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December 2002

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EMPIRICALLY ASSESSING DISTINCT FACTORS RELATED TO THE EFFECTIVENESS OF STRATEGIC IT AND NON-IT INVESTMENT DECISIONS

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Abstract

The effectiveness of strategic investment decisions (SIDs) is an important research topic that needs to take into consideration the impact of their IT content. In this study, a field survey was conducted to investigate the distinct factors that impact on the effectiveness of both strategic IT and non-IT investment decisions. A comprehensive list of potential factors was derived from past research and used as the basis for collecting data from 80 Taiwan enterprises. The collected data was divided into two sets, IT and non-IT investment projects. Using stepwise regression analysis for both data sets, two regression models were derived. It shown that, in both models, much of the variance of both IT and non-IT SIDs can be explained by distinct factors extracted from the factor list. A comparison and discussion was made in terms of distinct factors of two models. Finally, the implication of this for the evaluation and management of IT investment decisions is discussed.

Introduction

Strategic investment decision (SID) making has long been a topic of great interest in organizational theory, strategic management, financial management and the control perspective of information management. While the strategic potential of information technology (IT) is now well recognized, the orientation of information technology has changed from tactical to strategic while at the same time, the financial view of IT has changed from that of a cost to one of investment (Earl, 1989). Since a large amount of investment capital has been absorbed by strategic IT (Porter and Millar, 1985), strategic IT investments have increased in importance as part of organizations' strategic investments.

Although strategic information technology investment decisions (SITIDs) are a subset of SIDs, a number of phenomena show the problematic nature of IT investment. *First, decisions are more difficult than many other investment decisions (Powell, 1993) and management now faces a dilemma concerning the strategic use of IT (Willcocks, 1994).* Willcocks indicates that many organizations find themselves in a 'catch 22' position. Organizations thus fall into the 'IT productivity paradox' problem (Brynjolfsson and Hitt, 1996) of failing to identify IS/IT benefits and productivity.

Second, the outcomes of strategic IT investment projects are often poor. Some cases, e.g. that of the London Ambulance System, have reported failure in the use of IT (Hougham, 1996). In the case of the London Ambulance Service the single most important factor was the inadequacy of the organization to control such a large and technically complex operation. Moreover, Hochstrasser and Griffiths (1991) show that only 31% of companies reported that the introduction of IT had been very successful. In those successful cases, there may be no gains even if the system is successful. This phenomenon is brought about possibly because the system has so dramatically altered the environment that all assumptions about costs and benefits are rendered obsolete (Parker, 1996).

Third, it has been widely recognized that financial appraisal techniques cannot be used to evaluate IT investments effectively. Willcocks (1994) indicates factors such as inappropriate measures and the neglect of intangible benefits can also contribute to failure of IT investment evaluation. While this particular concern is well received by many, it is not clear on how we could

improve the situation. One possibility is that it is caused by the fact that existing evaluation techniques are too narrow (for example, they are mainly financially based) and lack an alignment mechanism. In the continuous effort of investigating the distinct factors which may impact on the effectiveness of IT and non-IT strategic investment decisions, we can see that while SITIDs form part of corporate SIDs, most previous research has concentrated on either SITIDs or SIDs, and the continuous nature of decisions (Simon, 1977) has been ignored. This revelation help direct our attention towards understanding the continuous nature of decisions which has been commonly neglected in previous research. At the same time, it is the negligence that has aroused our curiosity in finding out the fundamental question - "Does IT Matter?" in SIDs. In other words, what is the potential impact on SIDs of their IT content?

Against this backdrop, this study aims to extend our knowledge of both strategic investments and strategic IT investments. In particular, the study emphasizes on the potential impacts on SIDs of their IT content. It seeks to explore this issue from the perspective of investment decision problems. In particular, distinguishing variables of SIDs in relation to different degrees of IT involvement will be explored. It is also important to know what factors are changed because of IT involvement so that these differences can be taken account of in the evaluation and management of SITIDs. Specifically, the main objectives of this study are as follows. (1) To clarify the potential impacts on SIDs of their IT content. (2) To investigate the distinct factors which may impact on the effectiveness of IT and non-IT strategic investment decisions.

Theoretical Background

Since Porter and Millar (1985) advocate the use of information to increase the competitive advantage of an organization, the case studies describing such achievements are also well known: American Airlines, Baxter Hospital Supplies, McKesson, Otis Elevators and many others. But, as the strategic importance of IT has increased, the decisions about where and when to allocate resources to IT programs have become riskier and more difficult (Clemons and Weber, 1990). As a result, it is important to address two fundamental but critical questions: what is a strategic IT investment? And why do organizations introduce IT?

Although the strategic potential of IT is well recognized and IT is now of significant importance in capital investment (Willcocks, 1994), unlike strategic decisions or strategic investment decisions, there is no single, universally accepted definition of SITIDs. Obviously, introducing IT needs to link use to organizational strategy. However, some researchers (e.g. Powell, 1993) reveal the problems with the processes involved in strategic IT investment. In particular, he argues that often mere lip service is paid to the strategic nature of IT, and many IT investments labeled as strategic turn out to be operational in nature. Inheriting characteristics from strategic investment decision-making, the process of IT investment and the relationship of IT and strategy are major issues for researchers (e.g. Sheppard, 1990; Gatian et al., 1995), and many of them (e.g., Powell, 1993) confirm the difficulty of IT investment decisions. Ginzberg and Zmud (1988) distinguish between assessment techniques and the assessment situation. Thus, a summative evaluation asks whether goals have been achieved, whereas a formative evaluation is concerned with the process by which objectives are sought, and seeks to improve this. Ginzberg and Zmud (1988) also categorize the situations in which assessments take place in terms of the role of IT, stakeholders and the purpose of the evaluation.

Overall, these studies depict clearly the problematic nature of strategic IT investment decisions, the importance of managing SITIDs effectively and provide a useful background for the examination of SIDs in terms of IT involvement. However, much of the research related to SITID has mostly reported the difficulties involved in evaluating IT projects (e.g. Clemons 1991). This is insufficient as evaluation represents only a part of the whole decision process. Therefore, as a start, this study aims to follow the advice by Weill and Olson (1989) in that 'the first step in managing IT investment is to know exactly what that investment is'. In other words, it is critical to clarify understanding of the nature of SITIDs. Specifically, we will investigate the distinct factors that have impact on the effectiveness of both strategic IT and non-IT investment decisions. A comprehensive list of potential factors for the effectiveness of investment decisions was derived from past research used as the basis for collecting data from 80 Taiwan enterprises.

Data Collection

In order to investigate the issues presented above, empirical work was undertaken among Taiwanese manufacturers. The variables were operationalized in the form of a questionnaire. In order to increase the expected response rate, judgment sampling was used. Experts in two professional associations, the Chinese Association for Industrial Technology Advancement and the Chinese Productivity Center, helped to select organizations considered being representative of the population. A postal questionnaire and a reference letter from the experts were sent directly to named individuals in the selected organizations. The respondents were

all at management level and involved in investment decision-making processes. The unit of analysis here is a single strategic investment decision, since it is the complexity and context that are at issue rather than the organization itself (Hickson et al., 1986). Respondents were asked to evaluate propositions based on a strategic investment project developed and implemented in the last five years of which they had experience. 270 organizations were selected and 94 responded. Of these, 80 were valid for further analysis.

However, non-response errors may occur when the views of non-respondents are distinct from those of respondents, and when the number of non-respondents is large enough to outweigh the common view drawn from respondents. Face-to-face interviews or contact by telephone with a sub-sample of the people who do not return their questionnaires can be used to investigate the reasons for non-response. An effort was made to contact a sub-sample (12 cases); however, only 8 out of the 12 cases were available. Several reasons for non-response were given: (1) 3 cases indicated that only the office spokesperson could answer the question, (2) 2 indicated that the topic was too confidential, (3) 1 case indicated that no such investment case could be provided, and (4) 2 cases indicated that they did not have the knowledge to answer the questionnaire. As the study achieved a 30% response rate, this problem was minimized. At the same time, special caution has to be taken when trying to generalize research findings.

In the instructions provided with the questionnaire, the respondents were asked to supply details of a strategic investment project. However, based on the distribution of frequency, IT intensity seems to focus on the two extremes: 24 cases involve no IT, and 21 cases involve a level of at least 80% of IT. The other cases are distributed between these two extremes. Both effectiveness and IT-content are separated into higher and lower clusters. A project with IT involved more than 40% is considered as an IT project, otherwise it is considered a non-IT project.

Research relating to effectiveness can be categorized into two ways. The first is concerned with organizational effectiveness and focuses on the relationship between investment decisions and organizational performance. For example, some empirical studies investigate the relationship between strategic investment announcements and stock price (e.g. Woolridge and Snow, 1990). They focus on the relationship between announcements and decisions, not the outcomes of these decisions. Although organizations announce their strategic investment plans, and the stock market usually reacts positively, the outcomes are unknown. The current work belongs to the second group which focuses on decision effectiveness. Here, effectiveness compares actual performance against planned, whether original or subsequently chosen, target/outputs, outcomes and policy objectives (Willcocks, 1994). Accordingly, this study defines effectiveness as the objectives-attainment of decisions. Most variables are measured by a seven-point interval scale with semantic differentials for the two extremes. The measure of decision effectiveness is unavoidably subjective: a multi-objective function is used to determine the effectiveness, as follows:

$$Effectiveness = \frac{\sum_1^j (I_j * A_j)}{n}$$

I_j = the perceived importance of the j th objective,

A_j = the extent to which the j th objective is achieved,

and n = the total number of different objectives which respondents seek to attain.

Data Analysis

The Model Building Process

Examination of the co-linearity of variables. The first step in building the model is to examine the co-linearity of variables. The simplest way is by constructing pairwise scatter plots for each variable. However, when the number of explaining variables is large, this may not be feasible. Alternatively, by looking at the correlation matrix, we will be able to identify obvious co-linearity problems. The correlation matrix seems more appropriate for this study. The correlation matrix shows the results of the correlation test for all variables, and no obvious co-linearity among variables is revealed. Accordingly, no variable will be dropped.

Selection of variables in a regression equation. One of the sequential search approaches is needed to select variables for formulating a regression model. As suggested by Hair et al. (1995), stepwise estimation is the most popular sequential approach to variable selection. The most common stepwise technique is forward selection, which first chooses the single variable from all the potential independent variables that produces the highest value of R^2 . For each variable not included, an F statistic is calculated assuming that variable was included in the equation. The variable with the largest F statistic, as long as the statistic surpasses a

pre-established level, is then added to the equation the second step. F statistics are recalculated and the procedure is repeated. This procedure continues until no excluded variables remain with high F statistics above the pre-selected threshold level. The primary advantage of stepwise techniques is that they reduce the total set of potential variables to a more manageable number. This approach allows the analyst to examine the contribution of each predictor variable to the regression model and should be appropriate for this study. All the variables are then fitted into the full linear regression models by the stepwise approach.

Result

■ **IT Investment Projects**

As shown in Table 1, 5 of the 46 variables have been selected by the stepwise approach in the regression model. The overall fit of the model is highly significant (F=.0000). These five variables can explain approximately 87% ($R^2=86.7$) the variance of the effectiveness of IT-SIDs. For IT SIDs, five factors have been selected in the regression model including certainty of benefit, competitive position of company, urgency of the decision, important of IT and market situation.

Table 1. The Summary of SPSS Result of the Effectiveness of IT-SIDs

Model Description						
The effectiveness of IT-SIDs= $\beta_0+\beta_1$ (certainty of profit) + β_2 (competitive position) + β_3 (urgency of decision) + β_4 (importance of IT) + β_5 (market situation)+ μ						
Model Summary						
R	R Square	Adjusted R Square	Std. Error of the Estimate			
.931	.867	.846	3.96			
Analysis of Variance						
Model 1	Sum of Squares	df	Mean Square	F	Sig. of F	
Regression	3171.741	5	634.348	40.539	.0000	
Residual	485.084	31	15.648			
The Regression Equation and Associated Statistics						
Model		B	Std. Err.	β	t	Sig. t
1.	Certainty of profit	5.384	.554	.674	9.714	.000
2.	Competitive position of company	1.631	.548	.246	2.975	.006
3.	Urgency of the decision	1.919	.538	.280	3.567	.001
4.	Importance of IT	1.340	.439	.221	3.048	.005
5.	Market situation	-1.037	.442	-.167	-2.347	.025
6.	(Constant)	-20.103	3.445		-5.848	.000

■ **Non-IT Investment Projects**

As shown in Table 2, 5 of the 46 variables have also been selected by the stepwise approach in the regression model. The overall fit of the model is highly significant (F=.0000). These five variables can explain approximately 81% ($R^2=80.8$) of the variance in the effectiveness of non-IT SIDs. For non-IT SIDs, five factors have been selected in the regression model including certainty of benefit, management’s attitude toward risk, quality of communications in formal meeting, learning, and project reliance on existing IT infrastructure.

Table 2. The Summary of SPSS Result of the Effectiveness of Non-IT-SIDs

Model Description					
The effectiveness of non-IT-SIDs = $\beta_0 + \beta_1$ (quality of communication informal meeting) + β_2 (project relies on existing IT infrastructure) + β_3 (certainty of profit) + β_4 (learning) + β_5 (management's attitude toward risk)+ μ					
Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.931	.808	.653	5.07		
Analysis of Variance					
Model 1	Sum of Squares	df	Mean Square	F	Sig. of F
Regression	1788.195	5	357.639	13.917	.0000
Residual	950.991	37	25.697		
The Regression Equation and Associated Statistics					
Model	B	Std. Err.	β	t	Sig. t
1. Quality of communications in formal meeting	1.817	.652	.308	2.785	.008
2. Project relies on existing IT infrastructure					
3. Certainty of profit	2.789	.807	.352	3.455	.001
4. Learning					
5. Management's attitude toward risk	3.304	.687	.570	4.806	.000
6. (Constant)	2.217	.820	.300	2.703	.010
	-1.208	.557	-.237	-2.170	.036
	-18.977	6.157		-3.082	.004

Before the implications of these findings are discussed, the procedures for selecting these variables are clarified. The process of variable selection should be viewed as an intensive analysis of the correlation structure of the independent variables and how they individually and jointly affect the dependent variable under study (Chatterjee and Price, 1991). The variables that are not selected from the model should not necessarily be thought unimportant. Possibly, the variables are excluded simply because the regression coefficient is not significant when they enter the regression model in the selection procedure. The present model shows only one set of variables but there may be others.

Discussion and Implications

The analysis presented above has two important themes. One is the notion of the influence of SIDs by their IT content. The second theme is the exploration of critical factors for the success of investment decisions. From a statistical perspective, five factors have been found for each regression model and only one factor, certainty of benefit, has been selected for both models. Our finding suggests that the evaluation of benefit is critical for all SIDs, no matter whether IT is involved or not. Seeking more accurate information of benefits is critical for a better outcome to decisions. However, decision-making in large organizations is a diffuse process involving many players at multiple levels, and because of the strategic nature of the investment project, project evaluation becomes problematic and as a result, it is not easy to measure the benefits (e.g. King, 1975; Mintzberg et al., 1976). Beside the measuring problem, the benefits are also hard to identify, and intangible factors present are likely to significant. *Developing good evaluation measures is therefore an important step towards achieving success in IT/non-IT SIDs.*

For IT SIDs, four distinct factors have been selected in the regression model: competitive position of company, urgency of the decision, importance of IT, and market situation. These four factors associated with certainty of benefit explain approximately 87% ($R^2 = 86.7$) the variance of the effectiveness of IT-SIDs. The first distinct factor is the competitive position of company. Large, competitive firms do actively invest in strategic IT/IS for the express purpose of improving their relative competitive position (Gatian et al., 1995). *It suggests that IT alone will not provide sustainable competitive advantage but the strategic nature of IT is supported by a firm's competitive position.* This confirms that there are different views on the relationship between the adoption of IT and corporate strategic considerations (Sheppard, 1990). For example, 'the vicious circle of IT investment' (Powell, 1993) indicates the problem of alignment of IT and business strategy. The vicious circle may lead to sub-optimal decisions. *Firms*

need to clearly identify their competitive position and develop an IT investment project in a broader business strategic planning perspective. The analysis indicates that management may not be over optimistic in the prediction of any anticipated benefits of the investment project and this should be allowed in the evaluation.

Another important factor identified by the analysis is urgency, which is one of the content-related variables of investment decision. We conclude that strategic IT investment decisions are themselves bounded in time because, in a competitive world, all profitable opportunities are temporary, and the firm must act before the strategic window closes. Similar to our finding, Clemons (1991) indicates that often the strategic programs being undertaken have extremely long lead times. In particular, during the time between making the investment decision and the strategic programme coming on-line, the environment itself may have changed, thereby confounding analysis and adding considerable uncertainty. For example, after the IT investment, it may no longer be what the user wants because the environment has changed during the time of implementation and the original technology is no longer functionally appropriate. Willcocks (1994) also indicates that failure to take into account the timescale of likely benefits is the major problem faced by IT evaluation. In other words, even if all aspects of the system are implemented successfully, timing-related problems may lead to functionality and systemic risks.

The results show that the importance of IT in the whole project is highly (positively) correlated to the effectiveness of investment. This finding may seem very trivial, but it supports one of the important justifications of the current study in that few researchers have previously focused on the continuum nature of decisions according to the IT dimension. IT-SIDs are not 100% IT investments but involve partial IT investment. In this case, we argue the first step in managing IT investment is to know exactly what that investment is (Weill and Olson, 1989). It is necessary for management to clarify the nature of IT-SIDs and if management is aware of the potential impact on SIDs of their IT content, this may very well lead to a better outcome of the investment project.

Identification of the market situation of the company is a significant variable, which reflects the importance of the investment climate for the success of a decision. The negative value of beta indicates that a strong market situation may be harmful to the success of investment projects and they should be evaluated cautiously. On the other hand, a weak market situation will take the complexities of the firm's portfolio of projects into account more seriously, or a project that is likely to enhance the market situation of the company will be given a high priority in the evaluation of investment projects and thus lead to a satisfy outcome.

For non-IT SIDs, four distinct factors are selected by regression model including management's attitude toward risk, quality of communications in formal meeting, learning, project relies on existing IT infrastructure. These four factors associated with certainty of benefit interpret 81% ($R^2 = 80.8$) of total variation in the effectiveness of SIDs explained by the regression model. The organizational internal investment contextual factors, management's attitude toward risk, act as critical factor that will impact on the effectiveness of SIDs. However, the negative value of beta indicates that a stronger attitude toward risk may be harmful to the success of the investment projects. The SID, like Pettigrew's (1973) definition of a non-programmed innovative decision, needs to adopt a change that is new to the organization and to the relevant environment. Our findings suggest that SIDs are too risky to achieve and the treatment of uncertainty is quite difficult. For those innovative management, they need to enhance their capabilities to measure investment risk before any risk adjustment is made. It is necessary to identify the value of measurements and criteria with respect to the investment, and the selection of measurements and criteria vary according to the different objectives of investment projects.

Learning is also identified to be a critical factor for SIDs. This is in line with the suggestion by Butler et al., (1993) that items such as project success, correct choice, unexpected negative outcomes, satisfactory process and overall learning can measure the pure outcome of the investment project. They define effectiveness in terms of objectives-attainment and learning, and suggest that the results of learning lead to future improvements in decision-making. Specifically, similar to Butler et al's finding, we find that organizational learning contributes to the effectiveness of decision-making. Accordingly, management needs to pay careful attention to the monitoring and feedback systems of the organization in order to enhance the mechanisms of the learning organization.

Quality of communications in formal meetings also needs to be considered carefully. Although the political nature of organizational decision-making is widely discussed (e.g. Pettigrew, 1973; Eisenhardt and Zbaracki, 1992; Hickson et al., 1986), from a procedural rationality perspective, process rationality is important for the decision outcome. The decision-maker's investment knowledge, experience and educational levels are closely associated with alienated beliefs and attitudes toward it (Abdul-Gader et al., 1995). Without relevant knowledge and experience, managers cannot discuss the project in depth. Therefore, it is necessary to increase the number of levels of the hierarchy involved, the formal meeting/informal discussion held and the involvement of external organizations. All these efforts would improve quality of communications.

One interesting finding is that non-IT SIDs are not necessarily one hundred percent IT-free investments and could involve partial IT investments. In this case, existing IT infrastructure is still of importance to the effectiveness of non-IT SID. Indeed, compared with other types of investment projects, management knows much less about IT investment projects. In other words, investigation of the impact of IT itself and of existing IT infrastructure on decision-making will extend management's understanding of the nature of SIDs and SITIDs.

To this point, the study has concluded that the effectiveness of strategic investment decisions do need to take into consideration the impact of their IT content. If management is aware of the potential impact on SIDs of their IT content, this may well lead to a better outcome to the investment project. General speaking, those distinct factors for the effectiveness of non-IT SIDs are more likely to be organizational, internal investment context factors. But, for IT SIDs, the distinct factors are more related to the decision content (urgency of the decision, importance of IT) and external factors (competitive position of company, market situation).

Conclusions

With today's rapid technological advancement, the focus of information management has changed from a data processing to information technology. At the same time, the financial emphasis towards IT has changed from cost to investment (Earl 1989). Previous studies of SITIDs have ignored the continuous nature of decisions and the relationships between IT SIDs and the other non-IT SIDs. This therefore blurs the nature of SITIDs.

In order to clarify the potential impact on SIDs of their IT content, a comprehensive list of potential factors for the effectiveness of investment decisions was derived from past research. Two models each with five variables is then presented which clearly explores the critical factors for the effectiveness of IT and non-IT SIDs. Only one factor, certainty of benefit, has been selected for both models and four distinct factors selected for each model. Accordingly, it is necessary to conclude that managing the effectiveness of SITIDs is likely to focus heavily on the IT dimension since the impact of IT on the effectiveness of SIDs is revealed to be significant.

The study adopts a survey approach to the collection of empirical data about the strategic investment decision-making process. The research findings not only broaden our understanding of the practical conduct of investment decisions, but also help to bridge the gap between the understandings of strategic investment decision theory, strategic IT investment decision theory, and real-world practice. Finally, as far as research limitation is concerned, this study is limited by the relatively small sample size in which a larger sample size can be included in future studies for carrying out the model construction of stepwise regression analysis.

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