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Open Innovation Strategy of Japanese SMEs: From Viewpoint of ICT Use and Innovative Technology

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1. INTRODUCTION

Product innovation of Japanese small and medium-sized enterprises (SMEs) has been mainly carried out according to the so-called independence principle. This innovation method has run up against a brick wall, and they have been moving toward the open innovation system, which utilize positively managerial and innovation resources outside of SMEs by collaborating with other firms or organizations. Open innovation enhances new innovation by absorbing technology, knowledge and information outside of SMEs and combining them with internal innovation factors. According to Chesbrough (2003, 2006) which advocate the concept of “open innovation,” this is expected to create new excellent business models by collaborating with entities outside of an organization. The business model of how to integrate internal resources and external resource for innovation is more evaluated than technology that invents a new product. Under this environment, it is requested that the relationship with partners becomes more open. However, Japanese SMEs work on open innovation with partners who have long-term commitment such as capital ties (Idota et al., 2010), which is different from the Chesbrough type. In this paper, the characteristics of the Japanese SMEs which have been successfully engaging in open innovation are clarified by examining the open innovation strategy of Japanese SMEs. This paper proposes features of an open innovation model of SMEs in terms of the best use of the Japanese strong points, relationship with partners and ICT (Information Communication and Technology) use to promote this model.

2. OPEN INNOVATION

Up to now, the importance that procures a necessary resource from the outside of business has been emphasized (Teece, 1987). According to this, how to procure insufficient resources in firms from the outside is focused. The new open innovation

concept of Chesbrough, on the contrary, does not discriminate the subordinate-superior relationship among in internal and external resources. It focuses on the business model which aims to integrate these resources. In this sense, the ability to integrate them is more valuable than the resources for technological development.

Ability requested here is not specific to technology itself for innovation but ability to construct a business mode by making a rule, standardizing, and rearranging existing business activities. On the other hand, for open innovation, ability to procure necessary technologies from the market is required. It is important for such technology to be standardized to integrate easily with other technologies. Moreover, open procurement is required for open innovation.

3. PRODUCT ARCHITECTURE

The product architecture means an idea for manufacturing products. It has chiefly two types. The integral type implies that the assembling rule is not decided beforehand, but it can be adjusted in the production process in consideration of the entire optimality in the all stages of development and manufacturing. On the other hand, in the module type, the rule of parts is decided beforehand, while developing and manufacturing the product, parts combined are adjustable according to the rule. Because of the complexity of interface between parts, it is not possible to decide individual parts independently beforehand. Specific functions can be achieved by integrating two or more parts and then the interdependence of each part tends to be high.

Fujimoto terms this integral type as “*suriawase*” (type of Japanese adjustment) (Fujimoto, 2003). The ability to adjust parts or firms becomes important in the integral type. Various adjustments are required over the walls existing inside as well as outside of the firm, and success depends on this. Quality control is the result of the integration. Adjustment among parts is necessary for improving performance, quality, and the marketability of products. Moreover, adjustments are needed between parts as well as between complex functions like a product design, a productive technique, test and so on. Various adjustments are needed similarly between suppliers and an assembler when developing and manufacturing the product. The quality of products manufactured by the integral type is influenced by not only individual parts but also the success of adjustment. Accordingly in case of the integral type, related works increase since changes occur in the process of production. On the other hand, this type has merits such that adjustment is possible when unpredicted accidents might occur. Japanese firm has demonstrated the merits of the integral type.

On the other hand, interface among parts is rather simple and parts can be combined easily in the module type. The degree of independence of each part is high, since parts are designed and developed separately. If a big problem happens, it does not necessarily cause serious situation. For improving the independence of parts, it is necessary to standardize the rule of the design (design rule) and it is better that this standardization is determined by the industry level, and particularly the interface of parts. One part is also need to be simplified to achieve one function alone. In the module type, the cost reduction and resulting price is achieved by simplification and standardization. Since assembling parts is easy and interfaces of parts are standardized, the cost reduction is easier in the modulation. In the market with intense price competition, the modulation of parts is inevitable to reduce cost and price. However, competition becomes intense more and more, since it becomes easy for newly-established firms to enter the market of products with the modular type.

Because of standardization in a module type, research and development of parts can be done concurrently, and then firms can promote easily technological development. Parts are specialized to firms because of independence of other parts. Therefore, open innovation accelerated by the modulation (Chesbrough, 2003).

Since big firms have been chasing this so-called independence principle in the past, SMEs have been playing a supplementary role as subcontractors. However, SMEs and other ventures can make the best use of their own strong points, and the possibility of succeeding in incubation has risen in the module type. Moreover, the modulation of parts has a strategic meaning for SMEs toward open innovation since they can expand their business partners.

According to the background thus mentioned, Idota, et al. (2010) clarified partner's type in Japanese open innovation and the ICT use from the analysis based on the questionnaire survey for innovative SMEs Japan. In our previous research, it turned out that the approach based on the mutual trust cultivated for the long-term relationship was important basis for Japanese open innovation. It is considered that the Japanese success of innovation of the new products is due to not only procurement parts and technologies innovative partners own from the market but also to the long-term relationship cultivated among large and SMEs. The features of firms succeeded in open innovation could not be analyzed in more detail by the previous research. In what follows, in order to construct a model of Japanese open innovation based its strength, the features of SMEs succeeded in open innovation, and the relationship with partners, and success factors of the ICT use to promote this model are analyzed by focusing on the product architecture that characterize firms' product development.

4. METHOD OF THESE ANALYSES

This study is based on a mail survey conducted to 2,260 Japanese unlisted companies in industries such as manufacturing, construction, and information and telecommunication in January 2010. This survey targeted unlisted firms which were found in “Japan Company Handbook (*The Kaisha Shikiho*) the Unlisted Company in Second Half of 2009” (Toyokeiza, 2009) published by *Toyokeizaishinpo*, particularly those listed here were thought as actively engaging innovation activities. The number of valid responses is 152 (6.7%). The analysis covers three years from 2005 to 2008.

Let us summarize results of mail survey shown in Table 1. Responding firms has rather long history: firms with over 51 years operation are 67 (44.1%). Approximately two-third of firms (100; 65.8%) has capital less than 300 million yen. The number of employee with less than 300 is 109 (71.8%). The majority of respondents are thus small-sized firms. Regarding to the industry, 98 (63.2%) belongs to manufacturing, 25 (16.1%) to information and telecommunication companies, 19 (12.3%) to construction companies, and 13 (8.4%) to others.

Table 1. Summary statistics

		Freq.	%
Years of operation	51years over	67	44.1
	31-50years	36	23.7
	21-30years	27	17.8
	11-20years	14	9.2
	less than 10years	8	5.3
Capital (million yen)	less than 50	43	28.3
	51- 100	32	21.1
	101-300	25	16.4
	301-500	25	16.4
	501 over	27	17.8
The number of employees	less than 50	38	25.0
	51-100	20	13.2
	101-200	23	15.1
	201-300	28	18.4
	301-500	25	16.4
Industries (multiple answers)	501over	18	11.8
	manufacturing	98	63.2
	Construction	19	12.3
	information and telecommunication	25	16.1
	Others	13	8.4

Source: Authors

The situation of open innovation viewed by responses is summarized in Table 2. 56 (37.8%) have succeeded in open innovation in three years from 2005 to 2008. The number of firms with many integral technologies is 26 (17.6%), while that with the small number of integral technologies is 16 (10.8%). The total firms are 40 (28.4%). On the other hand, the number of firms with many module technologies is 14 (9.5%), whereas that with the small number of module technologies is 46 (31.1%). The total firms is 60 (40.6%).

The percentage of firms with the integral technological type succeeded in open innovation is 31.0% out of the entire firms of this category, while that of firms with the module technological type succeeded in open innovation is 45.0% out of the entire firms of the module technological type. As a result, the module type firm is found to have more innovation than those of the integral type firms.

Table 2. Open innovation and type of technology

	Open Innovation		
	Yes	No	Total
Much more integral technologies	4	12	16
More integral technologies	9	17	26
Integral and module technologies are the same	16	30	46
Less module technologies	22	24	46
Much less module technologies	5	9	14
Total	56	92	148

Source: Authors

In the following analysis, only the data of the module technology type firm is used. The features of the firm succeeded in open innovation and the success factors of the ICT use are clarified. “The presence of open innovation” is used for the explained variable, while the explanatory variables contain “years of operation (Logarithm),” “capital (Logarithm),” “the number of employees” and “the type of industry dummy,” in addition to “partner’s type,” “communications means,” “frequency,” “initiative of the joint development,” “type of shared information,” “relationship with partner,” “managerial characteristics,” “organizational ability,” “types of ICT use and its effect,” and “success factors of ICT use”.

5. RESULT OF ESTIMATIONS

(1) Partner and location

By adding the variables to the explanatory variables such as “Supplier in the

region,” “Supplier outside the region,” “Customer in the region,” “Customer outside the region,” “Same trade company in the region,” “Same trade company outside the region,” “Mother company or subsidiary company,” “University in the region,” and “University outside the region,” type of open innovation partners and partner’s location are analyzed. The estimation result is shown in Table 3. It is found that “Customers in the region ($p < 0.003$)” and “Mother company or subsidiary company ($p < 0.021$)” become positively significant. This indicates that SMEs owned the relationship with local customers and Mother Company tends to achieve more open innovation.

Table 3. Type of partner and partner's location

					Observations	=	60
					Prob > Chi2	=	0.0065
					Pseudo R2	=	0.3717
					Log likelihood	=	-27.031614
Open Innovation	Coefficient	Std. Err.	z-value	p-value	Marginal Effect		
ln (operation of year)	31.01879	17.4147	1.78	0.075	7.409197		
ln (capital)	-0.1112164	0.1790534	-0.62	0.535	-0.0265653		
No. of employee	0.0001561	0.0002483	0.63	0.53	0.0000373		
Suppliers in the region	-0.226915	0.3038065	-0.75	0.455	-0.0542013		
Suppliers outside the region	0.2664426	0.2466654	1.08	0.28	0.0636429		
Customers in the region	0.7070028	0.238092	2.97	0.003 ***	0.1688758		
Customers outside the region	0.2170853	0.177665	1.22	0.222	0.0518533		
Same trade company in the region	0.524972	0.4052421	1.3	0.195	0.1253956		
Same trade company outside the region	-0.0194227	0.2501075	-0.08	0.938	-0.0046393		
Mother company or subsidiary company	1.591917	0.6922443	2.3	0.021 **	0.3802478		
University in the region	-0.3477749	0.2641113	-1.32	0.188	-0.0830701		
University outside the region	0.0296012	0.3290466	0.09	0.928	0.0070706		
Manufacturing dummy	1.318166	0.9543666	1.38	0.167	0.3148593		
Construction_dummy	1.644135	1.109423	1.48	0.138	0.3927206		
Information_dummy	0.8194796	0.9853922	0.83	0.406	0.1957422		
Constant	-235.2532	132.5686	-1.77	0.076 *			

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors

(2) Means of communication, frequency, and Information of customer needs and idea

Here to achieve open innovation, how and with what means SMEs collect information on customer needs and idea is examined. Again by adding variables to explanatory variables such as “Face-to-face,” “Phone,” “E-mail,” “Frequency of development with partners,” “Frequency of negotiation with partners by face to face,” “When jointly developing, our company offers the idea and customer needs to partner,”

“When jointly developing, our company performs a leading role,” means of communication and frequency with partners, and agents who offer information on customer needs and idea are analyzed. Table 4 shows the result of estimation. Only two variables such as “Face-to-face ($p<0.061$)” and “E-mail ($p<0.028$)” become positively significant, while “When jointly developing, our company offers ideas and customer needs to partner ($p<0.017$)” become negatively significant. This result shows that SMEs obtain information via face-to-face and e-mail tend to achieve more open innovation.

Table 4. Means of communication, frequency, and Informer of customer needs and idea

				Observations	=	38
				Prob > Chi2	=	0.0934
				Pseudo R2	=	0.3841
				Log likelihood	=	-16.091381
Open Innovation	Coefficient	Std. Err.	z-value	p-value		Marginal Effect
ln (operation of year)	20.48303	19.03797	1.08	0.282		4.830633
ln (capital)	-0.252242	0.2590039	-0.97	0.33		-0.0594877
No. of employee	0.0001417	0.0005184	0.27	0.785		0.0000334
Face-to-fFace	1.326376	0.7075673	1.87	0.061	*	0.3128071
Phone	0.8063665	0.5741126	1.4	0.16		0.1901701
E-mail	1.447592	0.6570917	2.2	0.028	**	0.3413941
Frequency of development with partners	0.420518	0.4131768	1.02	0.309		0.0991732
Frequency of negotiation with partners by face-to-face	0.3787442	0.3762472	1.01	0.314		0.0893215
When jointly developing, our company offers the idea and customer needs to partner.	-0.5860078	0.2451894	-2.39	0.017	**	-0.1382016
When jointly developing, our company performs a leading role.	0.2179553	0.3332252	0.65	0.513		0.0514017
Manufacturing dummy	1.596883	1.031847	1.55	0.122		0.3766021
Construction_dummy	1.533389	3.168013	0.48	0.628		0.3616281
Information_dummy	0.3233238	1.058631	0.31	0.76		0.0762513
Constant	-159.0891	145.4119	-1.09	0.274		

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors

(3) Type of information sharing and relationship with partner

In order to examine the type of information sharing with partners, the following variables are added to the explanatory variables: “Customer needs;” “Demand forecast;” “Basic technological information;” “High-tech trend;” “Production machine (software) information;” “Development period information;” “Long-term customer;” and “Dispatching engineer for technical guidance.” The result of estimation is shown in Table 5. Which indicates “Capital ($p<0.014$),” “Demand forecast ($p<0.031$),”

“High-tech trend ($p<0.008$),” “Long-term customer ($p<0.008$)” and “Dispatching engineer for technical guidance ($p<0.082$)” become positively significant. “Number of Employee ($p<0.074$),” “Basic technological information ($p<0.028$),” “Production machine (software) information (0.016)” and “Development period information ($p<0.046$)” become negatively significant. The estimation results show that (i) trend of high-technology, (ii) demand are major information, while SMEs obtain information through (i) customers with long-term relationship and (ii) dispatching engineers.

Table 5. Type of sharing information and relationship with partner

				Observations	=	39
				Prob > Chi2	=	0.0006
				Pseudo R2	=	0.7031
				Log likelihood	=	-7.9304228
Open Innovation	Coefficient	Std. Err.	z-value	p-value	Marginal Effect	
ln (operation of year)	-31.92128	27.21862	-1.17	0.241	-3.586023	
ln (capital)	3.353043	1.361811	2.46	0.014 **	0.3766793	
No. of employee	-0.0022797	0.0012758	-1.79	0.074 *	-0.0002561	
Customer needs	4.27151	2.81602	1.52	0.129	0.4798595	
Demand forecast	7.164621	3.313569	2.16	0.031 **	0.8048703	
Basic technological information	-7.679169	3.500162	-2.19	0.028 **	-0.8626744	
High-tech trend	6.996751	2.621416	2.67	0.008 ***	0.7860119	
Production machine (software) information	-7.175403	2.98722	-2.4	0.016 **	-0.8060815	
Development period information	-3.968811	1.98591	-2	0.046 **	-0.4458544	
Long-term customer	7.245674	2.734415	2.65	0.008 ***	0.8139758	
Dispatching engineer for technical guidance	7.278651	4.189908	1.74	0.082 *	0.8176803	
Manufacturing_dummy	0.5258823	3.138687	0.17	0.867	0.0590774	
Construction_dummy	1.468049	2.595155	0.57	0.572	0.1649199	
Information_dummy	4.851848	3.644795	1.33	0.183	0.5450544	
Constant	170.6825	200.4429	0.85	0.394		

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors

(4) Organizational capability for succeeding in an open innovation

In this analysis, how organizational capability is related to open innovation is examined. Organizational capability implies internal sources SMEs owned which create innovation, and this consists of three factors such as technology, marketing and finance. The following three variables are selected as explanatory variables: “Production and processing technology ability;” “Marketing research ability;” and “Funding ability.” Table 6 summarizes the result, which indicates “Production and processing technology ability ($p<0.01$)” and “Funding ability ($p<0.057$)” become positively significant.

Table 6. Organizational capability

				Observations	=	60
				Prob > Chi2	=	0.0276
				Pseudo R2	=	0.2205
				Log likelihood	=	-33.095835
Open Innovation	Coefficient	Std. Err.	z-value	p-value		Marginal Effect
ln (operation of year)	18.77872	13.55449	1.39	0.166		5.630072
ln (capital)	-0.1869564	0.1666351	-1.12	0.262		-0.0560516
No. of employee	0.0001812	0.0002284	0.79	0.428		0.0000543
Production and processing technology ability	0.6631734	0.2570285	2.58	0.01	**	0.1988269
Marketing research ability	0.2282679	0.2208747	1.03	0.301		0.0684373
Funding ability	0.4050752	0.2124754	1.91	0.057	*	0.1214461
Manufacturing dummy	-0.9650262	0.9592955	-1.01	0.314		-0.2893257
Construction dummy	-0.9940926	1.089501	-0.91	0.362		-0.2980402
Information dummy	-1.02738	1.022523	-1	0.315		-0.3080201
Constant	-142.8525	103.1161	-1.39	0.166		

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors

(5) Managerial characteristics and organizational culture

Here the estimation model focuses on how the managerial system and organizational culture are related to open innovation, that is, innovation is also related to speed of decision-making, sharing information with other sections or departments inside SMEs, the relationship between management and R&D sections or top and middle management. Organizational culture such as open communication inspires innovative feeling of the firm. In order to examine these subjects, the variables are added to the explanatory variables such as “Basic research and the product development research are cooperated,” “The success and the failure factor of its own project are analyzed,” “Superior and subordinate's communications are active,” “There is place where the new product development is examined exceeding the section,” “There is a system that positively offers the other companies its own technology,” “We regularly evaluate and review of the customer” and “Customer trusts our company.”

The result of estimation is shown in Table. The variable such as “There is place where the new product development is examined exceeding the section (<0.06)” and “There is a system that positively offers its own technology to other companies ($p<0.082$)” become positively significant. These indicate that SMEs with open organization or thinking tend to achieve more innovation. The former indicated that to construct the open innovation system, firms need some open foundation, while the latter is a basis for open innovation system with partners outside the SMEs.

Table 7. Managerial characters and organizational culture

					Observations = 59
					Prob > Chi2 = 0.0442
					Pseudo R2 = 0.2801
					Log likelihood = -29.287722
Open Innovation	Coefficient	Std. Err.	z-value	p-value	Marginal Effect
ln (operation of year)	17.91962	13.8313	1.3	0.195	5.071795
ln (capital)	0.0591607	0.1762537	0.34	0.737	0.0167443
No. of employee	-0.0001331	0.0002207	-0.6	0.546	-0.0000377
Basic research and the product development research are cooperated.	-0.3504497	0.2537455	-1.38	0.167	-0.0991879
The success and the failure factor of its own project are analyzed.	0.5127677	0.3355602	1.53	0.126	0.1451288
Superior and subordinate's communications are active.	-0.4765964	0.3330466	-1.43	0.152	-0.1348912
There is place where the new product development is examined exceeding the section.	0.4606179	0.2448558	1.88	0.06 *	0.1303688
There is a system that positively offers its own technology to other companies.	0.3553979	0.2043103	1.74	0.082 *	0.1005884
We regularly evaluate and review of the customer.	0.2588857	0.2507435	1.03	0.302	0.0732725
Customer trusts our company.	0.5946864	0.3980189	1.49	0.135	0.1683143
Manufacture_dummy	0.6816385	0.8838711	0.77	0.441	0.1929244
Construct_dummy	-0.5103776	0.9913338	-0.51	0.607	-0.1444523
Information_dummy	0.0342199	0.8842766	0.04	0.969	0.0096853
Constant	-142.3754	105.7552	-1.35	0.178	

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors

Source: Authors

(6) ICT use and success factor of ICT use

Lastly, the relationship between ICT use and open innovation is examined. ICT promotes not only to strengthen the relationship among firms with communication technology but also to share information among different sections or department inside firm. The following variables are selected as closely related ICT use, namely “CRM (Customer Relationship Management),” “CTI (Computer Telephony Integration),” “SCM (Supply Chain Management),” “The number of development of new products and new services has increased by IT,” “Executives clarified the ICT introduction target,” “Executives were familiar with ICT,” “ICT personnel exercised the leadership for ICT us,” “We have continuously improved the business process and IT,” “When ICT was introduced, we reformed organizational structures, systems, and company's rules,”

“We collected the success cases with the IT introduction,” “We invested emphatically in ICT” and “We evaluated, analyzed introduced IT, and used it for the improvement.”

The resulted of estimation is shown in Table 8, which indicates the following variables are significant: “The number of development of new products and new services has increased by IT ($p<0.037$),” “Executives clarified the ICT introduction target ($p<0.018$),” “When ICT was introduced, we reformed organizational structures, systems, and company's rules ($p<0.009$)” and “We evaluated, analyzed introduced IT, and used it for the improvement ($p<0.025$)” become positively significant. “ICT personnel exercised the leadership for ICT use ($p<0.028$),” “We have continuously improved the business process and IT ($p<0.069$)” and “We invested emphatically in ICT ($p<0.063$)” become negatively significant. According to these results, four variables related to ICT use promote open innovation. For the successful introduction of ICT, it is required that top management has to indicate its target, the introduction of ICT must come with the reform of organization, and before or after the introduction of ICT, its effect must be checked all the time.

6. IMPLICATIONS

The following can be mentioned from the above-analyses results. At first, the characteristics of module technological type SMEs which has succeeded in open innovation are the follows: (i) they have high technology of production and manufacturing as well as the high funding capacity; (ii) The place where new product is not only developed only by persons in charge of research and development section but also by collaboration with sections or departments of firms; (iii) and firms have a system that offers its own technology to other firms or they jointly develop positively with partners. Thus, firms which have the high technology level and organizational culture that enables to collaborate outside as well as inside entities tend to achieve open innovation.

Secondly, partners who collaborate for open innovation are as follows: (iv) they are customers in the region or subsidiary companies. They are related with each other through long-term transactions or engineers dispatched for technical guidance; (v) customer needs and ideas are brought by collaborating the partners while engaging jointly in R&D; (vi) means of communications with these partners are through face-to-face or e-mail, and information needed from partners is forecast or high technology.

Table 8. ICT use and success factor of ICT use

					Observations	=	60
					Prob > Chi2	=	0.0099
					Pseudo R2	=	0.4221
					Log likelihood	=	-23.859743
Open Innovation	Coefficient	Std. Err.	z-value	p-value	Marginal Effect		
ln (operation of year)	-25.82684	19.39724	-1.33	0.183	-5.6565		
ln (capital)	-0.3662901	0.2505521	-1.46	0.144	-0.0802235		
No. of employee	-0.0004158	0.0004874	-0.85	0.394	-0.0000911		
CRM	-0.4030084	0.5709796	-0.71	0.48	-0.0882654		
CTI	0.2114542	1.8515	0.11	0.909	0.0463119		
SCM	2.080579	1.696772	1.23	0.22	0.4556808		
The number of development of new products and new services has increased by IT.	0.9023916	0.4315238	2.09	0.037	**	0.1976385	
Executives clarified the ICT introduction target.	0.9303418	0.3933239	2.37	0.018	**	0.20376	
Executives were familiar with ICT.	0.610873	0.4265794	1.43	0.152		0.1337911	
ICT personnel exercised the leadership for ICT use.	-0.9524121	0.4334203	-2.2	0.028	**	-0.2085938	
We have continuously improved the business process and IT.	-0.7279826	0.399964	-1.82	0.069	*	-0.15944	
When ICT was introduced, we reformed organizational structures, systems, and company's rules.	0.9973398	0.3820159	2.61	0.009	***	0.2184337	
We collected the success cases with the IT introduction.	-0.4480049	0.4608477	-0.97	0.331		-0.0981204	
We invested emphatically in ICT.	-0.9861223	0.5304871	-1.86	0.063	*	-0.2159768	
We evaluated, analyzed introduced IT, and used it for the improvement.	1.179137	0.5252596	2.24	0.025	**	0.2582502	
Manufacturing_dummy	0.1639907	0.9181609	0.18	0.858		0.0359166	
Construction_dummy	-0.9693063	1.054464	-0.92	0.358		-0.2122939	
Information_dummy	-0.288999	1.127284	-0.26	0.798		-0.0632955	
Constant	197.9671	147.4253	1.34	0.179	*		

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors

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Finally, the role of ICT use for open innovation is as follows: (vii) ICT including e-mail is very useful for an increase in the number of new products and services; (viii) there are the following three success factors of ICT use for open innovation:

- Managers have to take a lead for ICT use and show the clear target instead of yielding its lead to other staff.
- Do not invest in ICT excessively, but to evaluate and analyze ICT used. Use ICT for improvement.

- Organize and review the system and rule, and transform organization at a stretch when ICT is introduced.

It should be noted that when ICT is introduced, its objective is to reform organization: or use existing ICT skillfully and use it for the innovation.

7. DISCUSSIONS AND CONCLUSIONS

For open innovation of Japanese SMEs, module technology is also important similar to open innovation of the Chesbrough's type. The cooperation between long-term firms is already formed in Japanese firms, and SMEs with high module technology play the important role and supported open innovation. These firms dispatch engineers to partners and form the place where information is brought which is obtained by either face-to-face communications or e-mail. Information and the idea are used to develop new products in this place. The partners succeeded in open innovation with such firms are not procured from the open market, but from the long-term relationship.

Moreover, ICT is skillfully used for developing new product in such firms. Therefore, it is important to clarify the target that should be achieved because of the manager initiation, to introduce ICT with the organizational reformation, and to improve existing ICT enough to use it. These are success factors of ICT use of firms which make open innovation possible by using the module technology.

Japanese SMEs cannot disregard open innovation in the future. However, there are various problems to be solved, as Itami (2009) mentioned. These problems can be summarized as follows: (i) whether open cooperation can be constructed; (ii) whether cooperation among organizations can be formed; (iii) who bears costs for constructing collaboration; and (iv) whether mutual trust can be formed.

According to these results, it is important for Japanese SMEs to improve the module technology and to be maintaining the strong point of the technology and the long-term relationship between firms that have been cultivated up to now.

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