 

# Academic scientist's motivation in research commercialization from National Research Universities in Thailand: An individual Level

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**Abstract**

The main objective of this research was to study a model of the motivation of academic scientists to commercialise research by investigating the relationship between their motivation and influence factors, focusing on the individual level. Questionnaire surveys were used to collect the data. The target samples were selected from professors in national research universities in Thailand**.** The results from regression analysis showed that both personal driving force and opportunity recognition affected the motivation of academic scientists in research commercialization. The results of the analysis of variance, t-tests and Pearson Chi-Square identified the type of research, intellectual property ownership, taking a business course, involvement in the scientific community and having a personal connection with industry affected the driving force of the researcher. University-industry linkage directly affected to recognise opportunities. This research may help guide policy makers to increase research commercialization by academic researchers.

**Keywords:** academic scientist, research commercialization, scientist's motivation, academic entrepreneurship, university-industry linkage, national research university, technology transfer

## 1. Introduction

In the modern era of globalization, many countries are focusing on research to develop science and technology in the face of stiff international competition. This includes intensively commercialising the research agenda at universities or public laboratories to serve industry and to spur innovation. Transferring technology from universities to industry will drive the growth of the national economy (Roberts & Peters, 1981). Revazishvili (2008) stated that research commercialisation from universities creates opportunities to support economic and social growth.

Cooperation among the three parties—government, industry and university—clearly indicates that universities have become "a third actor" which is an important part of developing the economy (Etzkowitz, 2001). According to trends in research commercialisation policy, commercialised research is becoming the third mission of the academic researcher in addition to teaching and research. Universities should transfer science to business, commonly known as "knowledge commercialization" (Revazishvili, 2008). New knowledge and technology are created in terms of both basic and applied research. Researchers normally create basic or applied research in order to publish. Etzkowitz et al. (2000) named this "Ivory Tower" research. Traditionally, universities have enhanced their reputation through the quantity of published papers. However, most public papers cannot be developed for the commercial market known as the "public domain" (Thoms et al., 1993). In contrast, Siegel et al, (2004) stated that industry-oriented research has greater potential for commercial applications than academic research. Yang et al., (2009) mentioned that few researchers have addressed the relationship between research commercialisation and knowledge production and diffusion. One of the success factors in the commercialisation of research from universities is having academic researchers, but few university-based academic researchers produce research results that have commercial impact (Robert & Peters, 1981). Thus, in order to stimulate academic researchers to increase their engagement in research commercialisation, it is important to understand what factors motivate researchers.

The main purpose of this research was to study a model of the factors that motivate academic scientists to commercialise research by investigating the relationship between their motivation and influence factors, focusing on the individual level. This research may help guide policy makers to increase research commercialization by academic researchers.

 

## 2. Role of academic researcher in research commercialization from University

In early research, (Smilor, Gibson & Dietrich 1990), research commercialisation is defined as one technology transfer process that takes university research and applies it in industry in a practical and useful manner. Two types of research transfer are intellectual property licensing and spin-off (or a start-up company) (Pérez & Sánchez, 2003). Some papers include contract research. Many previous researchers stated that universities are the most important of the commercialised research organisations since they are a centre of human resources, idea resources, advisers and specialists (Rasmussen et al., 2006; Siegel et al, 2004; Smilor, Gibson & Dietrich, 1990; Etzkowitz, 1998 cited in Revazishvili, 2008).

Roberts & Peters (1981) determined that commercial innovation from a university faculty has two steps, invention and exploitation. Many academic scientists have commercially-oriented ideas; these scientists are known as "idea-havers". However, there are few academic entrepreneurs or "idea-exploiters". Exploitative behaviour is linked to background characteristics of the person. The model of Dorf & Worthington (1987) illustrated that the researcher is the one of the many partners in technology commercialisation that is a factor in commercialising technology. Siegel et al. (2004) contended that one of the key university/industry technology transfer stakeholders is university scientists who initiate the process to discover new technologies.

## 3. Academic Researcher's Motivation in Research Commercialization: Individual Level

The focus of this research was on the motivation of academic researchers to commercialise research at the individual level.

Smilor, Gibson & Dietrich (1990) studied university spin-out companies; they found pull factors, such as recognition of a market opportunity, drive to develop try something new, and desire to put theory into practice, were more important than push factors. The need for more money was only one of the push factors that impacted on researcher motivation. Orhan & Scott, (2001) reported that individuals become entrepreneurs primarily due to "pull" factors, rather than "push" factors. Siegel et al. (2004) summarised their study by concluding that the primary motive of the academic researcher was recognition within the scientific community including the number of publications or grants, and secondary motives were financial gain and a desire to secure additional research funding (mainly for graduate students and laboratory equipment).

To boost a researcher's motivation, Henrekson & Rosenberg (2001) suggested that supporting entrepreneurial behaviour by training through an entrepreneur program was crucial. Thus it followed that a university should develop in its researchers, the acknowledgement of the value of transferring knowledge, and set up an appropriate reward program to intensify efforts to produce successful researchers. Banal-Estañol & Macho-Stadler (2010) pointed out that the choice of research projects is affected by commercialisation incentives. Commercial rewards induce a more intensive search for groundbreaking innovations, which are more likely to be generated through riskier research programs. The organisation's optimal incentive scheme is derived in terms of the researchers' characteristics. On this point, organisations should use a high level of commercial incentives for scientists who have strong or weak intrinsic preferences for research. For those with strong preferences, the organisation needs to induce development, while for those with weak ones, it needs to induce effort.

Harman (2010) studied university research commercialisation from the perspective of technology transfer specialists and of science and technology academics. He found that the barriers to this process were the lack of entrepreneurship in researchers who did not have any idea about running a business and the complicated linkages to industry.

### *3.1 Researcher's characteristic*

The study of Roberts & Peters (1981) considered the background characteristics of the researcher, and linked the exploitation process to commercial innovation within the university faculty as being most ably predicted by the earlier occurrence of related behaviour by the individual. Erdos & Varga (2010) studied factors influencing the realisation of academic motivations behind the establishment of a spin-off firm. The results showed that there was a "classical" academic entrepreneur behind the formation of a university spin-off. Classical academic entrepreneurs have excellent publication and citation records and their scientific work is widely known internationally. In addition, these researchers came from the senior academic positions. Monetary rewards, as an incentive were not crucial to motivate them.

### *3.2 Entrepreneurial climate*

The entrepreneurial environment is the main key to growing a knowledge base, as shown in the study by Wessner (2003) of a successful university in the United States of America that commercialised its research. Rasmussen, Moen & Gulbrandsen (2006) considered research commercialisation was an individual issue and not a permanent obligation. Thus, the university should establish a reward system and should encourage the development of entrepreneurial knowledge to stimulate "academic entrepreneurs". Rasmussen, Moen & Gulbrandsen (ibid: 524) pointed out that the idea should be to give to the others in the form of knowledge and fulfill the gap between the scientist and industry. Even the idea or function of a scientist and of industry is different, but the way to solve this

 

problem is to construct a business framework and commercialise the research. Klofsten & Jones-Evans (2000) considered that the fundamental activities to motivate the researcher to become an entrepreneur were arranging an entrepreneurial culture within the university and providing business training. Similarly, Wong, Ho & Singh (2007) reinforced this in their study on increasing the attitude of scientists.

In a study on the relationship between research commercialisation and entrepreneurial commitment, Yang & Chang (2009) found that a faculty member's entrepreneurial commitment affected the amount of research produced. Supporting scientists to have more entrepreneurial commitment helps them to seek new knowledge. Grimpe & Fier (2009) indicated three sources of a scientist's motivation: first, recognition among the scientific community (promotion, financial reward, publication record or patents application); second, the provision of opportunities or resources such as funding for the scientist; and third, stimulation to increase the faculty's research productivity such as by publication or patent because such study results confirm that a scientist who has a track record of intellectual property is interested in industry. To increase the expansion of knowledge, patents or application research should be constrained to promote the scientist. In additional, the study of Banal-Estañol & Macho-Stadler (2010) found that the university should be concerned about monetary or reputation rewards to scientists who were successful in commercialising knowledge in order to motivate others.

*3.3 The linkage between university and industry*

Inzelt (2004) stated that key factors in the innovation process are interaction and collaboration among the three players—namely, the university, industry, and government. There are many levels of collaboration, but the personal connection between the scientist and industry is the most crucial and frequent. Etzkowitz & Leydesdorff (1998) defined a typology of interaction with industry that included three approaches: *"*(1) hands off, leave the matter entirely to the transfer office; (2) knowledgeable participant, aware of the potential commercial value of research and willing to play a significant role in arranging its transfer to industry; and (3) seamless web, integration of campus research group and research program of a firm*"*. Interaction indicators are input oriented and are measured by seeding money. Meanwhile, output is measured by joint publication or patents. Research and development contracts are measured by research funding, and input-output-innovation throughput.

Dorf & Worthington (1987) pointed out that a barrier to transfer knowledge is the lack of communication or collaboration between the researcher and industry, where the scientist has no market knowledge or ability to understand the user. The study suggested that seminars or conferences helped scientists apply their knowledge to market needs, with increased contract research helping the knowledge transfer process.

*3.4 University – industry linkage lead to recognition of opportunities*

Market opportunity and technology opportunity have been defined as scientific knowledge and the desire to apply knowledge (Morales-Gualdrón, Gutiérrez-Gracia & Dobón 2008). Collaboration between universities and industry should be increased because industry lacks the ability to conduct research into new inventions and innovation. At the same time, educational institutes lack the funds, fundamental structure, motivation and passion to apply ideas to products. Therefore, collaboration will help both parties. Universities can gain access to funds for research, equipment and advanced technology while industry can access knowledge and inventions developed by researchers (Diamant & Pugatch, 2007). Interaction between industry and researchers enhances new ideas. Funds and income from licensing also help researchers pay wages and purchase laboratory equipment (Markiewicz & Minin, 2004).

Successful university-industry linkage (UIL) can be measured by efficiency, continuous marketing, understanding between cultures, understanding of industrial problems, continuity of technology transfer to industry, and communication (Geisler, Furino & Kiresuk 1990). Scientists should know a customer's needs from industry such as by building a science community to create a research vision. The challenge to scientists is to develop a new research philosophy where everyone plays an important role in the technology transfer process (Thoms & Su, 1993).

According to the survey by Yang et al. (2009), commercialisation is based on the individual level. Faculty members are pulled by both economic influence and research excellence in this scientific-economic regime. Moreover, it reveals a possible trade-off relationship between research commercialisation, knowledge production and diffusion as long as faculty members need to rely on external funds. The high entrepreneurial commitment tends to confine the disclosure of faculty members' research results.

In summary, some previous researchers pointed out that motivation of the academic researcher from the individual perspective, is separated into two types of issues—intrinsic and extrinsic. Intrinsic issues relate to a motive that occurs from the internal driving force of researchers. They include the need for more money, academic entrepreneurship and awareness and interest which are associated with *"personal driving force"* in this research. It is related to the researcher's characteristics, the entrepreneurial climate and the linkage between the

 

university and industry.

On the contrary, extrinsic issues influencing the researcher's motivation come from the external environment, mostly from the university-industry linkage. Market opportunity or technology opportunity recognition leads to the researcher seeing the chance to apply knowledge toward commercialisation. This is associated with *"opportunity recognition"* in the current study.

In most of the studies reviewed, the motivation to commercialise research was studied in a variety ways. The aim of the current research was to manifest the model of the motivation of academic researchers with emphasis on the individual level thorough the analysis of the various factors.

## 4. Methodology and Data

### *4.1 Sampling and data collection*

A quantitative design was used for this study. The target population totally are 1,802 academic scientists, working in a science or science and technology faculty, from eight of the top-ranked national research universities in Thailand which all have a strong performance record in research. 30 questionnaires were sent to 30 researchers to analysed reliability. Cronbach's alpha was ranging from 0.670 to 0.819. Then, the edited questionnaire was sent to the academic researchers based on one of two methods depending on the location of each university. For the four universities located in Bangkok, the capital of Thailand, the questionnaire was distributed directly and identified by the received date. The other universities were out of the capital and the surveys were mailed with a reply-paid envelope. A period of four months was allowed to receive returned surveys. In total 385 surveys were returned from 1772 for a 21.72 percent response rate, with 372 (20.0 percent response rate) usable.

### *4.2 Measurement of analytical approach and variables*

A four-page questionnaire with a cover page explaining the purpose of the study was divided into five parts.

The first part involved demographics; respondents were asked their sex, age, educational level, and the disciplines of the researcher. In the second part, there were eight questions covering variables on the researcher's characteristics; academic position, number of years working in academic field, type of research that researcher focused on, number of publications and proceedings, intellectual property record, family background in business and revenue.

Entrepreneurial climate were concerned with whether the researcher was involved in an environment that aided entrepreneurship. Yes or no answers were required for five questions (Have you ever taken a business course, have you ever been involved in entrepreneurial culture, have you every participated with or talked with a successful researcher in commercialised research, and have you ever received any recognised money or reputation rewards from research commercialisation). The university-industry linkage factor was divided into two variables—linkage with industry by organisation and by personal connection. Each variable had three questions, requiring yes or no answers, the same as for the entrepreneurial climate.

Personal driving force is a factor regarding the need for more money or academic entrepreneurship by researchers that is driven by the inner- self. Meanwhile, opportunity recognition, such as a market opportunity or technology opportunity to apply knowledge is the result of an outside effect. A six-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree) was used to assess the opinion of each researcher.

A**nalysis of variance (ANOVA)** and independent sample *t*-tests were used to measure mean differences of these factors. Mean different of personal driving force and opportunity recognition Likert scale were re-grouped into three groups of the opinion level, (1-2 for low, 2.1-4 for medium, 4.1-6 for high), in order to use Pearson Chi-Square analysing the relationship of factors.

Independent variables were taken from researcher's characteristics, the entrepreneurial climate and the university-industry linkages. The hypotheses of the research questions were;

*Question1: Which variables affect personal driving force and opportunity recognition?*

H1: Researcher's characteristic affects to mean difference of researcher's personal driving force.

H2: Researcher who is involved in entrepreneurial climate affects to mean difference of researcher's personal driving force.

H3: University-industry linkage affects to mean difference of researcher's personal driving force.

H4: The mean difference of opportunity recognition is affected by university-industry linkages.

Motivation of Academic Entrepreneurs; Lam (2011) stated that there is no single type of entrepreneurial scientist driven by a common motive. Many early researchers found that entrepreneurs including academic entrepreneurs have a variety of motives for deciding to commercialise research (Goldfarb & Henrekson, 2003; Henrekson & Rosenberg, 2001; Kirkwood, 2009; Morales-Gualdrón, Gutiérrez-Gracia & Dobón 2009; Wong, Ho & Singh 2007). Thus, the hypothesis to study the motivation of academic researchers, especially the individual level dimension, is a construct comprised of two factors; personal driving force and opportunity recognition.

 

*Question2: Are personal driving force and opportunity recognition related to the motivation of academic researchers?*

H5: Motivation of academic researchers is affected by personal driving force and opportunity recognition.

Linear regression analysis was used to analyse the relative influence of personal driving force and opportunity recognition. A six-point Likert scales ranging from 1 (less) to 6 (most) was used to measure the level of each researcher's motivation to commercialise research.

## 5. Results

### *5.1 Demographics of respondents*

The demographics of the 372 research respondents; 197 (53.0 percent) were female and 175 (47.0 percent) were male. The ages ranged from 26 to 64 years (n = 366), with a mean of 21.82 years and the majority of respondents (44.1 percent) aged over 30 to 40 years. Furthermore, 303 respondents (81.5 percent) had a doctoral degree. A total of 372 people responded to the question about the field in which they were teaching or researching. There were several data groups in seven disciplines. Biological science (including anatomy, botany, microbiology, physiology and zoology) was the major group (22.6 percent), followed by chemical science (including chemistry, biochemistry, chemistry technology and industrial chemistry) with 21.8 percent, mathematics and statistical sciences recorded with 19.1 percent, physics and material sciences with 16.4 percent, applied science and technology (including applied science, computer science, food science and several technologies) with 14.5 percent, environmental and marine science (3.2 percent) and geology with 2.4 percent.

### *5.2 Mean differences of personal driving force*

The one-way ANOVA and *t*-test analysis were used for analysing the mean differences between personal driving force and opportunity recognition which were the dependent variables. The aim of this study was to identify the variables according to three factors that affect mean difference of personal driving force and opportunity recognition—namely, the researcher's characteristics, entrepreneurial climate and university-industry linkages.

#### 5.2.1 Researcher's characteristics

Six variables associated with researcher's characteristics were analysed by an *F*-test of the one-way ANOVA. The results in table 1 show that the mean of the personal driving force among groups of researchers categorised by type of research were significantly different ($F_{2,\ 10.603} = 11.971$, p-value < 0.001). Multiple comparisons and the least significant difference (LSD) statistic were used in order to identify the pairs of research type effects. The result of post-hoc test shows that the group of researchers whose emphasis was on basic research was different from the group of researchers who conducted applied research or commercialised research (p-value < 0.001).

The other variables associated with researcher's characteristics (intellectual property ownership and family background) were analysed by *t*-test. Both of these variables were divided into two groups of respondents. For intellectual property (IP) ownership, 14.40 percent were IP owners, and 85.60 percent were not. The *t*-test (table 3) showed the group means to be significantly different, with the mean for the group of IP owners being significantly higher than for the group without IP ($t = 2.723$, p-value < 0.05). With regard to family background, 25.06 percent were from a business family (parents or spouse), and had a significantly higher mean than the group of researchers who were not from a business family ($t = 1.679$, p-value < 0.05).

#### 5.2.2 Entrepreneurial climate

The group mean scores for the hypothesised differences on all variables in an entrepreneurial climate were analysed by *t*-test to determine the mean difference in personal driving force between the two groups of researchers involved and not involved in an entrepreneurial climate. The *t*-test (table 2) showed that the group of researchers who had taken a business course or had training in a business field was significantly higher than those who had not undertaken courses or had training ($t = 6.556$, p-value < 0.001). The scientific community was one variable that had a significant effect on the mean personal driving force ($t = 3.120$, p-value < 0.001). On the other hand, the mean score between the respondents who were involved in an entrepreneurial culture, or had been acknowledged with money or reputation rewards from successful commercial research was not different from the group.

#### 5.2.3 University and industry linkage

The *t*-test (table 2) shows that the group mean scores between researchers who connected and did not connect to industry. Joining with industry such as through a consultancy or a partnership via the organisational level did not affect a researcher's driving force. In contrast, the mean values between the group of researchers who had links to industry by their personal connections and those that didn't were significantly different. Altogether three linkage patterns boosted the intrinsic aspect—namely, doing contract research ($t = 3.827$, p-value < 0.001), joining a seminar or conference ($t = 3.369$, p-value < 0.005), and using a website to meet industry ($t = 1.631$, p-value < 0.1).

### *5.3 Mean difference of opportunity recognition*

There was only one factor (university-industry linkage) which could be used to study the influence of opportunity recognition; it was analysed using a *t*-test. There were significant differences between groups with regard to the

 

mean difference of opportunity recognition of researchers. Not only the organisational linkage, but also personal connections, significantly influenced group means on the opportunity for recognition ($p < 0.001$), see table 3.

*5.4 Factors related to personal driving force and opportunity recognition: Pearson Chi-Square*

Pearson Chi-Square were used to test the hypothesise of the variables that relate to personal driving force and opportunity recognition. Eleven variables, which affect on group mean differences of dependent variables, were selected to test. Table 3 shows the values of Chi-Square for the hypothesised. There are only two variables that have not affected to personal driving force, Family Background (Chi-square value = 6.839, degree of freedom = 6, p-value > 0.05), and university – industry linkage with personal acquiring from website (Chi-square value = 5.635, degree of freedom = 2, p-value > 0.05). As this result, research type and IP ownership support H1, training scientist community support H2, and doing contract research and joining seminar conference by personal support H3. For opportunity recognition, p-value of all variables is less than significant value 0.05. It was clear that all variables strongly supported H4.

*5.5 Motivation factors of academic researcher: regression analysis*

The effects of personal driving force and opportunity recognition on motivating academic researchers were studied by regression analysis. The value in the correlation matrix for both was not high (variables was 0.40 and less than 0.75). Furthermore, the Durbin-Watson statistic value is 1.848 that was greater than 1.5. Thus, there was no multicollinearity problem associated with the independents variables based on the regression analysis constraint. The *F*-test value in ANOVA was 106.806 which was significant (p-value < 0.001) indicating that at least one independent variable had an effect on the motivation of academic researchers. The coefficients (table 4) clearly confirmed that both personal driving force ($t = 8.957$, p-value < 0.001) and opportunity recognition ($t = 6.999$, p-value < 0.001) were significantly correlated with the motivation of academic researchers. The standardised coefficient also identified that the beta value of personal driving force (.407) was higher than for opportunity recognition (.318). The results of the regression analysis clearly support H5 that personal driving force and opportunity recognition have significantly positive effects on the motivation of academic researchers. Additionally, personal driving force had a higher correlation than opportunity recognition.

## 6. Discussion and conclusion

The results clearly revealed that motivation of academic researchers to commercialise research initiates from two factors of influence. First, personal driving force is an intrinsic factor of the researcher's desire to undertake commercial research. The need for more money and the entrepreneurship of the researcher are crucial stimuli for the researcher, but this is apparent in only a few scientists. This affirms with the previous study of Keerati-angkoon, Pichyangkura & Chandrachai (2011) who stated that successful research commercialisation still depends mostly on enthusiastic personal or the entrepreneurial spirit of scientists. Second, in the case of traditional scientists who are not interested in or aware of entrepreneurial activity or who have enough money, commercialisation can be stimulated by building up opportunity recognition, where the scientists can be known by the value of the technology they have developed and the market opportunity to apply their research results to industry in a practical manner. This confirms the previous studies of Smilor, Gibson & Dietrich (1990), Siegel et al. (2004) and Orhan & Scott (2001).

Based on Chi-Square results, the variables that influence personal driving force are consistent with previous studies. The type of research undertaken and the intellectual property ownership of the scientist's characteristic can indicate to driving force in a scientist.

The results indicated that two variables in the entrepreneurial climate had a significant effect on increasing personal driving force. A scientist who has been trained in business or entrepreneurship courses has greater awareness or is more interested in entrepreneurship, as reported by Henrekson & Rosenberg (2001). A researcher who is involved in the scientific community may be stimulated to imitate a successful person in research commercialisation (Siegel et al., 2004). Meanwhile, entrepreneurial culture had no significant effect on personal driving force. Furthermore, it should be noted that incentive or reward programs (based on either reputation or money) were not crucial to the researchers. This result contrasts with many early research reports.

The linkage between university and industry was strongly confirmed as being crucial to the researcher and has a critical impact not only on personal driving force, but also on opportunity recognition as was recognised by Diamant & Pugatch (2007), Markiewicz & Minin (2004), Geisler, Furino & Kiresuk (1990), Thoms & Su (1993) and Yang et al. (2009). The collaboration occurs in many forms. A scientist may recognise the opportunity via the organisation linkage or by personal meetings, but only the personal connection level has an impact on personal driving force. A model of motivation to commercialise research by academic scientists from this study is depicted in figure 1.

This research aimed to study a model of motivation to commercialise research by academic scientists by investigating the relationship between the motivation of academic scientists and influential factors, focusing on the individual level. The target samples were selected from academic researchers in national research universities

 

in Thailand. This study contributes useful information to policy makers on how to stimulate academic researchers in the university in order to increase research for commercialisation. For example, within university should be developed entrepreneurial climate by training business knowledge or setting up community among scientists.

However, this research has three limitations. First, it can be argued that the measurement of the relationships for all variables was at a comparatively rough scale for statistical analysis. Thus, future research should be carried out with a reconsideration of and improvements in these limitations. Second, this study considered only factors that were based on the individual level, even though motivation may be stimulated by external factors that come from the organisational level such as policy or funding. Finally, future research should involve other disciplines or faculties to avoid self-reported bias.

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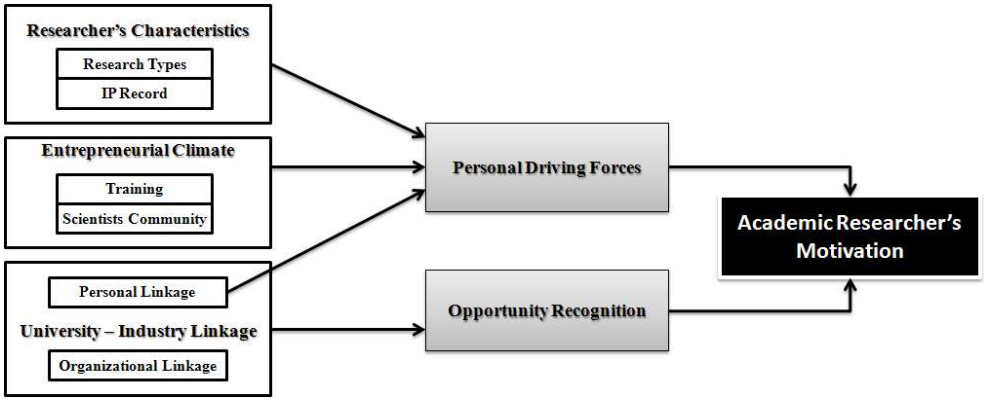


Figure 1 Model of motivation to commercialise research by academic scientists: individual level

 

Table 1. One-way ANOVA test of mean difference in personal driving force by researcher's characteristics

| Variable | | Sum of squares | df | Mean square | F-test | P-value |
|---|---|---|---|---|---|---|
| *Academic position* | Between groups | 6.054 | 3 | 2.018 | 2.182 | .090 |
| | Within groups | 336.710 | 364 | .925 | | |
| | Total | 342.765 | 367 | | | |
| No. of years in academic field | Between groups | 1.826 | 3 | .609 | .651 | .583 |
| | Within groups | 336.745 | 360 | .935 | | |
| | Total | 338.570 | 363 | | | |
| *Research type* | Between groups | 21.207 | 2 | 10.603 | 11.971 | .000 |
| | Within groups | 319.752 | 361 | .886 | | |
| | Total | 340.959 | 363 | | | |
| No. of publications | Between groups | 1.363 | 3 | .454 | .484 | .694 |
| | Within groups | 340.963 | 363 | .939 | | |
| | Total | 342.326 | 366 | | | |
| No. of proceedings | Between groups | 4.119 | 3 | 1.373 | 1.476 | .221 |
| | Within groups | 338.645 | 364 | .930 | | |
| | Total | 342.765 | 367 | | | |
| Monthly Revenue (Baht) | Between groups | 2.511 | 3 | .837 | .884 | .450 |
| | Within groups | 323.078 | 341 | .947 | | |
| | Total | 325.589 | 344 | | | |

Table 2. P-values of independent samples *t*-test of mean difference

| Variable | T-test | Df | P-Values | Mean difference | S.E. |
|---|---|---|---|---|---|
| personal driving force | | | | | |
| IP ownership | 2.723 | 366 | .007 | .38727 | .14224 |
| Family background | 1.679 | 365 | .094 | .19496 | .11612 |
| Training | 6.556 | 191.009* | .000 | .65917 | .10054 |
| Culture | 1.013 | 361 | .312 | .10319 | .10187 |
| Scientific community | 3.120 | 366 | .002 | .31233 | .10011 |
| Money reward | -.474 | 354 | .636 | -.04908 | .10362 |
| Reputation reward | -.366 | 364 | .715 | -.03939 | .10765 |
| UIL -Meet industry | .400 | 359 | .689 | .04279 | .10697 |
| UIL –Consultant | .631 | 358 | .528 | .06494 | .10288 |
| UIL –Partner | .651 | 352 | .516 | .07358 | .11311 |
| UIL-Contract research | 3.827 | 258.8.4* | .000 | .38405 | .10036 |
| UIL-Seminar, conference | 3.369 | 350.831* | .001 | .33631 | .09983 |
| UIL-Acquire from website | 1.631 | 365 | .104 | .17377 | .10651 |
| opportunity recognition | | | | | |
| UIL -Meet industry | 2.930 | 358 | .004 | .40663 | .13876 |
| UIL –Consultant | 5.058 | 356 | .000 | .65782 | .13006 |
| UIL –Partner | 3.980 | 350 | .000 | .57652 | .14486 |
| UIL-Contract research | 10.255 | 360 | .000 | 1.28854 | .12564 |
| UIL-Seminar, conference | 9.825 | | .000 | 1.16318 | .11839 |
| UIL-Acquire from website | 6.137 | 362 | .000 | .82227 | .13399 |

*Equal variance is not assumed

 

Table 3: Chi-Square value of researcher's characteristic, entrepreneurial climate, and university – industry linkage on personal driving force and opportunity recognition

| Variables | | Value | Df | Asymp. Sig. (2-sided) |
|---|---|---|---|---|
| Person driving force | Research Type | 14.767 | 4 | .006* |
| | IP Ownership | 11.717 | 2 | .003 |
| | Family background | 6.839 | 6 | .336 |
| | Training | 22.949 | 2 | .000 |
| | Scientist Community | 7.688 | 2 | .021 |
| | contract research | 10.913 | 2 | .004 |
| | seminar, conference | 11.123 | 2 | .004 |
| | acquire from website | 5.635 | 2 | .060 |
| Opportunity Recognition | Meet industry | 10.944 | 2 | .004 |
| | Consultant | 21.937 | 2 | .000 |
| | Partner | 13.494 | 2 | .001 |
| | contract research | 71.483 | 2 | .000 |
| | seminar, conference | 70.585 | 2 | .000 |
| | acquire from website | 31.582 | 2 | .000 |

Table 4. Coefficients of regression analysis

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | S.E. | Beta | | | Lower Bound | Upper Bound |
| 1. (Constant) | .038 | .250 | | .151 | .489 | -.454 | .529 |
| $X_1$PDF | .537 | .060 | .407 | 8.957 | .000 | .419 | .655 |
| $X_2$OP_REG | .376 | .054 | .318 | 6.999 | .000 | .270 | .482 |

a. Dependent Variable: Motivation**, PDF = Personal driving force, OP_REG = Opportunity recognition**