INDICES OF THE DIFFUSION OF INFORMATION TECHNOLOGY AMONG JAPANESE SMALL- AND MEDIUM-SIZED ENTERPRISES: AN AHP APPROACH

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ABSTRACT

This paper proposes a method of constructing a single index of ICT (information and communication technologies) use by SMEs (small- and medium-sized enterprises) by making use of AHP (analytical hierarchical process). Based on this index, we then attempt to extract factors to promote ICT use by SMEs. In so doing, we categorize SMEs into two groups, those with advanced and less advanced ICT use. For the former, we selected SMEs which had received awards for ICT use from organizations such as the IT *Hyakusen* Committee or Ministry of Economics, Trade and Industry. These were referred to as IT *Hyakusen* SMEs. For the latter, we selected SMEs from two of the largest SME clusters in Japan, Higashi-Osaka and Ohta Ward, Tokyo. Questionnaires were sent to more than 6,000 SMEs in these two clusters, and nearly 1,200 replies were received. With regard to an index of ICT use, this was derived using AHP for the following five items: (i) number of PCs owned by the SME; (ii) number of PCs connected by networks such as LANs; (iii) amount of software contributing to the efficient utilization of managerial resources; (iv) Internet use such as homepages, e-mail, and e-commerce; and (v) security measures such as introduction of security systems and organizational measures. Based on this index, we extracted specific determinants of ICT use promotion among the groups using regression analyses, including OLS, probit and logit estimation. We also identified obstacles to ICT use and policies sought by SMEs.

Keywords: AHP, probit and logit estimation, component analysis, software use, Internet use

1. Introduction

Small-and medium-sized enterprises (SMEs) have played an important role in the economic development of Japan, for example through their supply of high-quality parts to the manufacturing sector, and it is well known that the unsurpassed quality of Japanese products is largely based on SMEs. In the Information Society age, the ability of Japanese SMEs to survive depends on their skill in facing challenges from around the world. One means of coping with this challenge is through the adoption of ICT (information and communication technologies), which are a key to the full scale renovation of business activities. Our previous papers, such as Tsuji et al (2005), (2009), analyzed factors that promoted ICT use by SMEs. 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 metropolitan Tokyo. In 2004, questionnaires were sent to more than 6,000 SMEs in two clusters, and nearly 1,200 replies were received. Questions were related to (i) company characteristics (amount of capital, number of employees, etc); (ii) managerial orientation, which classifies SMEs into expansion, incentive-providing, adapting, or data-using categories; (iii) business environment, such as the degree of competition; (iv) purpose 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 the importance of ICT in business management. Those previous papers identified common issues requiring further analysis, namely (i) identification of factors which promote ICT use by SMEs, particularly management type and policies; and (ii) construction of an index to measure ICT use among SMEs.

With regard to factors of ICT use, our previous three papers successfully extracted factors using regression methods, such as OLS, logit and probit estimations. In particular, we found that one of the most important factors is "expectation from ICT use," such as "restructuring of the whole business process," which was identified as a significant factor in all of our estimations. SMEs with intensive use of ICT believe in its effect and make considerable investments in it. 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 precisely determine the ways they will introduce and use ICT, according to their specific goals. By probit analysis, the behavior of the CEO or top management was also found to be particularly 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. We also identified policies to promote ICT investment by SMEs, such as tax and subsidy schemes, and various deregulations.

In the previous papers, SMEs in two clusters, namely Higashi-Osaka and Ohta, were found to be less developed in ICT use. The results obtained are significant for identifying factors and policies for promoting ICT. However, for SMEs which have already achieved a certain level of ICT use, these are not necessarily attractive. In this paper, therefore, we selected SMEs whose level of ICT use was sufficiently advanced to provide references to other SMEs, and compare the results with those of the two SME clusters. In so doing, we selected awardees of the "selected 100 SMEs for best practices in the Kansai Area" and "selected 100 SMEs by METI (Ministry of Economic, Trade and Industry)". To facilitate comparison, the questions used in this paper were closely similar to those in the previous papers, and the same estimation methods were used, namely 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 on AHP. Section 3 describes the variables used for estimations; section 4 presents the method of estimations and actual estimations by OLS, logit and probit estimations; section 5 identifies problems and policies for ICT use by SMEs based our survey; and section 6 provides concluding remarks.

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) 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 processes. These applications are generally used independently on each PC. At more advanced stages of ICT implementation, 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 be concerned about the security of information systems. This item is considered to represent a high level of ICT use.

In Tsuji et al (2005), the index was constructed in such as way that 1 point was provided for questions 1 to 8 (which are indicated as routine work in Table 2 below), and 10 points for questions 9 to 13 (which are indicated as non-routine work in Table 2). Questions 1 to 8 are somewhat different to 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 the present paper, in contrast, we utilized a more rigorous methodology to construct the index, namely AHP (analytic hierarchy process), which attempts to provide numerical values to people's decision-making (Saaty (1980)). For example, when making a purchase, on what basis does a consumer decide? A consumer consider factors such as the price, performance and design of various alternatives, then make a decision based on his/her own criteria. AHP formulates the mechanism of such decision making. It allows us to give a numerical value to vague parts of people's decision making, with possible application to a 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 consumers' decision-making process, the "problem" of what to choose comes first, followed by several "alternatives". AHP attempts to comprehend the process of decision making, and assumes that there are several "criteria" relating the specific "problem" and the "alternatives". AHP's approach is therefore to construct an individual's decision making according to a hierarchic structure.

In this paper, we break down the main factors that boosted ICT use among SMEs into the following two: establishment of hardware and utilization of information systems. The former has two sub-factors, (i) the number of PCs owned, and (ii) number of PCs connected to networks such as LANs; while the latter consists of 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 consists of use related to routine and non-routine processes, (iv) Internet use includes use related to collecting and sending information and e-commerce, and (v) security use includes consists of use related to technical and organizational measures for security.

2.2. Items of software, Internet, and security use

This section explains specific items asked about in the questionnaires concerning software, Internet and security use. Questions relating to software use, Internet use and security use are listed in Tables 2, 3, and 4, respectively.

Table 1. Layer of questions in AHP

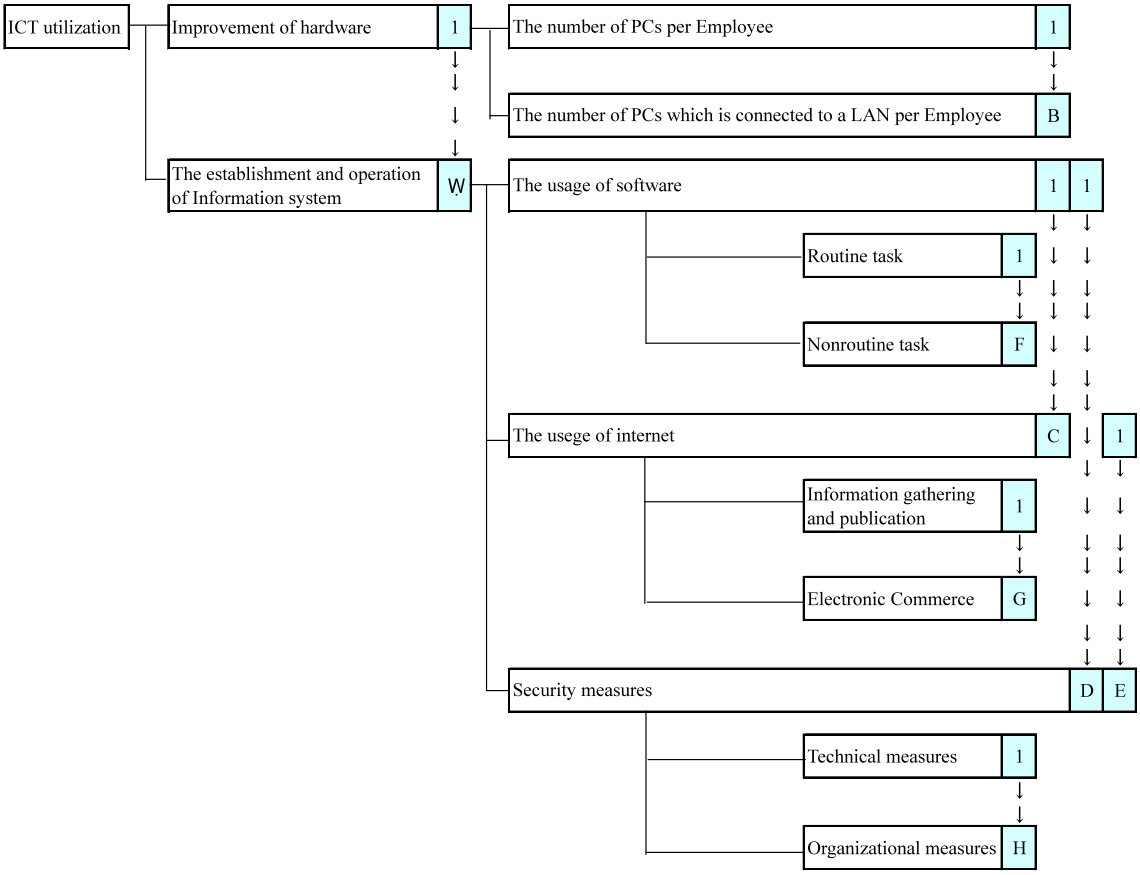

Table 2. Questions on software use

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

In accordance with replies received from 11 ICT experts, AHP weights the questions into three strata, as shown in Table 5. They rated "establishment and operation of information systems higher than "importance of hardware," with a weighting for the former of 0.801 versus 0.199 for the latter. Among factors in the former, "security measures" is rated at 0.453, while software use and internet use are 0.193 and 0.155, respectively. In particular, "organizational measures" in security was most highly evaluated, at 0.358.

Next, based on these weights obtained by AHP, we calculated indices of ICT use for each SME, and then compared the results between those for Higashi-Osaka/Ohta and IT *Hyakusen* SMEs selected by the committee. Results are summarized in Table 6 and Figure 1.

Table 5 Weight obtained by AHP

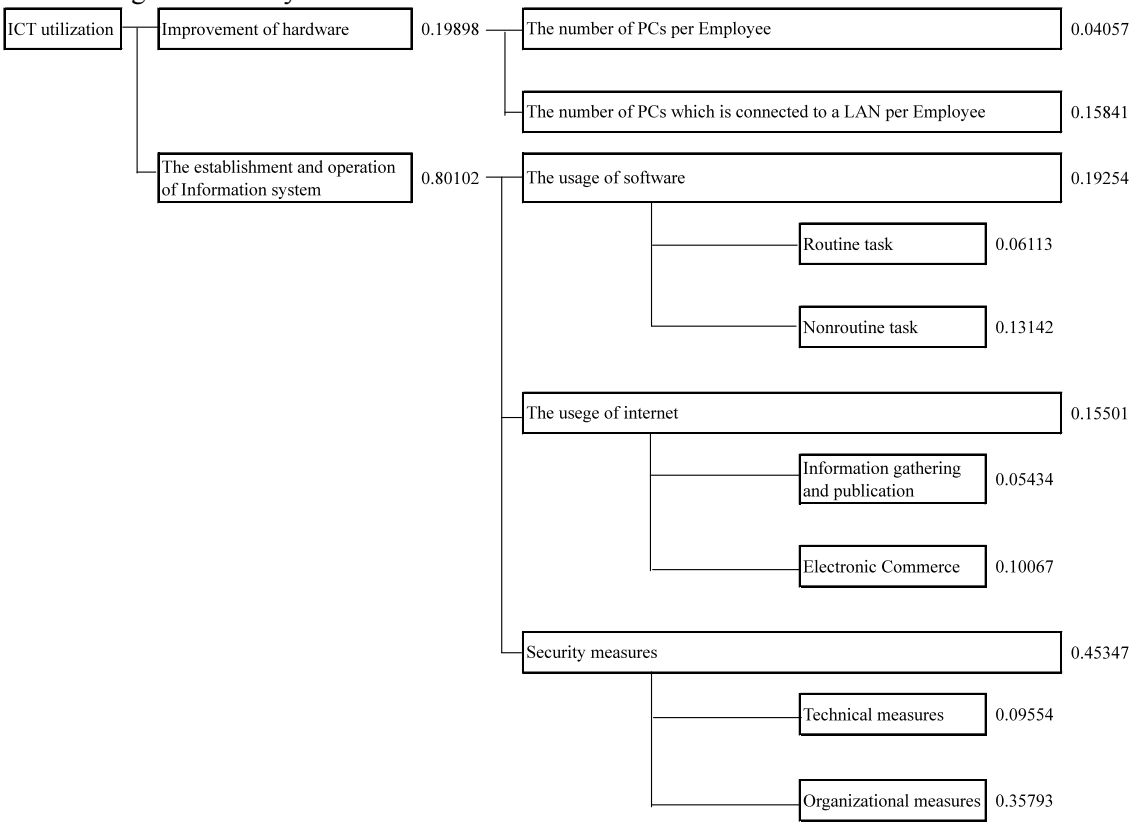

Table 6 Index of ICT use: Higashi-Osaka/Ohta and IT *Hyakusen*

	Frequency			Ratio (%)		
Degree of ICT Utilization	IT *Hyakusen*	Higashiosaka/Ohta	Total	IT *Hyakusen*	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
IT *Hyakusen*	0.17	0.06
Higashiosaka /Ohta	0.07	0.06
Total	0.08	0.06

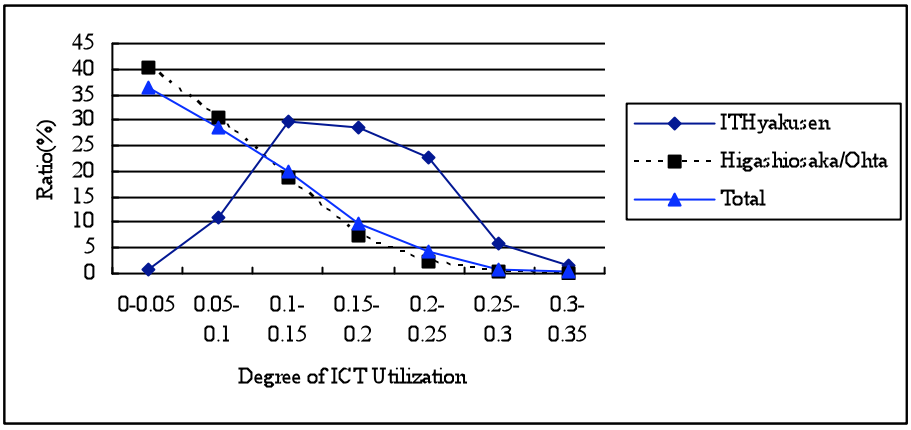

Figure 1. Distributions of indices of ICT use among two groups

Average indices for IT *Hyakusen* and Higashi-Osaka/Ohta were 0.17 and 0.07, respectively, indicating that the ICT use in the former is advanced. This difference allows extraction of 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 in the last fiscal year. The list of variables and related questions are provided in Table 7.

Among these six variables, the first four are explained as follows. First, company characteristics included variables such as the amount of capital, number of regular employees, number of part-time employees, and year of business establishment, and the generation of present owners. Second, management orientation requires a

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
	Number of Employees	20.5	31.1	78.9	108.5
	Number of part-time 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
	Ability to price 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 processes, such as administrative work	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
No. of companies		1,198		137	

notes: * shows the result of Analytic Hierarchy Process.

** four types of corporate management identified by factor analysis.

detailed explanation. The questionnaire included 10 items on managers' daily activities (Table 8). Because there was some overlap between the ten questions, an attempt was made to isolate the variables through component analysis. In this manner, four variables, which accounted for 70.1% of the total responses, were isolated in Higashi-Osaka/Ohta. The first included questions to determine to what extent an SME was geared

toward expansion, which is referred to as "orientation to expansion". The second category, "orientation to incentives," contained questions on management's performance vis-à-vis stakeholders and on any incentives it gave employees by relinquishing rights and responsibilities to them. The third variable included 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 was referred to as "orientation to adapting". The last variable, called "orientation to data use", contained questions on how firms make use of data for decision-making.

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

Table 8. Result of component analysis

Higashi-Osaka/Ohta

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

IT *Hyakusen*

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

With regard to (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 used for estimation are shown in Table 7.

4. Estimation

4.1. Estimation procedure

Factors determining the particular scores obtained by each SME are examined below. To examine the validity of these factors, the following regression model was constructed:

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

where Y_i is each SME's index of ICT use; X_{ji} denotes variables such as characteristics of the SMEs managerial behaviour, expectations for ICT use, etc.; β_i indicates the coefficients to be estimated; and e_i is the residual. For the actual estimation, a stepwise method was adopted to select variables by making use of the Akaike Information Criterion [AIC].

4.2. OLS estimation

The results of the OLS estimation are given in Table 9. In this model, variables related to SME size were significant, such as the amount of capital. Belonging to the retail sector was also significant, owing to the need for SME retailers to use software to manage the large number of customers and suppliers they deal with. Another interesting result was found in variables such "acceleration of business development", in the category of expectations from ICT use. Regarding managerial behaviour, "orientation to expansion" and "orientation to incentive" were significant. SMEs which replied positively to "having problems of ICT introduction" tended to be less developed in ICT use, since it had negative value. It is natural to assume that SMEs with a high index of ICT use invest more in ICT, and this has significant relationship with ICT investment in the last year.

Table 9. Results of OLS estimation

Higashi-Osaka/Ohta			**IT *Hyakusen***		
Variable	Coefficient	t-value	Variable	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 employees	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 ***
Able to price own products.	0.020104	1.42	Restructuring of the whole business process	-0.03926	-2.32 **
Current problems with ICT utilization	-0.113996	-2.09 **	Other business	-0.12262	-2.04 **
Company's understanding of importance 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 ***			
R^2	0.275		R^2	0.432	

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

With regard to IT *Hyakusen* SMEs, factors such as "Service industry (to business)," "Precise understanding of customer needs," and "Company's ICT investment in preceding year" were 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" were negatively significant. There were few factors which were commonly significant for both groups. In addition to "Company's ICT investment in preceding year", which was clearly significant, "Incentive type" of management was also significant. These results show ICT use in these two groups were somewhat different.

4.3. Logit and probit estimations

This section describes the results of logit and probit estimations. The rationale for the use of these is that variables defined by data obtained through mail survey usually take discrete values, and that logit and probit estimations are therefore better than OLS.

The results of logit and probit estimations are shown in Table 10. Results were similar to those for OLS estimation in the previous section. Amount of capital (marginal effect: 0.07602), wholesale (marginal effect: 0.14235), ICT investment in the previous year (marginal effect: 0.12299), and "acceleration of business development" as expectation of ICT use (marginal effect: 0.06821) were significant. Regarding managerial behaviour, "orientation to expansion" (marginal effect: 0.08267) and "orientation to incentive" (marginal effect: 0.07802) were also significant.

With regard to 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, and "Service industry (against business) (marginal effect: 0.6241) were significant.

Table 10. Result of logit and probit estimations

Higashi-Osaka/Ohta

Variable	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 employees	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 significance at the 1%, 5%, and 10% level.

IT *Hyakusen* SMEs

Variable	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 employees	-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
Able to price own products.	-0.21814	-1.53	-0.08427	-0.35635	-1.47	-0.0851
Log likelihood	-49.340223			-49.660311		

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

The common factors are "Expectation of rising profit," "Company's ICT investment in preceding fiscal year," and "Incentive type". These imply that in order to raise the ICT index, SMEs must increase ICT investment, provide proper incentives to employees, and share more information concerning management. In particular, IT *Hyakusen* SMEs had a negative marginal effect with regard to "Restructuring of the whole business process," implying that they do not intend to introduce ICT to restructure whole business processes, but rather for the promotion of incremental change.

5. Problems of ICT use and policy desired

5.1. Problems of ICT use

The analysis above has focused on factors that encourage ICT use. This section examines ICT-related issues faced by SMEs, in order to identify problems and recommend policies that could be implemented to solve them. In accordance with the replies to the questionnaires (Q9), the types of obstacles faced by SMEs in the two categories of ICT use (developed and developing) were examined. 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 length of time required to introduce new technologies. Here, we used OLS to analyze the relationship between the index of ICT use and replies to questions related to problems with ICT use. Variables utilized in estimation were selected by the stepwise method according to F values.

With regard to the software utilization model, the results of our estimation are 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, "Have yet to restructure business processes," were 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" were negatively related. SMEs with developed ICT use have a 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 delegate ICT introduction totally to ICT adviser(s)", "Company inability to keep up with rapid development of ICT" (t-value: 1.73), "Lack of leadership regarding ICT use," and "Lack of worker ICT Knowledge". Despite their supposed advanced state of ICT use, they also have problems, mainly regarding the ability of employees in introducing ICT.

The problem common to both groups was "Lack of leadership regarding ICT use", indicating that Japanese SMEs still require top management with strong ICT leadership. The surveys revealed the need to improve the ICT knowledge of employees and the ICT leadership of top management, which in turn implies that the problem is related to human resources. This is a key to policies aimed at promoting ICT use in SMEs.

Table 11. ICT use and problems of ICT introduction (OLS estimation)

Higashi-Osaka/Ohta			**IT *Hyakusen***		
Variable	Coefficient	t-value	Variable	Coefficient	t-value
Lack of leadership regarding ICT use	-0.08359	-2.48 **	Responsibility for ICT introduction is delegated to ICT adviser(s)	-0.19572	-3.42 ***
ICT is introduced without the restructuring of processes.	0.07785	2.01 **	Lack of worker ICT knowledge	-0.07536	-3.08 ***
Lack of worker cooperation with ICT usage at the office.	0.10436	1.95 *	Lack of leadership regarding ICT use	-0.06147	-2.07 **
The company allows adviser(s) to introduce ICT as they like.	0.09243	1.47	Cannot keep up with technological innovation	0.0566	1.73 *
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 system.	0.16874	3.98 ***			
ICT investment does not yield explicit profit.	-0.05888	-1.65 *			
ICT investment is very costly.	0.11276	3.46 ***			
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 significance 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. To examine this problem, we used the same OLS model as above. Results are 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" were positively related to the index. Financial support for ICT investment is sought, while IT *Hyakusen* SMEs rated "Introduction of e-bidding system" as a desired policy, implying that they need support for operating ICT.

6. Conclusions

Based on comprehensive mail surveys conducted in two major Japanese SME clusters, Higashi-Osaka and Ohta ward, and in IT *Hyakusen* SMEs awarded recognition for their ICT use, we constructed an index of ICT use by SMEs, and clarified factors promoting ICT use by SMEs. One of the most important factors in our estimation was the expectation that ICT use would promote the "acceleration of business development". SMEs with intensive use of ICT believe in its effect and make substantial investments in ICT to overhaul 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 will be able to precisely determine how they will introduce and use ICT, according to their specific goals.

Table 12. Policy desired by SMEs (OLS estimation)

Higashi-Osaka/Ohta			**IT *Hyakusen***		
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^2	0.086		R^2	0.032	

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

Analysis of problems related to ICT introduction by Higashi-Osaka/Ohta SMEs indicates positive relationships between the ICT index and "Each business partner wants to adopt its own ICT system" or "Deep concern regarding information security" is revealed. These indicate that the issues are mainly located in their firms and human resources. This due to the following reasons:

- large firms seek system consistency with their own ICT systems
- to answer requests from large firms, substantial 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 relationships with customers and employees who utilize ICT become important. IT *Hyakusen* SMEs, on the other hand, introduce and operate ICT without the help of outside experts, but rather using their employees, and do not introduce ICT via the overall restructuring of whole business activities, but rather to improve achieve incremental improvements in their businesses. Consistent with these methods of introducing ICT, they improve employee ICT capabilities and improve ICT systems.

This paper is focused on extracting factors which promote ICT use by SMEs. Once a clear understanding of these is obtained, they can be used to establish to suitable policy measures. Our analyses indicate that

Higashi-Osaka/Ohta requests tax exemptions and subsidies for ICT investment, based on the rational that a shortage of funds is the most serious obstacle to 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 business opportunities, such as the introduction of e-bidding systems. These findings clearly represent a basis for further policy measures. Despite the many policies implemented by various ministries of the government to date, as listed in Tsuji et al (2005), few seem to have been successful. Proper policy measures should be established based on rigorous research.

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