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The Effect of Team Diversity on R&D Licensing in the Thai Public Research Institute

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FOREWORD by EDITOR-in-CHIEF

We are glad to announce that the journal of *Science, Technology, & Innovation Policy and Management* (STIPM Journal) Vol 3, No. 1, July, 2018 is ready for public reading and views. The journal itself focus on STI policy and management.

The aim of this issue is to combine the various perspectives of R&D management and STI policy. Original papers as well as case studies-based research are presented to the readers.

STIPM Journal is an online research journal managed by the Center for Science and Technology Development Studies, Indonesian Institute of Sciences (PAPPIPTEK-LIPI). This journal is a blind peer reviewed journal, which provides free access to research thoughts, innovation, and original discoveries that are needed mostly by the research scholars. In this edition, the STIPM Journal contains six articles dealing with science, technology and innovation policy and management written by scholars from Japan, Thailand, India and Indonesia.

The first article, entitled *India's science, technology and innovation policy: Choices for course corection with lessons learned from China* by **G.D. Sandhya.** In this paper, an attempt has been made to look at how comprehensive India's STI policies with regard to policy components; a roadmap; and strategies for execution and boldness in terms of identifying and recognising the failures and recommend major structural changes. What is intended is to understand the relationship between the domain of S&T policy and expected outcomes; the mismatch between the policy expectations and outcomes. An attempt is being made to identify possibility for correction by taking lessons from other economies, such as China.

Second article were written by **Wati Hermawati, et al.,** entitled *Outcome and impact based evaluation of research program implementation: A case of Indonesian public research institute.* This article relates to outcome and impact based evaluation (OIBE) of a research program implementation at an Indonesian public research institute (PRI) 'A'. The major funding for PRIs in Indonesia comes from government. It is very essential, therefore, for various parties including policy makers to be informed about meaningful and relevant evaluation of the outcome and impact of such PRI to the welfare of the people, to technology development and innovation, and to the policy improvements in significant ways.

Hidenori Shigeno, et al., presents the third article, *Internal innovation capability and ICT use in the innovation process from the view of connectivity in Japanese SMEs.* This article discusses how internal innovation capability such as the technological level and R&D (Research and Development) contributes to the innovation and how it is promoted by ICT use. Using the survey data of about 650 SMEs (Small Medium Enterprise) from all over Japan, this study constructs two models with ICT or without ICT and focuses on how SEMs (Structural Equation Modeling) obtain information from external linkages and the role of ICT in the innovation process

The effect of team diversity in cross-functional teams for enhancing research commercialization: An experience of Thai public research institute is an article presented by **Warangkana Punyakornwong**. This article discusses the effect of team diversity and institutional factors in terms of top management support and incentive system on the number of license agreements in the context of the National Science and Technology Development Agency (NSTDA) in Thailand.

The fifth article entitled *A contextual scientometric analysis of Indonesian biomedicine: Mapping the potential of basic research downstreaming* is presented by **Ria Hardiyati, et al**. The article discusses how to obtain a rich contextual overview of the development of biomedicine research in Indonesia, for example in the context of the down-streaming potential of research publications. The results of text data processing using a computational model and bibliometric analysis will provide a richer contextual picture as a proxy to reveal the potential for down-streaming of basic research.

Final article was compiled by **Kristiana, et al.,** with the title *The value chain analysis to support industrial cluster development of oil palm-cattle integration in Pelalawan Regency, Indonesia.* This article discusses the value chain of oil palm-cattle integration proggram and to formulate reinforcement programs to develop cluster of oil palm-cattle integration with industrial cluster approaches. Among the five products from the oil palm-cattle integration program, the liquid organic fertilizer and solid manure are more profitable than the primary product of husbandry: the beef. Nonetheless, both products are highly dependent on the beef cattle existence. In other words, if the business of manure and liquid organic fertilizer are not profitable, the business of beef cattle will also fail.

In addition to all articles that presented in this volume, we also would like to thank the authors, editors, and reviewers who have worked very hard in this edition. We hope that all articles featured in this edition will be useful for the reader.

Jakarta, 16 July 2018

Editor-in-Chief

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The Effect of Team Diversity on R&D Licensing in the Thai Public Research Institute

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ABSTRACT

The main objective of this study is to examine the effect of team diversity and institutional factors in terms of top management support and incentive system on the number of license agreements in the context of the National Science and Technology Development Agency (NSTDA) in Thailand. The sample size is NSTDA's licensed and unlicensed projects in between 2011 and 2015. Data has been collected through a survey carried out on a sample of 134 licensed projects drawn from the population of 144 licensed projects between 2011 and 2015. With limitation of time and sensitivity of identifying about unsuccessful projects, only 29 unsuccessful projects were identified. Consequently, the total projects to be examined by Poisson regression analysis were 163 projects. The results of the identification of the research teams in each licensed project indicate a statistically significant positive relationship between the high degree of difference in terms of educational major/fields, the high degree of differences in experience and the number of license agreements. It contributes to a cognitive resource theory which suggests that diversity facilitates a more complex problem-solving process. In addition to team diversity, top management support, as the institutional factor, is also another key success factor in supporting effective research team to enhance the number of license agreements.

I. INTRODUCTION

Public Research Institutes (PRIs) are main actors in the public research system and are the primary tool for governments seeking to spur research and innovation in their economies. PRIs remain critical for countries' innovation and economic performance through their activities in creating, discovering, using and diffusing knowledge (OECD, 2011). In the context of developing countries, in which private firms usually have limited technological capabilities, PRIs may be even more important because they are the nexus of these countries' leading scientists and engineers (Intarakumnerd & Virasa, 2002). However, PRIs as public sector organizations are differentiated in

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comparison with their commercial counterparts in the private sector. There is no profit maximizing focus, little potential for income generation and generally speaking, no bottom line against which performance can be measured. (Boland & Fowler, 2000). The vast majority of PRIs still generate most of their income from the State (Boland & Fowler, 2000). As a result, the need for project management expertise in public sector organizations has become fundamental in order to deal with the enormous responsibility of managing a number of projects (Rwelamila, 2007). The impact of team diversity on team performance is of vital concern as today's organizations rely on teams to accomplish organizational goals (Poling, Woehr, Arciniega, & Gorman, 2006).

Team diversity is the individual differences of the members, including explicit and implicit differences, which is different from the diversity of business management and product diversity (Dongfeng, 2013). Arredondo (1996) considered member diversity in an organization as individual difference. It covered explicit differences (gender, age, race and other characteristics in demographic) and implicit differences (attitude, belief, life-style, personality and so on). Previous diversity research has generally examined demographic characteristics in groups and related this to various group outcomes, but the results linking group diversity and performances are inconclusive due to mixed findings (Jackson, 1992; Tsui, Egan, & O'Reilly, 1992). Some studies show that diversity in tenure, educational background, functional background, and ethnicity improve group performance (Bantel & Jackson, 1989; Hambrick, Cho, & Chen, 1996; Eisenhardt, Kahwajy, & Bourgeois III, 1997; O'Reilly, Williams, & Barsade, 1997). Other studies show that tenure, age, and ethnic diversity decrease performance (Zajac, Golden, & Shortell, 1991; Michel & Hambrick, 1992). However, this study uses the theoretical argument of cognitive resource diversity theory. Researchers in this area have argued that diversity has a positive impact on performance because of the unique cognitive resources that members bring to the team (Cox & Blake, 1991; Hambrick, et al., 1996). The underlying assumption of value in diversity is that teams consisting of heterogeneous members promote creativity, innovation, and problem solving, hence generating more informed decisions.

Although previous research investigated the effect of team diversity in terms of functions, educational background, and job tenure/organizational tenure on the group performance (Milliken & Martins 1996; Williams & O'Reilly 1998; Jehn, Chadwick, & Thatcher, 1997; Pelled, Eisenhardt, & Xin, 1999; Ely, 2004; Van Knippenberg & Schippers, 2007; Joshi & Roh, 2009; De Poel, Stoker, & Van der Zee, 2014), the distinctions between various definitions of demography and the effect of those definitions may have on organizational outcomes (Zenger & Lawrence,19 89). For instance, although Katz's (1982) work and Zenger and Lawrence (1989) both used demographic measures of tenure, the conceptual meaning of those measures differs. Katz examined group tenure and defined it as the average time project-group members have worked together. The key dimension of a group tenure is length of time. In contrast, Zenger and Lawrence examined similarity of organizational tenure which represents the differences in organizational tenure among project-group members. The key dimension of this measure is similarity. However, diversity research in teams is mainly considered important in new product development teams and in top management teams (Tilebein & Stolarski, 2009). A number of handbooks and desk references on diversity policies and programs are directed more at practicing managers than the field of research and often do not address the public sector specifically (Thomas, 1991; Loden & Rosener, 1991; Gardenschwartz & Rowe, 1993; Fine, 1995; Wilson, 1997).

In the context of PRIs, technology transfer has several major goals: bringing the benefits of public research and development (R&D) to potential users, finding innovative ways to fulfill agency missions in an era of relatively scarce resources, influencing the direction of technology development, and enhancing research funds through licensing revenues (Rubenstein & Heisey, 2005). Therefore, this research aims to investigate and explain how team diversity and organizational factors in The National Science and Technology Development Agency (NSTDA)—the largest public research institute in Thailand in terms of budget and researchers—could support effective research team in licensed projects, in order to enhance the number of license agreements. The study is structured in three steps. First, it formulates research questions and hypotheses, which predict that team diversity factors in terms of functional background, educational background, age, experience and organizational factors—such as top management support by executives and incentive system—are positively related to the increase of the number of license agreements. Second, these hypotheses are tested empirically by applying Poisson regression analysis and in-depth interview in outstanding case-studies. Third, based on the results of the hypotheses, this research illustrates how the degree of team diversity and institutional factors support effective research team in terms of the number of license agreements.

II. LITERATURE REVIEW AND HYPOTHESIS

A. Literature Review

Team diversity refers to the differences between team members in any attribute that may lead each single member of the group to perceive any other member of the group, as being different from himself/herself. These attributes and perceptions refer to all dimensions people can differ on, such as age, gender, ethnicity, religion and functional background, personality, skills, abilities, beliefs, and attitudes (Fay & Guillaume, 2007). Diversity in teams can also lead to a higher quality and quantity of ideas, solutions, and products (Bunduchi, 2009). However, diversity appears to have contradictory and/or complex effects that sometimes facilitate, and sometimes hinder, innovation and success (Ancona & Caldwell, 1990).

A number of researchers have proposed that the most important difference underlying diversity dimension is between social category diversity (differences in readily detectable attributes, such as sex, age, and ethnicity) and informational/functional diversity (differences in less visible underlying attributes that are more job-related, such as functional and educational background) (Jackson, 1992; Jehn, Northcraft, & Neale, 1999; Milliken & Martins, 1996; Tsui, et al., 1992).

The cognitive resource perspective argues for a positive effect of diversity. "Cognitive resources" refer to a team's means in terms of their pooled knowledge, skills, and ability (KSA), experiences and perspectives; it is therefore also referred to as the 'information/decision making' or 'trait' perspective. Diversity in task-related attributes is assumed to increase the pooled cognitive resources, which should in turn benefit a team's quality of decision making, problem solving, and creativity. Such a cross-functional team disposes over information on marketing, product development, production and financial issues, and thus can draw on a larger pool of expertise. The wider breadth of cognitive resources is suggested to benefit team performance, such that they are more creative and effective in the new product development (Fay & Guillaume, 2007). Ancona and Caldwell (1992) explained that only another study which has investigated the effects of the demographic composition on R & D groups. In that study, Zenger and Lawrence (1989) observed that age similarity was positively related to the frequency of communication among members of research team. For product development teams, however, the most important diversity variable may be the functional mix. Teams may differ in terms of the proportion of individuals from each functional area. At one extreme, a team might be made up entirely of individuals from research and development division. At the other extreme, one-third of a team's members might be from research and development, one-third from marketing, and one-third from manufacturing division. Team members must have varied skills and specific attitudes that are different and complimentary. The findings of Taylor and Greve (2006) indicated that future research should focus on concrete measures of the career experiences of team members rather than on surface-level diversity such as the demographic variables of age, gender, and race.

From the general management literature, organizational structure influences innovation processes such as learning and creativity (Burns & Stalker 1961). Especially senior/top management involvement has been found to increase the motivation and performance of team members (Swink, 2003) and senior managers can provide a clear vision and agenda to inspire action (Harman, Golhar, & Deshpande, 2002). In the public sector, top management support is seen as essential in overcoming cultural perceptions, particularly from employees expecting to follow traditional and vertical career pathways (Athanasaw, 2003).

On the other hand, incentive measures, such as salaries, secondary benefits, and intangible rewards, recognition or sanctions have traditionally been used to motivate employees to increase performance. Reducing dis-incentives or perverse incentives that favor non-conducive behavior can often be more important than inventing new incentives. Incentive systems reside within organizations, their structure, rules, human resource management, opportunities, internal benefits, rewards and sanctions, etc. Several studies adopt a broader and psychologically richer notion of motivation to incorporate its extrinsic as well as intrinsic aspects. They employ the three concepts of 'gold' (financial rewards), 'ribbon' (reputation and career rewards) and 'puzzle' (intrinsic satisfaction) (Stephan & Levin, 1992) to examine the complex mix of motives driving the behavior of scientists.

In the context of PRIs, institutional incentives can enable and encourage PRIs and scientists to engage in technology transfer activities. Interests and motivations may often differ between actors, which hinders or discourages technology transfer. The motivations and approaches to research may substantially diverge between scientists at PRIs and collaborators in industry. The following factors must be addressed, for example, career structures for scientists and incentive/reward system by PRIs (Zuniga & Correa, 2013). Aldrigde and Audretsch (2011) explained that the availability of human capital for research, the quality of scientists and engineers and the resources at their disposal, as well as incentives for career development are keys for increasing the likelihood to successfully bring research to the marketplace. In many countries, PRIs have created reward systems whereby the inventor receives a share of any profits made when licensing or spinning-off inventions. However, although some financial incentives may apply, many staff members remain reluctant to take part in such activities, especially as they are not taken into account for career progression. It is therefore important that the appraisal criteria also take into account other activities, such as patenting, licensing, mobility and collaboration with industry.

The literature on university/research institution-based technology transfer is clear to point out that the success of a PRI's licensing and spinoff program depends on its institutional structure, organizational capability, and incentive systems to encourage participation by researchers (Phan & Siegel, 2006). Diversity can become a driver for innovation and help strengthen organizations. PRIs should better recognize the value of diversity of individual characters, skills, positions, and they should also better value the potential for teamwork (Weingart, 2005; Arlinghaus, 2014). However, empirical data on how to get diversity in teams to work is still limited. (Guillaume, Dawson, Woods, Sacramento, & West, 2013). Therefore, based on the above literature, this paper extends team diversity research to a PRI context by focusing on R&D licensing because the commercialization of scientific research is particularly risky and uncertain, a strong scientific workforce in terms of their qualifications, critical mass, age and available equipment provides an important signal of scientific credibility and capability to any anticipated commercialized venture or project (Audretsch, Aldridge, & Oettl, 2006).

B. Hypothesis

This article focuses on licensed projects in NSTDA as one of the leading S&T centers in Southeast Asia. NSTDA consists of four national technology centers, together with the Corporate Office and Technology Management Centre (TMC). The four national technology centers are the National Centre for Genetic Engineering and Biotechnology (BIOTEC), the National Metal and Materials Centre (MTEC), the National Electronics and Computer Technology Centre (NECTEC) and the National Nanotechnology Centre (NANOTEC). NSTDA's main mission is to conduct R&D in the four main technology areas as well as to develop and support R&D in universities and other institutions, using in-house national technology centers and granting mechanisms. NSTDA has also been involved in S&T manpower development in Thailand, creating S&T infrastructure and working with the private sector in support of national socio-economic goals.

There are two research questions. First research question is:

To what degree does team diversity support effective research teams in enhancing the number of license agreements in different technology context, for example, information and communication technology (ICT), biotechnology, material technology and nanotechnology in PRIs, and why?

1) Hypothesis 1a: High degree of difference in functions/departments
2) Hypothesis 1b: High degree of difference in educational levels
3) Hypothesis 1c: High degree of difference in educational majors/fields
4) Hypothesis 1d: High degree of difference in ages
5) Hypothesis 1e: High degree of difference in years of work experience in each position

And second research question is:

To what extent and what institutional factors contribute to effective research teams in enhancing number of license agreements in PRIs?

6) Hypothesis 2a: Top management support is strongly related to enhance number of license agreements
7) Hypothesis 2b: NSTDA's incentive system is strongly associated with the increase number of license agreements

However, the relationships among the above factors are summarized in analytical framework in Figure. 1.

III. METHODOLOGY

This study applied both quantitative and qualitative methods as the mixed methods approach. It collected or analysed not only numerical data, which is customary for quantitative research, but also narrative data, which is the norm for qualitative research in order to address the research question(s) defined for a particular research study. In order to collect a mixture of data, researchers might distribute a survey that contains closed-ended questions to collect the numerical, or quantitative, data and conduct an interview using open-ended questions to collect the narrative or qualitative data (Williams, 2007).

In terms of quantitative method, the sample size was NSTDA's licensed and unlicensed projects between 2011 and 2015. Data collection was conducted by sending questionnaires to one member, either of a head or a member of project as a project representative. After screening information about availability of researchers in NSTDA, the population of licensed projects was 144 projects. It relied on Poisson regression analysis because the number of license agreements (Figure 2) as a dependent variable

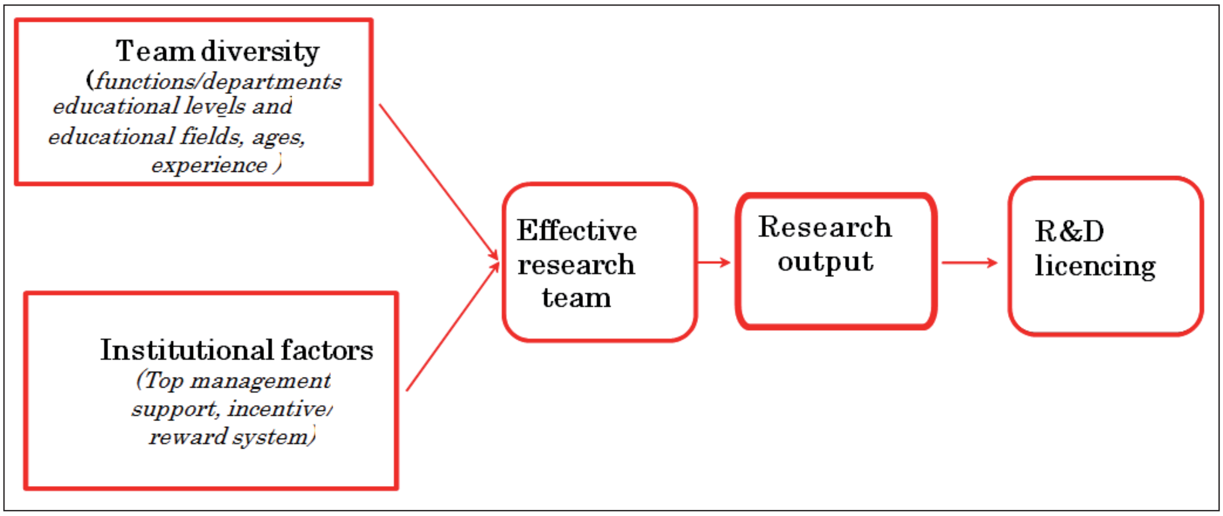

Figure 1. Analytical framework

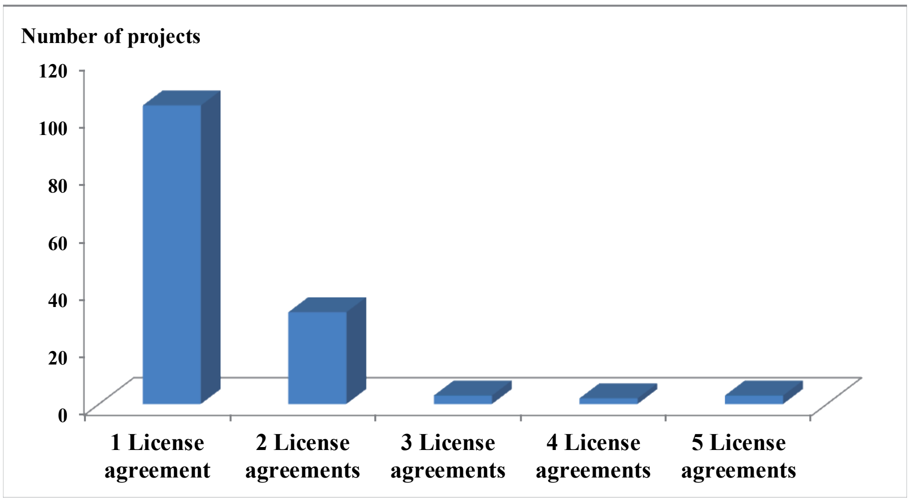

Figure 2. The number of license agreements between 2011 and 2015

was asymmetric and right-skewed distribution which can be approximated with an important class of discrete distribution, Poisson distribution. The Poisson distribution, then, is of greatest importance for the study of rare events (Land & McCall, 1996).

In practical applications, the Poisson should only be used where the number of events observed is reasonably large (typically >25, and preferably >100) and the probability of an individual event occurring at any particular time or place is small (typically <0.10). Events are assumed to occur entirely independently and do not occur simultaneously or at the same location. In many applications of the Poisson the mean, λ, is not large, but there is no requirement for λ to be small (de Smith, 2015).

This study adopted mainly quantitative research approach; variables are summarized in Table 1. Poisson regression analysis was used to estimate the number of license agreements. Dependent variable was the number of license agreements and there were twelve independent variables in seven groups; degree of difference in functions/departments, degree of difference in education levels, degree of difference in educational fields, degree of difference in ages, degree of difference in experience, top management support, and incentive system. They were dummy variables. Jaccard (2001) clearly explained concept about how to create and interpret dummy variables. A dummy variable is a variable that is created by the analyst to represent group membership on a variable. For example, in the case of gender, it can create a dummy variable and assign a 1 to all males and a 0 to all females. This method of scoring is called "dummy coding" or "indicator coding" and involves assigning a 1 to all members of one group and a 0 to everyone else.

When a qualitative variable has more than two levels, it is necessary to specify more than one dummy variable to capture membership in the different groups. In general, one needs m – 1 dummy variables, where m is the number of levels of the variable. Suppose we had as a predictor variable a person's party affiliation that could take on three values, Democrat, Republican, or Independent. In this case, we need 3 - 1 = 2 dummy variables to represent party affiliation. For the first dummy variable, DD, we assign all Democrats a 1 and everyone else a 0. For the second dummy variable, DR, we assign all Republicans a 1 and everyone else a 0. Although we could create a third dummy variable for Independents and assign them a 1 and everyone else a 0, such a variable is completely redundant with the other two dummy variables. Once we know whether someone is a Republican (by means of the first two dummy variables), he or she is an Independent. The reasoning behind this is more evident if one considers a dummy variable for gender. We create a single dummy variable to discriminate the two groups whereby males are assigned a score of 1 and females a score of 0. If we create a second dummy variable that assigns a score of 1 to females and a score of 0 to males, it is perfectly negatively correlated with the first dummy variable and, hence, redundant. With dummy coding, the group that does not receive a 1 on any of the dummy variables is called the reference group for that variable. In the examples above, the reference group for gender is females and for party affiliation the reference group is Independents (Jaccard, 2001).

Table 1.
Variables used Poisson Regression Analysis

Variables name	Definition	Type of variables
1. Dependent variable		
1.1 License	Number of license agreements	Numerical variable
2. Independent variables		
2.1 Degree of difference in functions/ departments	Low degree is a reference group	
2.1.1 Mfunc	Medium degree (Team has members both from same laboratory and different laboratories in PRIs)	Dummy variables (1=Medium; 0 =High; 0=Low)
2.1.2 Hfunc	High degree (Team has members both from same laboratory/different laboratories in PRIs and external partners (university researchers/companies)	Dummy variables (0=Medium; 1 =High; 0=Low)
2.2 Degree of difference in education level	Low degree is a reference group	
2.2.1 Medulevels	Medium degree (Team has members from two levels; ex: bachelor degree and master degree.)	Dummy variables (1=Medium; 0 =High; 0=Low)
2.2.2 Hedulevels	High degree (Team has members from three levels; ex: bachelor degree, master degree, and doctoral degree.)	Dummy variables (0=Medium; 1 =High; 0=Low)
2.3 Degree of difference in education fields	Low degree is a reference group	
2.3.1 Medufields	Medium degree/balance (The percentage of number of different disciplines compared with team size as between 50% and 75%; ex: team has 5 members and members graduated from 3 different disciplines. As a result, it accounted for 60%)	Dummy variables (1=Medium; 0 =High; 0=Low)
2.3.2 Hedufields	High degree/variety (The percentage of number of different disciplines compared with team size as more than 75%; ex: team has 5 members and members graduated from 4 different disciplines. As a result, it accounted for 80%)	Dummy variables (0=Medium; 1 =High; 0=Low)
2.4 Degree of difference in age	Low degree is a reference group	
2.4.1 Mages	Medium degree (Team has members who have 2 ranges of ages; ex: 25-34 years olds and 45-55 years olds.)	Dummy variables (1=Medium; 0 =High; 0=Low)
2.4.2 Hages	High degree (Team has members who have 3 ranges of ages more than 3 ranges; ex: 25-34 years old and 35-44 years old or/and 45-55 years old)	Dummy variables (0=Medium; 1 =High; 0=Low)
2.5 Degree of difference in experience	Low degree is a reference group	
2.5.1 Mexperience	Medium degree (Team has members who have 2 ranges of experience; ex: 3-5 years and 5-7 years.)	Dummy variables (1=Medium; 0 =High; 0=Low)
2.5.2 Hexperience	High degree (Team has members who have 3 ranges of experience or more than 3 ranges; ex: 3-5 years and 5-7 years and more than 9 years)	Dummy variables (0=Medium; 1 =High; 0=Low)

Variables name	Definition	Type of variables
2.7 Top management	Top management support by executives. For example, providing researchers appropriate advice, facilitating research team by budget allocation for market trials, etc.	1= Top management support is strongly related to enhance number of license agreements 0= Top management support is not strongly related to enhance number of license agreements
2.8 Incentive	Incentive system means money incentive in case of licensing, recognition awarded by your organization and career path incentive.	1= NSTDA's incentive system is strongly associated with the increase number of license agreements 0= NSTDA's incentive system is not strongly associated with the increase number of license agreements

On the other hand, interview results about the outstanding projects in terms of the number of license agreements and achievements can be discussed to complement regression analysis.

IV. RESULT AND DISCUSSION

A. Result

A head of project or a researcher as a representative of each project is requested to answer questionnaire depending on the available time the researchers have. The main questions in a questionnaire consist of three sections. The first section contains the basic information of a respondent. The second section comprises questions about team diversity in a project, such as type of technology, degree of differences in functions, educational levels, major field of education, age, and work experiences. The third section focuses on questions in terms of institutional factors such as: did the project receive top management support? Did incentive system stimulate research team to have final goal for R&D licensing?

Data had been collected through a survey carried out on a sample of 134 licensed projects drawn from the population of 144 licensed projects between 2011 and 2015. It accounts for 93% of total licensed projects. There are 49 ICT projects, 33 biotechnology projects, 29 material technology projects, and 23 nano technology projects. This study tries to mix between licensed and unlicensed/unsuccessful projects. With limitation of time and sensitivity in identifying about unsuccessful projects, it received only 29 unsuccessful projects, comprising 9 ICT projects, 6 biotechnology projects, 8 material technology projects, and 6 nano technology projects. Therefore, total projects to examine by regression analysis are 163 projects, consisting of 134 licensed projects and 29 unlicensed projects. However, a limitation of this analysis is due the fact that most variables are dummy variables, except a number of license agreements as a dependent variable.

The results from Poisson regression analysis are presented in Table 2–5. Table 2 shows the descriptive statistics. It provides the means, standard deviations (SD), minimum (Min) and maximum values (Max). Although the value in the "Value/df" column for the "Pearson Chi-Square" row in Table 3 is 0.531, the test of model effects as shown in Table 4 indicates that the model is a proper fit for the variables considered as in the sig column; the p-values are less than 0.05 which is within the 95% confidence level.

In Table 5, the parameters show that three variables are statistically significant predictors of the number of license agreements at the 95% confidence level ($p < 0.05$). That is to interpret that high degree of difference in educational majors/fields, high degree of difference in experience, and top management support strongly influence the number of license agreements, whereas high degree of difference in functions, educational levels, age, and incentive will in turn lead to a decrease in the number of license agreements. On the other hand, it can be explained that a change

Table 2.
Descriptive Statistics

	Number of Obs.	Mean	SD	Min.	Max.
Dependent variable					
Number of license agreements	163	1.17	0.91	0	5
Independent variables					1
Mfunc	163	0.24	0.43	0	1
Hfunc	163	0.28	0.45	0	1
Medulevels	163	0.16	0.37	0	1
Hedulevels	163	0.50	0.50	0	1
Medufields	163	0.61	0.49	0	1
Hedufields	163	0.25	0.44	0	1
Mages	163	0.47	0.50	0	1
Mage	163	0.07	0.26	0	1
Mexperience	163	0.40	0.49	0	1
Hexperience	163	0.25	0.44	0	1
Top mgt	163	0.40	0.49	0	1
Incentive	163	0.34	0.48	0	1

Table 3.
Goodness of Fit

	Deviance	Pearson Chi-Square	Log Likelihood	Akaike's Information Criterion (AIC)	Bayesian Information Criterion (BIC)
Value	89.927	79.707	-193.757	413.515	453.734
df	150	150			
Value/df	0.600	0.531			

Source: The Author

Table 4.
Omnibus Test Model Effects for Poisson Regression Model

Likelihood Ratio Chi-Square	df	Sig.
30.790	12	0.002

Table 5.
Parameter Estimates **of Poisson Regression Model**

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
(Intercept)	0.364	0.571	-0.757	1.485	0.405	1	0.524	1.439
Mfunc	0.005	0.193	-0.374	0.385	0.001	1	0.978	1.005
Hfunc	-0.130	0.179	-0.480	0.221	0.526	1	0.468	0.878
Medulevels	-0.192	0.240	-0.663	0.278	0.643	1	0.423	0.825
Hedulevels	-0.361	0.256	-0.863	0.142	1.982	1	0.159	0.697
Medufields	-0.096	0.182	-0.452	0.260	0.280	1	0.597	0.908
Hedufields	0.403	0.192	0.027	0.779	4.421	1	0.035	1.496
Mages	-0.149	0.162	-0.468	0.169	0.847	1	0.357	0.861
Hages	-0.260	0.280	-0.809	0.290	0.858	1	0.354	0.771
Mexperience	0.018	0.211	-0.396	0.432	0.007	1	0.931	1.018
Hexperience	0.431	0.166	0.106	0.757	6.739	1	0.009	1.539
Top mgt.	0.365	0.161	0.050	0.679	5.159	1	0.023	1.440
Incentive	-0.242	0.152	-0.541	0.057	2.521	1	0.112	0.785

Source: The Author

in the high degree of difference in educational majors/fields, experience, and top management support will lead to an increase in the number of license agreements by 49.6% (from Exp(B) -1 =1.496 -1 =49.6%), 54% and 44% respectively.

B. Discussion

The results of this study contribute to the literature about cognitive resource theory which posits that diverse values among teammates will contribute to a better team performance. Members will share information from a greater variety of perspectives, a practice that leads to higher quality analysis of tasks, which in turn fosters higher quality results (Woehr, Arciniega, & Poling, 2013). Moreover, it reinforces suggestion by Wiersema and Bantel (1992) and Schwenk (1984) that low diversity teams are usually more prone to have declining performance, unlike teams with high diversity as the team members will be challenging each other's perceptions, which usually allow them to reach better-justified decisions. Although several studies examined the relationship between education levels and team performance (Jackson, May, & Whitney, 1995; Jehn et al., 1997; Knight et al. 1999), this study investigates the effect of both educational level and educational major/fields of the licensed projects. The choice of a specific educational major may reflect one's cognitive strength and personality (Holland, 1973). For instance, an individual educated in computer science can be expected to have a somewhat different cognitive disposition than an individual educated in marketing or advertising (Hambrick & Mason, 1984).

Moreover, different technology projects require different educational fields to support effective research team. On the other hand, each study had different demographic measures of tenure/ experience. Katz (1982) examined group tenure and defined it as the average time project-group members have worked together. The key dimension of group tenure is length of time. Although the relationship is not linear, the members of project groups of long tenure tend to communicate less frequently than the members of short-tenured project groups. In contrast, the level of organizational tenure diversity in the team—that is, diversity in the amount of time team members have worked for an organization (in line with Chi, Huang, & Lin, 2009). This study has different definition from previous studies. It defines "experience" as the amount of time each member has worked with and experienced in each position for an organization.

After interviewing heads of some projects which have outstanding performance in terms of a number of license agreements or outstanding achievement, two projects could be explained to support the results from Poisson regression analysis—that is why high degree of difference in educational major/fields and high degree of difference in experience influences the number of license agreements, as follows:

1) VAJA (ICT project)

   Vaja is a Thai text-to-speech software developed by Human Language Technology Laboratory (HLT) under NSTDA. VAJA has been able to synthesize all Thai words since it has a text analysis module which can generate the pronunciation of every word, even those not found in a dictionary. VAJA can convert normal language text into speech. This project had outstanding performance in terms of having more than 3 license agreements. One characteristic of this research team was the mix among members who had experience between 1–3 years, 3–5 years, 7–9 years and more than 9 years as having the high degree of difference in experience. This project had 8 members. Their educational fields consisted of speech technology, computer science, electrical engineering, global information and telecommunication studies, information technology, linguistics, and computer engineering.

   The percentage of a number of different disciplines compared with team size was 87.5% as having the high degree of difference in educational fields. These different disciplines can support key processes for developing Thai speech processing technology like VAJA. Key educational fields to use in text processing, linguistic processing and wave form synthesis is computer science/ information technology/speech technology, whereas members of team who had linguistic knowledge are important to help team to develop Thai speech processing technology in terms of linguistic/prosodic processing.

In the period of software testing, members who had expertise in electronic engineering/computer engineering are the key person to do alpha testing in order to evaluate the quality of software and ensure beta readiness. These tests focus on finding bugs, which run typically 1–2 weeks per test cycle with numerous cycles based on how many issues are discovered and how many new features are released.

After passing alpha test, engineering teams had to get feedback from a selected group of end-users and resolve problems in beta test (usually 3–6 weeks per test cycle). When releasing version 1, 2, etc., engineering teams continue to check the performance and fix bug of software including the continuous development with researchers. In addition, top management support by NSTDA president was one of the key success factors because former NSTDA president between 1999–2000 provided suggestions to research team and stimulated research team to do this project in order to help disabled persons.

2) Integrative sugarcane breeding to increase sugar yield (Biotechnology project).

The project had the outstanding performance in terms of investing large budget between NSTDA and company and integrating between biotechnology and ICT. This research team consisted of 7 NSTDA members, one university researcher, and a company. Considering only educational fields of main 8 members except company representative, it was found that the percentage of a number of different disciplines compared with the team size was 87.5% as having the high degree of difference in educational fields.

Three members who had expertise in plant and soil science, genome technology, and molecular biology were responsible for developing molecular marker relating to selecting sugar content, whereas one member who had expertise in phytochemistry and proteomics research had to develop proteomics technique for selecting gene relating to sugar content.

In addition, bioinformatics and computer science and engineering researchers had the main mission to develop RNA-seq technique for selecting gene relating to sugar content and two ICT researchers who had expertise in electronic and signal processing were responsible for developing image processing technique for selecting sugarcane's genetic background.

Another implication from the Poisson regression results is top management support as a statistically significant predictor of the number of license agreements.

Research findings prove that top management support is one of the key variable supporting effective team to enhance research commercialization in terms of R&D licensing in the context of PRIs. They contribute to the literature about top management support because they strengthen the idea proposed by Hitt, Nixon, Hoskisson, & Kochhar (1999), that top/senior management support has been reported to be critical to innovation and commercialization processes. The primary support offered is usually in the form of resources to the project team, including both financial resources and political supports . In this study, examples of two technology projects can be explained as follows:

1) A Novel Preservative System for natural rubber Latex (Material technology project).

This project was one of the successful project in terms of having more than 3 license agreements. Although a research team had the high degree of difference in experience among members who have experience between 3–5 years, 5–7 years, and more than 9 years, it was not a barrier of this team to deliver quality research results. It can be proven by many research awards; Invention Award 2013, in the Agriculture, and Agro-Industry from the National Research Council of Thailand (NRCT); "Gold Medal Award" in Agriculture and Agricultural Industry field from 41 International Exhibition of Inventions of Geneva, 2013 and "Special Prize" from Korea Invention Promotion Association, KIPA for the project of Thai Advanced Preservative System for rubber soother; Gold Prize Award 2013 for Energy Conservation and Environmental protection, Korea Invention Promotion Association for the project of "Innovative Recovery of Rubber and Inorganic Substances from Sludge Waste in Natural Rubber Latex Industry", at the 41st International Exhibition of Inventions of Geneva 2013, Gold Prized Award 2013, in Agriculture for the project of "Recovery of Skim Natural Rubber and Waste in Natural Rubber Latex Production Process", at the Seoul International Invention Fair SIIF 2012.

In addition, top management support by NSTDA executives was also one of the key success factors. It can be observed from NSTDA's organization structure that NSTDA executives separated Rubbers Laboratory from Polymers Research Unit and set it to be Natural Rubber Focus Unit. This new research unit consisting of 20 members with the main missions to carry out research and development, to produce innovative technology, and to support the development of the Thai rubber industry.

2) Mobile solar-operating system (SOS) water purification unit.

When Thailand faced its worst floods in 2011, Executive Director of NANOTEC assigned Dr. Chamorn Chawengkijwanich, a researcher at NANOTEC to set her team and develop the first locally made prototype solar powered water purification unit "SOS water" which combined the use of antimicrobial nanocoating to ceramic filters. Compared to conventional ceramic filter, an antimicrobial nanocoating ceramic filter will increase an extra security by killing or incapacitating bacteria left in the water and preventing the growth of mold and algae in the body of the filter.

As a result, the project was implemented to meet the need of providing drinking water to communities affected by the 2011 mega flooding in Thailand. NANOTEC had donated the first version of this prototype to HRH Princess Maha Chakri Sirindhorn, Executive Vice President of the Thai Red Cross Society on June 28, 2012 for community relief effort.

After donating the prototype SOS water to the Thai Red Cross Society, the same team developed and customized this prototype following the specifications of two companies and licensed them.

V. CONCLUSION

This study extends the team diversity research to the context of the public research institutes (PRIs), which is different from previous studies that mainly focused on private sector. It examines the effect of team diversity and institutional factors in terms of top management support and incentive system on the number of license agreements by employing Poisson regression analysis.

Key findings indicate that the high degree of difference in educational majors/fields and experience is a significant factor that influences the number of license agreements. It contributes to a cognitive resource theory which suggests that diversity facilitates a more complex problem-solving process; that is, a higher quality of decision making from different experiences and perspectives, that group members bring to their team (Gruenfeld, Mannix, Williams, & Neale, 1996). In contrast, the high degree of difference in educational levels has negative relationship with the number of license agreements. It is not consistent with that reported by Gaunya (2015). Gaunya found that a statistically significant positive relationship between educational level diversity and employee performance. Although Gaunya and this research are similar to investigate team diversity in the public sector, different organizational context and different definitions of variables may deliver different results. First, Gaunya focused on 180 line officers and 10 management level officers from the department of Probation and Aftercare Services, but this study concentrate on 163 research teams in the public research institute. Second, Gaunya investigated difference in educational level by individual but this study examines degree of difference in educational levels in each research team.

Another key finding is top/senior management support is one of the key success factors supporting effective research team to enhance the number of license agreements. It relates to observation of Sundberg and Sandberg (2006). They explained that achieving cultural change in the public sector is harder than in other sectors, as the large bureaucracies inherent to many public sectors mitigate against any moves towards flatter, looser structures as issues such as predictability, fairness and continuity are prioritized above innovation and change. Changes are subject to a higher level of scrutiny, require greater participation involving more consultation than in the private sector (MacIntosh, 2003).

However, this generality should be interpreted with careful consideration. It should be noted that the sample of teams is limited to research teams involving license agreements based on a public research institute. Future research should be conducted by using comparative studies between two public research institutes in order to illustrate some of their markedly different characteristics and the differences in team performance.

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