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Internal Innovation Capability and ICT Use in the Innovation Process from the View of Connectivity in Japanese SMEs

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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

JOURNAL OF STI POLICY AND MANAGEMENT

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ABSTRACT

Since new information necessary for innovation mainly comes from the outside a firm, it is essential that the firm should innitially obtain such information, and then integrate it with indigenous resources for innovation owned by the firm. During these two processes, it is needless to say that Information and Communication Technology (ICT) has important roles to play. The research questions of this study are to examine 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 Small Medium Enterprises (SMEs) from all over Japan, this study constructs two models with ICT or without ICT and focuses on how Structural Equation Modeling (SEMs) obtain information from external linkages and the role of ICT in the innovation process. SEM is employed to show the causality among factors to promote innovation. The estimation results show that (i) top management is important to promote innovation; (ii) SMEs use two channels to connect to external linkages with and without ICT; and (iii) ICT is the basis of other factors which promote innovation.

I. INTRODUCTION

The emergence of the information economy triggered by information and communication technology (ICT), and furthermore, the transition to the knowledge economy are not unique to Japan; SMEs have realized that common global structural changes have been going on. However, various SMEs in Europe and the U.S. have taken the role of inducing such changes themselves. Venture companies in the IT and biotech industries, for example, are specific representative of these SMEs. They are destroying existing business models and creating new products and services, a phenomenon aptly called ‘creative destruction’. SMEs in Japan, on the other hand, can be said to be victims of this process instead of innovators. In the midst of such rapid and turbulent changes, it goes without saying that sustained innovation is required to regain vitality and, furthermore, growth.

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In our main research, onsite surveys of SMEs inside and outside Japan, questionnaire surveys, and literature reviews have been conducted thus far, in order to identify the need to foster innovation by SMEs and answer the question of how innovations are produced. This paper seeks to construct a new theory on SME innovation by reviewing and comprehending findings and knowledge obtained to date, from a unified perspective. Conventional research on innovation, in general, has focused thematically on individual factors such as absorptive capability, R&D, and open innovation. While this approach has its advantages, it is critical to research innovation as a single process from a broad perspective and framework. This analyzes how SMEs acquire new information and ideas as the source of innovation; how they organize and conduct R&D to integrate these ideas with management resources within the firm; and finally, how they produce the concrete output of these steps that lead to the development of new products. Our research especially seeks to answer what elements are needed in this process, and how they should be combined and be made mutually supporting.

Another research question is placed in the role of ICT in the innovation process, as the importance of ICT was already mentioned. In the age of the information society, ICT can contribute to the above innovation process by (i) aiding the firm to obtain related information from outside via the transaction networks with customers and suppliers, and via research networks such as universities research networks; (ii) sharing information for innovation with relevant R&D sections and employees inside the firm; and (iii) shortening the R&D process by concurrent engineering. The RQs of the study are to examine how ICT contributes to the innovation of SMEs as well as what factors promote ICT use. In particular, this study attempts to construct two models of the SME innovation process, to identify factors that promote innovation and examine how ICT use affects internal capacity by a rigorous statistical method focusing on the causal relationship between innovation factors.

With these questions in mind, the paper is structured as follows to shed light on the mechanisms of innovation in SMEs. In the next section, related literature is surveyed, and Section 3 provides hypotheses to be examined. In Section 4 data obtained by the questionnaire and the first R&D model for analysis is presented. Section 5 shows the results by SEM. The second ICT model and the estimation results are discussed in Section 6. The discussions on the results of two models are provided in Section 7, and the last section offers a conclusion.

II. LITERATURE REVIEW

As new information required for innovation is produced outside the firm (Chesbrough, 2003), how the firm handles the information is critical. Cohen and Levintal (1990) and Zahra and George (2002) consider the innovation process as a learning process, which consists of absorbing new information, integrating the information with management resources within the company, converting the information, and delivering new products and services to the market. They emphasize absorptive capability as being critical for innovation and divide it into potential capability and realized capability. Mariano and Pilar (2005) expand absorptive capability by including communication with external parties, know-how and experience within the organization, diversity and multiplicity of the knowledge structure, and strategic positioning. For analysis, many experts examined the cause-and-effect relationships between a variety of factors and capabilities (Lawson and Samson, 2001; Perdomo-Ortiza, Benitob and Galendeb, 2009).

A critical concept today for advancing innovation is R&D. Like innovation, a great amount of diverse studies on R&D has been carried out. The reason is that R&D is risky, and its high rate of failure has drawn the interest of management scholars from the start (Booz, Allen, and Hamilton, 1982; Crawford, 1987; Cooper, 2001; Nadia, 2011). Based on such research, many guidebooks and textbooks on R&D have been published, for example by Crawford (1987, 1997), Smith and Reinertsen (1998), Cooper (2001), and Kahn (2013). In general, the R&D process is divided into processes such as conception of ideas, selection for commercial application, development, prototyping, and commercialization (Booz et al., 1982).

Previous research has mainly addressed R&D from the perspective of organizational theory. Those studies focused on areas such as acquisition of new information through the R&D organization, sharing of the information between members, and the conversion of the information to knowledge, and furthermore, from tacit knowledge to explicit knowledge. Accordingly, two roles are considered critical in the R&D process: the gatekeeper, the key person who incorporates new information, and the transformers, who convert the acquired information into knowledge and transmits it to members in the organization (Freeman, 1979; Tsuji, Idota, Ueki, Shigeno, & Bunno, 2016). To smoothly convey information, trustworthiness between R&D members is a prerequisite (Leven & Cross, 2004; Colquitt & Rodell, 2011). Many of these discussions on R&D consider R&D's success or failure as the outcome of their analyses. However, in this paper the essence of R&D is not the focus. Instead its relationship to the outcome of R&D in the innovation process is analyzed.

The effect of ICT use on productivity has become one of the research objectives, and it was widely agreed that ICT is an effective measure to improve the productivity of the firm through appropriate management of human capital and organizational structure (Brynjolfsson & Hitt, 2000; Brynjolfsson & Saunders, 2009). Moreover, ICT was viewed as an effective tool for innovation. However, it was not clarified yet how ICT use enhances innovation activity, or how it promotes other internal innovation capacity or R&D.

III. ESTABLISHMENT OF HYPOTHESES

From the above discussions, the following hypotheses to be tested are set forth. First, for manager-based innovation, it is assumed that in addition to producing direct innovation with technical abilities possessed by the manager himself or herself, the manager demonstrates leadership in the innovation-related organization within the firm. In such case, rather than expressing autocratic power, the manager's leadership has qualities such as nurturing the organization and personnel, and coordinating between members and organizations (Greenleaf, 1977).

H1: Top management creates innovations.

H2: Top management leads R&D and influences the organization and implementation of R&D.

This paper assumes two channels, the transaction channel and the intellectual channel, for external linkages, which are the sources of ideas for innovation. The following two hypotheses regarding the channels are posed:

H3: The transaction channel increases the internal innovation capability and R&D capability of SMEs.

H4: The intellectual channel increases the internal innovation capability and R&D capability of SMEs.

Next, incorporating the results of our research on internal innovation capability and R&D, this paper assumes that information from external linkages increases internal innovation capability, and, as a result, R&D is stimulated. The following hypotheses are set forth:

H5: Internal innovation capability stimulates R&D.

H6: R&D elevates innovation.

Finally, we integrate the above hypotheses and set forth the following hypothesis.

H7: External linkages promote innovation in SMEs.

The next section develops models to test these hypotheses.

IV. DATA AND ANALYTICAL MODEL

A. Questionnaire survey

This model is based on the survey conducted in February 2012. In general, a survey is conducted to verify hypothesis. However, the data already obtained was used, and the questionnaire was similar to verify the above hypotheses. The samples were selected as follows: from the lists of *Teikoku Data Bank*, 3,959 firms were selected from the manufacturing, construction, information and communications, and service industries. The criteria of the selection was that sample firms had to satisfy the following conditions: (i) unlisted; (ii) the number of employees is more than 20, (iii) earning positive profits in the recent three terms, that is, one and a half year, and (iv) the amount of sales is increasing. The reason for these limitations was to reduce the number of samples in the appropriate size. The valid number of responses was 647, and the response rate was 16.2%. The summary statistics is shown in Table 1.

Table 1.
Summary statistics

Outcome Variables					
Innovation	N	Min	Max	Av	S.D.
1. Presence of product innovation	637	0	1	0.67	0.47
2. Presence of process innovation	637	0	1	0.49	0.5
Explanatory Variables					
Top management					
1. Management seeks for short-run profits,	632	1	5	2.84	1.092
2. Management specialized in niche market.	607	1	5	3.21	1.235
3. Employees capability is raised by job rotation.	629	1	5	3.2	1.079
4. Open management outcome to employees	642	1	5	4.1	1.028
5. Propose achievement goal for employees and follow that outcome to reward.	642	1	5	3.78	0.955
6. Management specialized in special technology and product	643	1	5	3.59	1.146
7. The top manager voluntarily shows the idea and decides a new business.	641	1	5	3.71	0.99
8. The top manager takes the lead to do new business.	641	1	5	3.89	0.964
External linkages					
Intellectual channel					
University	647	0	1	0.04	0.2
Public organization	646	0	1	0.05	0.22
Transaction channel					
Suppliers	647	0	2	0.36	0.624
Customers	647	0	2	0.41	0.656
Technology (Internal capability)					
4. Offer own technology for other firms positively.	627	1	5	2.78	1.141
5. Received technical proposals from the other companies	624	1	5	2.79	1.11
6. Analysis of product and technology data both own and other firms.	624	1	5	2.95	1.085
7. Understanding the strong point of the partner, and collaborating in that field each other.	627	1	5	3.41	1.1
Owning original technology and development.	640	1	5	3.58	0.914
The number of patents (for five years).	523	0	59	1.5	5.207
R&D organizational structure					
1. Decision making is speedy.	607	1	5	3.58	1.13
2. Give responsibility and authority to R&D department.	606	1	5	3.52	1.098
3. Team members' discussion about the agenda of each other freely.	606	1	5	3.36	1.066
5. Competitive environment for R&D members.	606	1	5	2.64	0.993
6. R&D members were recruited from internal and external sections.	604	1	5	2.01	1.1
8. New product and service development are discussed beyond the departments.	606	1	5	3.03	1.21
9. Allocate budget based on preference position.	605	1	5	2.77	1.125
10. R&D incentive and awards system.	606	1	5	2.57	1.297
R&D implementation					
1. The ideas of the new product and service originated from within the firm.	627	1	5	3.14	1.136
2. Basic research and R&D are coordinated.	625	1	5	2.72	1.113
3. R&D is directly connected to new product and service.	625	1	5	2.86	1.172
4. Offer own technology for other firms positively.	627	1	5	2.78	1.141
5. Analysis of both product and technology data.	624	1	5	2.95	1.085
6. Accept other firm's technological proposals.	626	1	5	3.4	1.142
7. Collaboration with alliance firms in common strong domain of each other.	627	1	5	3.41	1.1
8. Concentrated on main business, others are outsourcing	625	1	5	2.93	1.125
9. Target market.	624	1	5	2.79	1.11
10. Many ideas are obtained by customers.	628	1	5	3.04	1.073
ICT Use					
2. ICT assists the advertisement of products.	612	1	5	3.14	1.256
3. ICT makes the speed of decision making faster.	615	1	5	3.44	1.09
4. ICT shortens the development period of new product.	601	1	5	2.83	1.126
5. ICT increases the number of new product and services development.	601	1	5	2.7	1.062
6. ICT makes it easy to obtain consumers' need.	608	1	5	3.16	1.068

Individual characteristics					
Year of establishment	626	1854	2011	1969	23.3
Capital (Log)	638	2.3	11.1	7.85	1.02
The number of employees	621	1	600	50.6	51.4
The number of Patents (past five years)	523	0	59	1.5	5.207
The ratio of R&D to Sales	478	0	70	2.6	5.2

B. Construction of variables

1. Outcome variable

We took the number of achieved innovation in the questionnaire as an outcome variable, namely respondents were asked whether they achieved innovation during 2006–2010. Particularly, QII.1 asked whether they supplied new product or service to the market, while QII.3 asked whether they introduced new production methods or new methods of marketing. The former was related to product innovation, and the latter to process innovation. Firms were asked to reply "yes" or "no." The number of positive replies was taken as a variable. More than two-thirds replied "yes" for product innovation, while more than half replied so for process innovation.

2. Top management

The ability of top management was not observable, and we asked questions related to the nature of this ability, which consisted of eight items. Each question required a reply using the five Likert scale from 5 to 1. Those were as follows:

QI.1. Management seeks short-run profits

QI.2. Management specialized in niche market

QI.3. Employees capability is raised by job rotation

QI.4. Open management outcome to employees

QI.5. Propose achievement goal for employees and follow that outcome to reward

QI.6. Management specialized in special technology and product

QI.7. Top management voluntarily shows the idea and decides new business

QI.8. Top management takes the lead to do new business

By using all these questions, factor analysis of the likelihood method was conducted. After the Varimax rotation, the result is shown in Table 2. Two questions such as "QI.7. Top management voluntarily shows the idea and decides new business" and "QI.8. Top management takes the lead to do new business" were extracted as

Table 2.
Factor analysis for top management

Observation variables	factor 1	factor 2	factor 3	factor 4	communality
7. The top manager voluntarily shows the idea and decides a new business.	**0.89**7	0.064	-0.006	0.137	0.828
8. The top manager takes the lead to do new business.	**0.796**	0.097	0.012	0.162	0.669
5. Propose achievement goal for employees and follow that outcome to reward.	0.111	0.993	-0.012	0.010	0.999
4. Open management outcome to employees.	0.004	0.445	-0.035	0.177	0.230
3. Employees capability is raised by job rotation.	0.070	0.333	0.035	0.179	0.149
1. Management seeks short-run profits.	0.003	-0.010	0.999	0.014	0.999
2. Management specialized in niche market.	0.087	0.137	0.034	0.688	0.502
6. Management specialized in special technology and product.	0.256	0.252	-0.012	0.573	0.459
Variance	1.529	1.391	1.004	0.911	
Proportion	19.115	17.386	12.549	11.385	
Cumulative	19.115	36.501	49.050	60.435	

significant. The latent variable regarding these is termed "Top management." These two observed variables coincide with what we learned from the in-depth interview. The average values of replies of QI.7 and 8 were 3.71 and 3.89, respectively, implying that they were greater than the average 3 (Table 1).

3. External linkages

QIV.(1) asked the sources of information related to innovation such as transaction partners, organizations, universities, and respondents were required to reply "yes" or "no." If they replied "yes" to either buyer or seller, they were considered as obtaining information from transaction partners, while if they replied positively to university or public research institutions, they obtained from the intellectual channel. In either case, the number of the positive replies was taken as a value of the variable.

4. Internal innovation capability

(i) Technology

Internal innovation capability consists of various factors, but the numbers of replies to the questions related to those factors were small and significant variables were not extracted. Therefore, we focused on questions related to technology, since it is closely related to innovation. Then, QIII.1 asked whether the following questions hold true to your firm, contained questions related to the technological level of firms, which were as follows:

QIII.1.4. Offer own technology for other firms positively

QIII.1.5. Received technical proposals from the other companies

QIII.1.6. Analysis of product and technology data both own and other firms

QIII.1.7. Collaboration with alliance firms in common strong domain of each other

We also find other following questions related to technology:

Owning original technology and development

The number of patents (for five years)

We applied factor analysis to these questions by using the same method as before, and the result of factor analysis is shown in Table 3.

According to the result of factor analysis, one latent variable was extracted, which consists of "QIII.1.5 Received technical proposals from the other firms" and "QIII.1.7 Collaboration with alliance firms in common strong domain of each other." The latent variable from these questions was referred to as "Technology," In particular; QIII.5 implied the possibility that SMEs with the high technical level may be engaged in collaboration with larger firms to which SMEs supply parts and components. This may correspond to SMEs' innovation of improvement-type.

(ii) R&D characteristics

R&D has two characteristics such as R&D organizational structure and R&D implementation, and we began with discussing the former. The R&D organizational structure was asked in question "QIII.2. To what extent the following items are true for your firm."

Table 3.
Factor analysis for internal innovation capability (Technology)

Objective variables	factor1	factor2	Communality
5. Received technical proposals from the other firms.	**0.849**	-0.258	0.598
7. Collaboration with alliance firms in common strong domain of each other.	**0.545**	0.185	0.418
4. Offer own technology for other firms positively.	**0.488**	0.179	0.346
6. Analysis of product and technology data both own and other firms.	0.188	0.553	0.431
Owning original technology and development.	-0.044	0.446	0.316
The number of patents (for five years).	-0.084	0.375	0.121
Variance	1.616	0.613	
Proportion	26.938	10.220	
Cumulative	26.938	37.158	

Questions were as follows:

QIII.2.1 Decision Making is speedy

QIII.2.2 Give responsibility and authority to R&D department

QIII.2.3 Team members discuss the agenda with each other freely

QIII.2.4 Competitive between R&D members

QIII.2.5 R&D members recruited from internal and external sections

QIII.2.6 New product and service development is discussed beyond the departments

QIII.2.7 Allocate budget based on preference position

QIII.2.8 R&D incentive and awards system

To eight related questions, factor analysis was similarly applied, and the results are shown in Table 4. The first factor extracted contained "QIII.2.1 Decision making is speedy", "QIII.2.2 Give responsibility and authority to R&D department", and "QIII.2.3 Team members discuss the agenda with each other freely". Particularly, QIII.2.2 was related to decentralization and autonomy of R&D units. From our field research, it was observed that the speed of decision making is a merit of SMEs. From these, it followed that the latent variable from these observation was referred to as "R&D structure."

Previous literature also discussed about autonomy and found autonomy as a variable to elevate innovation from Japanese data, whereas Argyres and Silverman (2004) and Lerner and Wulf (2007) claimed that centralization in R&D organizations is better to pursue innovation in terms of efficient allocation of resources and coping with shifts of technologies, markets, and other environments over R&D. This study supports the autonomy as a factor promoting innovation.

"QIII.2.3: Team members discuss the agenda with each other freely" is related to another important nature of R&D, which is mutual understanding and confidence among members in the process of the diffusion of information and knowledge, which is emphasized by Szulanski, Cappetta, and Jensen (2004), Leven and Cross (2004), and Colquitt and Rodell (2011).

To identify another factor related to R&D, QIII.(1) was employed, which consisted of the following ten questions on R&D performances and arrangements:

QIII.1.1: The ideas of the new product and service are often created inside the firm

QIII.1.2: Basic research and R&D are coordinated

QIII.1.3. R&D is directly connected to new product and service

QIII.1.4: Offer own technology for other firms positively

QIII.1.5: Accept other firm's technological proposals

QIII.1.6: Analysis of product and technology data both own and others firms

QIII.1.7: Collaboration with alliance firms in common strong domain of each other

QIII.1.8: Concentrated on main business, others are outsourcing

Table 4.
Factor analysis for R&D organizational structure

Objective Variables	Factor 1	Factor 2	communality
1.Decision making is speedy.	**0.968**	-0.194	0.680
2. Give responsibility and authority to R&D department.	**0.956**	-0.056	0.832
3. Team members discuss the agenda with each other freely.	**0.633**	0.330	0.838
8. New product and service development is discussed beyond the departments.	0.141	0.626	0.550
6. R&D member recruited from internal and external sections.	-0.154	0.544	0.187
5. Competitive environment for R&D members.	0.026	0.653	0.453
9. Allocate budget based on preference position.	0.101	0.654	0.654
10. R&D incentive and awards system.	-0.042	0.577	0.297
Variance	4.663	0.502	
Proportion	51.816	5.574	
Cumulative	51.816	57.391	

QIII.1.9: Target market

QIII.1.10: Many ideas are obtained by customers

Factor analysis was also applied for these questions, and results were summarized in Table 5. The first factor consisted of "QIII.1.3. R&D is directly connected to new product and service", "QIII.1.2: Basic research and R&D are coordinated", and "QIII.1.1: The ideas of the new product and service often are create inside the firm." These factors indicated the direction and performance of R&D and accordingly the latent variables based on these observed variables was referred to as "R&D implementation." This variable, in other words, indicated whether actual R&D leads to achieve innovation, which is an essential question to R&D and various previous papers has also analyzed that (Leonard-Barton, 1988；Iansiti, 1998). The organizational arrangement or environment to achieve "QIII.1.1: The ideas of the new products and services often are created inside the firm" has been analyzed widely (Sundgren, Dimenas, Gustafsson, & Selart, 2005).

V. ESTIMATION OF R&D MODEL

A. R&D model

The model with additional internal innovation capability is determined by the R&D model. By this addition, the mode contains two sub-process related to internal innovation capabilities as well as R&D, which could lead to more detailed analysis of SMEs' innovation process. The path diagram is expressed in Figure 3 and the estimation results of the direct effect are summarized in Table 7. The fitness of the model is shown in Table 8.

1. Path diagram and standardized direct effect

The R&D model adds one variable, which indicates the latent variable of "technology," as well as the firm's technological ability to collaborate with external linkages. As already explained, mother companies may not accept SMEs as subcontractors, if they do not have sufficient technological capability. Since all definition and contents of the latent variables are already explained, the remaining issue is related to the cause-and-effect relationship among the latent variables. It must be identified which variables are causes and which are results. The path diagram and the estimation results of standardized direct effect are shown in Figure 1 and Table 6, respectively.

At first, the path diagram of the R&D model shows the following interesting observations:

Table 5.
Factor analysis for R&D implementation

Objective Variables	Fact-or1	Fact-or2	Fact-or3	Fact-or4	Fact-or5	Commu-nality
3. R&D is directly connected to new products and services.	**0.878**	0.163	0.209	0.052	0.092	0.1224
2. Basic research and R&D are coordinated.	**0.840**	0.138	0.245	0.103	0.044	0.1764
1. The ideas of the new products and services are often created in the firm.	**0.571**	0.114	0.218	0.088	0.162	0.5652
4. Offer own technology for other firms positively.	0.173	0.970	0.125	0.104	0.027	0
6. Analysis of both product and technology data.	0.302	0.135	0.936	0.084	0.079	0
5. Accept other firm's technological proposal.	0.100	0.345	0.085	**0.537**	0.046	0.5695
7. Collaboration with alliance firms in common strong domain of each other.	0.111	0.249	0.299	**0.553**	0.158	0.504
9. Target market.	0.154	0.024	0.152	0.087	0.674	0.4894
8. Concentrated on main business, others are outsourcing.	0.181	0.157	0.117	0.355	0.339	0.6709
10. Many ideas are obtained by customers.	0.178	0.122	0.133	0.168	0.358	0.7601
Variance	2.037	1.241	1.107	0.797	0.770	
Proportion	0.331	0.202	0.194	0.128	0.125	
Cumulative	0.331	0.533	0.728	0.858	0.983	

(i) Top management

Three paths from top management to two R&D latent variables and innovation are positively significant. This implies that top management plays an essential role in the R&D model. This shows that these paths are reflection of the innovation of top management-type. This also explains why the path to "technology" is not significant; in this type of innovation, owner (top management) is also an engineer and he/she directly contributes to innovation.

(ii) Transaction channel

The path from transaction partner is positively significant to "R&D structure," but not so to "R&D implementation." This implies that through the transaction channel which is based on the supply chain, information related to constructing R&D units or the framework of R&D units in a concrete way is transferred to SMEs.

(iii) Intellectual channel

The paths from university/research institutions which are positively significant are found to "technology" as well as to "R&D implementation," which are positively significant. This is a bit different from the transaction channel, implying that through the intellectual channel, information related to cutting-edge technology directly affects not only to the level of technology of SME but also to the orientation or direction of "R&D implementation." The former is reasonable since SMEs can learn the latest technology from university laboratories, which elevate the technological ability and then change the direction of R&D. Moreover, one path from university/research institutions provides indirect effect to "R&D structure" through "technology," indicating the level of technology determines the R&D organizational structure. In other words, it shows that the higher the level of technology will creates more sophisticated or advanced R&D.

2. Causal relationship

The latent variable of technology is found to be the first among all latent variables due to the results of SEM. It is technology that SEMs have to elevate to connect with external linkages. This indicates that the level of technology is the most important, which leads to R&D. The causal relationship is not vice versa. These are the same results as our previous studies (Tsuji, Ueki, Idota, & Akematsu 2013). This is also consistent with observations from our field research.

3. Fitness of model

The fitness of the SEM model is shown in Table 7 which is determined by GFI (goodness-of-fit index) and AGFI (adjusted goodness-of-fit index) which take the value between 0 and 1 indicating criteria of the explanatory power of the model. If GFI ≥ AGFI and both indices are 0.9 or more,

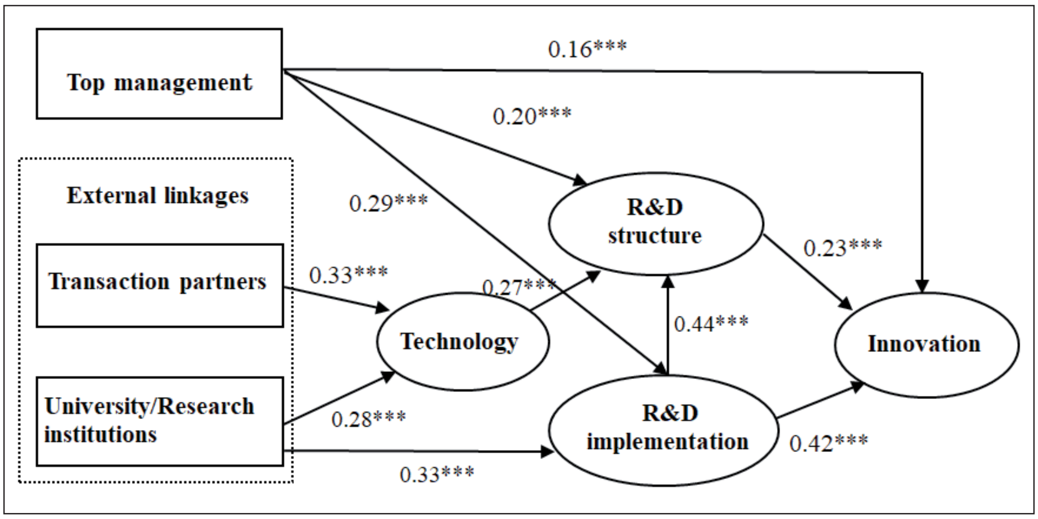

Figure 1. Path diagram of the R&D model

Table 6. Standardized direct effect (R&D model)

From	To	Standardizing Coefficient	SE	*t*-value	*p*-value
Top management	R&D structure	0.204***	0.047	4.951	0.001
Top management	R&D implementation	0.285***	0.040	6.074	0.001
Top management	innovation	0.158***	0.021	3.060	0.002
Transaction partner	technology	0.334***	0.288	2.735	0.006
University/ Public research institution	technology	0.278***	0.744	3.170	0.002
University/ Public research institution	R&D implementation	0.331***	0.618	3.583	0.001
Technology	R&D structure	0.270***	0.059	4.766	0.001
R&D structure	Innovation	0.228***	0.020	3.896	0.001
R&D implementation	R&D structure	0.442***	0.060	9.773	0.001
R&D implementation	innovation	0.418***	0.029	6.751	0.001

Source: Authors

the model can be judged as proper. CFI (comparative fit index) evaluates the model in terms of goodness-of-fit showing how much the model is improved in comparison with the independent model estimated under the assumption that there is no correlation among the observed variables. It takes the value from 0 to 1, and the model is judged as being good fit if CFI is 0.9 or more. Moreover, RMSEA (root mean square error of approximation) is an index that expresses the divergence between the estimated and actual distribution of the model expressed in terms of the amount of degrees of freedom. The model can be judged as good fitness, if it is 0.10 or less. The results show that GFI (0.946), AGFI (0.922), CFI (0.943), and RMSEA (0.058) satisfy all above conditions.

4. Total effect and verification of hypotheses

Table 8 shows standardized total effects, which show all related paths are positively significant.

Regarding hypotheses stated earlier, all effects from top management and external linkages are positively significant, which is demonstrated by **H3** and **H4**. As explained earlier, technology activates two categories of R&D, implying **H5** is verified. Finally since two categories of R&D enhance innovation, this demonstrates **H6**. Accordingly, external linkages are verified to promote innovation, which **H7** is demonstrating.

VI. ESTIMATION OF ICT MODEL

A. ICT model

The purpose of the section is to examine the role of ICT in the innovation process, and ICT

Table 7.
Fitness of the R&D model

χ^2value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
300.912	94	0	0.946	0.922	0.943	0.058	384.912

Table 8.
Standardized total effect of the R&D model

To \ From	Transaction partner	University/ Public research institution	Top management	technology	R&D implementation	R&D structure
technology	0.334***	0.278***	--	--	--	--
R&D implementation	--	0.331***	0.285***	--	--	--
R&D structure	0.090***	0.221***	0.330***	0.270***	0.442***	--
Innovation	0.21***	0.189***	0.352***	0.062***	0.519***	0.228***

is one factor of internal innovation capability. In so doing, one more latent variable named ICT is introduced in the previous mode of R&D model, which is referred to as the ICT model. On the other hand, to make analysis as simple as possible, particularly to make the pass diagram simple, the latent variable of top management is deleted.

The questionnaire contains questions on ICT use related to innovation which were asked in QV.4. The questions used in this analysis are summarized as follows:

QV.4.2: ICT assists the advertisement of products

QV.4.3: ICT makes the speed of decision making faster

QV.4.4: ICT shortens the development period of new product

QV.4.5: ICT increases the number of new product and services development

QV4.6: ICT makes it easy to obtain consumers' need

These questions required replies to the five Likert scale from 5 to 1 and the data is also summarized in Table 1. The method of constructing the latent variable related to ICT, instead of factor analysis, the SEM model can calculate it automatically in case the questions to use are already determined. The latent variable is termed "ICT." Therefore, the ICT model expands the previous R&D model by adding one more latent variable. Accordingly, the purpose of the ICT model is to examine whether ICT contributes to SMEs' innovation and how ICT relates to other latent variables of the internal innovation capability, that is, the causality among the latent variables.

Since in this model, the roles of ICT with respect to the external linkages is emphasized, top management as an internal sources of idea is not analyzed. Then the hypotheses to be verified are as follows:

HICT1: The transaction channel increases the internal innovation capability such as ICT and technology and R&D capability of SMEs

HICT2: The intellectual channel increases the internal innovation capability such as ICT and technology and R&D capability of SMEs

HICT3: Internal innovation capability such as ICT and technology stimulates R&D

HICT4: R&D elevates innovation

HICT5: External linkages promote innovation in SMEs

B. Estimation results

The framework of the ICT model is basically the same as the previous model, and estimation results are summarized in Figure 2 and Table 9; the former shows the path diagram, while the latter the estimation results of the direct effect. Regarding the sources of ideas, top management is erased, because of (i) emphasizing the roles of ICT in terms of connecting the external linkages through transaction and intellectual channels, (ii) comparing the results of the R&D model, and (iii) maintaining the simplicity of analysis.

From the results, the following characteristics of ICT roles in the innovation process are observed.

1. Roles of ICT use

Basic results are similar to the previous model regarding the latent variables used in the previous R&D model, but great changes are found in paths from "ICT" to all other latent variables such as "technology," "R&D structure," "R&D implementation," and "innovation," implying that ICT plays important roles in the innovation process. It also follows from Table 9 that ICT directly promotes innovation. Through ICT, SMEs obtain information on innovation from the two categories of external linkages such as transaction and intellectual channels. There are other direct paths from "transaction partners" to "technology" and from "university/research institutions" to "R&D implementation," indicating that SMEs obtain information via face-to-face communications. Therefore, SMEs can make use of two channels with or without ICT for innovation. Table 9 particularly shows that ICT is located first in the innovation process, which indicates it is an origin affecting other factors of innovation. In this sense, it can be said that ICT is the most important part in the internal innovation capability.

2. Connectivity

There are two paths from external linkages to ICT which affect other latent variables, which is already mentioned. This indicates that in addition to the paths from the external linkages identified in the R&D model, SMEs possess other routes which connect to external linkages via "ICT." It is reasonable for ICT to create new tools for the external linkages. However, there is one difference from the paths of the R&D model; the path from "university/research institution" to "technology" does not exist. On the other hand, a new path from "technology" to "R&D implementation" appears. That is, "ICT" takes over the direct channel from "university/research institution" to "technology" but it creates a new path which indirectly connects from "university/research institution" to "R&D implementation."

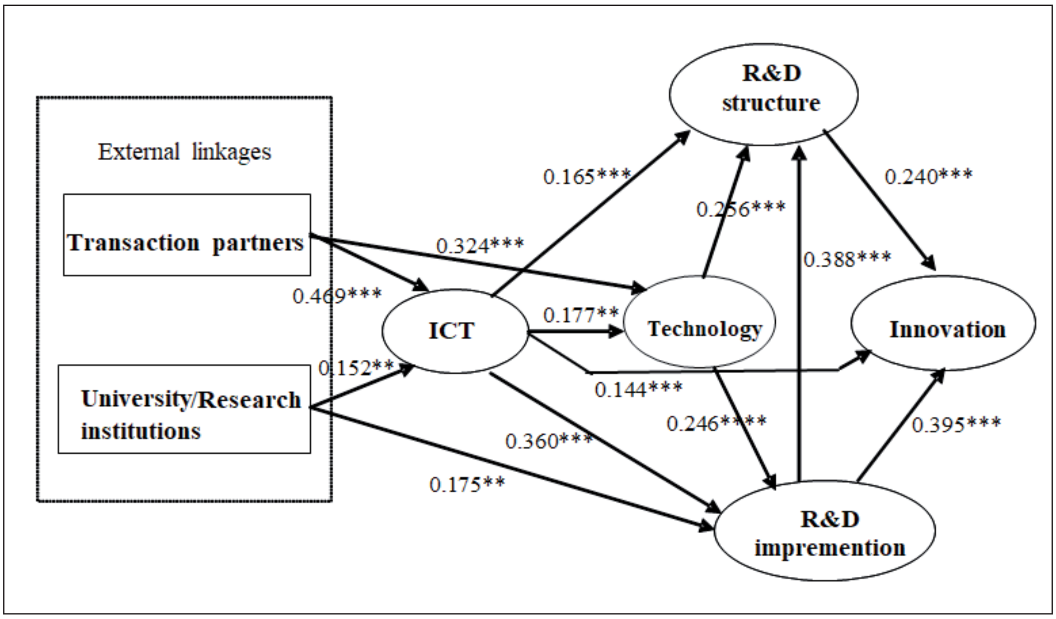

Figure 2. Path diagram of the ICT model

Table 9.
Standardized direct effect (ICT model)

From	To	Standardizing Coefficient	SE	*t*-value	*p*-value
Transaction partners	ICT	0.469***	0.225	4.468	0.000
Transaction partners	Technology	0.324***	0.296	2.882	0.004
University/Research institutions	ICT	0.152**	0.416	2.085	0.037
University/Research institutions	Technology	0.130	0564	1.613	0.107
University/Research institutions	R&D implementation	0.175**	0.446	2.377	0.017
ICT	Technology	0.177**	0.092	2.343	0.019
ICT	R&D implementation	0.360***	0.056	6.848	0.000
ICT	R&D structure	0.165***	0.065	3.651	0.000
ICT	Innovation	0.144***	0.027	2.577	0.010
Technology	R&D implementation	0.246***	0.051	4.200	0.000
Technology	R&D structure	0.256***	0.068	4.458	0.000
R&D implementation	R&D structure	0.388***	0.068	7.823	0.000
R&D implementation	Innovation	0.395***	0.030	5.966	0.000
R&D structure	Innovation	0.240***	0.020	3.938	0.000

Note: ***, **, and * indicate the significance level of 1, 5, 10%, respectively.

3. Fitness of the ICT model

The test statistics of the fitness of the model is shown in Table 10 implying all tests are satisfied as well.

4. Total effect and verification of hypothesis

Again, the standardizing total effects are shown in Table 11. All latent variables are positively significant to innovation in which ICT has the second largest coefficient next to R&D implementation.

Regarding hypothesis, since the transaction and intellectual channels have positively significant paths to ICT and R&D, this demonstrates **HICT1** and **HICT2**. The paths from ICT and technology have been positively significant to two R&D latent variables, implying **HICT3** is verified. Two latent variables related to R&D are positively significant to "innovation", which indicated that R&D elevates innovation and then satisfies **HICT4**. Finally, from these it follows that external linkage enhances innovation, which is demonstrated by **HICT5**.

VII. DISCUSSIONS

This study, thus far, uses two models of how SMEs obtain information outside the firm, integrate it with domestic resources they own, and achieve innovation. In these two models, the hypotheses proposed are verified. Here in this section, by comparing the conclusions obtained in this paper with those of previous papers, we clarify the characteristics of the models. First, regarding top management-type of innovation, the conclusions we obtained are similar to those of our previous studies and other literature. Since Schumpeter, innovators who were full of venture spirit to take risks and challenges for innovation as prerequisite for the theory of innovation. This study, on the other hand, does not assume a priori that all managers behave in this way, but we successfully verified from data that top management played the role as innovators in the innovation process. Second, this study demonstrates that, in two channels such as transaction and intellectual, R&D's contents and effects to innovation are different. In particular, from the transaction channel, the autonomy of R&D organizations and mutual understanding and confidence among related engineers in SMEs are found important, whereas in the intellectual channel, the level of technology and R&D orientation or implementation are essential. The connectivity to external linkages is similar to results obtained by other studies (Dyer & Nobeoka, 2000; Todo, Matous, & Inoue, 2016; Tsuji et al, 2016). However, this study is a bit different from others in the context of organization and structure to achieve better performances. Some of the variables listed in the questions shown in Table 4 are not significant, which are summarized as follows:

QIII.2.4: Competition among R&D members

QIII.2.5: R&D members are selected from internal and external sections

QIII.2.6: New product and service development is discussed beyond the departments

QIII.2.7: Allocate budget based on preferences

QIII.2.8: R&D incentive and awards system

Table 10.
Fitness of the ICT model

χ^2value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
382.522	137	0.000	0.945	0.925	0.947	0.052	484.522

Table 11.
Standardizing total effect

From / to	Transaction partner	University/ research institute	ICT	Technolo-gy	R&D imple-ment-tation	R&D struc-ture
ICT	0.469***	0.152**	--	--	--	--
Technology	0.407***	0.157***	0.177***	--	--	--
R&D implementation	0.269***	0.268***	0.404***	0.246***	--	--
R&D structure	0.286***	0.169***	0.366***	0.352***	0.388***	--
Innovation	0.242***	0.168***	0.391***	0.182***	0.488***	0.240***

Other studies emphasized cross-functional teams as well as quality control (QC) (Tsuji et al., 2016, Tsuji, Idota, Ueki, Shigeno, & Bunno, 2018). Award scheme provides incentives (Lerner & Wulf, 2007), while employment scheme provides job rotations, promotion, and wages and salaries. These differences are considered due to the framework of this study such that R&D is examined in the whole process of innovation from the origins of ideas to the final outcome of innovation. On the other hand, others focused and emphasized particular or individual issues. It is required for us to improve questionnaire or analytical tools.

In the R&D model, it is technology that absorbs new information owned by external linkages, and technology in the context is one of internal innovation capability. In this sense, innovation is achieved by absorbing new information and transforming it to knowledge by R&D and sharing among members. R&D does not necessarily enhance technology. Therefore, this study demonstrates that our fundamental causality in the innovation process such as external linkages → internal innovation capability → R&D → innovation is still valid. In two channels, the level of technology as an internal innovation capability is essential and with absorptive capability SMEs can obtain new information (Cohen & Levinthal, 1990; Tsuji et al. 2013, Tsuji et al. 2016).

Regarding the role of ICT in the innovation process, this study obtains more important effect of ICT, namely ICT not only directly but also indirectly contributes to innovation, and ICT is essential to innovation since it is located first in the innovation process. The role of ICT seems to be emphasized greater than it was expected by the earlier literature such as Brynjolfsson and Hitt (2000) and Brynjolfsson and Saunders (2009).

VIII. CONCLUSION

The characteristics of this paper lie in the facts on which we based our field research, the models are constructed to verify how actual innovation and R&D are conducted in SMEs and the essential factors for achieving them are. As a result, we obtain some different results from those of previous papers.

This study, however, owns some limitations which are to be solved by future analysis. They are as follows: (i) this paper cannot identify gate keepers or transformers which previous papers aimed to identify; (ii) further studies have to focus on the transforming information to knowledge, bridging the technology and market, combining basic and applied R&D, and nurturing human resources to contribute to these; and (iii) this study verified the importance of ICT in the innovation process, but it did not fully examine how ICT connects SMEs and other external linkages, or how ICT can share information and collaborate personnel in the different sections.

Another requirement for further study should be focused on policy, which is not discussed here in detail. Our in-depth interviews found that instead of large amounts of subsidies, SMEs want small subsidies to support investment in new fields which include funds for supporting consortiums for applications of new technologies, exhibitions in the trade shows, and human resource development (HRD) and so on. Some SMEs can own specific technologies, but due to human resources and financial capability, they cannot complete them as forms of final products. The above policies assist SMEs to stimulate their innovation. The amount of funds offered by policy does not matter, and targets of supporting policies are much more important.

REFERENCES

Argyres, N. S. & Silverman, B. S. (2004). R&D, organization structure, and the development of corporate technological knowledge. *Strategic Management Journal*, *25* (8–9), pp. 929–958. https://doi.org/10.1002/smj.387

Booz, Allen, & Hamilton. (1982). *New product management for the 1980's*. New York: Booz, Allen & Hamilton, Inc.

Brynjolfsson, E. & Hitt, L. (2000). Beyond computation: Information technology, organizational transformation and business performance. *Journal of Economic Perspectives*. *14*(4), pp. 23–48. https://doi.org/10.1257/jep.14.4.23

Brynjolfsson, E. & Saunders, A. (2009). *Wired for innovation: How information technology is reshaping the economy*. Cambridge, MA: MIT Press

Chesbrough, H. W. (2003). *Open innovation: The new Imperative for creating and profiting from technology.* Boston, MA: Harvard Business School Press.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), pp. 128–152.

Colquitt, J. A., & Rodell, J. B. (2011). Justice, trust, trustworthiness: A longitudinal analysis integrating three theoretical perspectives. *Academy of Management Journal*, *54*(6), pp. 1183–1206.

Cooper, R. (2001). *Winning at new products: Accelerating the process from idea to launch* (3rd ed.). Massachusetts: Perseus Publishing.

Crawford, C. (1987). *New product management* (2nd ed.). Illinois: Richard D. Irwin

Crawford, C. (1987, 1997). *New product management* (5th ed.). Illinois: Richard D, Irwin

Dyer, J., & Nobeoka, K. (2000). Creating and managing a high performance knowledge-sharing network: The Toyota case. *Strategic Management Journal, 21*(3), pp. 345–367

Freeman, L. C. (1979). Centrality in social networks: Conceptual clarification. *Social Networks*, *1*(3), pp. 215–239.

Greenleaf, R. K. (1977). *Servant leadership: A journey into the nature of legitimate power and greatness.* New Jersey: Paulist Press.

Iansiti, M. (1998). *Technology integration.* Boston, MA: Harvard Business School Press.

Kahn, K. (2013). *The PDMA handbook of new product development* (3rd ed.). Hoboken, New Jersey: John Wiley & Sons Inc.

Lawson, B., & Samson, D. (2001). Developing innovation capability in organisations: a dynamic capabilities approach. *International Journal of Innovation Management*, *5*(3), pp. 377–400.

Lerner, J., & Wulf, J. (2007). Innovation and incentives: Evidence from corporate R&D. *Review of Economics and Statistics*, *89*(4), pp. 634–644.

Leonard-Barton, D. (1988). Implementation as mutual adaption of technology and organization. *Research Policy*, *17*(5), pp. 251–267.

Leven, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science, 50*(11), pp. 1477–1490.

Mariano, N. & Pilar, Q. (2005). Absorptive capacity, technological opportunity, knowledge spillovers, and innovative effort. *Technovation, 25*(10), pp. 1141–1157.

Nadia, B. (2011). A framework for successful new product development. *Journal of Industrial Engineering and Management*, *4*(4), pp. 746–770. (https://doi.org/10.3926/jiem.334)

Perdomo-Ortiza, J., lez-Benitob , J.G., & Galendeb, J. (2009). The intervening effect of business innovation capability on the relationship between total quality management and technological innovation. *International Journal of Production Research*, *47*(18), pp. 5087–5107. (https://doi.org/10.1080/00207540802070934)

Smith, P.G., & Reinertsen, D.G. (1998). *Developing products in half the time* (2nd ed.). New York, NY: John Wiley and Sons.

Szulanski, G., Cappetta, R., & Jensen, R.J. (2004). When and how trustworthiness matters: Knowledge transfer and the moderating effect of causal ambiguity. *Organization Science*, *15*(5), pp. 600–613

Sundgren, M., Dimenas, E., Gustafsson, J., & Selart, M. (2005). Drivers of organizational creativity: A path model of creative climate in pharmaceutical R&D. *R&D Management*, *35*(4), pp. 359–374.

Todo, Y., Matous, P. & Inoue, H. (2016). The strength of long ties and the weakness of strong ties: Knowledge diffusion through supply chain networks. *Research Policy*, *45*(9), pp. 1890–1906.

Tsuji, M., Ueki, Y., Idota, H., & Akematsu, Y. (2013). The formation of internal innovation capability and external sources in ASEAN Economies. In TMD Center (ed.), *Proceedings of 6th Annual Conference of the Academy of Innovation and Entrepreneurship (AIE) 2013* (46). Oxford University, UK.

Tsuji, M., Idota, H., Ueki, Y., Shigeno, H., & Bunno, T. (2016). connectivity in the technology transfer process among local ASEAN Firms. *Contemporary Economics*, *10*(3), pp. 193–203.

Tsuji, M., Ueki, Y., Shigeno, H., Idota, H., & Bunno, T. (2018). R&D and non-R&D in the innovation process among firms in ASEAN countries based on firm-level survey data. *European Journal of Management and Business Economics, 27*(2), pp. 198–214.

Zahra, H. & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, *27*(2), pp. 185–203.