

**ISSUES OF COMMERCIALIZATION
ACTIVITIES OF BIOTECHNOLOGY-RELATED
RESEARCHES IN MALAYSIAN RESEARCH
UNIVERSITIES**

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Abstract

This study aims to explore issues of commercialization activities of research results among academic researchers who work in biotechnology-related researches in Malaysian Research Universities. Accordingly, the conceptual framework based on the 'Innovation Implementation' model has been assessed for its applicability in describing the phenomenon under study. Through interviews, elements as specified in the 'Innovation Implementation' model were found in this case study. Significant patterns and themes were also identified that suggest local industries, funding for research, development and commercialization as well as leadership, political interference, researcher's attitude, transition management and legal perspectives are considered as the contextual factors that affect the commercialization activities of research results. Finally, the revised framework of commercialization-activities implementation based on the findings from qualitative analysis was recommended.

Keywords: *Commercialization activities, research results, biotechnology, academic researchers and qualitative analysis.*

Introduction

The changing nature of the university's role makes the commercialization of university-research results more relevant nowadays. Faced with budgetary difficulties, universities now attempt to actively market their discoveries to the industry, use their inventions to form new companies and engage in commercial activity related to economic development. These initiatives are described by Slaughter and Leslie (1997) as marking a new era of academic capitalism leading to what Etzkowitz (1983) terms as entrepreneurial universities.

Nelson (2001) contrasts these new initiatives with older norms favouring the open dissemination of research discoveries. Previously, scientists working in university laboratories were, in general, content to pursue their investigations without giving much thought to the practical application of the results. The discovery and development of patentable inventions was not the primary objective of their research efforts. Today, we are witnessing a distinct departure from tradition, where many academic scientists avoided patenting and involvement with the industry (Feldman & Desrochers, 2004) and choose to focus on teaching and research. Nevertheless, the changing role of universities from knowledge production to capitalization of knowledge, with the objective of improving regional or national economic performance as well as the university's financial advantage, (Etzkowitz, Wester, Gerbhard & Terra, 2000) has led to an increase in commercial activities among universities in the last two decades.

This evolution of the role of the university in developed countries also imposed new demands and pressures on the developing countries' higher education system (Altbach & Ogawa, 2002; Teichler, 2003). Within this context, in developing countries, research universities are seen as vehicles for technology transfer and a medium through which knowledge exchange is made more effective. For the first time, under the 9th Malaysia Plan (2006–2010), the Ministry of Higher Education (MOHE) has opened up applications for research universities (RUs) in Malaysia. Subsequently, four universities, i.e., Universiti Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM) and Universiti Putra Malaysia (UPM) were awarded research university (RU) status after undergoing several rounds of an auditing process by a committee developed by the Ministry of Higher Education. The vision of the RUs is active involvement in the generation of new ideas, the implementation of innovative research methods and the use of intellectuals in the science of discovery beyond

the boundaries of existing knowledge. The mission of the RU's is to be at the heart of the countries' development where faculty members and students participate in research within a conducive environment, and to allow for education exploration and the search for creative-knowledge discovery in order to generate wealth for better life. To achieve the vision and mission, the designated RUs will be given at least an additional RM100 million each for research development and commercialization activities including universities' research grants and postgraduate scholarships.

This highlights the importance of promoting commercialization activities of research results among academic researchers. In addition, the individual academic researcher is central to the knowledge and technology transfer process in making strategic decisions about how to disseminate his/her research results in the university. Researchers decide whether or not to collaborate with the industry, disclose their inventions to their university and/or start a company based on their knowledge. An increase in activity at the level of the individual academic will also accompany the shift from policy to implementation. With the realization that academic researchers are viewed as critical to the process, further understanding is required to identify issues related to commercialization activities of research results.

Why Biotechnology?

A considerable amount of research has been done by scholars on identifying the factors that affect the low rates of university research commercialization in Malaysia. However, the factors which influence and hinder research commercialization are not generalizable to all technology due primarily to the nature of technology itself. Biotechnology is a very good example. Jarret (2007) indicates that achieving regulatory approval is one of the major hurdles to biotechnology commercialization as it involves expensive, long-range research and corresponding comprehensive data.

In addition, in the Ninth Malaysia Plan (2006–2010), biotechnology is a highly prioritized sector in Malaysia's national policy because the government has high hopes of achieving international excellence and academic and commercial success in this field. Recognizing Malaysia's strong potential in advancing biotechnology for wealth creation and societal well-being, the National Biotechnology Policy (NBP) was launched in 2005. The 15-year plan, drawn up by the NBP, aims to make Malaysia a global biotechnology hub and a

biotechnology R&D hub by the year 2020. Nine major thrusts were identified whereby biotechnology development in agriculture, health and industrial sectors has been accorded top priority besides R&D, human capital development, financial infrastructure, legislative and regulatory framework, strategic positioning and government commitment. The plan comprises three phases covering capacity building (2005–2010), science to business (2011–2015) and global business (2016–2020). Malaysia is now entering the second phase of implementing the NBP. The focus has shifted towards bringing scientific discoveries from research activities to the global marketplace through commercialization and product development. BiotechCorp has been paving the road in strengthening private sector collaboration with public universities and research institutes to expedite bringing Malaysian R&D to the global marketplace. Total investment under the NBP is expected to be around RM30 billion (US\$7.9 billion) whereas a total of RM2.1 billion has been allocated for biotechnology in the Ninth Malaysia Plan. Out of this, an initial RM300 million has been allocated to BiotechCorp to initiate commercialization, technology acquisition, entrepreneur development and the development of an intellectual property framework.

Therefore, Malaysian research universities with relatively good research and development track records could eventually contribute to the progress of biotechnology. Accordingly, the challenges faced by Malaysian research universities in bringing biotechnology related research to the market will be the focus of this study.

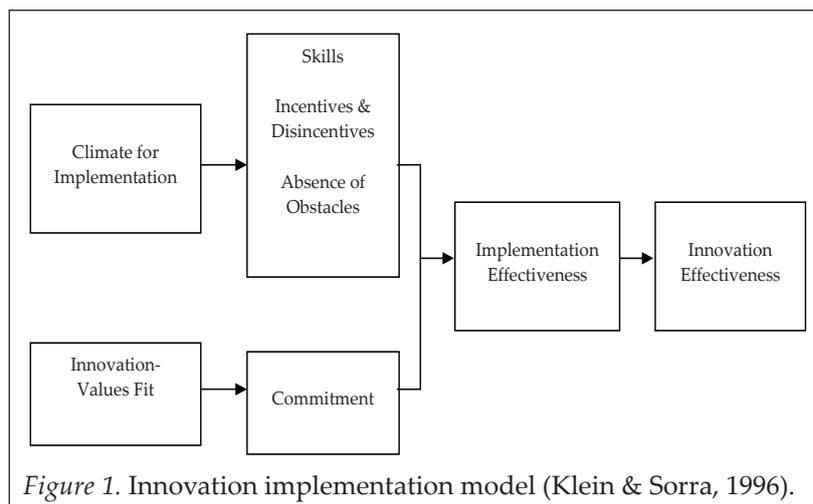
Commercialization Activities of Research Results

Several authors have called attention towards the fact that studies regarding commercialization at universities have hardly been focused on technology transfer i.e. areas related to patenting, licensing and spin off (Litan, Mitchell & Reedy, 2007; Mowery & Sampat, 2005; Meyer-Krahmer & Schmoch, 1998). Less attention has been focused on the other activities that occur before the technology leaves the university setting. In order to have a better understanding of the commercialization among academic researchers in Malaysian research universities, other activities, that occur before the technology leaves the university setting, is needed to be looked at. Thus, the scope of commercialization used in this study are more comprehensive, not limited to technology transfer activities such as patenting, licensing and spin off, but initial efforts that contribute to the commercialization are also taken into account, including knowledge transfer activities that have value and commercial motives.

Although there have been other studies on technology transfer, particularly, the study which focused on academic researchers, they had been done mainly in developed countries [(refer works by Audretsch & Stephan (1996, 1999); Bercovitz & Feldman (2004); Di Gregoria & Shane (2003); Keck (1993); Louis, Blumenthal, Gluck & Stoto, (1989); McFetridge (1993); Thursby & Thursby (2002); Zucker, Darby & Armstrong (2002); Zucker, Darby & Brewer (1998)]. In Malaysia, for example, the study toward commercialization was done by Senin (2006) and Sadullah (2002). Sadullah (2002) in his general survey gauged perspectives about university-industry collaboration in Malaysia. Interestingly, both studies highlighted that Malaysian academics were not committed to research commercialization in Malaysian Universities. This finding, combined with the researcher's experience, has motivated the researcher to look at this matter in depth.

Theoretical Background

Klein and Sorra (1996) provided a significant theoretical path (Figure 1) addressing an important university research commercialization question: Why does university research commercialization vary among universities? Organizations fall short in successfully exploiting innovation because they are unable to develop new products or services. Klein and Sorra (2006) proposed that ineffective implementation was another cause for the unsuccessful attempts by organizations to exploit innovations. The conditions for effective implementation are (a) strong organizational climate for implementation supported by (b) the organizational members' perceptions of the innovation-values fit.

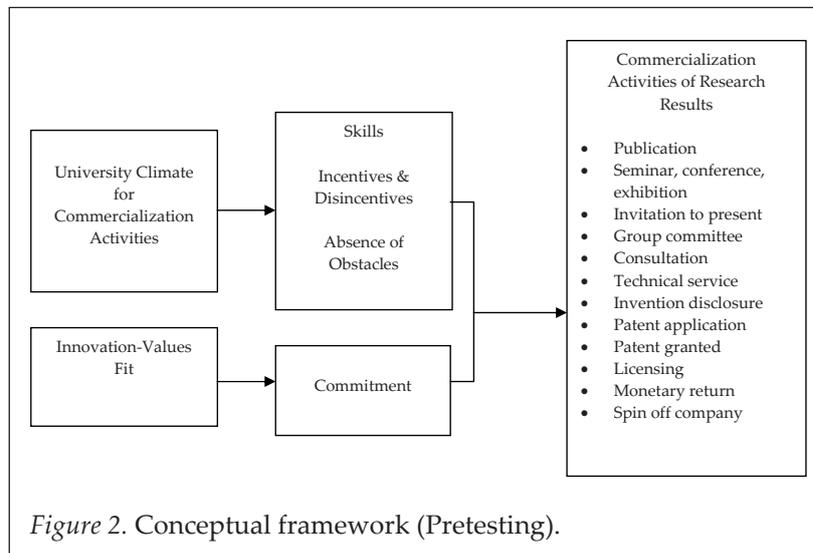


A strong climate encourages the use of innovation by (a) providing resources to develop employability, (b) establishing a reward system that provides incentives and disincentives, and (c) removing processes and resource obstacles. The perceived fit between innovation and the employee's values influence the level of individual commitment towards implementing the innovation. These circumstances better bridge the organization's ability to shift from adopted policies to demonstrated productivity.

Conceptual Framework

The Klein and Sorra (1996) model presented a wide range of variables and environmental factors that can have an impact on implementation effectiveness. However, only limited research has been done on their models within a higher educational institution setting using the academician as a unit of analysis. Drawing on the aspects of the innovation-implementation theory (Figure 1) as related to innovative activity, these dimensions are positively related to the commercialization of research. Commercialization of research could also be considered as innovation since innovation is defined as the adoption of an idea or behaviour that is new to the organization (Damanpour, 1988, 1991; Daft & Becker, 1978; Hage, 1980; Hage & Aiken, 1970; Oerlemans, Meeus & Boekema, 1998; Wood, 1998; Zaltman, Duncan & Holbek, 1973; Zammuto & O'Connor, 1992). However, this theoretical framework needs to be elaborated to address the complexity of the study by the development of the conceptual framework.

Based on Figure 2, the conceptual framework (pretesting) showed the institutional influences and individual attitude on the commercialization activities of research results. The foundation of the conceptual framework is that the university climate for commercialization and innovation-values fit are recognized as the critical factors which lead to the commercialization activities of research results. As theoretically conceived by Klein and Sorra (1996), the innovation-values fit construct is important to consider when evaluating the innovation-implementation effectiveness within an organization. The influence of the university climate on the commercialization of research conveys that it is not about finding which one factor contributes the most towards promoting the commercialization of research, but rather it is the perception of all the factors collectively that is most important. Commercialization activities of research results response to implementation effectiveness as implementation behaviour is defined as an individual's consistent and committed use of a particular innovation (Klein & Sorra, 1996).



The framework also showed that the university climate for commercialization activities and innovation-values fit will affect the 11 items of the commercialization activities of research results among academic researchers. It pointed out that the vision of research university will be to encourage researchers to consider their knowledge transfer activities as knowledge assets that can be transferred outside the scholarly community (Landry, Amara & Ouimet, 2007).

Noticeably, most of the research to date has focused on the technology at the time it leaves the university either through licensing to commercial firms or the creation of start-ups. Little attention has been focused on the other activities that occur before the technology leaves the university setting. In order to have a better understanding of the commercialization activities among academic researchers in Malaysian research universities, other activities that occur before the technology leaves the university setting is needed to be looked at. Thus, the scope of the commercialization activities used in this study are more comprehensive, not limited to technology transfer activities such as patenting, licensing and spin off, but the initial efforts that contribute to the commercialization activities are also taken into account, including knowledge transfer activities that have value and commercial motives. All the 11 items used by Jusoh (2008) will be focused on in this qualitative study. Similarly, Jusoh's study was also conducted on research university, however with the focus on Total Quality Management using the quantitative approach. In addition, the aforementioned 11 items are consistent with those identified by Landry et al. (2007).

The 11 items are (a) publishing academic writing; (b) communication with other users outside the academic environment/priority parties such as private firms or government agencies through seminar, conference, exhibition, report in printed or electronic media; (c) presentation of research to group and organizations who could make direct use of them; (d) involvement in committees which are interested in using and exploiting new knowledge based on the research; (e) the given consultation/technical services (based on technology field/research result) to private firms, government agencies or others; (f) disclosing the invention based on research; (g) applying patent based on research; (h) got patent based on research; (i) giving the licence to another party or organization to produce or market the product from research; (j) the licenses that have been given to the other party, would result in monetary return; and (k) research results could create spin off companies that specifically produce and commercialize the research product.

Methodology

The methodological approach used in this study is framed within qualitative research. The single-case study is an appropriate design under several circumstances. The single case can be used to determine whether a theory's propositions are correct or whether some other alternative set of explanations might be more relevant (Yin, 2003). Single-case research design also serves the purpose of theory testing particularly well, if they are most or least likely or crucial cases. Single-case studies can also reject variables as being necessary or sufficient conditions (Dion, 1998). For the purpose of this study, a research university which has a proven track record leading towards spin off of biotechnology-related research has been selected as a single case. This research university's uniqueness qualifies its selection as the single case as Yin (1994) recommends.

As in any qualitative case study, 'the crucial factor is not the number of respondents but rather the potential of each person to contribute to the development of insights and understanding of the phenomenon' (Merriam, 1988, p. 77). As such, by using purposive sampling and snowball sampling, eleven academic researchers who worked on biotechnology-related research were selected to participate in the interview.

Semi-structured interviews were the principal research instrument used in the case study. The interviews for this study began at the end of July 2009 and ran until October 2009. E-mail requesting interviews

were sent to potential academic researchers prior to the fieldwork. Interviews were conducted according to the respondents' schedules and availability and at their preferred locations.

An interview protocol representing lists of questions to be asked to each respondent was also created prior to the fieldwork. Three questions from the interview were asked in order to get the perception of the participants regarding the university climate factors and the eleven commercialization activities of their research results. The questions were: (a) How did your university help academic lecturers in that particular commercialization activity? (b) How did your university deal with lecturers who committed or did not commit to that particular commercialization activity and (c) How did your university help you to reduce the difficulties in that particular commercialization activity? Those particular commercialization activities referred to the eleven commercialization activities as the questions were asked pertaining to one commercialization activity at a time. In order to examine innovation-values fit factors, the following two questions were asked: (a) As a lecturer/senior lecturer/associate professor/professor, how does this commercialization activity benefit you? and (b) Have you been involved in this commercialization activity? If yes, what were the difficulties that you often encountered in this commercialization activity? If you have not been involved in this commercialization activity, what are the reasons?

While having a predetermined list of questions, during the interviews the wording of the question was not necessarily the same and the order of the questions were often modified based on the participant's responses. Additional questions were often asked. All interviews were conducted in English. However, the participants were allowed to answer in Malay or English, whichever language they were most comfortable with. On the average, the interviews lasted approximately one hour and fifteen minutes.

To ensure confidentiality, develop trust and encourage the respondents to provide full information, names were coded. A refers to the first academic researcher interviewed while B refers to the second academic researcher interviewed. Interviews were recorded on tape with the respondents' permission. Taping the interview allows the researcher to concentrate on the discussion and listen to the interview as often as needed. Repeatedly listening to a taped interview enables the researcher to capture the essence and meanings of words, which facilitates quality analysis of data. Follow up inquiries were often made by telephone or e-mail.

Validity and Reliability

According to Breakwell (2000), 'the interview approach relies upon respondents being able and willing to give accurate and complete answers to questions posed, no matter what their format. Yet respondents may be motivated to lie. They may dislike or distrust the researcher. They may wish to sabotage the research. They may be too embarrassed to tell the truth. Even if they wish to cooperate, they may be unable to answer accurately because they cannot remember the details requested or because they do not understand the questions.'

The above factors allowed the researcher to set several strategies to ensure internal validity. In this study multiple sources of data or triangulation was used which included document investigation, participant observation, and interviews (Denzin, 1988). However, Guba and Lincoln (1985, p. 288) felt that the triangulation of data-collection methods strengthen the 'dependability' and 'consistency' of the results obtained from the data. Guba and Lincoln (1985) believed that the two terms better describe the term 'reliability' and are linked with internal validity since it is impossible to have internal validity without reliability, a demonstration of internal validity amounts to a simultaneous demonstration of reliability' (Guba & Lincoln, 1981, p. 120).

The interview protocol developed at the outset of the case-study research was not only helpful in guiding the researcher during the fieldwork but also helped to ensure that the study could be repeated with similar results, therefore reinforcing its reliability (Yin, 2003, p. 37).

Results

The case study revealed a detailed pattern as to what extent the Innovation-Implementation Model can be applied to describe and explain the commercialization activities of the biotechnology-related research among academic researchers in the context of Malaysian research universities.

It can be concluded that the university climate as well as the innovation value-fit factors are important in promoting the commercialization activities of biotechnology-related research in the case study conducted. Based on the interview of eleven academic researchers, for university climate, it is apparent that most academic researchers perceived the commercialization of their research geared up the

publication activities because of the institutional policy that gives most incentives to publication. Problems and issues related to the eleven commercialization activities, faced by the participants, were the lack of experience of patenting, Technology Transfer Office (TTO) staff's lack of experience in patenting process, negotiating agreements with the industry, TTO not aggressive enough to push companies to pay for consultation and licensing fees that have been agreed, very limited workshop and training regarding spin offs and time constraint to create spin off. It is interesting to note that there are two groups of academic researchers involved in biotechnology-related research; the lecturer and the medical lecturer, who hold different perspectives due to different responsibilities and research approaches. The different issues raised by the medical lecturers were about conflict of interest, and costly medical products to produce.

The finding for the innovation-values fit (the perceived fit between the commercialization activities and the employee's values) showed that most participants of the case study, viewed job satisfaction as the most important benefit of their commercialization activities. According to Klein and Sorra (2006), this innovation-values fit will influence the level of individual commitment towards implementing the innovation (commercialization activities). Thus, job satisfaction is interrelated with commitment. Job satisfaction normally depends on what the employees can get or receive from the job. As humans, academic researchers are also subject to the problems of dissatisfaction at the workplace. If they are not satisfied, they may not be committed to deliver the best. Many studies have shown that committed workers are more likely to become high-performing workers who benefit their organization in terms of productivity and profit (Narimawati, 2007; Tella, Ayeni & Popoola, 2007). In the context of this study, most participants perceived job satisfaction in terms of intangible benefits as they felt that there is no compromise in any commercialization activity as it is supposed to be their obligation as an academician. Some of them perceived job satisfaction in terms of tangible benefits like promotion and monetary return. This finding is consistent with the previous research done by Jaafar, Ramayah and Zainal (2006) who found that responsibility and opportunity for promotions ranked as the important motivating factors that affect job satisfaction.

From the interviews it was found that several factors other than the university climate and the innovation-values fit factors influence the commercialization activities of research results among academic researchers. The other factors related to the commercialization activities of the biotechnology-related researchers are the lack

of local industries, funding for research and development and commercialization (R&D&C), leadership, political interference, researcher's attitude toward commercialization, management transition and legal perspectives.

The lack of industries related to biotechnology is the barrier for researchers to bring out their research results to the committee. They perceived that the reality is that most of the biotechnology companies are Small Medium Enterprises (SMEs) which hardly involved themselves in commercialization activities. Moreover the available industries are not serious in the commercialization activities of the research results because of funding and some due to conflict of interest. G commented that local companies do not seem to support the commercialization process for the right reason. When money becomes the main objective, the company's interest does not match the researchers' interest anymore.

In this study, the academic researchers involved in biotechnology-related research find themselves in a different position from their peers at institutions in developed countries. They tend to be underfunded and are unable to purchase and apply the latest research equipment. H remarked that funding the research itself is a problem. Finding the right facilities is very tedious and has caused researchers to be disheartened. When even the process of buying the equipment is difficult, researchers would be demotivated to move forward.

Commercialization funding was also reported as a problem. C complained that finding funding for commercialization projects is a huge problem even for public-sector bodies. C explained that, due to the lack of local regulation guidelines, enforcement and certification, such as CE for medical devices, researchers in the medical field need to take it upon themselves to get proper certification for their products in order to be able to market the products for use. Acquiring such certification means researchers bearing the additional cost for the whole tedious process, doing it on their own accord. Apart from difficult funding opportunities, organizations like the public-sector bodies could help to supply only a fraction of the required funding amount.

The behaviour of leaders plays a fundamental role in facilitating, nurturing and supporting commercialization activities within a university. Participants in this study claim that the university-level leadership act as the catalyst that stimulates commercialization activities. They perceived that the Vice Chancellor (VC) and the Deputy Vice Chancellor (DVC) were good at planning strategy and

vision. A commented that the current VC is very supportive and helpful towards their commercialization activities. C also commented that this is even more when the current DVC of research and innovation comes from the same research background. His experience helps him to make the process easier for his researchers.

Political interference also influences participants in the commercialization activities. F viewed politics as a barrier as the intention to create spin offs cannot be achieved because of the current political climate. Speaking from personal experience, the participant mentioned that she had been invited to present the research result in one company, but because of politics, the management changed, and the arrangement was cancelled. This discouraged the researcher from commercializing her research result. C faced difficulty in getting funding for the commercialization of his product. C explained how after repeated rejections from one of the funding agencies, who claimed that his product was not good enough to be commercialized, he had resorted to help from a political figure in order to realize his commercialization process.

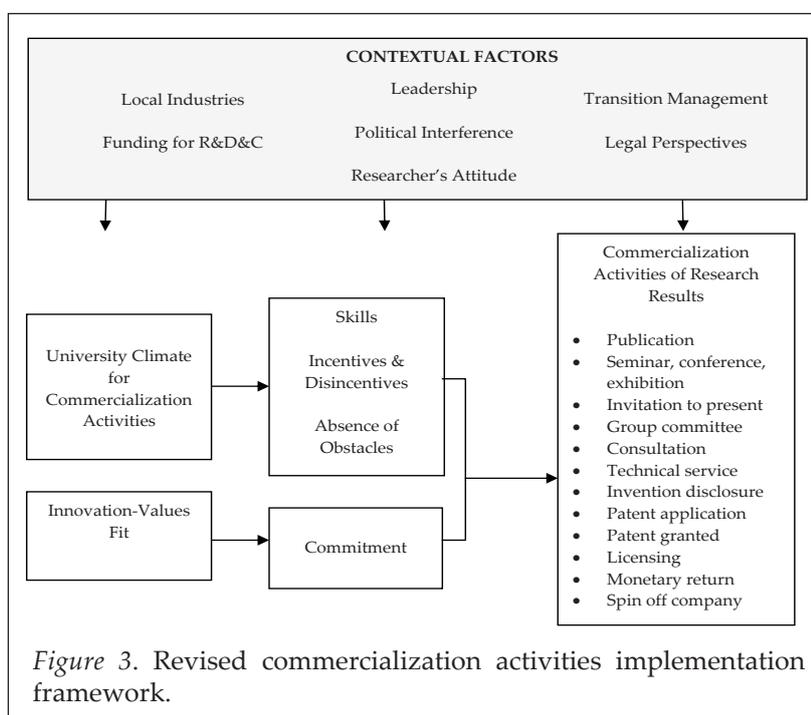
The researchers' attitude toward commercialization activities also influences their engagement in the commercialization activity: H emphasized that he remained convinced that the main reason for conducting research was not for commercialization.

Another factor is management transition. To improve the process of commercialization activities, a university introduced a new system or an institution to facilitate the academic researchers. However, H explained how, due to TTO being a new establishment at the university, sometimes caused overlapping of processes with the previous institution that had handled the matter before.

From the legal perspective, J complained about the Non-Disclosure Agreement (NDA) that the university had implemented which had frightened outside parties away from inviting academic researchers to present their research results. Besides that, the participants also complained about the civil service system in Malaysia that restricts them to create spin offs compare to other countries. For H, the restriction which disallowed civil servants from operating and running a company was a serious disadvantage. He cited Harvard which is a profit organization (in contrast with local universities as nonprofit organizations), having its own staff running companies while still functioning as active academic staff. Here is an illustrative comment from H:

“...in the US, every university is a company. Harvard University has two components: Harvard University, the university and Harvard incorporated. So you declare the university as a non-profit organization, but Harvard incorporated is a profit organization...and a lot of companies are put under this...And of course because everything owned is within Harvard incorporated, the flexibility of you running a company and becoming a professor is not an issue. And that’s how Walter Gilbert runs a company that’s now called M-gene and at the same time is a professor at Harvard. Here we are not allowed to. Any government servant is not allowed to become an executive...or play an executive role.”

Based on the findings, a revised innovation-implementation framework is derived accordingly (Figure 3). The revised commercialization activities-implementation framework incorporates the qualitative findings as contextual factors into the conceptual framework (pretesting) in this study that affects the degree of relationship between the university climate for commercialization and the innovation-values fit and commercialization activities of the research results throughout the is project’s life cycle.



Discussion

The university climate for commercialization activities are critical in stimulating, enabling, facilitating and nurturing the commercialization of research, behaviour and mindset among the academic researchers. When the university climate is perceived to be accommodative and conducive for commercialization activities, a higher level of academic commercialization activities can be witnessed in the university. Hence, there is a strong need to understand the university climate for commercialization activities that contribute toward the commercialization of research among lecturers so that steps can be taken by the management to create a conducive commercialization-activities environment that is in line with their expectations.

The findings of this study indicate that the university climate for commercialization activities should be given due consideration as they significantly affect the consistency of the commercialization activities of the research compared to the innovation-values fit factors. For example in this study, the absence of disincentives in most commercialization activities of research result will make the academic researchers satisfied with whatever their achievement in their commercialization activities. Furthermore incentives are also lacking at some level of commercialization activities such as in patenting, licensing and spin off. This will cause the academic researcher to be involved in certain types of commercialization activities where more incentives are given.

This study also revealed that there are deficiencies in the university Technology Transfer Office (TTO) itself. Most participants complained that the TTO did not have experienced staff in helping their product-patenting process, were not aggressive in collecting repayments from the industries on behalf of the researchers and there was a lack of spin off-activities exposure. Obviously, policies should address issues that are critical to the success of the commercialization of research such as royalty-income distribution, assignment of responsibility for seeking patent protection, researcher and institutional conflict of interest, management of licensees' contractual performance and training in spin off companies. Given that this initiative is relatively new, university officials and policymakers need to seek guidance on the "best practice".

The higher education systems in Malaysia during this study period consisted only of four research universities with limited autonomy which were tightly controlled by the government. This limits the ability

of the academics to engage in collaborative activities with industries. For instance, academic staff employed by these universities were considered civil servants, subject to strict public-service regulations imposed by the Malaysian Public Service Department, including restrictions not only on the number of working hours with the industry but also on the amount of money that could be received from activities such as consultant fees. Universities and their academic staff were not allowed to engage in commercial activities, including the exploitation of academic research results. Commercialization activities of research results therefore were minimal during this study period as indicated by the findings of the survey of commercialization activities of research results among academic researchers. Thus, the Intellectual Property Commercialization Policy for R&D projects, introduced in June 2009, can be used as a platform to further evaluate the impact of this policy on the commercialization of research results among Malaysian academic researchers.

Conclusion

Conclusively, this research suggests that the university climate for commercialization activities and innovation-values fit do affect the choice of the method used for commercializing the research results. However there is one limitation to the evidence obtained. The primary evidence is derived from a single-case study at one of the Malaysian research universities and from a small number of participants due to the lack academic researchers who have experience in all the commercialization activities that have been studied. There is a need for evidence from additional studies from both the private and other public universities in Malaysia as well. Nevertheless, this suggests the opportunity for further research in this topic.

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