfer programs, comprised of activities in which students participate in a series of Problem-based Learning (PBL) tutorials that examine various scientific commercialisation issues such as corporate culture and intellectual property and work in groups on a project based on a commercially successful scientific idea are not being implemented in Malaysian research universities

Table 1: Engineering programs at Malaysian universities

Universities	Duration (years)	Technology transfer program	Entrepreneur program
University Kebangsaan Malaysia (UKM)	4	No	Yes
Universiti Malaya (UM)	4	No	Yes
University Sains Malaya (USM)	4	No	Yes
University Technology Malaysia (UTM)	4	No	Yes
University Putra Malaysia	4	No	Yes

even though, the Malaysian government has strongly emphasised the need for commercialisation of university innovations.

The Vice Chancellor of the University of Science Malaysia (USM) has stated that commercialisation of the university's research is still in its infancy which indicates that there are still many things that can be done to promote a culture of entrepreneurship and an awareness of the importance of commercialisation of university research.

Researchers opine that students in engineering programs should be exposed to the importance of technology transfer to facilitate their transformation into technoentrepreneurs (technology entrepreneurs). This approach will help the university commercialise their research more rapidly, especially when engineering students who are exposed to the importance of commercialisation start working with their professors and other researchers on the process of commercialising their innovation. In addition, the incorporation of commercialisation aspects into the engineering curriculum may also compensate for the problematic practice of conventional academia that limits the commercialisation process, i.e., engineering students with knowledge of the commercialisation process will assist university researchers by participating in the protection and commercialisation of Intellectual Property Right (IPRs), which is overly time-consuming (Smith and Parr, 2003). Currently, faculty members are focused on teaching material that is relevant to the requirements imposed by the government. However, the importance of commercialisation issues to engineering students may also trigger the same awareness for research academics who are more interested in pursuing their research than in devoting time to the commercial exploitation of their inventions.

Thus, it is now essential for Malaysia to follow the example of policy makers in a number of countries by promoting these developments, encouraging collaboration between universities and industry and providing monetary incentives to academics to facilitate their commercial involvement (Mowery *et al*., 2004; Link and Siegel, 2005).

RESULTS AND DISCUSSION

The present study discusses an approach for integrating the commercialisation of university research into the Malaysian education system from the perspective of engineering faculty. The data from the study indicate that there is potential for incorporating courses related to the commercialisation of university research into the Malaysian educational system. The study has several limitations and suggests that more research needs to apply to this issue. This study was limited by the fact that these types of courses have not yet been tested by other faculty, e.g., law school, medical school and social science faculty. Thus, researchers believe that the integration of the proposed course should also be employed by faculty in other research areas to provide a more complete understanding of the commercialisation process and a more thorough analysis of the situation in Malaysia.

Potential activities and general courses that reflect the exposure of Malaysian engineering students to technology transfer are shown in Table 2. The propose that exposure should occur as early as possible in the 2nd year of the engineering program. Using this approach, the importance of the commercialisation of university research in the engineering curriculum would be incorporated as a practical strategy for Malaysian universities to maximise their commercialisation development.

Table 2: General courses reflecting the exposure of Malaysian engineering students to technology transfer

Delivery	Tutorials	Presentations-case studies	Series of lectures	Group work	Final presentation
Problem-based learning (3 units) Year 3	Examining various scientific commercialisation issues such as corporate culture, intellectual property, ethics, governance and conceptualisation	Presentation of scenarios to students in a series of steps Debate, presentation of an enquiry for which the students must argue a particular position	From experts about the technology	On a project that is based on a scientific idea that has become a commercial success	Before the faculty members, venture capitalists,
Attachment to scientists (6 units) Year 4	Monitoring of students conceptual understanding by researchers	Student identification of market size, understanding customer pain, developing business plans	From experts about the technology	Building a theoretical start-up company	Before the faculty members, venture capitalists, angels
Negotiating skills (3 units) Year 2	Training students to negotiate with venture capitalists	Students present their innovations to the venture capitalists	Perspectives from venture capitalists	Elevator-pitch training among peers	Before venture capitalists on the product
Business plan competition made compulsory once over 4 years	Examining the development of business plans for investors	Students study previous case studies of commercialised innovations by engineering faculty	Perspectives from industry and venture capitalists	Students work with inventors and industry to learn about inventions and potential markets	Before industry representatives and venture capitalists on that product

CONCLUSION

The commercialisation of university research in Malaysia is still new and more research about this topic is needed. Incorporating the commercialisation of university research into engineering education will help to establish this commercialisation process and develop more understanding about this issue.

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