

An Empirical Analysis of Factors Promoting IT Use by SMEs: Case of Two SME Clusters in Japan

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EXTENDED ABSTRACT

This paper attempts to extract empirically factors that promote the introduction and usage of IT by SMEs (Small- and medium-sized enterprises) through the method of mail surveys and in-depth interviews conducted in two of Japan's largest SME clusters, Higashi-Osaka and Ohta Ward, in the metropolitan area of Tokyo. We sent questionnaires to more than 6,000 SMEs in these 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 IT use, such as raising profit and productivity; (v) expectations for IT use; and (vi) other factors such as IT investment in the most recent fiscal year and the company's understanding of importance of the IT in business management. Regarding management orientation, a detailed explanation is called for. The questionnaires contain ten items regarding managers' daily activities. Since there is some overlap between the ten questions, an attempt was made to isolate the variables through component analysis. In this manner, four variables, which account for 70.1% of the total responses, were isolated. The first of these includes questions to determine to what extent an SME is geared toward 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. We selected the followings indexes to represent the degree of IT use by SMEs: (i) the amount of software that contributes to efficient utilization of managerial resources; and (ii) Internet usage. Based on these data, we extracted the factors by making use of regression methods such as OLS, logit and probit estimations. Thus, the result of estimations can be compared.

One of the most important factors we found in our research is "expectation from IT 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 IT believe in its effect and actually invest lots. It follows from this that the most important way to promote IT 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 IT, according to their specific goals. By the probit analysis, the behaviour of COE or the top management was also found to be especially important. Since IT 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. 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.

Once we correctly grasp those factors, then we can make use of them to establish suitable policy measures to enhance SMEs. Based on rigorous researches, proper policy measures should be established.

1. INTRODUCTION

SMEs undergird Japan's entire manufacturing sector by supplying it with high-quality parts; it is well known that the unsurpassed quality of Japanese products is largely based on SMEs. This paper examines current IT use by SMEs, namely, examines empirically what are the factors that promote IT use by SMEs. The analysis is based on field surveys, a mail survey and in-depth interviews conducted by the authors 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. We sent questionnaires 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; (ii) managerial orientation; (iii) business environment; and (iv) purposes of IT use; (v) expectations for IT use; (vi) other factors. These are independent variables which explain the degree of IT use by SME. As for dependent variables which present the degree of an SME's IT use, the following two were selected: (i) the amount of software that contributes to efficient utilization of managerial resources; and (ii) Internet usage. Based on these data, we identify the factors that promote IT use by regression analysis such as OLS, logit and probit estimations.

2. INDICES OF IT DEVELOPMENT

IT utilization cannot be described with a single index, since various factors are involved, including firm size, industry, business practices, etc. For the surveys, the following indicators of IT 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; and (iv) Internet use. (i) and (ii) are simple quantitative proxies for IT use: having more PCs is roughly indicative of greater IT usage. Items (iii) and (iv) are more qualitative measures of IT use.

2.1. Index of Software use

In our 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 IT use, since the latter deals with more complicated and integrated utilization than the former. This scoring seemed somewhat arbitrary. In this paper, we focus on the usage of software and the Internet. The former is related to item (iii) in Q2 of our

questionnaires; in answering this question, SMEs were asked if they used the software listed in Table 1 below. It is reasonable to assume that software used by many (few) SMEs is less (more) important, so that it should be assigned smaller (larger) point value. The weight for the software is assigned according to the percentage of SMEs that gave affirmative responses to questions 1-13: namely, the weight is the reciprocal of the percentage. As the index deals with more advanced and integrated uses, more points were assigned to these uses. The sum positive replies of these 13 questions weighted as indicated is a composite dependent variable referred to as "software use."

Table 1. Question on Software

2.2. Index of Internet Use

The index presented in (iv) above deal with Internet use in the same manner as does item (iii)

1. Sales management (including POS and barcode)
2. Accounting, 3. Payroll management
4. Purchases management,
5. Inventories management
6. Design management (including CAD/CAM)
7. Production management, 8. Logistics
9. Enterprise resource planning (EPR) packages
10. Customer Relations Management (CRM)
11. Groupware, 12. Sales Force Automation (SFA)
13. Supply Chain Management (SCM)

of the questionnaire on software use. That is, the weight for the Internet use is assigned according to a reciprocal of the percentage of SMEs which provide affirmative responses to questions 1-5, which correspond to Q3-3, as shown in Table 2. One point was assigned for each affirmative response, and the sum positive replies of these 5 questions weighted as indicated is a composite dependent variable referred to as Internet use. The quantitative analyses are based on these indices.

Table 2. Questions on Current Internet Use

1. Create and manage the company's homepage or related web pages
2. Employees' personal e-mail accounts (number of addresses)
3. Create and utilize electronic bulletin boards, and/or electronic meeting boards
4. Create and utilize mailing lists of customers and business partners
5. Establish a private domain name

3. FACTORS THAT AFFECT IT USE

Here, we explain variables that encourage IT use. The questionnaires asked SMEs about (i) company characteristics, (ii) management orientation, (iii) business environment; (iv) purposes of IT use, such as raising profit and productivity; (v) expectations for IT use; and (vi) other factors such as IT investment in the most recent fiscal year and the company's understanding of importance of the IT in business management. Company characteristics include variables such as industrial category, amount of capital, and number of employees.

Regarding management orientation, a detailed explanation is called for. The questionnaires contain ten items regarding managers' daily activities, shown in Table 3. Since there is some overlap between the ten questions, an attempt was made to isolate the variables through component analysis. In this manner, four variables, which account for 70.1% of the total responses, were isolated. The first of these includes questions to determine to what extent an SME is geared toward 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 to what degree top management considers employee suggestions. Since such behaviours 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. The results of the component analysis are summarized in Table 3.

Regarding business environment, seven variables

were selected, including winning of new business partners, product characteristics and the effect of new entrants into the market. Finally, since the introduction and use of IT depend on firms' expectations regarding their future business and management, nine variables were selected for the fourth category, including increased profits, promotion of higher productivity, and timely decision-making.

4. ESTIMATION METHODS

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 the index of IT use; X_{ji} denotes variables such as the characteristics of the SMEs, amount of IT investment, expectations for IT use, etc.; β_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]). The following two models were estimated, in accordance with the index selected: (i) the software utilization model; and (ii) the Internet utilization model. We use two estimation methods so as to clear the verifiability of the models; namely, OLS, and logit and probit models.

5. OLS ESTIMATION

The index for this model measures software utilization. By using this index, two methods – the OLS, and logit and probit estimations -- are examined.

5.1. Software Utilization Model

The result of the estimation is given in Table 4. In this model, variables 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 retailers need software to manage the large number of customers and suppliers they deal with. Another interesting result is found in variables such "restructuring of the entire business process," in the category of expectations for IT use.

Table 3. Result of Component Analysis

Managerial Orientation	Common Factors			
	Meeting challenges	Providing Incentives	Adapting	Using data
There is employee training and rotation, to utilize each employee's ability and knowledge	0.836	0.152	0.124	0.126
The company offers IT training to executives, managers and employees	0.813	0.056	0.074	0.210
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	0.200	0.824	-0.006	0.301
Senior managers are given broad responsibilities and authorities	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's opinion on how to improve management	0.281	0.538	0.587	0.064
Past business data are extensively analyzed in company management	0.074	0.230	0.255	0.784
Monthly business data are utilized to improve management	0.345	0.175	0.123	0.708
Eigenvalue	2.308	1.745	1.531	1.422
Rotated Factor Pattern (%)	44.8	10.7	7.3	7.2
Cumulative Proportion (%)	70.1			

5.2. Internet Utilization Model

Table 5 shows the results when the estimation of Internet use is the parameter. In this estimation, the size of the firm again affects Internet use. Management orientations such as “expanding” and “providing incentives” are also important for Internet use, while “adapting” has a negative effect. Expectations from IT use such as “higher productivity in non-routine tasks” and “restructuring of the entire business process” are the most significant. The Internet is used to introduce new businesses activities or obtain new business partners, which are not achieved by routine tasks but by non-routine ones, or by restructuring of whole businesses. “Higher productivity in routine tasks” has a negative correlation, but this is because SMEs have higher IT use often had already experienced the reform of routine works. SMEs with low levels of Internet use still have higher expectation of improving productivity by IT.

5.3. Summary of OLS Estimations

These estimations show that various factors significantly affect IT use by SMEs. To shed light on the factors that most important of these factors, the results given in the tables are summarized

below: In two estimations, expectations for restructuring of the entire business process are commonly perceived as significant. This implies that SMEs tend to use IT as a tool to seek new business through restructuring and to adjust to the transformation of the business environment. In addition to this, IT investment in the preceding fiscal year is also commonly significant in two estimations.

6. LOGIT AND PROBIT ESTIMATION

We will present the results of the logit and probit estimations. The rationale for using these two is that variables constructed by data obtained through mail survey usually take discrete values, logit and probit estimations better methods than OLS.

6.1. Software Utilization Model

The results of estimations indicate in Table 6. In these estimations, let us discuss the result obtained by the probit model. “Restructuring of the whole business process” and “Company’s IT investment in the preceding fiscal year” are the most significant as in the OLS estimations. In addition, three variables in management orientation also have important influence, and this implies that management orientation is a key factor for software use by SMEs.

Table 4. Result of OLS Estimation of Software Utilization Model

	Variable	coefficient	t-value
Characteristics of firms	Wholesale	0.000001	2.7 ***
Managerial orientation	Using data	0.001496	1.5
Expectations from IT use	Restructuring of the entire business process	0.002645	2.29 **
	Company's IT investment in preceding fiscal year	0.004306	4.55 ***
R ² 0.096			

Note: *, **, and *** are significant at 10%, 5%, and 1% level, respectively.

Table 5. Result of OLS Estimation of Internet Use

	Variable	coefficient	t-value
Company Attribute	number of employees	0.0000242	2.58 **
Management orientation	Expansion	0.0007315	2.64 ***
	providing incentive	0.0004788	1.77 *
	Adapting	-0.0010619	-2.05 **
Expectations from IT use	higher productivity in routine tasks	-0.0006143	-1.71 *
	higher productivity in non-routine tasks	0.0008138	2.70 ***
	restructuring of the entire business process	0.0010619	3.16 ***
Company's IT investment in preceding fiscal year		0.0006394	2.28 **
R ² 0.123			

Note: *, **, and *** are significant at 10%, 5%, and 1% level, respectively.

6.2. Internet Utilization Model

The result of this estimation is shown in Table 7. "Expanding" in management orientation and "restructuring of the whole business process" are the most significant. The amount of investment last year also has a strong influence. "Company's understanding of importance of IT in business management" and "higher speed of decision-making in management and business" are also significant at the 5% level, in addition to "securing good employees and human resource management". The important management orientations are often the same as in software utilization model.

6.3. Summary of Logit and Probit Estimation

We can summarize the results here. By focusing on the probit estimation, we find that management orientation is the most important factor. This point is more clarified than in the previous OLS models. Moreover, the speed up of decision-making, and human resource management that secures good employees are new factors that are not obtained in the OLS model. In this sense, The logit and probit models are not substitutes, but complement to the OLS estimation.

7 CONCLUSIONS

Based on our intensive survey in two Japanese major SME clusters, Higashi-Osaka and Ohta ward, two indices of IT use by SMEs were constructed, and the factors promoting IT use by SMEs were clarified. The most important factors we found in

Table 6. Result of Logit and Probit Estimation of Software Utilization Model

Variables	Logit			Probit		
	coefficient	p-value	marginal effect	coefficient	p-value	marginal effect
Capital	0.000076	0.060	0.000018	--	--	--
Years of Operation	0.184350	0.071	0.043998	0.097084	0.081	0.036240
expanding	--	--	--	0.150280	0.007	0.056097
Incentive	--	--	--	0.150280	0.007	0.056097
Data Using	0.147771	0.127	0.035268	0.121742	0.022	0.045445
Obtain new business partners every year.	--	--	--	-0.083516	0.053	-0.031175
Development of ability for planning, R&D, and technology	0.358013	0.053	0.085556	--	--	--
To secure good employees and human resource management	0.313383	0.095	0.074392	0.209700	0.041	0.077959
Active communication and accumulation sharing of information knowledge	-0.271124	0.022	-0.06470	--	--	--
Restructuring of the whole business process	0.334408	0.005	0.079811	--	--	--
Company's IT investment in preceding fiscal year	0.465844	0.000	0.111180	0.316854	0.000	0.118277
Log likelihood	-358.313			-427.485		

our estimation is expectations for IT use, such as “restructuring the whole business process,” which repeatedly emerges as significant. SMEs with intensive use of IT believe in its effect and actually invest lots. It follows from this that the most important way to promote IT use among SMEs is to 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 IT to meet their specific goals.

The behaviour of top management is also found to be important, especially in the probit model. The empirical study identified the following types of management outlooks that affect IT use: orientation to expanding, to adapting, to using data and to providing incentives. Similar conclusions were reached by Tsuji and Choe (2004), who also identified factors that encourage regional information policies. Using the same empirical

methodology as the present study, these authors concluded that leadership shown by top local government officials is more crucial than the availability of funding. The current study has sought to understand how top management determines what information technologies are to be used, and what kind of decision-making leads to greater IT use. The authors believe that IT's prime function is to create entirely new business models. Ideally, IT completely transforms businesses, and the economy itself, through Schumpeterian creative destruction. Most SMEs that successfully use IT create new business models based on a more intensive use of IT.

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Table 7. Result of Logit and Probit Estimation of Internet Utilization Model

Variables	Logit			Probit		
	coefficient	p-value	marginal effect	coefficient	p-value	marginal effect
Information services	--	--	--	0.7655127	0.093	0.2930451
Number of employee	--	--	--	0.0043313	0.034	0.0017005
COE's generation	0.2147792	0.011	0.0525628	--	--	--
Expanding	0.2529977	0.008	0.0619160	0.1823141	0.002	0.0715782
Incentive	0.2040279	0.028	0.0499317	0.1332995	0.019	0.0523346
Adapting	-0.2919589	0.002	-0.0714510	-0.1417308	0.015	-0.0556449
We are constantly developing new business and products.	0.1329419	0.090	0.0325348	--	--	--
To secure good employees and human resource management	0.4388415	0.013	0.1067115	0.2357852	0.031	0.0921742
Company's understanding of importance of IT in business management	0.2462921	0.018	0.0602750	0.1470214	0.020	0.0577220
Higher speed of decision-making in management and business development	-0.2498375	0.038	-0.0611426	-0.1729264	0.020	0.1059098
Restructuring of the whole business process	0.4335908	0.000	0.1061125	0.2697587	0.000	0.1059098
Company's IT investment in preceding fiscal year	0.3357048	0.000	0.0821569	0.1507169	0.009	0.0591729
Log likelihood	-395.371			-376.657		

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