COMMERCIALISATION ACTIVITIES IN BIOTECHNOLOGY RESEARCH RELATED AMONG ACADEMICIANS IN MALAYSIA

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ABSTRACT

The paper analyses the perceptions of 79 academic researchers regarding their involvement in commercialisation activities of their research activities in a research university environment base on a questionnaire. Factor analysis and reliability tests were conducted to identify dimensions of commercialisation activities and to determine statistical reliability of the dimensions. Subsequently, Kruskal Wallis tests were conducted to examine whether perceptions on commercialisation activities results differ based on the demographic background of the researchers. The findings of this study reveal perceptions on the commercialisation dimensions are ranked highest for researchers who are professors with more than 10 years research experience while having high level of experience as university administrators.

Keywords: Academic researchers; commercialisation activities; Kruskal Wallis

INTRODUCTION

There is much confusion about the difference among research results, knowledge, and technology. Typically, research results yield new knowledge. In contrast, technology involves a tool with which people can extend their living and working environments. The essence of a technology is its practical value; its doing something vs. its understanding. However, technology does not necessarily imply a physical artifact, machine, or device. Often, practical value or utility can be embodied in a formula, a piece of software, or set of procedures. The important point is that technology implies the application of knowledge having practical value and utility. Research results are not the same thing as a technology. Research results, whether empirical findings, statistical relationships, or new conceptual schema, are new knowledge. Knowledge is the bridge between research and technology, but different from practical or useful application, which is at the heart of technology (Gray & Walters, 1998, p.219).

Universities are increasingly being recognized as having a key role in the regional development process. Universities also make many contribution to economic and social/cultural in nature to their localities (Goddard, Charles, Pike, Potts & Bradley, 1994) but commercialisation have a particular appeal to policymakers in times of seemingly accelerating technological change, strikingly uneven regional economic performance and tight budgets for higher education. Due to that, universities have to put effort to commercialise their research results as alternative sources of income. As they are valued for their academic contributions, including teaching and research at the same time as they have to commercialise any inventions and discoveries they have made.

The individual academic researcher is central to the knowledge and technology transfer process in order to make strategic decisions about how to disseminate the results of the research activities in the university. The academic researcher is the one who decides whether or not to collaborate with industry, disclose their inventions to their university and start a company based on his/her knowledge. However, even with encouragement and advocacy from the government, the issues to transfer the potential research results to the industry to be developed and commercialised still experiencing low success rates. How to get the universities to better contribute to innovation process has become an important issue in the international agenda and also in Malaysia.

Transferring the results of university research to industry may take several forms and thus can be achieved in different ways. These include publications, conferences, consulting, conversations, recruitment of graduates, co-supervising, collaborative research, patents and licenses (Agrawal & Henderson, 2002). Some of these methods involve the transfer of knowledge about new technologies to the economy as a public good (Gu & Whewell, 1999). Estimates of relative importance of different knowledge channels suggest that these 'non-commercial' methods represent the majority of knowledge transferred from universities to industry (Agrawal & Henderson, 2002).

Although there had been other researches on knowledge and technology transfer which are focused on faculty members, the research had been done mainly in developed countries (refer works by Zucker, Darby & Armstrong, 1998; Zucker, Darby & Brewer, 1998; Zucker & Darby, 2001; Louis, Blumenthal, Gluck & Stoto, 1989; Bercovitz & Feldman, 2004). Furthermore, most of the technology transfer studies used a Technology Transfer Office (TTO) report as a performance guideline. Jensen, Thursby & Thursby (2003) noted that many technology transfer office directors believe that substantially less than half of the inventions with commercial potential are disclosed to their office.

As such, a potential issue in the form of gaps between the declared commercialisation activities of TTO and how the academicians view their research commercialisation activities may arise. Noticeably absent from the institution and technology transfer literature is a systematic and broad based analysis of the commercialisation activities of research results.

The integration of the demographic variables would be useful to explain the differences in perceptions based on the background of the respondents. Previous researches by Allen, Link & Rosenbaum (2007) as well as Morgan, Kruytbosh & Kannankutty (2001) indicate that some demographic variables may influence individual perceptions thus affecting their commercialisation activities. Thus, this research seeks to investigate the extent to which commercialisation activities differ based demographic background.

This paper focuses on commercialisation activities at the research universities in Malaysia. The primary unit of analysis is the academic researcher who is involved in biotechnology related research. Although the scope of the research is limited to research universities, however, there is still a possibility to derive some general trends, indicators and facts which would contribute to the theory and guide further research.

METHODS

This section presents methods utilised in this research including sampling, measurements and analysis.

Sampling

Listing of academic researchers was obtained from the Malim Sarjana expertise database developed by Higher Education Ministry. The list include active academic researcher comprising of molecular biology, plant biotechnology, animal biotechnology, industrial and environmental biotechnology, forensic biotechnology, food biotechnology, biopharmacy biotechnology, marine biotechnology, bioinformatics and biosafety and bioethics field of research.

Within the context of this exploratory research, each research university is treated as independent, thus making stratified sampling method appropriate to form the final sampling frame for the survey. Stratified random sampling is composed of grouping the members of the population into strata. By using simple random sampling scheme, samples are drawn from each stratum and than the selected observations are pooled to form a single sample set.

Measurements

A modified version of a questionnaire measuring research results using items developed in earlier study by Jusoh (2008) was used for this research. The questionnaire consists of 11 items and several questions on the demographic background of the respondents. The 11 questions specifically referred to commercialisation activities of their research result. Commercialisation activities of research results include: (1) publishing academic writing, (2) communicated to 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, (3) invited to present research results to group and organization who could make direct use of them, (4) been involved in committee which is interested in using and exploiting new knowledge based on the research result, (5) given consultation service/technical (based on technology field/research result) to private firm, government agency or others, (6) disclosed the invention based on my research result, (7) applied patent based on my research result, (8) got patent based on research result, (9) gave the licence to other party or organization to produce or market the product from my research (10) the license that have been given to other party, have been resulted in monetary return and (11) research result has created spin off company that specifically produce and commercialize the research product. The aforementioned 11 items are consistent with those identified by Landry, Amara & Ouimet (2006).

Academic researchers responded to the 11 items based on a 5-point frequency scale (1= Never, 2=Rarely, 3=Sometimes, 4=Often and 5=Very Often). The independent variable of interest for this study was academic researchers' demographic background. The demographic information solicited is as follows: research experience, highest level of education, experience as administrator/top level management and academic post status.

ANALYSIS

The analyses used in this study are essentially exploratory and broadly address the research question of interest. The purpose here is mainly to document any differences in response based on the demographic background of the selected participants.

Data will initially be analysed using descriptive statistics to provide basic understanding of the demographic background and questionnaire items. Before data analyses, some preliminary steps need to be completed to ensure goodness of data for subsequent analysis. In this study, the construct validity was evaluated by using exploratory factor analysis (EFA) while the statistical reliability of commercialisation activities of research result dimensions was determined by looking at Cronbach's alpha values.

Subsequently, different of means for each item assessing commercialisation activities of research result were compared for each demographic variable using Kruskal Wallis test. Non-parametric method for testing for difference in mean ranking will deploy Kruskal Wallis test due to the qualitative nature of the untreated data which is in ordinal form (Rasli, 2005). Based on prior empirical studies on knowledge and technology transfer, the following research hypothesis[1] using Kruskal Wallis was formulated to compare mean ranking of all items (attributes) measuring the commercialisation activities of research results by each demographic variable.

Ha_1 : There is difference in mean ranking of research result based on the demographic background.

[1] Originally there are 11 items and 4 demographic variables in the questionnaire thus implying the possibility of 11x4=44 hypotheses to be generated. However, all the hypotheses are group into 1 major research hypothesis.

RESULTS

Frequency Analysis of Demographic Background of Academicians Working on Biotechnology Related Researches in Malaysian Research Universities

Seventy nine academic researchers working on biotechnology related researches in Malaysian research universities participated in the survey. The descriptive analysis over the collected data illustrated the diverse background of respondents even though they originated from four Malaysian research universities.

With reference to Table 1, it is evident that most of the respondents have more than ten years research experience in the university (43%), followed by academic researchers with five to ten years experience (35.4%) and those with less than five years experience (21.5%). As expected, a majority of the respondents (78.5%) possess a doctoral qualification. Whereas, Master holders and Post Doctoral holders occupy second and third places respectively. With regards to the experience of the researchers as administer or top level management, the analysis revealed that most of the respondents (49.4%) have experience at faculty level, possess no experience at all (29.1%), have experience at the university level (15.2%) and have experience at the research center level (6.3%). Finally, the status of the respondents consists of associate professor (29.1%), senior lecturer (25.3 %), professor (24.1%) and lecturer (21.5%)

Table 1: Descriptive Analysis of Demographic Background

RESEARCH EXPERIENCE	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Less than 5 years	17	21.5	21.5	21.5
5 to 10 years	28	35.4	35.4	57.0
More than 10 years	34	43.0	43.0	100.00
Total	79	100.0	100.0	
EDUCATION LEVEL	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Master	10	12.7	12.7	12.7
PhD	62	78.5	78.5	91.1
Post doctoral	7	8.9	8.9	100.0
Total	79	100.0	100.0	
ADMINISTER /TOP LEVEL MANAGEMENT EXPERIENCE	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Faculty	39	49.4	49.4	49.4
Research Centre	5	6.3	6.3	55.7
University	12	15.2	15.2	70.9
No experience	23	29.1	29.1	100.0
Total	79	100.0	100.00	
ACADEMIC POST	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Lecturer	17	21.5	21.5	21.5
Senior Lecturer	20	25.3	25.3	46.8
Associate Professor	23	29.1	29.1	75.9
Professor	19	24.1	24.1	100.0
Total	79	100.0	100.0	

Frequency Analysis of Commercialisation Activities of Research Results of Academicians Working on Biotechnology Related Researches in Malaysian Research Universities

Table 2 summarizes frequency data of the seventy nine academicians working on biotechnology related researches in Malaysian research universities who participated in the survey. The highest percentage of frequency for the eleven items of commercialisation activities of research results

can be summarized into three groups. High responses were obtained for the first frequency scale (never) for the following group: create spin off companies (74.7%) obtain monetary return from commercialisation (73.4%), gave license to external parties to commercialise (72.2%), obtain patent based on research results (70.9%) and apply patent based on research results (51.9%). The second high responses were obtained for the fourth frequency scale (often) for the following groups: publication via academic writing (51.9%) and seminar, exhibition and printed/electronic media (39.2%). The third high responses were obtained for the third frequency scale (sometimes) for the following groups: gave consultation service/technical expertise (34.2%), disclosed invention based on research results (34.2%), invitation to present research results elsewhere (30.4%) and involved in committee keen to exploit research (30.4%).

Table 2: Descriptive Analysis of Commercialisation Activities of Research Results Frequency

Items	Percentage (%)				
	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Very Often (5)
Publication via academic writing	1.3	2.5	24.1	**51.9**	20.3
Seminar, exhibition and printed/electronic media	8.9	10.1	27.8	**39.2**	13.9
Invitation to present research results elsewhere	20.3	19.0	**30.4**	25.3	5.1
Involved in committee keen to exploit research	21.5	16.5	**30.4**	29.1	2.5
Gave consultation service/ technical expertise	15.2	16.5	**34.2**	27.8	6.3
Disclosed invention based on research results	25.3	15.2	**34.2**	22.8	2.5
Apply patent based on research results	**51.9**	11.4	13.9	16.5	6.3
Obtain patent based on research results	**70.9**	1.3	19.0	7.6	1.3
Gave license to external parties to commercialise	**72.2**	12.7	8.9	3.8	2.5
Obtain monetary return from commercialisation	**73.4**	10.1	10.1	5.1	1.3
Create spin off companies	**74.7**	8.9	10.1	2.5	3.8

Construct Validity Using Factor Analysis and Reliability Test

In general, construct validity is the extent to which a particular item relates to other items consistent with theoretically derived hypotheses concerning the variables that are being measured. The factor analysis used a principal component analysis as the extraction method and Varimax with Kaiser Normalisation rotation method to explain the item variance.

Two statistical tests should be done in order to allow for the application of factor analysis, namely, Kaiser-Meyer-Olkin (KMO) sampling adequacy test and the Barlett's test of sphericity. The KMO sampling adequacy test statistic for this study is 0.847 which is higher than the threshold value of 0.5 (Hair, Anderson, Tatham & Black, 1998). This is supported by the Barlett's test of sphericity value of 0.00 that is less than 0.05. These two tests seem to support the usage of the factor analysis method using Varimax rotation with Kaiser Normalisation and Principal Component Analysis. Varimax with Kaiser Normalisation was applied prior to factor rotation, thus keeping factors with an eigen value of one and greater. This procedure was chosen

to eliminate error variance (Tinsley & Tinsley, 1987). Whereas, a principal component analysis was the chosen extraction method to describe the data set with a smaller set of new variable.

The factor analysis extracted three factors based on eigen value criteria more than one. Table 2 presents the factor loading, eigen value and percentage of variance explained and reliability coefficient for every group. These three factors together accounted for 70.96% of the total variance. Based on Table 2, since the scale reliability coefficients using Cronbach Coefficient Alpha for the three groups are greater than 0.7 all the dimensions are deemed as statistically reliable. Nunnally (1978) suggested that a set of items with a coefficient alpha greater than 0.7 can also be considered as internally consistent.

Within the context of this research, typology development has been used as analytical strategy where a quantitative survey was conducted, developed factors through a factor analysis and using this factors as a typology (Caracelli & Greene, 1993). Items of Research Commercialisation Activities of Reseach Results are regrouped into different groups based on the extraction value of the rotated component matrix namely CNB, TT and IPAW as indicated in Table 3.

Table 3: Result of the Factor Analysis and Reliability Analysis of Commercialisation Activities of Research Results

Commercialisation Activities of Research Results	Components		
	CNB	TT	IPAW
Involved in committee keen to exploit research	.818		
Invitation to present research results elsewhere	.813		
Gave consultation service/ technical expertise	.810		
Seminar, exhibition and printed/electronic media	.737		
Disclosed invention based on research results	.557		
Obtain monetary return from commercialization		.850	
Create spin off companies		.824	
Gave license to external parties to commercialise		.767	
Obtain patent based on research results			.878
Apply patent based on research results			.850
Publication via academic writing			.512
Eigen value	5.179	1.539	1.088
Percentage of Variance Explained	47.077	13.987	9.895
Reliability coefficient	.856	.853	.777

The first group can be classified as committee and network building (CNB) and comprises of five items from the commercialisation activities of research results. The following are the items of CNB: involved in committee keen to exploit research, invitation to present research results elsewhere, gave consultation service/technical expertise, seminar, exhibition and printed/electronic media and disclosed invention based on research results.

The second group can be classified as technology transfer (TT) and comprises of three items from the commercialisation activities of research results. The following are the items of TT: obtain monetary return from commercialisation, create spin off companies and gave license to external parties to commercialise.

The final group of commercialisation activities of research results can be classified as intellectual property and academic writing (IPAW). The items classified under this group are the following: obtain patent based on research results, apply patent based on research results and publication via academic writing.

Comparing Means of Commercialisation Activities of Research Results by Demographic Background Using Kruskal Wallis

The Kruskal-Wallis tests are applicable for all cases in this research, where all the demographic variables have more than two categories; research experience, highest level of education, experience as administrator/top level management and academic post status. Forty-four Kruskal-Wallis based hypotheses were formulated accordingly. As an example, for the first item, the null hypothesis would be: there is no difference in mean ranking of *My research results have been published in various forms of academic writing* based on research experience. The null hypotheses would be rejected if the p-values were found to be lower than 0.05 for all the Kruskal Wallis tests. For this paper, p-values that are less than 0.05 will be highlighted.

The significant findings for the Kruskal Wallis and its relevant descriptive statistics are as follows:

1. There is difference in mean ranking of *My research results have been published in various forms of academic writing* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (45.34) while mean ranking of impact by those who have less than 5 years research experience is the lowest (25.00).

2. There is difference in mean ranking of *Other than towards academicians, my research results have been communicated to other users outside the academic environment/priority parties such as private firms or government agencies through seminars, conferences, exhibitions and reports in the printed or electronic media* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (46.41) while mean ranking of impact by those who have less than 5 years research experience is the lowest (26.03).

3. There is difference in mean ranking of *I have been invited to present to a group and organizations which could make direct use of my research results* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (51.66) while mean ranking of impact by those who have less than 5 years research experience is the lowest (24.35).

4. There is difference in mean ranking of *I have been involved in a comittee which is interested in using and exploiting new knowledges based on the research results* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (45.19) while mean ranking of impact by those who have less than 5 years research experience is the lowest (28.21).

5. There is difference in mean ranking of *I have given consultation/technical services (based on my area of specialization/research results) to private firms, government agencies and others* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (50.65) while mean ranking of impact by those who have less than 5 years research experience is the lowest (23.53).

6. There is difference in mean ranking of *I have disclosed the invention/innovation based on my research results* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (46.82) while mean ranking of impact by those who have less than 5 years research experience is the lowest (32.12).

7. There is difference in mean ranking of *I have applied patent based on my research results* based on research experience whereby the mean ranking of impact by those who

have more than 10 years research experience is the highest (47.68) while mean ranking of impact by those who have less than 5 years research experience is the lowest (31.41).

8. There is difference in mean ranking of *I have got patent based on my research results* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (47.32) while mean ranking of impact by those who have 5 to 10 years research experience is the lowest (38.32).

9. There is difference in mean ranking of *The university/I have licenced to other parties or organizations to produce or market the products from my research* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (46.66) while mean ranking of impact by those who have 5 to 10 years research experience is the lowest (35.91).

10. There is difference in mean ranking of *The license granted to other parties, has resulted in monetary returns to the university/me in the form of royalties, equities and profit sharing* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (47.60) while mean ranking of impact by those who have less than 5 years research experience is the lowest (33.85).

11. There is difference in mean ranking of *My research results have created spin off company(ies) that specifically produce and commercialize my research product* based on research experience whereby the mean ranking of impact by those who have more than 10 years research experience is the highest (45.78) while mean ranking of impact by those who have less than 5 years research experience is the lowest (34.32).

12. There is difference in mean ranking of *I have disclosed the invention/innovation based on my research results* based on education level whereby the mean ranking of impact by those post doctoral holder is the highest (52.43) while mean ranking of impact by those PhD holder is the lowest (36.75).

13. There is difference in mean ranking of *I have got patent based on my research results* based on education level whereby the mean ranking of impact by those post doctoral holder is the highest (54.57) while mean ranking of impact by those PhD holder is the lowest (37.23).

14. There is difference in mean ranking of *The university/I have licenced to other parties or organizations to produce or market the products from my research* based on education level whereby the mean ranking of impact by those post doctoral holder is the highest (51.64) while mean ranking of impact by those PhD holder is the lowest (37.05).

15. There is difference in mean ranking of My *research results have been published in various forms of academic writing* based on administration/top level management experience whereby the mean ranking of impact by those who have administration/top level management experience at university level is the highest (54.88) while mean ranking of impact by those who have no administration/top level management experience at all is the lowest (28.39).

16. There is difference in mean ranking of *Other than towards academicians, my research results have been communicated to other users outside the academic environment/priority parties such as private firms or government agencies through seminars, conferences, exhibitions and reports in the printed or electronic media* based on administration/top level management experience whereby the mean ranking of impact by those who have administration/top level management experience at university

level is the highest (53.38) while mean ranking of impact by those who have no administration/top level management experience at all is the lowest (28.24).

17. There is difference in mean ranking of *I have been invited to present to a group and organizations which could make direct use of my research results* based on administration/top level management experience whereby the mean ranking of impact by those who have administration/top level management experience at university level is the highest (51.63) while mean ranking of impact by those who have no administration/top level management experience at all is the lowest (26.37).

18. There is difference in mean ranking of *I have disclosed the invention/innovation based on my research results* based on administration/top level management experience whereby the mean ranking of impact by those who have experience at university level is the highest (52.71) while mean ranking of impact by those who have no administration/top level management experience at all is the lowest (26.17).

19. There is difference in mean ranking of *I have applied patent based on my research results* based on administration/top level management experience whereby the mean ranking of impact by those who have experience at university level is the highest (53.58) while mean ranking of impact by those who have no administration/top level management experience at all is the lowest (28.35).

20. There is difference in mean ranking of *I have got patent based on my research results* based on administration/top level management experience whereby the mean ranking of impact by those who have experience at university level is the highest (54.88) while mean ranking of impact by those who have who have no administration/top level management experience at all is the lowest (32.13).

21. There is difference in mean ranking of *The university/I have licenced to other parties or organizations to produce or market the products from my research* based on administration/top level management experience whereby the mean ranking of impact by those who have experience at university level is the highest (53.04) while mean ranking of impact by those who have who have no administration/top level management experience at all is the lowest (30.46).

22. There is difference in mean ranking of *The license granted to other parties, has resulted in monetary returns to the university/me in the form of royalties, equities and profit sharing* based on administration/top level management experience whereby the mean ranking of impact by those who have experience at university level is the highest (57.21) while mean ranking of impact by both those who have no administration/top level management experience at all and have administration/top level management experience at research centre level are the lowest (29.50).

23. There is difference in mean ranking of *My research results have created spin off company(ies) that specifically produce and commercialize my research product* based on administration/top level management experience whereby the mean ranking of impact by those who have experience at university level is the highest (47.92) while mean ranking of impact by those who have administration/top level management experience at research centre is the lowest (30.00).

24. There is difference in mean ranking of My *research results have been published in various forms of academic writing* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (53.42) while mean ranking of impact by those who work as senior lecturer is the lowest (29.35).

25. There is difference in mean ranking of *I have been invited to present to a group and organizations which could make direct use of my research results* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (55.05) while mean ranking of impact by those who work as lecturer is the lowest (27.85).

26. There is difference in mean ranking of *I have applied patent based on my research results* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (54.53) while mean ranking of impact by those who work as lecturer is the lowest (34.18).

27. There is difference in mean ranking of *I have got patent based on my research results* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (51.47) while mean ranking of impact by those who work as associate professor is the lowest (35.30).

28. There is difference in mean ranking of *The university/I have licenced to other parties or organizations to produce or market the products from my research* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (50.50) while mean ranking of impact by those who work as lecturer is the lowest (33.94).

29. There is difference in mean ranking of *The license granted to other parties, has resulted in monetary returns to the university/me in the form of royalties, equities and profit sharing* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (51.63) while mean ranking of impact by those who work as lecturer is the lowest (34.32).

30. There is difference in mean ranking of *My research results have created spin off company(ies) that specifically produce and commercialize my research product* based on academic post whereby the mean ranking of impact by those who work as professor is the highest (49.71) while mean ranking of impact by those who work as senior lecturer is the lowest (35.70).

Overall, the study shows that out of the eleven commercialisation activities of research results, only two commercialisation activities are shown to have significance difference in mean ranking based on its p-value being less than 0.05 for all demographic background. This implies that there is a difference in mean ranking of *I have got patent based on my research results* and *The university/I have licenced to other parties or organizations to produce or market the products from my research* based on research experience, highest level of education, experience as administrator/top level management and academic post status. The biggest impact for the three commercialisation activities are from academic researcher who has experienced more than 10 years, post doctoral holder, experience as administrator/top level management at university level and entitled as professor.

Interesting to note, research experience is shown to have significance difference in mean ranking based on its p-value being less than 0.05 for all eleven commercialisation activities of research results with highest mean for the academic researchers who have more than 10 years experience. However, highest level of education, experience as administrator/top level management, post doctoral holder and academic post status have some effect on other commercialisation activities of research results with highest mean for the academic researchers who have post doctoral holder, experience as administrator/top level management at university level and entitled as professor. This finding also supported by previous work done by Allen et al., (2007) that indicate faculty research productivity according to appointment type (tenure-track faculty were more research productive than were faculty on other appointments) and

research productivity by rank (e.g., full professor, associate professor, and assistant professor) were significant predictors of faculty research productivity.

CONCLUSIONS AND RECOMMENDATIONS

Whether shaped by the actual or perceived significance of demographic background, the finding of this study shows that demographic background have some effect on academic researchers who were involved in commercialisation activities of their research result in biotechnology related research.

By classifying the commercialisation activities of research results into different categories or dimensions, it is possible to identify and develop a more focused commercialisation activities of research result categories – CNB, TT and IPAW for each different group of academic researchers in commercialisation activities of research results in biotechnology related research in Malaysian Research University.

The Kruskal Wallis tests further showed that there are differences between demographic backgrounds in commercialisation activities of research result with academic researchers who have more than 10 years experience, experience as administrator/top level management at university level and entitled as professor scoring highest mean compare to the other demographic background. Therefore, it is recommended that university should practice an approach or policy to take into account demographic background such as research experience, level of education, experience as administrator/top level management and academic post status in motivating the commercialisation activities of research results among academic researchers.

For the present study, the sample was chosen from academic researchers who involve in biotechnology related research. Further comparative works may be conducted across different field of research such as information technology, engineering, social sciences etc. Comparisons among different field of research can help to understand the pattern of commercialisation activities of research results across different field of research, so that more focused research attention on commercialisation activities toward research result can be made. A possible study can be carried out on the private and public universities in Malaysia.

Although this study shows significant demographic background differences in perception at academic researcher level, it is not completely clear how those differences play out at the institutional level. Within this context, qualitative studies might complement this quantitative research in providing a richer and deeper understanding of how academic researcher benefit from commercialisation activities of their research results.

REFERENCES

Agrawal, A. & Henderson, R. (2002). Putting Patents in Context: Exploring Knowledge Transfer from MIT. *Management Science*. 48(1), 44-60.

Allen, Link & Rosenbaum. (2007). Entrepreneurship and Human Capital: Evidence of Patenting Activity from the Academic Sector, *Entrepreneurship: Theory and Practice*.937-951

Bercovitz, J. & Feldman, M. (2004) *Academic Entrepreneurs: Social Learning and Participation in University Technology Transfer.* Mimeograph, University of Toronto.

Caracelli, V. J. & Greene, J. C. (1993). Data analysis Strategies for Mixed-method Evaluation Designs. *Educational Evaluation and Policy Analysis.* 15(2), 195–207.

Goddard, J.B., Charles, D.R., Pike, A., Potts, G. & Bradley, D. (1994) *Universities and Communities*, Committee of Vice Chancellors and Principals, London.

Gray, D. O & Walters, S. G. (1998) *Managing the industry/university cooperative research center : a guide for directors and other stakeholders* . United States of America: Battelle Press.

Gu, W. & Whewell, L. (1999). *University Research and the Commercialization of Intellectual Property in Canada.* Occasional Paper No. 21.

Hair, J.F., Jr., Anderson, R.E., Tatham, R.L. & Black, W.C. (1998). *Multivariate Data Analysis* (5th ed.). Upper Saddle River, New Jersey: Prentice Hall.

Jensen, R.A., Thursby, J.C. & Thursby, M.C. (2003). Disclosure and Licencing of University Inventions: the Best We Can Do with the S We Get to Work With. *International Journal of Industrial Organization*. 21(9), 1271-1300.

Jusoh, A. (2008). *Hubungan Amalan Pengurusan Kualiti Menyeluruh Dengan Tahap Pemindahan Teknologi: Suatu Kajian Empirikal Mengikut Perspektif Penyelidik Universiti.* PhD Thesis. Universiti Utara Malaysia.

Landry, R., Amara, N. & Ouimet, M. (2006). Determinants of Knowledge Transfer: Evidence from Canadian University Researchers in Natural Sciences and Engineering.

Louis, K.S., Blumenthal, D., Gluck, M.E. & Stoto, M.A. (1989). Entrepreneurs in academe: An exploration of behaviors among life sciences. *Administrative Science Quarterly*. 34, 110-131.

Morgan R. P., Kruytbosh C. & Kannankutty N. (2001). Patenting and Invention Activity of U.S. Scientists and Engineers in the Academic Sector: Comparisons with Industry. *The Journal of Technology Transfer*. 26(1-2), 173-183.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

Pallant, J. (2005). *SPSS Survival Manual.* (2nd ed.). New York: Open University Press.

Rasli, A. (2005). *IT Competencies and The Conditions for Training Effectiveness: A Study on Malaysian University Clerical Workers*. Denmark: Roskilde University

Tinsley, H. E. A., & Tinsley, D. J. (1987).Uses of Factor Analysis in Counseling Psychology Research. *Journal of Counseling Psychology*, 34, 414–424.

Zucker, L.G & Darby, M.R (2001). Capturing Technological Opportunity via Japan's Star Scientists: Evidence from Japanese Firms' Biotech Patents and Products. *Journal of Technology Transfer*. 26, 37-58.

Zucker, L.G., Darby, M.R. & Brewer, M.B. (1998). Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises. *American Economic Review*. 88(1), 290-306.

Zucker, L.G., Darby, M.R. & Armstrong, J. (1998). Geographically Localized Knowledge: Spillovers or Markets? *Economic* Inquiry. 36(1), 65-86.