

# **Factors and Policies for the Diffusion of Information and Communications Technology among Japanese SMEs**

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## **Abstract**

In this paper, we make an attempt to extract factors to promote ICT (Information, Communications Technology) use by SMEs (Small- and medium-sized enterprises). For this purpose, we first construct an index of ICT use. The previous papers Tsuji et al [2005] and Bunno et al [2006a], [2006b] challenged this issue by conducting extensive mail surveys and in-depth interviews in two of the largest SME clusters in Japan, Higashi-Osaka and Ohta Ward, Tokyo. Questionnaires to more than 6,000 SMEs in two clusters were sent, and received nearly 1,200 replies. The papers identified factors including policies to promote ICT for SMEs. SMEs analyzed there, however, are found to be not necessarily so innovative in ICT use, in other words, they are not good examples. Therefore, we conducted mail survey again on SMEs which were awarded in ICT use by organizations such as IT *Hyakusen* Committee and the Ministry of Economics, Trade and Industry, which select 100 SMEs for best ICT practices every year. We refer those SMEs selected by these two as to IT *Hyakusen* SMEs. They are supposed to be advanced in ICT use. Focus on these SMEs, we can analyze ICT use from the view of advanced SMEs. As for an index of ICT use, we utilize AHP (Analytical Hierarchical Process) including the following five items: (i) the number of PCs owned by SMEs; (ii) the number of PCs connected by networks such as LAN; (iii) the amount of software that contributes to efficient utilization of managerial resources; (iv) Internet use such as homepages, e-mail, and e-commerce; and (v) security measures such as introducing security systems and organizational measures. 11 ICT experts were asked about their weights of above five items by pair-wise comparison. This paper proposes a method of constructing a single index of ICT use based on these five items by making use of AHP. Based on this index, we extract exactly the factors promoting ICT use by IT *Hyakusen* SMEs by making use of the regression analysis. The results

obtained are compared with those of previous studies.

## 1. INTRODUCTION

In the process of Japanese economic development, Small-and medium-sized enterprises (SMEs) have been playing the important role by supplying it with high-quality parts to the manufacturing sector, for example; it is well known that the unsurpassed quality of Japanese products is largely based on SMEs. In the age of information Society, Japanese SMEs facing challenges from the world are required to survive. In cope with this, they have to adopt ICT (Information and communications technology), which is a key to renovate whole business activities. Our previous papers such as Tsuji et al [2005], Bunno et al [2006a], [2006b] analyzed what the factors that promote ICT use by SMEs are. We conducted field surveys, a mail survey and in-depth interviews in two of Japan's most prominent SME clusters, located in Higashi-Osaka city, Osaka Prefecture, and Ohta ward, in the metropolitan area of Tokyo. In 2004, questionnaires were sent to more than 6,000 SMEs in two clusters, and received nearly 1,200 replies.

Questions sent to SMEs were related to (i) company characteristics (amount of capital, number of employees, etc); (ii) managerial orientation, which classifies SMEs as the expansion, incentive-providing, adapting, or data-using category; (iii) business environment such as the degree of competition; (iv) purposes of ICT use, such as raising profit and productivity; (v) expectations for ICT use; and (vi) other factors such as ICT investment in the last fiscal year and the company's understanding of importance of the ICT in business management. Those previous papers have common issues to be analyzed, which are (i) to identify factors to promote ICT use by SMEs, especially we focus on management type and policies; and (ii) to construct an index to measure ICT use among SMEs.

Let us summarize (ii) first. Tsuji *et al* [2005] constructed the following data to represent the degree of ICT use by SMEs: (i) the amount of software that contributes to efficient utilization of managerial resources; and (ii) Internet use. Based on these data,

the former constructed an index in such a way that 1 point is provided for simple use of software or the Internet, while 10 points for more complicated and integrated utilization. This scoring may seem somewhat arbitrary. Bunno *et al* [2006a], however, considers that the software or the Internet which is used by many (small) SMEs is less (more) important so that it should have smaller (larger) point. The weight for the software is assigned according to the percentage of SMEs which provide affirmative responses to questions relating use: the weight is a reciprocal number of the percentage. In other words, this index deals with more advanced and integrated uses, more points were assigned to them.

Bunno *et al* [2006b] constructed an index to represent the degree of ICT use of SMEs by applying the AHP (Analytical Hierarchical Process). The index is mainly based on (i) utilization of hardware and (ii) utilization of information systems. The former consists of items such as (iii) the number of PCs owned by SMEs; (iv) the number of PCs connected by networks such as LAN, while the latter such as (v) software use, (vi) Internet use, and (vii) security measures. In addition, (v) software use includes those related to routine and non-routine works, (vi) Internet use those related to collecting and sending information and e-commerce, and (vii) security use those related to technical and organizational measures for security. In order to calculate weights for AHP, 11 ICT experts were asked to reply the importance of those indices and items. This paper adapts an index constructed by AHP, which is the same as Bunno *et al* [2006b].

As for factors of ICT use (i), previous three papers successfully extracted the factors by making use of regression methods such as OLS, logit and probit estimations. Especially, Bunno *et al* [2006a] and [2006b] found that one of the most important factors is “expectation from ICT use,” such as “restructuring of the whole business process,” which is identified as a significant factor in all of our estimations. SMEs with intensive use of ICT believe in its effect and actually invest lots. It follows from this that the most important way to promote ICT use among SMEs is to encourage them to be forward-looking. Once they adopt such an outlook, SMEs can determine the exact ways in which they will introduce and use ICT, according to their specific goals. By the probit

analysis, the behaviour of CEO or the top management was also found to be especially important. Since ICT use is a function of a business's management and strategy, the decisions made by senior managers are crucial. Even if SMEs operated under optimal conditions, they would not be able to use new technologies to their advantage without correct decisions by their managers.<sup>1)</sup> We also identified policies to promote ICT investment by SMEs such as tax and subsidies schemes, various deregulations.

In the previous papers, SMEs in two clusters, namely, Higashi-Osaka and Ohata are found to be less developed in the ICT use. The results obtained are significant for identifying factors and policies for promoting ICT. However, for SMEs which achieved already certain level of ICT use, those are not necessarily attractive. In this paper, therefore, we select SMEs which level of ICT use is advanced enough to give references to other SMEs, and compare results with those of two SME clusters obtained by Bunno et al [2006b]. In so doing, we select SMEs among those warded as "selected 100 SMEs for best practice in the Kansai Area" and "selected 100 SMEs by METI (Ministry of Economic, Trade and Industry)". In order to compare, this paper adapted the almost same questions as in those previous papers, and the same estimation methods such as OLS, Logit and Probit analysis.

The paper consists of six sections. In section 2 we construct the indices of ICT use by SMEs by focusing AHP. The variables for estimations are in section 3. In section 4, the method of estimations and actual estimations by OLS, logit and probit estimations are presented. In section 5, problems and policies for ICT use by SMEs are identified based our survey. Concluding remarks are given in section 6.

## **2. INDEX OF ICT DEVELOPMENT**

### **2.1. Index Constructed by AHP**

ICT utilization cannot be described with a single index, since various factors are involved, including size, industry, business practices, etc. For the surveys, the following indicators of ICT use by SMEs were selected: (i) number of PCs owned; (ii) number of

PCs connected to networks such as LANs; (iii) the extent to which software that contributes to the efficient utilization of managerial resources has been implemented; (iv) Internet use; and (v) security. No explanation is required for (i) and (ii), since these indices are simple quantitative proxies for ICT use: having more PCs is equivalent to using ICT more intensively. Items (iii) and (iv) are more qualitative measures of ICT use, since having a large number of computers does not necessarily mean using them efficiently. Initially, software packages -- for example, for accounting and marketing management -- are introduced to promote efficiency in internal tasks. These applications are generally used independently on each PC. At more advanced stages of ICT, the various applications are no longer used separately but are interconnected and share databases. Item (iii) sheds more light on this. Subsequently, the PCs in one or several offices are connected to each other, generally with a groupware program. This use is covered by item (iv). SMEs, which own software as well as hardware, tend to concern about the security of information systems. This item is thought to be the high level of ICT use.

In the previous study, Tsuji *et al* [2005] the index was constructed in such a way that 1 point is provided for question 1 to 8, and 10 points for questions 9 to 13. Questions 1 to 8 are quite different from 9 to 13 in their description of ICT use, since the latter deals with more complicated and integrated utilization than the former. This scoring may seem somewhat arbitrary. In this paper, we utilize more rigorous methodology for constructing an index, which is AHP.

In Bunno *et al* [2006a], [2006b], AHP (Analytic Hierarchy Process) was adopted, which attempts to give people's decision-making a numerical value.<sup>2)</sup> For example, when making a purchase, on what basis does a consumer decide? A consumer considers factors such as the price, performance and design of various alternatives, then makes a decision based on his/her own criteria. AHP formulates the mechanism of such decision making. It allows us to give numerical value to vague parts of people's decision making, with possible application to wide array of fields. An individual makes a decision based on his/her own criteria. Normally, not only one but several evaluation criteria exist, and these often conflict with each other. In a consumer's decision-making process, the

“problem” of what to choose comes first, followed by several “alternatives”. AHP attempts to comprehend the process of the decision making, assuming that there are some “criteria” relating the specific “problem” and the “alternatives”. Thus, AHP’s approach is to construct an individual’s decision making according to the hierarchic structure.

In this paper, we break down the main factors that boosted ICT use among SMEs into the following two; establishment of hardware, utilization of information system. The former has two sub-factors; (i) number of PCs owned; (ii) number of PCs connected to networks such as LANs, while the latter consists of following three; (iii) the extent to which software that contributes to the efficient utilization of managerial resources has been implemented; (iv) Internet use; and (v) security measures. Moreover, (iii) software use includes those related to routine and non-routine works, (iv) Internet use those related to collecting and sending information and e-commerce, and (v) security use those related to technical and organizational measures for security.

## **2.2. Items of Software, Internet, and Security Use**

In this section, concrete items asked in questionnaires which represent software, Internet and security use are explained. Questions relating to software use, Internet use and security use we asked are listed in Table 2, Table 3, and Table 4, respectively.

Table 1. Layers of Questions in AHP

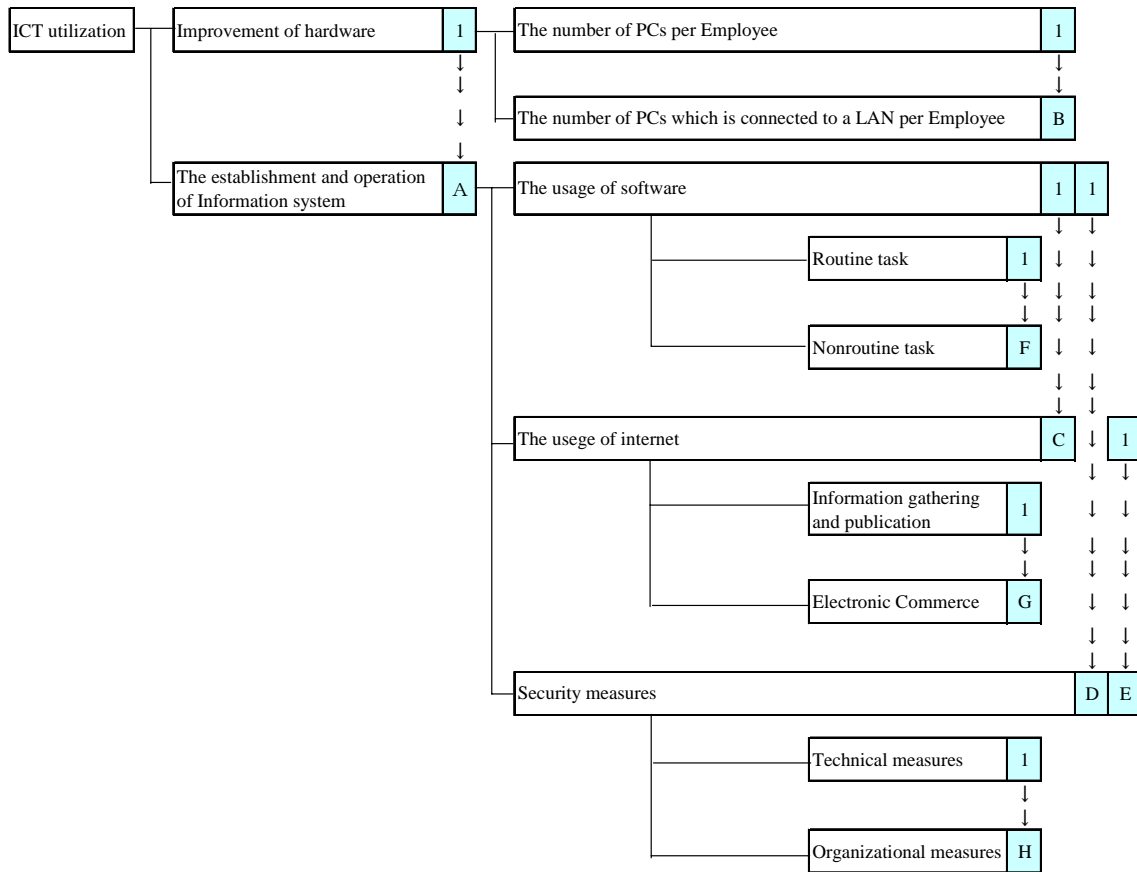


Table 2. Questions on Software Use

Routine works
1. Sales management (including POS and bar code)
2. Accounting
3. Payroll management
4. Purchase management
5. Inventory management
6. Design management (include CAD/CAM)
7. Production management
8. Logistics
Non-routine works
9. Enterprise resource planning (EPR) package
10. Customer Relations Management (CRM)
11. Group-ware (office information sharing system)
12. Sales Force Automation (SFA)
13. Supply Chain Management (SCM)

Table 3. Questions on Internet Use

Collection /exchange of information
1. Collection /exchange of information
2. PR of company and products
3. Efficient business management
e-Commerce
4. Net-banking
5. e-commerce with companies (BtoB)
6. e-commerce with consumers (BtoC)

Table 4. Questions on Security Use

Technical measures
1. Introduction of Passwords
2. Construction of firewalls
3. Anti-virus measures
Organizational measures
4. Establishment of security principle
5. Risk analysis
6. Classification of confidential information
7. Management of confidential information and customers' data
8. System audition and information security audition

**2.3. Weight of items derived by AHP**

According to replies of 11 ICT experts, AHP provides weight of questions of three layers. Those are shown in Table 5. They rated “the establishment and operation of information system” higher than “importance of hardware,” namely, the former is 0.801, while the latter 0.199. Among the factors in the former, “security measures” is rated 0.453, while the software use and internet use are 0.193 and 0.155, respectively. Especially, “organizational measures” in security is most evaluated such as 0.358 by IT specialists.

Nest, based on these weight obtained by AHP, we calculate indices of ICT use of each SME, and compare with those of Higashi-Osaka/Ohta and IT *Hyakusen* SMEs selected by the committee, and Table 6 and Figure 1 summarize the results.

Table 5 Weight Obtained by AHP

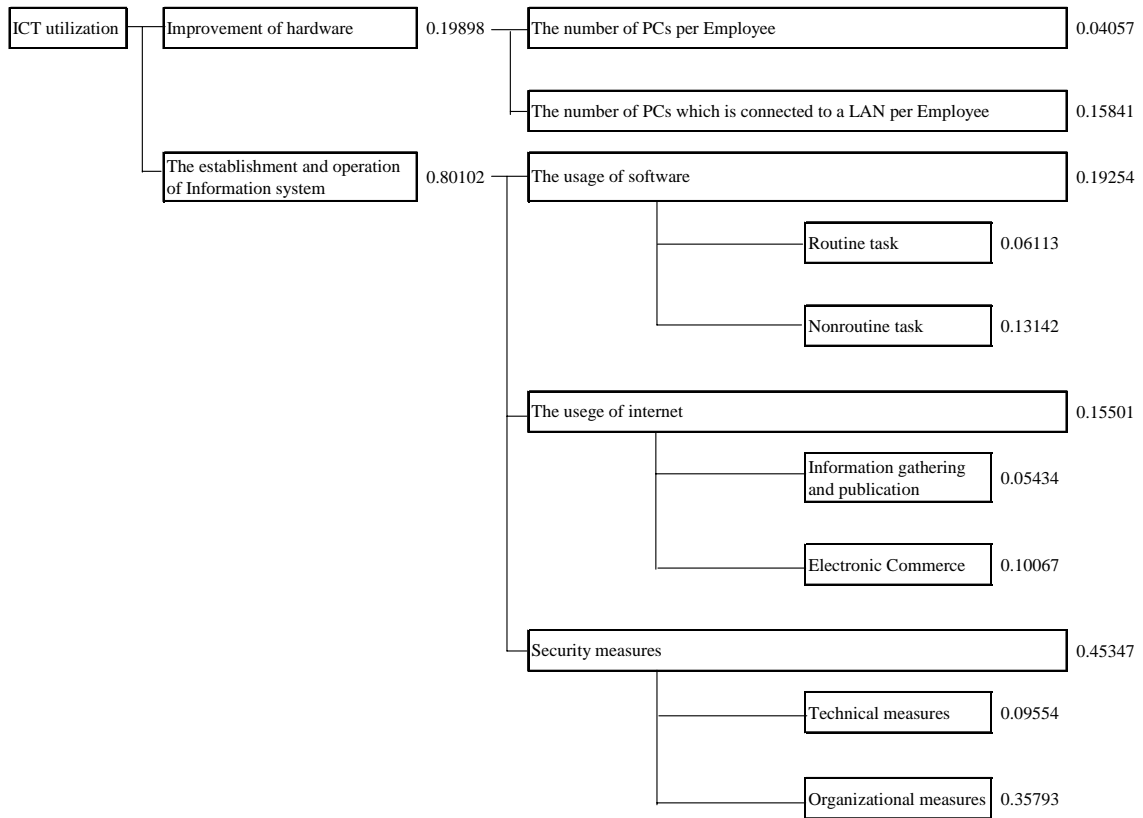


Table 6 Index of ICT use: Higashi-Osaka/Ohta and IT Hyakusen

Degree of ICT Utilization	Frequency			Ratio (%)		
	ITHyakusen	Higashiosaka/Ohta	Total	ITHyakusen	Higashiosaka/Ohta	Total
0-0.05	1	485	486	0.73	40.48	36.4
0.05-0.1	15	364	379	10.95	30.38	28.39
0.1-0.15	41	227	268	29.93	18.95	20.07
0.15-0.2	39	90	129	28.47	7.51	9.66
0.2-0.25	31	26	57	22.63	2.17	4.27
0.25-0.3	8	5	13	5.84	0.42	0.97
0.3-0.35	2	1	3	1.46	0.08	0.22
Total	137	1,198	1,335	100	100	100
Degree of ICT Utilization	Average	Standard Deviation				
ITHyakusen	0.17	0.06				
Higashiosaka/Ohta	0.07	0.06				
Total	0.08	0.06				

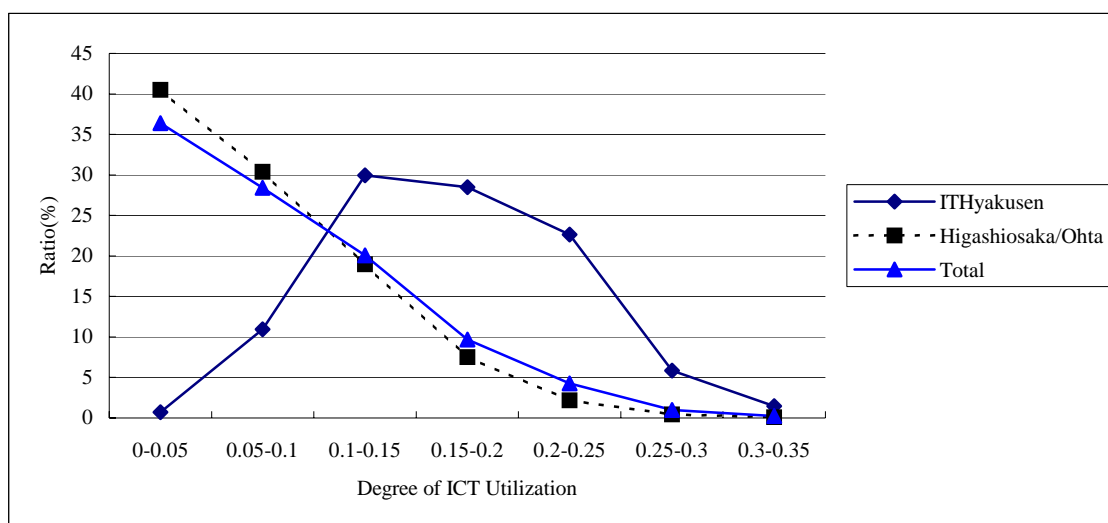


Figure 1 Distributions of indices of ICT use among two groups

The average indices of IT *Hyakusen* and Higashi-Osaka/Ohata are 0.17 and 0.07, respectively, and the former can be said they are advanced in ICT use. In this sense, we can extract the essential factors promoting ICT use among SMEs.

### 3. FACTORS THAT AFFECT ICT USE

Here, we explain variables which encourage ICT use. The questionnaires asked SMEs about (i) company characteristics, (ii) managerial orientation, (iii) business environment, (iv) importance of the introduction of ICT, (v) expected results from ICT use, and (vi) ICT investment of last fiscal year. The list of these variables and concrete related questions can be referred in Table 7.

Among these six variables, we explain the first four in what follows. At first, (i) Company characteristics include variables such as amount of capital, and number of regular employees, number of part-time employees, and year of business establishment, and the generation of present owners.

(ii) Regarding management orientation as one variable, a detailed explanation is

required. The questionnaires contain ten items on managers' daily activities, shown in Table 8. Since there is some overlap between the ten questions, an attempt was made to isolate the variables through the component analysis. In this manner, four variables, which account for 70.1% of the total responses, were isolated in Higashi-Osaka/Ohata. The first of these includes questions to determine to what extent an SME is geared toward expansion, which is referred to as "orientation to expansion". The second category, "orientation to incentives," contains questions on management's performance vis-à-vis stakeholders and on any incentives it gives employees by relinquishing rights and responsibilities to them. The third variable includes questions on the extent to which firms learn from their mistakes and on whether top management considers employee suggestions. Since such courses of action are indicative of management's responsiveness, this factor is referred to as "orientation to adapting". The last variable, called "orientation to data use", contains questions on how firms make use of data for decision-making.

On the other hand, four variables, which account for 57.5% of the total responses, were isolated in IT *Hyakusen* SMEs. Three factors are almost the same as those of Higashi-Osaka/Ohta, namely, the first component "orientation to adapting"; the second, "orientation to expansion"; the third "orientation to incentives". The fourth variable includes questions on "Company's performance is disclosed to employees". Since such courses of action are indicative of information share between members, this last factor is referred to as "orientation to information-sharing"<sup>3)</sup>. The results of the component analysis on IT *Hyakusen* SMEs are also summarized in Table 8.

As for (iii) business environment, seven variables were selected, including winning of new business partners, product characteristics, the effect of new entrants into the market, and conditions related to hiring new employees. Finally, since the introduction and use of ICT depend on firms' expectations regarding their future business and management, nine variables were selected for (v) the sixth category, including increased profits, promotion of higher productivity and timely decision-making. The summary statistics of all variables that are used for estimation is shown in Table 7.

Table 7 Summary Statistics

Variables		Higashi-Osaka/Ohta		IT Hyakusen	
		Average	Stan. Dev.	Average	Stan. Dev.
ICT utilization *		0.0713	0.0561	0.165	0.0578
Characteristics of firm	Capital (10 thousand Yen)	1963.7	2612.5	13356.1	40297.1
	The number of Employees	20.5	31.1	78.9	108.5
	The number of Part-time job Employees	5.7	10.8	32.7	74.7
	Operation years	44.1	79.9	49.1	40.2
	CEO's generation	1.8	0.8	2.2	0.1
Managerial behavior **	Self-renovation type	0	1	0	1
	Incentive type	0	1	0	1
	Business improvement type	0	1	0	1
	Information-sharing type	0	1	-	-
	Information share type	-	-	0	1
Business Environment	We obtain new business partners every year.	3.106	1.33	3.689	1.034
	The share of new products and services in our business is larger than before.	3.055	1.214	3.008	1.044
	Many purchase orders are repeatedly from the same business partners.	3.932	1.01	3.91	0.95
	We can price our own products.	3.323	1.26	3.403	1.193
	In recent years, we have not been able to employ younger (30-year-old or younger) workers.	2.938	1.59	2.121	1.214
Importance of the introduction of ICT in business management		3.974	1.122	4.728	0.051
Expectation of ICT usage	Increased profit	2.712	0.964	3.44	0.072
	Higher productivity of routine works, such as administrative works	3.292	0.828	3.744	0.046
	Higher productivity of non-routine business, such as project planning	2.536	0.956	3.069	0.08
	Higher speed of decision-making in management and business development	2.867	0.902	3.45	0.064
	Restructuring of the whole business process	2.598	0.9	3.252	0.067
	Active communication and accumulation sharing of information knowledge	3.012	0.895	3.511	0.06
	Precise understanding of customer needs	2.733	0.91	3.183	0.076
	Better customer satisfaction by improvement in services and products	2.697	0.918	3.323	0.068
Company's ICT investment last Fiscal Year (10 thousand Yen)		292.735	1,646.98	2,781.20	5,591.50
Amount of samples		1,198		137	

notes: \* shows the result of Analytic Hierarchy Process.

\*\* shows the four types of corporate management which was clarified by the method of factor analysis.

Table 8. Result of Component Analysis

<b>Higashi-Osaka/Ohta</b>				
Managerial Behavior	Common Factors			
	Expansion	Providing incentives	Adapting	Using data
There is employee training and rotation to utilize each employee's ability and knowledge.	<b>0.836</b>	0.152	0.124	0.126
The company offers ICT training to executives, managers and employees.	<b>0.813</b>	0.056	0.074	0.21
Employees are apprised of the company's plans for next 2-3 years.	<b>0.599</b>	0.515	0.179	0.156
New lines of business are constantly being sought and products developed.	<b>0.552</b>	0.284	0.321	0.085
Company's performance is disclosed to employees.	0.2	<b>0.824</b>	-0.006	0.301
Senior managers are given broad responsibility and authorities.	0.112	<b>0.567</b>	0.488	0.194
Company studies competitors' mistakes and learns from them	0.172	0.015	<b>0.844</b>	0.288
Companies listen to any employee's opinion on how to improve management.	0.281	0.538	<b>0.587</b>	0.064
Past business data are extensively analyzed in company management.	0.074	0.23	0.255	<b>0.784</b>
Monthly business data are utilized to improve management.	0.345	0.175	0.123	<b>0.708</b>
Eigen value	<b>2.308</b>	<b>1.745</b>	<b>1.531</b>	<b>1.422</b>
Rotated Factor Pattern (%)	<b>44.8</b>	<b>10.7</b>	<b>7.3</b>	<b>7.2</b>
Cumulative Proportion (%)	<b>70.1</b>			

**IT Hyakusen**

Managerial Behavior	Common Factors			
	Adapting	Expansion	Information-sharing	Providing incentives
Senior managers are given broad responsibility and authorities.	<b>0.684</b>	0.081	0.071	0.219
Company studies competitors' mistakes and learns from them	<b>0.683</b>	0.205	0.198	0.063
Companies listen to any employee's opinion on how to improve management.	<b>0.643</b>	0.309	0.195	0.193
Past business data are extensively analyzed in company management.	<b>0.493</b>	0.184	0.19	0.272
The company offers ICT training to executives, managers and employees.	0.149	<b>0.734</b>	0.205	0.207
There is employee training and rotation to utilize each employee's ability and knowledge.	0.336	<b>0.625</b>	0.282	0.085
Employees are apprised of the company's plans for next 2-3 years.	0.166	0.257	<b>0.82</b>	0.274
New lines of business are constantly being sought and products developed.	0.296	0.389	<b>0.484</b>	0.002
Company's performance is disclosed to employees.	0.264	0.127	0.153	<b>0.779</b>
Monthly business data are utilized to improve management.	0.252	0.266	0.384	<b>0.387</b>
Eigen value	<b>1.975</b>	<b>1.413</b>	<b>1.317</b>	<b>1.045</b>
Rotated Factor Pattern (%)	<b>19.8</b>	<b>14.1</b>	<b>13.2</b>	<b>10.4</b>
Cumulative Proportion (%)	<b>57.5</b>			

## 4. ESTIMATION

### 4.1. Estimation Procedure

The factors that determine the particular scores obtained by each SME will be examined below. To examine the validity of these factors, the following regression model was constructed:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \dots + \beta_n X_{ni} + e_i, \quad (1)$$

where  $Y_i$  is each SME's index of ICT use;  $X_{ji}$  denotes variables such as the characteristics of the SMEs, managerial behaviour, expectations for ICT use, etc.;  $\beta_i$  indicates the coefficients to be estimated; and  $e_i$  is the residual.

For the actual estimation, the following procedures were followed: (i) a stepwise method was adopted to select variables by making use of the Akaike Information Criterion [AIC].

#### 4.2. OLS Estimation

The result of the OLS estimation is given in table 9. In this model, a variable related to SME size, such as amount of capital is significant. Belonging to the retail sector is also significant; the reason for this is that SME retailer needs software to manage the large number of customers and suppliers they deal with. Another interesting result is found in variables such “speedup of business development”, in the category of expectation from ICT use. Regarding managerial behaviour, “orientation to expansion” and “orientation to incentive” are significant. SMEs which replied positively to “having problems of ICT introduction” tend to be less developed in ICT use, since it has negative sign. It is rather natural that SMEs with high index of ICT use invest more in ICT, and this has significant relationship with ICT investment in the last year.

As for IT *Hyakusen* SMEs, factors such as “Service industry (to business),” “Precise understanding of customer needs,” and “Company’s ICT investment in preceding year” are significant, while “In recent years, we have not been able to employ younger (30-year-old or younger) workers,” and “Restructuring of the whole business Process” are negatively significant. There are few factors which are commonly significant for both groups. In addition to “Company’s ICT investment in preceding year”, which is easily found to be significant, “Incentive type” of management is also significant. These results show that two groups are rather different in ICT use.

Table 9. Results of OLS Estimation

<b>Higashi-Osaka/Ohta</b>			<b>IT Hyakusen</b>		
Variables	Coefficient	t-value	Variables	Coefficient	t-value
Wholesale	0.108218	2.24 **	Increased profit	0.08145	4.32
Other Industries	-0.177798	-1.90 *	Precise understanding of customer needs	0.02829	1.96 *
Capital	0.059095	2.55 **	In recent years, we have not been able to employ younger (30-year-old or younger) workers.	-0.01813	-1.94 *
Number of employee	0.039080	1.76 *	Company's ICT investment in preceding year	0.02862	2.88 ***
Self-renovation type	0.056447	2.92 ***	Information service industry	-0.10949	-3.19 ***
Incentive type	0.057142	3.08 ***	Incentive type	0.0466	2.9 ***
Data-using type	0.029738	1.63	Service industry (to business)	0.09988	2.71 ***
We can price our own products.	0.020104	1.42	Restructuring of the whole business Process	-0.03926	-2.32 **
Current problem of ICT utilization	-0.113996	-2.09**	Other business	-0.12262	-2.04 **
Company's understanding of importnace of ICT in business management.	0.036607	1.77 *	Construction firm	0.12799	1.87 *
Higher speed of decision-making in management and business development	0.055713	2.47 **	Constant	0.10501	1.52
Close cooperation with customers and business partners	0.037392	1.71 *			
Company's ICT investment in preceding fiscal year	0.094963	5.08 ***			
Constant	-0.329898	-3.02 ***			
<b>R<sup>2</sup></b>	<b>0.275</b>		<b>R<sup>2</sup></b>	<b>0.432</b>	

note: \*\*\*, \*\*, and \* indicate the significant at the 1, 5, and 10% level.

### 4.3. Logit and Probit Estimations

Here we will present the results of logit and probit estimations. The motivation of these two is that variables are constructed by the data obtained through mail survey usually take discrete value, and so that logit and probit estimations are better methods than OLS.

In these estimations, we divide SMEs into two categories; ones with larger index

than the average; while ones with smaller. The equations to be estimated are as follows:

$$\text{Logit model: } F(\mathbf{x}_i \Gamma b) = \frac{\exp(\mathbf{x}_i \Gamma b)}{1 + \exp(\mathbf{x}_i \Gamma b)} \quad (2)$$

$$\text{Probit model: } F(\mathbf{x}_i \Gamma b) = F(\mathbf{x}_i \Gamma b) \quad (3)$$

where  $F$  denotes the standard normal distribution function,  $x_i$  variables similar to OLS estimation.

The result of logit and probit estimations is shown in Table 10. This is similar to OLS estimation in the previous section. Amount of capital (marginal effect: 0.07602), wholesale (marginal effect: 0.14235), ICT investment of previous year (marginal effect: 0.12299), and “speedup of business development” as expectation of ICT use (marginal effect: 0.06821) are significant. Regarding managerial behaviour, “orientation to expansion” (marginal effect: 0.08267) and “orientation to incentive” (marginal effect: 0.07802) are also significant.

As for IT *Hyakusen* SMEs, “Expectation of raising profit (marginal effect: 0.34985),” “Incentive type (marginal effect: 0.21382)” and “Information share type (marginal effect: 0.16303)” as managerial orientation, “Service industry (against business) (marginal effect: 0.6241) are significant.

The common factors are “Expectation of rising profit,” “Company’s ICT investment in preceding fiscal year,” “Incentive type”. These imply that in order to raise the ICT index, SMEs must increase in ICT investment, provide proper incentive to employees, and share more information for their management. Especially, IT *Hyakusen* SMEs has negative marginal effect to “Restructuring of the whole business process,” this implies that they are not intend to introduce ICT for restructuring whole business process, but for gradual promotion of their business process.

Table 10. Result of Logit and Probit Estimations

**Higashi-Osaka/Ohta**

Variables	Logit-model			Probit-model		
	Coefficient	Z-value	Marginal effect	Coefficient	Z-value	Marginal effect
Wholesale	0.59488	2.21 **	0.14560	0.36210	2.26 **	0.14235
Capital	0.33063	2.48 **	0.08263	0.19057	2.43 **	0.07602
Number of employee	0.21774	1.81 *	0.05442	0.13118	1.82 *	0.05233
Self-renovation type	0.34980	3.30 ***	0.08742	0.20725	3.31 ***	0.08267
Incentive type	0.33117	3.19 ***	0.08277	0.19560	3.21 ***	0.07802
Data-using type	0.15875	1.53	0.03968	0.09387	1.56	0.03744
Expectation of raising profit	0.20587	1.74 *	0.05145	0.12350	1.77 *	0.04926
Higher speed of decision-making in management and business development	0.27243	2.15 **	0.06808	0.17100	2.28 **	0.06821
Close cooperation with customers and business partners	0.17851	1.42	0.04461	0.10323	1.40	0.04118
Company's ICT investment in preceding fiscal year	0.52190	4.88 ***	0.13043	0.30833	5.02 ***	0.12299
Log likelihood	-322.779			-322.712		

note: \*\*\*, \*\*, and \* indicate the significant at the 1, 5, and 10% level.

**IT Hyakusen SMEs**

Variables	Logit-Model			Probit-model		
	Coefficient	Z-value	Marginal effect	Coefficient	Z-value	Marginal effect
Expectation of raising profit	0.89584	3.13 ***	0.34606	1.46499	2.96 ***	0.34985
Company's ICT investment in preceding fiscal year	0.3235	2.04 **	0.12497	0.53355	1.97 **	0.12741
Information service industry	-1.47889	-2.85 ***	-0.41669	-2.45233	-2.71 ***	-0.404
Incentive type	0.53265	2.48 **	0.20576	0.89536	2.42 **	0.21382
Service industry (against business)	2.04558	2.94 ***	0.62907	3.38663	2.78 ***	0.6241
Restructuring of the whole business process	-0.40718	-1.72 *	-0.15729	-0.67029	-1.65 *	-0.16007
Other business	-1.58192	-2.07 **	-0.39069	-2.53838	-1.99 **	-0.36926
Number of employee	-0.20655	-1.25	-0.07979	-0.3355	-1.22	-0.08012
Information share type	0.40801	2.02 **	0.15761	0.68267	1.97 **	0.16303
We can price our own products.	-0.21814	-1.53	-0.08427	-0.35635	-1.47	-0.0851
Log likelihood	-49.340223			-49.660311		

note: \*\*\*, \*\*, and \* indicate the significant at the 1, 5, and 10% level.

## **5. PROBLEMS OF ICT USE AND POLICY DESIRED**

### **5.1. Problems of ICT Use**

Thus far, the analysis has focused on factors that encourage ICT use. This section examines the ICT-related issues that SMEs are facing, so as to identify problems and recommend policies that could be implemented to solve them.

According to replies to our questionnaires (Q9), the kinds of obstacles faced by SMEs in each category of developed (developing) in ICT use were examined. The obstacles for the developed group were identified as related to security, coordination with purchasers and sellers, and funding for ICT investment, while those for the developing group were lack of leadership, difficulty in keeping up with technological change, lack of confidence regarding return on investment, and the length of time required to introduce new technologies. Here, by using OLS, we analyze the relationship between the index of ICT use and the replies to questions related to problems of ICT use. Variables utilized in estimation are selected by the stepwise method according to F values.

Let us examine first the software utilization model. The result of our estimation is indicated in table 11. Among questions in Q9, 16: "Concern with leakage of personal data through introduction of ICT", Q9, 12: "Attempt by business partners to adopt their own ICT systems", and Q9, 3: "Do not restructure business works yet," are positively related with this index at a significant level. On the other hand, Q9, 11: "Company's inability to keep up with rapid development of ICT" and Q9, 1 "no leadership" are negatively related. SMEs with developed ICT use have strong desire to restructure whole business systems, or to overcome their problems by renovating business activities. Under these circumstances, they tend to have problems with business partners and employees who actually operate software.

IT *Hyakusen* SMEs, on the other hand, have the following problems: “We leave everything of ICT introduction to ICT adviser(s)”; “Company’s inability to keep up with rapid development of ICT” (t-value: 1.73); “Lack of leadership regarding ICT use,” and “Lack of workers' ICT Knowledge”. They are supposed to be advanced in ICT use, but they also have problems mainly regarding ability of employees for introducing ICT.

The common problem to both of group is “Lack of leadership regarding ICT use”, and this shows Japanese SMEs still requires top management with strong ICT leadership. The surveys revealed that ICT knowledge on employees and ICT leadership of top management are to be improved, and this implies that the problem related to human resources. This is a key to policies to promote ICT in SMEs.

Table11. ICT Use and Problems of ICT Introduction (OLS estimation)

Higashi-Osaka/Ohta			IT <i>Hyakusen</i>		
Variables	Coefficient	t-value	Variables	Coefficient	t-value
Lack of leadership regarding ICT use	-0.08359	-2.48 **	We leave everything of ICT introduction to ICT adviser(s)	-0.19572	-3.42 ***
ICT has been introduced without any restructuring of works.	0.07785	2.01 **	Lack of workers' ICT Knowledge	-0.07536	-3.08 ***
Lack of workers' cooperation with ICT usage at the office.	0.10436	1.95 *	Lack of leadership regarding ICT use	-0.06147	-2.07 **
The company leaves adviser(s) to introduce ICT as they like.	0.09243	1.47	We can't keep up with technological innovation	0.0566	1.73 *
We cannot catch up with the rapid development of ICT.	-0.12258	-3.05 ***	Constant	0.41383	29.08
Each business partner wants to adopt its own ICT systems.	0.16874	3.98 ***			
ICT investment does not yield explicit profit.	-0.05888	-1.65 *			
ICT investment is very costly.	0.11276	3.46 ***			
We have deep concern for information security, if ICT is introduced.	0.17897	5.44 ***			
Constant	0.32699	13.24 ***			
$R^2$	0.080		$R^2$	0.132	

note: \*\*\*, \*\*, and \* indicate the significant at the 1, 5, and 10% level.

## 5.2. Policies advantageous to ICT use as suggested by empirical research

This section analyzes what kinds of policies are required to encourage the adoption of new technologies. In order to examine this problem, we use the same OLS model. The result of our estimation is shown in Table 12. “Tax exemptions on ICT investment,” “Grants and other financial support for ICT investment,” “Commendation of small company business models that make use of ICT,” and “Deregulation” are positively related to the index. They ask financial support for ICT investment, while IT *Hyakusen* SMEs rated “Introduction of e-bidding system” as a policy desired, and this implies they need a support for operating ICT.

Table 12. Policy Desired by SMEs (OLS estimation)

Higashi-Osaka/Ohta			IT <i>Hyakusen</i>		
Variables	Coefficient	t-value	Variables	Coefficient	t-value
Tax exemptions on IT investment	0.18270	5.05 ***	Introduction of e-bidding system	0.09244	1.92 *
Grants and other financial support for IT investment related projects	0.13411	3.86 ***	Implementation of education for PC operation	-0.06549	-1.86 *
Deregulation	0.07800	2.02 **	Constant	0.38426	31.48
Commendation of small company business models that make use of IT	0.20267	2.75 ***			
Constant	0.27649	13.19 ***			
R <sup>2</sup>	0.086		R <sup>2</sup>	0.032	

note: \*\*\*, \*\*, and \* indicate the significant at the 1, 5, and 10% level.

## 6. CONCLUSIONS

Based on the intensive mail surveys in two Japanese major SME clusters such as Higashi-Osaka/Ohta ward, and IT *Hyakusen* SMEs which were awarded for their ICT use, an index of ICT use by SMEs is constructed, and we clarify the factors promoting ICT use by SMEs. One of the most important factors we found in our estimation is

expectation from ICT use such as “speedup of business development”. SMEs with intensive use of ICT believe in its effect and actually invest lots so as to renovate their businesses. It follows from this that the most important way to promote ICT use among SMEs is encourage them to be forward-looking. Once they adopt such an outlook, they can determine the exact ways in which they will introduce and use ICT, according to their specific goals.

According to the result of estimation on problems related to ICT introduction which Higashi-Osaka/Ohta SMEs own, the positive relationship between ICT index and “Each business partner wants to adopt its own ICT systems” or “We have deep concern for information security” is revealed. These indicate that the issues are mainly located in the offices and human resources. This due to the following reasons:

- large firms individually ask to reply to their own ICT systems
- in order to answer to requests from large firms, the large amount of funds are required
- lack of human resources to handle ICT
- security of data related to customers, transactions, and privacy

SMEs with advanced ICT use in these regions tend to shift of whole business activities or solve managerial problems through restructuring their businesses. In so doing, problems such as the relationship with customers and employees who utilize ICT becomes important.

IT Hyakusen SMEs, on the other hand, introduce and operate ICT without help of outside experts, but with their employees, and they do not introduce it in such a way to restructure whole business activates, but to improve their businesses gradually and partially. In accordance with these manners of introducing ICT, they improve employees ICT capability and renovate ICT systems.

This paper focuses on extracting factors promoting ICT use by SMEs. Once we correctly grasp those, then we can make use of them to establish to suitable policy measures. Our estimations find that Higashi-Osaka/Ohta request tax exempts and subsidies for ICT investment. The rational behind this is that shortage of funds is the most serious obstacle for ICT investment. Since the speed of technological development

is so rapid, these policies are necessary for SMEs. IT *Hyakusen* SMEs, on the other hand, are interested in measures to expand their business chances such as the introduction of e-bidding system. These findings surely become basis for further policy measures. They are so many policies implemented so far by various ministries of the government, which is listed in Tsuji et al [2005], and Small and Medium Enterprise Agency [2001], [2002], [2003], [2004]), but it hardly concludes that they seem to be are successful. Based on rigorous research, proper policy measure should be established.

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## **8. Notes**

- 1) Similar conclusions were reached by Tsuji and Choe (2004), who also tried to identify factors that encourage regional information policies by using the same framework. They concluded that the leadership of top local government is the most significant.
- 2) For AHP, refer to Saaty [1980] and [1986], for example.
- 3) This category was referred to as “orientation to data use” or “data-using type” in Tsuji et al [2005] and Bunno et al [2006a], [2006b].

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