

**THE FACTORS TO IMPROVE COMMERCIALISATION RATE: A CASE
STUDY IN UNIVERSITI TEKNOLOGI MALAYSIA (UTM)**

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DEDICATION

This dissertation is dedicated to my mother and father, whose love, understanding, and patience provided tremendous support and encouragement to me throughout the period of my master study.

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ABSTRACT

The aim of this study was to improve the commercialization rate in Universiti Teknologi Malaysia (UTM), for achieving this goal variety factors and issues were examined to identify how they effect on the procedure of university commercialization. These factors include role of technology transfer office /center, availability of finance, availability of potential licensee and entrepreneurial orientation (EO) among university researcher. Among these four factors, this study focused more on the entrepreneurial orientation (EO) among academic researchers and its effect on the commercialization rate in UTM. This study was based on a qualitative research method and was designed to use a case study approach. For investigating the factors and issues in this study, a total of ten face-to-face interview was conducted. The respondents were chosen from inventors, researchers, academic entrepreneurs, and Technology Transfer Office staff in UTM. The researcher utilized the content-analysis approach to analyze the data obtained from the semi-structured interviews of the respondents. The results indicated that, the must critical factor was availability of finance. This study also addressed the implications and recommendation for research and practitioners.

ABSTRAK

Tujuan kajian ini adalah untuk meningkatkan kadar pengkomersilan di Universiti Teknologi Malaysia (UTM), bagi mencapai matlamat ini, pelbagai faktor-faktor dan isu-isu telah dikaji untuk mengenal pasti bagaimana ia memberi kesan ke atas prosedur pengkomersilan universiti. Faktor-faktor ini termasuk peranan pemindahan teknologi pejabat/pusat, ketersediaan kewangan, kesediaan lesen berpotensi dan orientasi keusahawanan (*entrepreneurial orientation*,EO) di kalangan penyelidik universiti. Di antara keempat-empat faktor ini, kajian ini memberi lebih tumpuan kepada EO di kalangan penyelidik akademik dan kesannya terhadap kadar pengkomersilan di UTM. Kajian ini adalah berdasarkan kaedah penyelidikan kualitatif dan telah direkabentuk dengan menggunakan pendekatan kajian kes. Bagi menjalankan penyiasatan faktor-faktor dan isu-isu dalam kajian ini, sejumlah sepuluh wawancara secara langsung telah dijalankan. Para responden telah dipilih dari pencipta, penyelidik, usahawan akademik, dan kakitangan Pejabat Pemindahan Teknologi di UTM. Penyelidik menggunakan pendekatan analisis-kandungan untuk menganalisis data yang diperolehi daripada temu bual bersama responden secara separa-berstruktur. Hasil kajian menunjukkan bahawa, faktor yang kritikal adalah ketersediaan kewangan. Kajian ini juga menggariskan implikasi dan cadangan untuk penyelidikan dan pengamal.

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LIST OF ACRONYMS AND ABBREVIATIONS

AR	- Academic Research
AUCC	- Association of Universities and Colleges of Canada
AUTM	- Association of University Technology Managers
EO	- Entrepreneurial orientation
GERD	- Gross Expenditure on R&D
ICC	- Innovation and Commercialization Centre
IP	- Intellectual Property
IPR	- Intellectual Property Rights
IRPA	- Intensification of Research in Priority Areas
MASTIC	- Malaysian Science and Technology Information Centre
MAVCAP	- Malaysia Venture Capital
MOA	- Ministry of Agriculture and Agro-Based Industry, Malaysia
MOHE	- The Ministry of Higher Education, Malaysia
MOSTE	- Ministry of Science, Technology and Environmental, Malaysia
MOSTI	- Ministry of Science, Technology and Innovation, Malaysia
MP	- Malaysia Plan
MPIB	- Malaysian Pine Apple Industry Board

MTDC	- Malaysian Technology Development Corporation
MyIPO	- Intellectual Property Corporation of Malaysia
NIE	- Newly Industrializing Economies
NIS	- National Innovation System
NSDC	- The National SME Development Council
OECD	- The Organization for Economic Co-operation and Development
PMSEIC	- Prime Minister's Science, Engineering and Innovation Council
R&D	- Research and Development
R&D&C	- Research, Development and Commercialization
RC	- Research Commercialization
RM	- Ringgit Malaysia
SME	- Small and Medium Enterprise
SMI	- Small and Medium Industry
TT	- Technology Transfer
TTC	- Technology Transfer Center
TTO	- Technology Transfer Office
UCF	- University Challenge Fund
UCF	- University Challenge Fund
UPM	- Universiti Putra Malaysia
USM	- Universiti Sains Malaysia
USO	- University Spin-Off

- USPTO - United States Patent and Trademark Office
- UTM - Universiti Teknologi Malaysia
- VC - Venture Capital

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Due to the significant role of regional development and knowledge based economy, universities are playing different roles in their communications with the business community while they transfer technology to the industry (McAdam et al., 2012). The commercialization of academic studies is treated to be as “the process in which ideas, knowledge, and innovations would be conveyed to tangible assets” (PMSEIC, 2001) including benefits that satisfy society and economy at large scale.

Nowadays studies on the university research commercialization and the various models for university technology transfer are receiving more attention (Jolly, 2011; Siegel et al., 2003). Present research also desires to examine commercialization of the research output in Malaysian universities and it would attempt to explore notable factors affecting commercialization process.

The current study is conducted at Universiti Teknologi Malaysia (UTM) as a case study, which is a leading university in Malaysia (Aziz et al., 2011). In this study

main motivation is to investigate university commercialization procedures acted in Universiti Teknologi Malaysia and to introduce the major players in the commercialization process at the University.

This chapter includes a background, problem statement, research questions, and also research objectives. Later issues such as the scope of the study and the importance of the study will be discussed.

1.2 Research Background

The university R&D output is an important source of significant technological innovations. According to Florida and Choen (1999), universities are known as talent promoters in the knowledge economy, which are operating as an important infrastructure towards building such capacities for nations and regions to survive and succeed in the knowledge economy. Hence the commercialization of technological and scientific knowledge generated within universities, research centers, laboratories that are publicly funded research organizations, is increasingly regarded via policymakers as input for regional economic growth to be sustainable and developed (Ndonzuau et al., 2002).

Traditionally, teaching and research have been the university's main objectives but recently the commercialization of research results or 'entrepreneurial science' has emerged as a new role for universities in society (Rasmussen et al., 2006). Therefore the universities are required to adopt with new roles in regional and national economic development. In this regard universities treat this challenge as threefold issue: one is to promote the domain of commercialization, another is to make more visible its contribution to economic development and finally is to address

the relationship between commercialization and other related operations (Rasmussen et al., 2006).

According to OECD (2000b) recently universities are gaining more autonomous, more funding, and therefore more commercialization activities. The developments in research commercialization, patenting and licensing activities in the U.S. universities have resulted from Bayh-Dole act issued by US (1980), and became effective on July 1, 1981 (Carlsson and Firdh, 2002). It created exclusive rights to universities to commercialize publicly funded research. Therefore, the business sector needed intellectual property (IP) rights to select, promote and commercialize university research. Prior to this Act, universities weren't interested in commercializing research, mainly because it imposes notable fixed costs (Bozeman, 2000).

Goldfarb and Henrekson (2003, pp. 644-651), who conducted an exploratory study on the two national policies (US and Sweden) towards commercialization of university research, state that:

“The US model is mainly concentrated on offering (economic) incentives for universities to commercialize their research output and then allowing them to experiment to find the best means by which to do that. In contrast, the Swedish model, which is similar to most European Union countries’ models in some respects, is very much an attempt by the government to directly create mechanisms that facilitate commercialization.”

The Australian government has introduced various policies in order to provide universities with the ground work for enhancing research commercialization. Emphasize was made on the notion to universities to be more entrepreneurial in technology transfer activities. As university research commercialization activities in

Australia improve in collaboration with industry and community at large, UCCs (University Commercialization Companies) have to promote university research without compromising the university's mission and academic values. The objective is to increase national innovation and economic growth (Thika, 2010).

The study of research outcomes commercialization at the Iranian technology park shows that there are five groups of factors affecting the commercialization including: 1) research-oriented factors, 2) industry-oriented factors, 3) government, 4) technology parks and growth centers, and 5) environmental issues (Jalili et al., 2011). They also point out that the most important factor in the commercialization process is government role. For them government's main important role is to provide research market through productive capabilities, stimulating other parts, and also through expanding this market to a nationwide (Jalili et al., 2011).

As an example in Saudi Arabia universities are taking a critical role in changing the economy from a resource based to knowledge-based. In this case universities are serving not only as sources for knowledge creation but also they act as sources for entrepreneurial activities (Audretsch et al., 2011). While most studies about identifying the scientist entrepreneurship have been done in the OECD (The Organization for Economic Co-operation and Development) countries, work of Alshumaimri et al. (2011) that was done in the context of the Middle East (Saudi Arabia) indicates academic entrepreneurship in this area different from what already have been revealed from studies in OECD countries. In contrast to OECD, insufficient skills among younger scholars in Saudi Arabia make them to more open to entrepreneurship.

Since 1970s Malaysia has started as a middle-income country through expanding economic activities. Later in 1980s Malaysia changed its economy from a raw materials producer into electronics exporters (Wonglimpiyarat, 2011). Malaysian Gross Expenditure on R&D (GERD) of RM 3.6 billion placed it 37th in the world ranking in 2005. Among the GERD of the East Asian Newly

Industrializing Economies (NIE), Malaysia was ranked fourth after South Korea, Singapore and Hong Kong (MOSTI, 2008) (See Appendix A).

In Malaysia, the commercialization and innovation development has been assigned as 'Niche 1' by the Malaysian Ministry of Higher Education, which implies the emphasis and urgency (MOHE, 2010) under the Tenth Malaysian Plan. In terms of commercialization activities in education sector, the trend had been; i) setting up private universities, ii) creating consultancy centers, iii) Concentration on research identification of research agenda, and iv) emphasizing research commercialization. The last one has received more budgets (i.e. 191.5 billion RM in 2010). The budget was allocated for developing innovation in Malaysian economy where it is found that university R, D & C is one of the key success factors (Aziz et al., 2011).

The government conducted essential measures to expand commercialization of research findings through providing grants and funds (Chandran, 2010). Grant plans encompass the entire process from the idea to commercialization and marketing (Wonglimpiyarat, 2011). Many agencies and departments including the Ministry of Science, Technology and Innovation (MOSTI), Malaysian Technology Development Corporation (MTDC) and the Malaysian Biotechnology Corporation are involved in addressing things related to grants and funds. In line with these corporations there are other departments that assist in providing startups, financing, loans and venture capital funding.

1.2.1 Background of Universiti Teknologi Malaysia (UTM)

UTM with two campuses In Johor Bahru (i.e. Main campus) and Kuala Lumpur (i.e. Small campus), is a leading innovation-driven entrepreneurial research

university working on science and technology. UTM is one of the universities in Malaysia, with 2000 academic staff, 16,000 undergraduate and 9,000 postgraduate students. There are 14 faculties, 1 language academy, 5 schools for graduate studies, and 1 school for continuing education. It has been established in 1904 as the country's first technical school but later it evolved into a college and later in 1975 it was upgraded to Universiti Teknologi Malaysia. UTM's main motivation is to handle creativity and innovation processes, which contribute the Malaysian wealth creation (Official website UTM, 2012).

UTM has had the highest commercialization output among Malaysian universities, which is assessed based on four domains, including Patent, Trademark, Commercialized product and R&D with Potential for Commercialized Products (MOHE, 2008) (See appendix B). UTM's R&D and commercialization activities have been ruled under various policies, including IP Commercialization Policy, Intellectual Property Policy, and R & D Policy (Official website UTM, 2012).

UTM's has set its R&D with research centers in certain fields of studies. Research Management Centre (RMC) is responsible for handling researches, which also preserves a Directory of Researchers and List of R&D Products. Innovation and Commercialization Centre (ICC) is UTM's one stop center for technology innovation and commercialization. ICC also carries out intellectual property managing and exploitation.

It's structure role in driving R&D and commercialization as discussed earlier can be seen in the accumulated IPs until 15 September 2011 that was 2,170 cases, including Patent Pending, Patent Granted, Utility Innovation Pending, Utility Innovation Granted, Industrial Design Application, Industrial Design Registered, Trademark Application, Trademark Registered, Copyright and Layout-Design of Integrated Circuit (UTM source) (See Table 3.1). In addition, UTM was awarded the highest number of intellectual property registered with MyIPO, the Malaysian

Intellectual Property Office, which handles the IP filing in Malaysia (Official website UTM, 2012).

1.3 Statement of Problem

Malaysian government allocated remarkable budget to support R&D and commercialization activities in research institutions, especially universities. It was reported that under the 9th Malaysia Plan (2006 - 2010), a total of RM 3.101 billion has been invested to fund R&D projects. Meanwhile, the 10th Malaysia Plan (2011 – 2015) provided RM 741 million for R&D for the first two years of the five year plan. In addition, global comparisons indicate that Malaysia obtained the third rank among the top 10 countries in 2010 for patent and utility innovation granted (MyIPO, 2012) (See Appendix C). But, it has been asserted that only a small percentage of the Malaysia universities' R&D outcome have been commercialized (Aziz et al., 2011). Out of 3,707 research projects conducted under the Seventh Malaysia Plans (1996-2000), only 527 have been commercialized (Sadullah, 2005).

According to Jolly (2011), technology-based inventions mainly would not move beyond the conception phase. Ideas always may come to mind but seldom leave a sign. The same situations would be applied for patents, but in many cases they would be as trophies of the inventor or records of technical achievement (Jolly, 2011). Yet the process of commercialization has not gone forward nor it is simple to do. Even in developed nations, for example Europe, success in such processes is limited. Despite its few successes, still Malaysia is at the beginning journey of commercialization (Chandran, 2010). Thus, there are some specific problems in the commercialization pathway of Malaysian universities.

Another issue that must be considered here is that transforming technology into wealth is usually accompanied with potential risks that may decline degree of success in project development or may affect investment in such projects (Drof & Worthington, 1990; Eldred & McGrath, 1997). In addition, the amount of funding that allocated to certain project is limited. Then, the success of research commercialization is critical issue for government and universities. On the other hand, under the financial crisis that government may encounter a funding shortage, universities must seek various sources for funding and revenue, which make them more "entrepreneurial" (Todorovic et al., 2011).

In order to manage the knowledge transferring process in terms of skills and governance structure matter, technology transfer centers are playing a critical role (Swamidass and Vulasa, 2009). Such centers seem to be the main place that any invention would be disclosed for the first time. These centers indicated great capabilities for commercialization as well. It is clear that they finance researches in inventions, helping business planning, opening to venture capitalists, helping in recruiting startup teams, and incubator space (Wu, 2007). Despite their great attention to support the invention yet they are suffering from insufficient resources and competencies (Swamidass & Vulasa, 2009). Furthermore, they also have problems with insufficient skills and budgets to support their programs. Time also is another issue for staff whom are working in these centers. In short, they may succeed in patenting and inventing but they may have insufficient resources for commercializing them (Wright et al., 2008).

Most of literatures that are related to university research commercialization in Malaysia investigate institutional and external factors of technology transfer. But still there is a shortage in the amount of commercialized product in universities. Therefore examining of behavioral characteristics of university researchers can be crucial to enhance the university commercialization rate. Entrepreneurial orientation (EO) indicates the procedures, techniques and decision-making styles researchers utilize to act entrepreneurially (Clausen and Korneliussen, 2012). Lack of strategies like risk-taking, proactiveness, innovativeness that are the dimensions of EO

(Lumpkin and Dess, 1996) among academic researchers prevents them to pursuing entrepreneurial activities.

Hence, they require recognizing critical factors affecting the process of technology development and technology commercialization among Malaysian universities and research centers. Then, the aim of this study is to investigate UTM commercialization activities and to identify factors affecting commercialization in view of academic entrepreneurs. For achieving this purpose, following research questions are designed.

1.4 Research Questions

Question 1: How entrepreneurial orientations among UTM's researchers affect the commercialization in UTM?

Question 2: What factors influence the commercialization of university research output in Universiti Teknologi Malaysia (UTM)?

1.5 Research Objectives

The present study is an effort toward study the major factors that affect the university outputs commercialization and also the process of university commercialization. Following are research objectives:

- To examine how entrepreneurial orientations among UTM's researchers affects the commercialization in UTM.
- To identify those factors affecting the commercialization of university research output in Universiti Teknologi Malaysia (UTM).

1.6 Scope of The Study

The study tries to investigate commercialization factors at Universiti Teknologi Malaysia (UTM). The respondents were selected from the inventors, researchers, academic entrepreneurs, technology transfer office/center staffs, and administrative personnel in UTM. It is hoped, that the result of this study can be used in proposing useful recommendations and strategies that will help those engaged in the university commercialization processes and university (UTM).

1.7 Importance of Research

Technology is a critical issue in national economic development and essential for companies to gain competitive advantage or to improve and maintain their competitive position in the market place. Most technologies are developed in research institutions, especially from university. Transfer of technologies from noncommercial to the private sector is known as major activity that is corporate to new business startup, enhancing current business operations, and also generation of new jobs (Maktin, 1990; Parker and Ziberman 1993; Proctor 1993). Therefore, enhancement of main technologies would definitely lead into greater social wealth.

A number of studies investigate the technology transfer and commercialization by universities, such as studies by Reimers (1999), AUCC (2001), Tornatzky, et al. (2002), Lambert (2003), Miles and Daniels (2007), and Smilor and Matthews (2004). However, most of the studies come from developed nations. A developing country like Malaysia is still behind in terms of its research capabilities. Obviously, Malaysia is taking beginning steps toward research commercialization. In this respect, MOHE is attempting to support universities' R&D activities since 2006, which intends to drive quality research by period time from 2008 – 2010. However, recently MOHE promoted research excellence through producing innovation and its commercialization for the time period 2011 – 2012 (Aziz et al., 2011).

Therefore, current study desires to investigate research commercialization operations at UTM. The findings of the study increase the body of knowledge on technology transfer and university commercialization particularly in UTM and generally in Malaysia.

It is very important to identify factors affecting research output commercialization in the university. Recognizing these factors is beneficial for several groups. Researchers, academic entrepreneurs and technology transfer office/center staffs obtain a better view on commercialization their research outputs to correct their weaknesses and offer required changes in the performance. In addition, commercialization in research context is risky and costly (Eldred & McGrath, 1997). It is urged to know significant factors in success or failure in the context of university research commercialization. Current research offers important information for universities to be implemented in long-term plans.

Transforming and commercialization together provides a beneficial ground in which universities would have more benefits to the public (Expert Panel on the Commercialization of University Research, 1999), and also it would assist financing more projects (Association of Universities and Colleges of Canada, 2001).

Nowadays, Malaysia is at risk of less effective commercialization therefore enhancement effectiveness of technology transfer is critical for government. Hence, the finding of this study helps government to improve its commercialization policies to enhance the commercialization rate in UTM.

REFERENCES:

- Aarikka-Stenroos, L., Sandberg, B. (2012). From new-product development to commercialization through networks. *Journal of Business Research*, 65, 198-206.
- Abdullah, S. H., Mohd. Osman, M. H., and Alias, R. A. (2008). The development of information technology entrepreneurship through post-graduate education & incubation program in Malaysia. In Ismail K. (Ed.) *Issues in Commercialization and Management* (pp. 118-138). Printed in Malaysia by Univison Press.
- About Universiti Teknologi Malaysia (UTM): Brief History of UTM, Vision & Mission, Faculties & Schools. Retrieved January 12, 2012, from <http://www.utm.my/about/introduction-about-utm/>
- Abu talib, N. (2007). *Commercialization and Its Discontents*. Ph.D. Thesis. University of Stirling.
- Aldrich, H. and Martinez, M.A. (2001). Many are Called, but Few are Chosen: An Evolutionary Perspective for the Study of Entrepreneurship. *Entrepreneurship Theory and Practice*, 25: 41-56.
- Alshumaimri, A., Aldridge, T., Audretsch, D. (2011). Scientist entrepreneurship in Saudi Arabia. *J Technol Transf. Springer Science+Business Media*.
- Amat Senin, A. (2008). University-Industry Technological Links in Malaysia: Commercialization of University Research Results. In Ismail K. (Ed.) *Issues in Commercialization and Management* (pp. 73-93). Printed in Malaysia by Univison Press.
- Association of Universities and Colleges of Canada (2001). *Background Report on the Facilities and Institutional Support Costs Incurred by Canadian Universities*

in Conducting Federally Sponsored Research. Association of Universities and Colleges of Canada, Ottawa, Canada.

AUCC (Association of Universities and Colleges of Canada) (2001). *Commercialization of University Research*. Viewed 10 January 2008, <http://www.aucc.ca/_pdf/english/reports/2001/commerc_05_25_e.pdf>.

Audretsch, D. B., Leyden, D. P., & Link, A. N. (2011). Universities as research partners in publicly supported firms. Paper to be presented at the Basque Institute of Competitiveness.

AUTM (Association of University Technology Managers) 1997, AUTM Licensing Survey. Northbrook, Ill: AUTM.

Award and Recognitions Channel: UTM Wins Intellectual Property Award. Retrieved January 5, 2012, from <http://www.awards.utm.my/blog/utm-wins-intellectual-property-award-for-the-third-time/>

Aziz, K. A., Harris, H., & Norhashim, M. (2011). University Research, Development & Commercialisation Management: A Malaysian Best Practice Case Study. *World Review of Business Research*, Vol. 1. No. 2. Pp. 179 – 192.

Badawy, Michael K. (1988), "What We've Learned: Managing Human Resources," *Research Technology Management*, 31 (5), 19-35.

Bailyn, Lotte (1985). Autonomy in the Industrial R&D Lab. *Human Resource Management*, 24 (2), 129-46.

Baird, I. S. & Thomas, H. (1985). Toward a contingency model of strategic risk taking. *Academy of Management Review*, 10, 230-243.

Bandura, A. (1986). *The social foundations of thought and action*. Englewood Cliffs: Prentice Hall.

- Barge-Gil, A., & Modrego, A. (2011). The impact of research and technology organizations on firm competitiveness. Measurement and determinants. *Journal of Technology Transfer*, 36(1), 61–83.
- Bercovitz, J., & Feldmann, M. (2006). Entrepreneurial Universities and Technology Transfer: A Conceptual Framework for Understanding Knowledge-Based Economic Development. *Journal of Technology Transfer*, 31: 175-188.
- Birley, S. (2000). The role of networks in the entrepreneurial Process. In: Storey, D.J. (Ed.), *Small Business. Critical Perspectives on business and management*. , Routledge, London, pp. 1495–1508.
- Blau, P. M. and W. R. Scott (1962), *Formal Organizations*. San Francisco, CA: Chandler.
- Bøllingtoft, A. (2012). The bottom-up business incubator: Leverage to networking and cooperation practices in a self-generated, entrepreneurial-enabled environment. *Technovation*, doi:10.1016.
- Boehm, J. (2008). *Entrepreneurial Orientation in Academia*. Germany: Gabler Edition Wissenschaft.
- Bozeman, B. (2000). Technology transfer and public policy: A review of research and theory. *Research Policy*, 29, 627–655.
- Bozeman, B. (2001). Technology transfer and public policy: A review of research and theory. *Research Policy*, 29, 627–655.
- Brockhaus, R. H., Sr. (1980). Risk taking propensity of entrepreneurs. *Academy of Management Journal*, 23, 509-520.
- Brown T. E., Davidsson, P., and Wiklund (2001). An Operationalization of Stevenson's Conceptualization of Entrepreneurship as Opportunity-Based Firm Behavior. *Strategic Management Journal*. 22: 953–968(DOI: 10.1002/smj.190).

- Byers, T. H., Dorf, R. C., Nelson, A. J. (2011). *Technology Venture from Idea to Enterprise* (3rd ed.). Printed in Singapore. The McGraw-Hill companies.
- Cannella, A. A., Park, J. H., and Lee, H. U. (2008). Top management team functional background diversity and firm performance: Examining the roles of team member colocation and environmental uncertainty. *Academy of Management Journal*, vol. 51, no. 4, pp. 768–784.
- Chandran V.G.R. (2010). R&D commercialization challenges for developing countries: The case of Malaysia. *Tech Monitor*, Nov-Dec 2010, p. 25-30.
- Chandler, G., Hanks, S., (1998). An examination of the substitutability of founder's human and financial capital in emerging business ventures. *Journal of Business Venturing*, 13:353369.
- Chandran V.G.R., Farha A.G., and Veera P. (2009). The role of collaboration, market and intellectual property rights awareness in university technology commercialization. *International Journal of Innovation and Technology Management*, Vol. 6, no. 4, pp. 363-378.
- Chandran, V.G.R., Farha, A.G., and Veera P. (2008). The commercialization of research results among researchers in public universities and research institutions, *Asian Profile*, Vol. 36, no. 3, pp. 235-250.
- Chandran, V.G.R., and Wong, C.Y (2010). Patenting activities by developing countries: The case of Malaysia, *World Patent Information*. doi: 10.1016/j.wpi.2010.01.001.
- Chesbrough, H. W., and Teece D. J. (1995). "When is virtual virtuous? Organizing for innovation." *Harvard Business Review* 74.1: 65.
- Chhabra, E. (2007). A Critical Assessment of the Venture Capital Industry in Malaysia, Master's thesis, Malaysia University of Science and Technology.

- Chiesa, V., Piccaluga, A. (1998). Transforming rather than transferring scientific and technological knowledge—the contribution of academic ‘Spin out’ companies: The Italian way. In: Oakey, R.P., During, W.E. (Eds.), *New Technology-Based Firms in the 1990s*, Vol. 5. Paul Chapman Publishing, London.
- Chukumba, C. O. (2005). *University License agreements, Faculty Disclosures, Start-ups, Entrepreneurship, Financial Market Conditions and Technology Transfer*. Ph.D. Thesis. University of Notre Dame.
- Clausen, T., Korneliussen, T. (2012). The relationship between entrepreneurial orientation and speed to the market: The case of incubator firms in Norway. *Technovation*, <http://dx.doi.org/10.1016/j.technovation.2012.05.004>
- Collier, A. (2007). Australian framework for the commercialisation of university scientific research. *Prometheus*, 25 (1), 51–68.
- Colyvas, J., Gelijns, A., and Mazzoleni, R. (2002). How University Inventions Get into Practices. *Management science*, Vol. 48, No.1, pp. 61-67.
- Comacchio, A., Bonesso, S., Pizzi, C. (2011). Boundary spanning between industry and university: the role of Technology Transfer Centres. *J Technol Transf*, DOI 10.1007/s10961-011-9227-6.
- Covin, J. G., & Slevin, D. P. (1988). The influence of organization structure on the utility of an entrepreneurial top management style. *Journal of Management Studies*, 25, 217-234.
- Covin, J. G., & Slevin, D. P. (1989). Strategic management of small firms in hostile and benign environments. *Strategic Management Journal*, 10, 75-87.
- Covin, J. G., & Slevin, D. P. (1991). A conceptual model of entrepreneurship as firm behavior. *Entrepreneurship: Theory & Practice*, 16, 7-25.

- Crabb, Thomas. M. (2002). Research and Development, a First Consideration in Commercialization. *SAE TECHNICAL PAPER SERIES*, volume, 1.
- Creswell, J. W. (1998). *Qualitative Inquiry and research Design, Choosing Among Five Traditions*, Thousand Oaks: Publications.
- Creswell, J. W. (2003). *Research Design Qualitative, Quantitative, and Mixed Methods Approaches (2nd ed.)*. Thousand Oaks: SAGE Publications.
- Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches (Second ed.)*. Thousand Oaks: Sage Publications.
- Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and mixed methods approaches*. London, SAGE Publication, Inc.
- D'Este, P., & Perkmann M. (2010). Why do academics engage with industry? The entrepreneurial university and individual motivations. *Journal of Technology Transfer*.
- Daghfous, A., (2004). An empirical investigation of the roles of prior knowledge and learning activities in technology transfer. *Technovation*, 24, 939-953.
- Dai, Yixin (2007). Patent or Publish? – University Researcher's Choice between Traditional and Commercial Research Outcomes. Ph.D. Thesis. Syracuse University.
- Das, T. K., & Teng, B. S. (2001). Trust, control, and risk in strategic alliances: An integrated framework. *Organizational Studies*, 22, 251-83.
- Day, G. S. (1994). The Capabilities of Market-Driven Organization. *Journal of Marketing*, 58 (October), 3-13.

- Debackere, Koenraad, Bart Clarysse, and Michael A. Rappa (1996), "Autonomy in the Industrial Laboratory: The Dilemma Revisited," *The Journal of High Technology Management Research*, 7 (1), 61-78.
- Dess, G., Lumpkin, G., & Covin, J. (1997). Entrepreneurial strategy making and firm performance: Tests of contingency and configuration models. *Strategic Management Journal*, 18, 677-695.
- Dorf, R.C., and Worthington K.K.F. (1987). Models for Commercialization of Technology from Universities and Research Laboratories. *Journal of Technology Transfer*, 12 (1), 1-8.
- Dorf, R.C., Worthington, K.K.F. (1990). Technology transfer from universities and research laboratories. *Technology Forecasting and Social Change*, 37, 251-266.
- Dubini, P., & Aldrich, H. (1991). Personal and extended networks are central to the Entrepreneurial process. *Journal of Business Venturing*, 6, 305-313.
- Eisenhardt, K. M., and Martin, J. A. (2001). "Dynamic capabilities: What are they?" *Strategic Management Journal* 21.10/11: 1105.
- Eldred, E.W., McGrath, M.E. (1997a). Commercializing new technology—I. *Research • Technology Management*, January-February, 41-47.
- Eldred, E.W., McGrath, M.E. (1997b). Commercializing new technology — II. *Research • Technology Management*, March-April, 29-33.
- Eldred, E.W., McGrath, M.E.,(1997a). Commercializing new technology. *Research technology management*, March-April, p22-33.
- Elfenbein, D. (2005). Publications, Patents, and the Market for University Inventions. Mimeo.

- Esterberg, K. G. (2002). *Qualitative Methods in Social Research*: McGraw-Hill Higher Education.
- Expert Panel on the Commercialization of University Research (1999). *Public Investments in University Research: Reaping the Benefits*. Advisory Council on Science and Technology, Ottawa, Ontario.
- Eyton, Anthony T. (2004). Enhancing commercialization at the interface. *Research Money*; 18, 10; ProQuest Central p.8.
- Florida, R., Choen, W.M., (1999). Engine or infrastructure? The university role in economic development, in: Branscomb, L.M., Kodama, F., Florida, R. (Eds.), *Industrializing knowledge—university–industry linkages in Japan and the United States*.
- Flower, A. C. (Ed.) (2006). *Intellectual property technology transfer*. Washington, D.C.: Bureau of National Affairs.
- Franklin, M., Lockett, A. (2001). Academic and surrogate entrepreneurs in university spin-out companies. *Journal of Technology Transfer*, 26, 127–141.
- Freel, M.S. (2003). Sectoral patterns of small firm innovation, Networking and proximity. *Research Policy*, 32 (5), 751–770.
- Galbraith, C. S., DeNoble, A. F., Ehrlich, S. B., and Kline, D. M. (2007). Can experts really assess future technology success? A neural network and Bayesian analysis of early stage technology proposals. *Journal of High Technology Management Research*, 17, 125–137.
- Ghuri, P., and Gronhaug, K.(2002). *Research Methods in Business studies: A Practical Guide*. Harlow, UK: Financial Times and Prentice Hall.
- Golder, P. N., & Tellis, G. J. (1997). Will it ever fly? Modeling the takeoff of really new consumer durables. *Marketing Sci.* 16(3) 256–270.

- Golder, P. N., & Tellis, G. J. (1993). Pioneer advantage: Marketing logic or marketing legend. *J. Marketing Res.* 30 158–170.
- Golder, P. N., Shacham, R., and Mitra, D. (2009). Innovations' Origins: When, By Whom, and How Are Radical Innovations Developed?. *Marketing Science.* 28, 166-179.
- Goldfarb, B., & Henrekson, M. (2003). Bottom-up versus top-down policies towards the commercialization of university intellectual property. *Research Policy*, 32(4), 639-658.
- Harman, G., & Harman K., (2004). Government and universities as the main drivers of enhanced Australian university research commercialization capability. *Journal of Higher Education Policy and Management*, Vol. 26 No. 2.
- Harmon, B., Ardishvili, A., Cardozo, R., Elder, T., Leuthold, J., Raghian, M., and Smith, D. (1997). Mapping The University Technology Transfer Process. *Business Venturing* ,12, 423-434.
- Harris, M. L., Gibson, M.L., Taylor, S.G., and Mick, T.D. (2008). "Examining the entrepreneurial attitudes of business students: The impact of participation in the small business institute. United State Association for Small Business and Entrepreneurship", USASBE.
- Hart, S. L. (1992), "An Integrative Framework for Strategy-Making Process," *Academy of Management Review*, 17, 327-51.
- Hauksson, A.Q. (1998). The commercialization of university research discoveries: Are university technology transfer offices stimulating the process? Ph.D. dissertation. MIT.
- Heirman, A. and Clarysse, B. (2006), Do intangible assets and pre-founding R&D matter for innovation speed in start-ups?. *Journal of Product Innovation Management.*

- Hertzfeld, H. R., Link, A. N., & Vonortas, N. S. (2006). Intellectual property protection mechanisms in research partnerships. *Research Policy*, 35 (6): 825-838.
- Hindle, K., & Yencken, J. (2004). Public research commercialisation, entrepreneurship and new technology based firms: an integrated model. *Technovation*, 24, 793-803.
- Hisrich, R.D., Peters, M.P., & Shepherd, D.A., (2005). *Entrepreneurship* (6th ed.). Boston, MA: Irwin McGraw-Hill.
- Hite, J.M., & Hesterly, W.S. (2001). The evolution of firm networks: From emergence to early growth of the firm. *Strategic Management Journal* ,22 (3), 275-286.
- Hornig, D., &Hsueh, C. (2005). How to improve efficiency in transfers of scientific knowledge from university to firm: The case of universities in Taiwan. *The Journal of Academy of Business, Cambridge*, Vol. 7 Num. 2.
- Hornig, D., &Hsueh, C., (2005). How to improve efficiency in transfers of scientific knowledge from university to firm: The case of universities in Taiwan. *The Journal of Academy of Business, Cambridge*, Vol. 7 Num. 2.
- Howells, J. (2006). Intermediation and the role of intermediaries in innovation. *Research Policy*, 35, 715-728.
- Howells, J., Nedeva, M., and Georghiou, L. (1998). *Industry-Academic Links in the UK*. HEFCE, Bristol, Final report to Higher Education Funding Council for England, the Higher Education Funding Council for Wales and the Scottish Higher Education Funding Council.
- Hsu, D.H., & Bernstein, T. (1997). Managing the university technology licensing process: Findings from case studies. Association of University Technology Managers Net. Retrieved 8/18/2004 from

<http://www.autm.net/pubs/journal/97/1-97.html>

- Hynes, B. (1996). Entrepreneurship Education and Training-Introducing Entrepreneurship into non-business Disciplines. *Journal of European Industrial Training*, Vol. 20, no.8, pp 10-17.
- ICC (Innovation & Commercialisation Centre) (2011): What is UTM ICC. Retrieved November 8, 2011, from <http://www.icc.utm.my/en/whatisutmicc.html>.
- Ismail, K. (2007). *The commercialization of University Patents: A Case Study*. University of Strathclyde; Hunter Centre for Entrepreneurship, United Kingdom.
- Ismail, K., & Wan Omar, W. Z. (2008). The Commercialization Process of Patents by Universities. In Ismail K. (Ed.) *Issues in Commercialization and Management* (pp. 1-27). Printed in Malaysia by Univison Press.
- Ismail, K., Mason, C., Cooper, S., and Wan Omar, W. Z. (2008). Licensing to established companies or spin-off Formations? How the decision making process has been made in commercialization of university patents. In Ismail K. (Ed.) *Issues in Commercialization and Management* (pp. 29-57). Printed in Malaysia by Univison Press.
- Jalili, N., Mousakhani, M., Behboudi, M. (2011). Nationalized Model For Commercialization, Field Study In Iran. *Interdisciplinary Journal of Research in Business*, Vol. 1, Issue. 4, pp.118-129.
- Jensen, R., & Thursby, M. (2001). Proofs and prototypes for sale: the licensing of university inventions. *American Economic Review*, 91(1), 240-59.
- Johannisson, B. (1988). Business formation—A network approach. *Scandinavian Journal of Management*, 4 (3/4), 83–99.

- Johannisson, B. (1998). Personal networks in emerging knowledge-based firms: Spatial and functional patterns. *Entrepreneurship & Regional Development*, 10, 297–312.
- Johannisson, B. (2000). Networking and entrepreneurial growth. In: Sexton, D.L., Landstrom, H. (Eds.), *The Blackwell Handbook Of Entrepreneurship*. Blackwell Publishers, Oxford, pp. 368–386.
- Johnson, W. H. A. (2008). Roles, resources and benefits of intermediate organizations supporting triple helix collaborative R&D: the case of Precarn. *Technovation*, 28 (8), 495–505.
- Jolly, V. K. (2011). Commercializing New Technologies: *Getting from Mind to Market*. Retrieved January 10, 2012, from Smashwords.
- Knight, G. A. (1997). Cross-cultural reliability and validity of a scale to measure firm entrepreneurial orientation. *Journal of Business Venturing*, 12, 213-225.
- Kohli, R., Lehmann, D. R., Pae J. (1999). Extent and impact of incubation time in new product diffusion. *J. Product Innovation Management* 16(2) 134–144.
- Kreiser, P. M., Marino, L. D., & Weaver, M. K. (2002). Assessing the psychometric properties of the entrepreneurial orientation scale: A multi-country analysis. *Entrepreneurship: Theory & Practice*, 26, 71-93.
- Krueger, N. F., Reilly, M. D., and Carsrud, A. L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing*, 15: 411-432.
- Kuratko, D. H., & Hodgetts, R. M. (2006). *Entrepreneurship: A contemporary approach*. South-Western Division of Thomson Learning.
- Lach, S. and M. Schankerman (2002). *Incentives and Inventive Activity in Universities*. Hebrew University and London School of Economics, Mimeo.

- Lam, Alice. (2011). What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'?. *Research Policy*, p15.
- Lambert, R 2003, Lambert Review of Business-University Collaboration, HMSO, viewed 20 April 2010, <http://www.eua.be/eua/jsp/en/upload/lambert_review_final_450.1151581102387.pdf>.
- Lee, J. S. K. (1992). Quantitative versus qualitative research methods: Two approaches to organisation studies. *Asia Pacific Journal of Management*, 9(1), 87-94.
- Lee, Y., & Gaertner, R. (1994). Technology Transfer to Industry: a Large Scale Experiment with Technology Development and Commercialization. *Policy Studies Journal*, 22, 384-400.
- Lerner, J. (2005). The university and the start-up: lessons from the past two decades. *Journal of Technology Transfer*, 30(1), 49-56.
- Li, C. Y. (2012). The influence of entrepreneurial orientation on technology commercialization: The moderating roles of technological turbulence and integration. *African Journal of Business Management*. Vol. 6(1), pp. 370-387.
- Lieberman, Marvin B. and David B. Montgomery (1998), "First-Mover Advantages," *Strategic Management Journal*, 9 (Special Issue: Strategy Content Research), 41-58.
- Liles, P.R. (1974). *New business ventures and the entrepreneur*. Homewood, IL: Richard D. Irwin.
- Liyanage, S., & Greenfield, P.F. (1999). Towards a fourth-generation R&D management model-research networks in knowledge management. *International Journal of Technology Management* ,18, 294-372.

- Lockett, A., Wright, M. and Franklin, S. J. (2003). Technology transfer and universities ,spin-out strategies. *Small Business Economics*, 20(2), 185-200.
- Low, H. H., Rasli, A. Md., and Amat Senin, A. (2011). Enhancing Academic Researchers' Perceptions toward University Commercialization. *Int. J. Eco. Rec.*, 2(5), 33-48.
- Lowe R., & Marriott S. (2006). *Enterprise: Entrepreneurship and Innovation – Concepts, Contexts and Commercialization* (1st ed.). Netherland: Butterworth-Heinemann (An imprint of Elsevier).
- Lowe, J., Taylor, P. (1996). The sustainable of Academics Spin-offs Enterprise. In Oakey, R., During, W., and Kauser, S. (eds), *New Technology Based Small Firms In 1990s*, London, Chapman.
- Luan, C., Zhou, C., liu, A., (2010). Patent Strategy in Chinese universities: a comparative perspective. *Scientometrics*, 84:53-63.
- Lumpkin, G. T., & Dess, G. G. (2001). Linking two dimensions of entrepreneurial orientation to firm performance: The moderating role of environment and industry life cycle. *Journal of Business Venturing*, 16, 429-451.
- Lumpkin, G., & Dess, G. (1996). Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*, 21, 135-172.
- Lumpkin, G.T. & Dess, G.G. (2001). Linking two dimensions of entrepreneurial orientation to firm performance: the moderating role of environment and industry life cycle. *Journal of Business Venturing*, 16, 429-451.
- Lussier, R. N., Sonfield, M. C., Frazer, J. D., Greene, F., & Corman, J. (1998). *The entrepreneurial strategy matrix and venture performance: An empirical analysis*. Paper presented at the 22nd National Small Business Consulting Conference.

- Lyon, D. W., Lumpkin, G. T., & Dess, G. G. (2000). Enhancing entrepreneurial orientation research: Operationalizing and measuring a key strategic decision making process. *Journal of Management*, 26, 1055-1085.
- MacMillan, I.C., Zemann, L., and Subbanarasimha, P. N. (1987). Criteria distinguishing successful from unsuccessful ventures in the venture screening process. *Journal of Business Venturing*, 2, 123-37.
- Malaysia (2006), Ninth Malaysia Plan, 2006-2010, Government Printers, Kuala Lumpur.
- Malaysia (2011), Tenth Malaysia Plan, 2011-2015, Government Printers, Kuala Lumpur.
- Malecki, E.J. (1997). Entrepreneurs, networks, and economic development: A review of recent research. In: Katz, J.A. (Ed.), *Advances in Entrepreneurship, Firm Emergence, and Growth*. JAI Press, London, pp. 57–118.
- Markman, D. G., Gianiodis, T. P., Phan, H. P., & Balkin, B. D. (2005). Innovation speed: Transferring university technology to market. *Research Policy* 1058-1075.
- Mason, J. (2002). *Qualitative Researching* (2nd ed.): SAGE Publications.
- MASTIC (Malaysian Science and Technology Information Centre) (2010). *Insights@Mastic : Innovation*. Vol. 11&12, Bumper Issue.
- MASTIC (Malaysian Science and Technology Information Centre) (2012). *Intensification of Research and Development Grant (IRPA)*. Retrieved January 10, 2012, from <http://www.mastic.gov.my/servlets/>.
- Matkin, G. (1990). *Technology Transfer and the university*. New York: Macmillan Publishing Company.

- McAdam, R., Keogh, W., Galbraith, B., & Laurie, D., (2005). Defining and improving technology transfer business and management processes in university innovation centres. *Technovation* 25, 1418-1429.
- McAdam, R., Miller, K., McAdam, M., Teague, S. (2012). The development of University Technology Transfer stakeholder relationships at a regional level: Lessons for the future. *Technovation*, 32, 57–67.
- Miles, N., & Daniels, R. (2007). *The State of the Innovation Economy in the UK-2007: Problems, Opportunities and Solutions*. viewed 20 April 2011, <<http://o2c.elektomi.net/controversy-corner/State%20of%20InnovEco.pdf>>.
- Miles, M. B., and Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (Second edition ed.). London: Sage Publications.
- Miller, D. (1983, July). The correlates of entrepreneurship in three types of firms. *Management Science*, 29, 770-792.
- Miller, D. (1987). The structural and environmental correlates of business strategy. *Strategic Management Journal*, 8, 55-76.
- Miller, D., & Friesen, P. H. (1983). Strategy-making and environment: The third link. *Strategic Management Journal*, 4, 221-235.
- Miller, Danny and Peter H. Friesen (1978), "Archetypes of Strategy Formulation," *Management Science*, 24 (9), 921-33.
- Miller, W.L., & Morris, L. (1999). *Fourth Generation R&D: Managing Knowledge, Technology and Innovation*. 1st Edition. John Wiley and Sons, New York, USA.
- Ministry of Science, Technology and Environmental (MOSTE) Malaysia (2008). National Survey of Research and Development 2008.

- Minshall, T., & Wicksteed, B (2005). *University Spin Out Companies: Starting to Fill the Evidence Gap: A Report on a Pilot Research Project Commissioned by the Gatsby Charitable Foundation*. Cambridge, UK: St. John's Innovation Centre Ltd and SQW Ltd.
- Mohd. Sadullah, A. F. (2005). *Facing the Challenges: Universities and Technologies Development in Malaysia*. Symbiosis, Malaysia.
- MOHE (Ministry of Higher Education) 2010, *Niche 1: commercialisation and innovation development*, AKEPT (Higher Education Leadership Academy) Centre For Leadership Research and Innovation, Putrajaya, viewed 18 April 2010, <http://www.mohe.gov.my/akept/doc/ACLRI/Niche_1.pdf>.
- MOHE (2008). *"R&D Products of Public Universities in Malaysia: Commercialized Products, Products with Commercial Potential, Patents and Trademarks (Until August 2008)"*, Department of Higher Education, Ministry of Higher Education (MOHE), Malaysia.
- Moroz, P.W., Hindle, K.G., and Anderson, R.B. (2008). Commercialisation of new knowledge within universities: exploring performance disparities. *International Journal of Technology Intelligence and Planning*, 4(1), 4-19.
- MOSTI (Ministry of Science, Technology and Innovation, Malaysia) (2011). *Pre Commercialisation Fund (Technofund): Guidelines for Applicants*. 10 March.
- MTDC (Malaysian Technology Development Cooperation): *The Right Catalyst*. Retrieved January 8, 2012, from <http://www.mtdc.com.my/catalyst>.
- Muir, A. E (1997). *The Technology Transfer System Inventions: Marketing, Licensing, Patenting, Setting, Practice, Management, Policy*. Xiii, 240 p. vols. Latham, N.Y.: Latham Book Pub., 1997.
- Muscio, A. (2007). The impact of absorptive capacity on SMEs' collaboration. *Economics of Innovation and New Technology*, 16(8), 653–668.

- Muscio, A. (2009). What drives the university use of technology transfer offices? Evidence from Italy. *Journal of Technology Transfer*, DOI 10.1007/s10961-009-9121-9127.
- Muzyka , D., Birley, S., and Leleux, B. (1996). Trade-offs in the investment decisions of European venture capitalists. *Journal of Business Venturing*, 11(4), 273-88.
- MyIPO (2012), Patent Statistics: Application and Granted Patents and Utility Innovations from 1986-2011. Retrieved January 22, 2012, from <http://www.myipo.gov.my/en/resources/statistics/160.html> .
- Naman, J., & Slevin, D. (1993). Entrepreneurship and the concept of fit: A model and empirical tests. *Strategic Management Journal*, 14, 137-153.
- Ndonzuau, F.N, Pirnay, F., Surlemont, B. (2002). A stage model of academic spin-off creation. *Technovation*, 22, 281–289.
- Niosi, Jorge (1999). Fourth-generation R&D: from linear models to flexible innovation. *Journal of Business Research*, 45, 111–117.
- O’Shea, R. P., Allen, T. J., O’Gorman, C., & Roche, F. (2005). Universities and technology transfer: A review of academic entrepreneurship literature. *Irish Journal of Management*, 26, 11- 29.
- OECD (2001), *2000 Development Co-operation Report*, The DAC Journal, 2.
- Palmberg, C. (2008). The transfer and commercialization of nanotechnology: a comparative analysis of university and company researchers. *Journal of Technology Transfer*, 33, 631-652.
- Parker, D. D., & Ziberman, D. (1993). University technology transfer: Impact on local and US economies. *Contemporary policy Issues*, 11(2) :87-99.

- Patton, E., & Appelbaum, S. H. (2003). *The case for case studies in management research [Electronic version]*. *Management Research News*, 26(5), 60-71.
- Patton, M. (2002). *Qualitative research and evaluation methods (3rd ed)*. Thousand Oaks, CA: Sage Publications.
- Patton, M. Q. (2000). *Qualitative Research and Evaluation Method*. London: SAGE Publications.
- Penrose, Edith T. (1958), *The Theory of Growth of the Firm*. Oxford: Blackwell.
- PMSEIC. (2001). *Commercialisation of Public Sector Research*, Canberra
- Powers, J.B. . Academic entrepreneurship in higher education: institutional effects on performance of university technology transfer, dissertation. Indiana University; 2000.
- Proctor, P. (1993). Universities seek rule as technology transfer catalysts. *Aviation Week and Space Technology*, 139(19):55-56.
- Rahal, A. D. (2005). *Assessment framework for the evaluation and prioritization of university technologies for licensing and commercialization*. Ph.D. Thesis. University of Central Florida, Orlando.
- Rasmussen, E., & Borch, O. J. (2010). University capabilities in facilitating entrepreneurship: A longitudinal study of spin-off ventures at mid-range universities. *Research Policy*, 39 , 602–612.
- Rasmussen, E., Moen, O., & Gulbrandsen, M. (2006). Initiatives to promote commercialisation of university knowledge. *Technovation*, 26(4), 518-533. doi:10.1016/j.technovation.2004.11.005.
- Rasmussen, E., Moen, Ø., Gulbrandsen, M. (2006). *Initiatives to promote commercialization of university knowledge*. *Technovation*, 26, 518–533.

- Reimers, N., (1999). *Best North American Practices in Technology Transfer*. Report to Expert Panel on the Commercialization of University Research of the Prime Minister's Advisory Council on Science and Technology, ACST, viewed 20 March 2002, <<http://www.acst-ccst.gca.ca>>.
- Research Management Centre (RMC): IP Commercialization Policy. Retrieved January 12, 2012, from <http://www.utm.my/rmc/policies/209-ip-commercialization-policy.html> .
- Riley, K. J. (2003). Strategies to Successful Commercialization of Space-Based Technologies. *SAE TECHNICAL PAPER SERIES*, 01-2338.
- Ritchie, J., & Lewis, J. (2003). *Qualitative Research Practice: A Guide for social Science Student and Researchers*: SAGE Publications.
- Roberts, E. B. (1991), The technological base of the new enterprise. *Research Policy*, vol. 20, no. 4, pp. 283–297.
- Robinson, W. T., & Fornell, C. (1985). Sources of market pioneer advantages in consumer goods industries. *J. Marketing Res.* 22 305–317.
- Robson, (2003). *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*, second edition, Oxford: Blackwell, pp. 386-389.
- Rogers, E.M., Jong Yin, and Joern Hoffman (2000). “Assessing the Effectiveness of Technology Transfer Offices at U.S. Research Universities”. *The journal of the Association of University Technology Manager*, Vol XII. Pg. 60.
- Rogers, E.M., Takegami, S., Yin, J., (2001). Lessons learned about technology transfer. *Technovation* 21, 253-261.
- Rohaizat and Fauziah (2002). Introducing Entrepreneurship Curriculum In Technical Disciplines. *IntEnt2002*.

- Ross, J. (1987). Corporations and entrepreneurs: Paradox and opportunity. *Business Horizons*, 30, 76-80.
- Rothaermel, F.T., Agung, S.D., and Jiang, L. (2007). University entrepreneurship: taxonomy of the literature. *Industrial and Corporate Change*, 16, 691–791.
- Rothschild, L., & Darr, A. (2005). Technological incubators and the social construction of innovation networks: An Israeli case. *Technovation*. 25 (1), 59–67.
- Rubin, H. J., & Rubin, I. S. (1995). *Qualitative Interviewing The Art of Hearing Data*: SAGE publications.
- Salkind, N. J. (2007). *Exploring Research* (6th ed.): Pearson Education International.
- Sarachek, B. (1978). American entrepreneur and the Horatio Alger myth. *The Journal of Economic History*, 38, 439-456.
- Sawhney, M., Wolcott, R. C., & Arroniz, I. (2006). The 12 different ways for companies to innovate. *MIT Sloan Management Review*. 47, 75-81.
- Scholz, R. W., and Tietje O. (2002). *Embedded Case Study Methods: Integrating Quantitative and Qualitative Knowledge*. Thousand Oaks; London; New Delhi, Sage Publications.
- Schumpeter, Joseph A. (1934), *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.
- Sekaran, U. (1992). *Research Method for Business : A Skill Building Approach*. New York ,John Wildy.
- Shah, S. K., & Corley, K. G. (2006). Building better theory by bridging the quantitative - qualitative divide. *Journal of Management Studies*, 43(8), 1821-1835.

- Shane, S. (2004). *Academic Entrepreneurship: University Spin-offs and Wealth Creation*. Cheltenham: Edward Elgar.
- Shane, S., and Cable, D. (2002). Network Ties Reputation, and The Financing of New Ventures. *Management Science*, Vol. 48, No. 3, pp. 364-381.
- Shaw, E., Conway, S., 2000. Networking and the small firm. In: Carter, S., Jones-Evans, D. (Eds.), *Enterprise and Small Business. Principles, Practice and Policy*. Prentice Hall, Harlow, pp. 367–383.
- Siegel, D.S., Waldman, D.A., Link, A.N. (2003). Assessing the impact of organizational practices on the productivity of university technology transfer offices: an exploratory study. *Research Policy*, 32(1), 27-48.
- Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology offices: An exploratory study. *Research Policy*, 32(1), 27-48.
- Siegel, D., Thursby, J., Marie, C., Thursby, M., and Ziedonis, A. (2001). Organizational issues in university-industry technology transfer: an overview. *Journal of Technology Transfer*, 26, 5–11.
- Siegel, D.S., Waldman, D., Atwater, L., & Link, A. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management*, 21 (1–2), 115–142.
- Smart, D., & Conant, J. (1994). Entrepreneurial orientation, distinctive marketing competencies and organizational performance. *Journal of Applied Business Research*, 10(3), 28.
- Smilor, R., & Matthews, J. (2004). University venturing: technology transfer and commercialisation in higher education. *International Journal of technology Transfer & Commercialisation*, vol. 3, no. 1, pp. 111-128.

- Smith, Barfield, (1996). Contributions of Research and Technical Advance to the Economy. Brookings Institution, Washington, DC.
- Song, X. M., and Parry, M. E. (1997). A Cross-National Comparative Study of New Product Development Processes: Japan and the U.S. . *Journal of Marketing*, 61(April), 1-18.
- Spithoven, A., Clarysse, B., & Knockaert, M. (2010). Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, 30(2), 130–141.
- Stevenson HH, Jarillo JC. 1990. A paradigm of entrepreneurship: entrepreneurial management. *Strategic Management Journal* , Summer Special Issue 11: 17–27.
- Stevenson HH. 1983. A perspective on entrepreneurship. *Harvard Business School Working Paper* 9-384-131.
- Strickland, L. (2007). Commercializing Your Business: A Primer. *Carolina Newswire* : Article Archives. Retrieved October 18, 2011, from <http://carolinanewswire.com/news/News.cgi?database=columns.db&command=viewone&id=296>.
- Svensson, R. (2007). Commercialization of patents and external financing during the R&D phase. *Research Policy*, 36, 1052–1069.
- Swamidass, P.M., & Vulasa, V. (2009). Why university inventions rarely produce income? Bottlenecks in university technology transfer. *The Journal of Technology Transfer*, 33(8), 672-678.
- Swanson, R. A., & Holton, E. F. I. (2005). *Research in Organizations: Foundations and Methods of Inquiry*. San Francisco: Berrett-Koehler Publishers, Inc.
- Temsiripoj, W. (2003). Academic-Industry Links in Thailand and the UK: A Comparative Analysis. PhD thesis, Manchester University.

- Thika, A.Gj. (2010) *Fundamental Characteristics of University Commercialization Companies in South Australia*. Ph.D. thesis. University of South Australia.
- Thiruchelvam K, Chandran VGR, Kwee NB, Yuan WC, Sam CK (2010). Towards effective policies for innovation financing in Asia-Financing innovation: the experience of Malaysia, working in Progress Report submitted to the IDRC Project.
- Thompson, J. L. (1999). A strategic perspective of entrepreneurship. *International Journal of Entrepreneurial Behaviour & Research*, Vol. 5 No. 6, pp. 279-296. © MCB University Press, 1355-2554.
- Thursby, J. G., & Thursby, M. C. (2003). University Industry Licensing ; Characteristics, Concern, Issues, from the Perspective of the Buyer. *Journal of Technology Transfer*, Vol. 28, pp. 207-213.
- Thursby, J. G., & Thursby, M. C. (2004). Are Faculty Critical? Their Role in University- Industry Licensing. *Contemporary Economics Policy*, Vol. 22, No. 2, pp. 162-178.
- Thursby, M. C., Jensen, R., and Thursby, J. M. (2001). Objective, Characteristics and Outcomes of Major University Licensing; a Survey of Major U.S Universities. *Journal of Technology Transfer*, Vol. 26, No. 1-2, pp.59-72.
- Thursby, M.C., Thursby J., and Mukherjee (2005). Are There Real Effects of Licensing on Academic Research: a Life Cycle View Mimeo.
- Timmons, J. A., & Spinelli, S. (2007). *New venture creation: Entrepreneurship for the 21st century* (7th ed.). Massachusetts: McGraw-Hill.
- Todorovic, Z. M., McNaughton, R. B., & Guild, P. (2011). ENTRE-U: An entrepreneurial orientation scale for universities. *Technovation*, 31, 128- 137.

- Tornatzky, L., Waugaman, P., & Gray, D. (2002). *Innovation U.: New University Roles in a Knowledge Economy*. Southern Growth Policies Board, ISBN 0-927364-25-5.
- Tornatzky, L., Waugaman, P., and Gray, D. (1999). Industry-University Technology Transfer: Models of Alternative Practice, Policy and Program. *Southern Growth Policies Board, USA*.
- Trochim, W. M. K., & Donnelly, J. P. (2008). *The Research Methods Knowledge Base (3rd ed.)*. Mason, OH: Cengage Learning.
- Urban, G. L., Carter, T., Gaskin, S., and Mucha, Z. (1986). Market share rewards to pioneering brands: An empirical analysis and strategic implications. *Management Sci.* 32(6) 645–659.
- UTM (Univesiti Teknologi Malaysia) (2010). Annual Report on Fact & Figures Universit Teknologi Malaysia.
- UTM (Univesiti Teknologi Malaysia) (2011). Research Alliances. Retrieved November 20, 2011, from http://www.utm.my/research/index.php?option=com_content&task=view&id=61&Itemid=105.
- Venkatraman, N. (1989), "Strategic Orientation of Business Entreprises: The Construct, Dimensionality, and Measurement," *Management Science*, 35 (8), 942-62.
- Vincett, P.S. (2010). The economic impacts of academic spin-off companies, and their implications for public policy. *Research Policy*, 39 , 736–747.
- Walter, A., Auer, M., Ritter, T. (2006). The impact of network capabilities and entrepreneurial orientation on university spin-off performance. *Journal of Business Venturing*, 541– 567.

- Wang, Y. and Lu, L. (2007). Knowledge transfer through effective university-industry interactions: empirical evidences from China. *Journal of Technology Management in China*, 25(2), 119-33.
- Watson, R. & Wilson, N. (2002). Small and medium size enterprise financing: a note on some of the empirical implications of a pecking order. *Journal of Business Finance & Accounting*, 29 (3 and 4), 557-78.
- Wickhman, P. A. (2004). *Strategic entrepreneurship* (3rd ed.). Harlow: Pearson Education.
- Wiklund, J. (1999, Fall). The sustainability of the entrepreneurial orientation-performance relationship. *Entrepreneurship: Theory & Practice*, 24(1), 39-50.
- Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing*, 20, 71-91.
- Wittamore, K., Bahns, R., Brown, A., Carter, P., Clements, G., and Young, C. (1998). International technology transfer - a developing empirical model, management of technology, sustainable development and eco-efficiency. In: *The Seventh International Conference on Management of Technology*, 16–20 February, Orlando (on CD).
- Wonglimpiyarat, j. (2010). Commercialization strategies of technologies: lessons from Silicon Valley. *Journal of Technology Transfer*, 35, 225-236.
- Wonglimpiyarat, J. (2011). Government programmes in financing innovations: Comparative innovation system cases of Malaysia and Thailand. *Technology in Society*. 33, 156-164.
- Worasinchai, L., Ribie`re, V.M., and Bechina Arntzen, A.A. (2008). Working knowledge, the university-industry linkage in Thailand: concepts and issues.

The Journal of Information and Knowledge Management Systems, 38(4), 507-524.

Wright, M., Clarysse, B., Lockett, A., & Knockaert, M. (2008). Mid-range universities' linkage with industry: Knowledge types and the role of intermediaries. *Research Policy*, 37(8), 1205-1223.

Wright, M., Clarysse, B., Mustar, P., and Lockett, A. (2007). *Academic Entrepreneurship in Europe*. Cornwall: Edward Elgar Publishing.

Wright, M., Lockett, A., Clarysse, B., and Binks, M. (2006). University spin-out companies and venture capital. *Research Policy*, 35, 481–501.

Wu, W. (2007). Cultivating research universities and industrial linkages: The case of Shanghai, China. *World Development*, 35(6), 1075-1093.

Wu, W. (2009). Managing and incentivizing research commercialization in Chinese Universities. *The Journal of Technology Transfer*, DOI 10.1007/s10961-009-9116-4.

Xue, P. (2007). Intellectual Property Protection and Management in Chinese Universities. *Intellectual Property Protection*, vol.26.pp 45-51.

Yin, R. K. (1984). *Case Study Research-Design and Methods*. Beverly Hills, CA: Sage Publications.

Yin, R. K. (2003). *Case Study Research: Design and Methods (3th ed.)*. Thousand Oaks, California: SAGE Publications.

Yin, R., (1994). *Case study research: Design and methods (2nd ed.)*. Beverly Hills, CA: Sage Publishing.

- Zahra, S. A. (1993). New product innovation in established companies: Associations with industry and strategy variables. *Entrepreneurship Theory and Practice*, 47-69.
- Zahra, S. and Wiklund, J. (2000). Top management team characteristics and resources recombinations among new ventures. Paper presented at the Strategic Management Society Annual Meeting, Vancouver, 15-18 October.
- Zhang, J. (2009). The performance of university spin-offs: an exploratory analysis using venture capital data. *J Technol Transf*, 34:255–285.
- Zhao, F. (2004). Commercialization of research: a case study of Australian universities. *Higher Education Research and development*, Vol. 23, No. 2.
- Zhao, L.M., & Reisman, A. (1992). Toward meta research on technology-transfer. *IEEE Transactions on Engineering Management*, 39 (1), 13-21.
- Zimmer, T.W. and Scarborough, N.M (1998). *Essentials of entrepreneurship and small business management*. Upper Saddle River, NJ: Prentice Hall.