

Firm Size and Different Behaviors in IT Investment Decisions*

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ABSTRACT

The influencing factors of large-scale IT investment decisions are rarely investigated in an empirical perspective. We find out different behaviors in IT investment decisions according to the size of organization. Large scale IT-investment decisions (e.g. system downsizing) can be the outcome of decision-makers' motivation to adopt and control new IT systems. However, this phenomenon is salient in the large-sized organization rather than small-sized ones. Based on our investigation, we predict general IT decision-making behaviors in organizations when making IT investment decisions.

Keywords: Organizational Investment Decisions, System Downsizing, Firm Size

1. Introduction

With growing complexity of the general business environment, information systems are playing a more central role in organizations. A large volume of batch transactions has turned into distributed, real time transactions with the introduction of ERP and SCM applications. In advance, increasing needs for more flexible and interoperable systems encourage organizations to consider innovation of fundamental IS platforms despite immense investment at the initial stage. This large-scale IS invest-

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ment can be an inevitable strategic necessity because of cut-throat competition. On the other hand, it bears great deal of risk over all the processes of large scale IT projects so that a business may be seriously harmed by the failure of IS projects. The OTR group [30]) reported that 200 of large scale IS projects were 90% of over budget, 60% of over run of time, and 98% of specification changes in. Furthermore, during new system development, legacy applications can be frozen for months (McFarlan [26]) and the technical performance of a new system can be significantly below the estimated level (Willcocks and Margetts [39]). The failure rate of large scale IS projects has even been reported to be up to 85% since the 1980s (Alter [3]). Hence, major IS investment decisions need to be taken in a greatly careful manner.

Rational decision-making is a result of trade-offs between expected benefit and risk; moreover, with the increase of investment, risk aversion behavior is formally assumed in the literature on decision theory (Arrow [5], March [24]). However, the notable trend toward system downsizing in Korea defies the established belief on IS project risk behavior. Hence, we believe that our observation requires a better explanation for risk attitudes associated with large scale IT projects. With the high failure rate of major IS projects, IS research has been focused on the identification of risk factors and success criteria for IS investment. Most of the studies were limited to the assessment of IS risk (Anderson and Narasimhan [4], Willcocks and Margetts [39], Moynihan [29], Schmidt *et al.* [32]) or management of IS risk (Jiang and Klein [20], Adeleye *et al.* [2]). Hence, we failed to find IS studies on underlying ground theories explaining our observation of large-scale IS projects that bears an inherently high level of managerial and operational risks.

We find that one possible theoretical explanation can be given by the studies on risk-taking behaviors from cognitive sciences and psychology. Schwarzer [33] argued that distorted perception of risk can be caused by either the lack of proper estimation of risk or the motivation to undertake risk. Hence, with the high uncertainty of results and difficulties of ex-ante appraisal of IS risk, we speculate on the possibility of biased perception of risk resulting in investment decisions by decision-makers' motivation to take such actions. Therefore, our research objectives include the following:

First, we test the factors explaining IT investment decisions, such as recognition of risk and motivation of taking risk.

Second, we identify the firm size as an important exogenous factors influencing decision-makers' understanding and motivation in system downsizing decisions.

Finally, based on our results, we deliver managerial implications on IS decision-making behaviors for more practical IS management and efficient IS governance structure.

2. Theoretical Background

In the survey conducted in 2004, 45% of Korean companies that are maintaining mainframes replied that they were seriously considering system downsizing (HiTech Information [19]). Now, according to our empirical investigation in 2006, about 20% of companies are keeping mainframes. This number includes the companies that have partially adopted mainframes in the progress of evolutionary system migration. Even in finance sector, which highly values the stability and security of their mission critical systems, nearly 60% of companies already have migrated to Unix or NT platforms. To briefly review the ex-ante appraisal level of project risk in Korea, we asked the companies how much their projects were over-budget or over-run with system downsizing: 67% of companies replied that the projects were 5% to 60% of over-budget, and 62% answered they experienced 5% to 40% over-run. Similar probability of the project management failure with global criterion is observed from the sample of our survey.

Companies should pay direct cost of mis-planned or ill-managed IS projects. Moreover, the delay of an IS project increases the related opportunity costs magnifying associated risk. Hence, we first review the studies on IS project risk to investigate why IS projects are inevitably risky and how the risk-taking decisions on IS projects are addressed in IS studies. Second, we investigate the ground theories on the risk-taking decision model, which presumably can deliver clues to our research question.

2.1 Studies on IS Project

IS project risk means the intrinsic uncertainty of project success and the potential deficiencies from project failure (Schmidt *et al.* [32]). Hence, by definition, IS project risk involves both project management failure (Anderson and Narasimhan [4], Zmud [44], Schmidt *et al.* [32]) and potential risks from new system execution (Davis [9], McFarlan [27]). The former is affected by mainly three project dimensions: project size,

experience with technology, and project structure (McFarlan [27]). As a representative large-scale project, IS platform downsizing to new, untested system bears inherent risk in these three dimensions. Furthermore, even in the execution period, 75% of large scale information systems are reported to be 'operational failures' because of malfunctionality or no system usage (Gibbs [17]).

A potential limitation of IS project risk management lies in the difficulties of risk assessment at the investment appraisal stage. There is no validated information available for IS decision-makers so that various counter-measures can be taken (Schmidt *et al.* [32]). For example, as a way of risk assessment with new IS investment, the TCO (Total Cost of Ownership) framework has been widely adopted. However, this approach is so situation-specific that the costs which are relevant and significant to decision-makers vary by company and even within companies (Ellram [14]). Therefore, benchmarking of previous IS projects does not deliver valuable information to IS decision-makers. On the other hand, some evaluation tools for IS investment (e.g. TCO) exclusively focus on the cost issues so that a solution with richer features or functions usually does not get the attention it deserves (McCready [26]). However, beyond the cost-focused perspective, the most crucial but atypical ability required for an IS investment decision is to recognize the likely long-term consequences by adoption or non-adoption of a new information system (Vitale [35]). These factors bring about inevitable risks in IS investment decisions, hence a number of IS studies identified the IS risk factors (Anderson and Narasimhan [4], Willcocks and Margetts [39], Moynihan [29], Schmidt *et al.* [32]) and developed the success criteria for IS investment (Jiang and Klein [20], Adeleye *et al.* [2]). However, studies have paid limited attention to IS risk management, and they have focused on a methodological approach to the resolution, so they have not delivered any valuable and comprehensive explanation for the ongoing phenomena of risk-taking decisions in the IS area.

2.2 Studies on Firm size and Decision-Making Behavior

Management theory acknowledges that differences exist between small businesses and large businesses. Firm size is thought to be a useful and manageable approximation of firm resources which are held to affect firm's decision making behavior. Furthermore, firm size provides a simple criterion for segmenting firms into groups showing a similar risk-taking behavior, hence many researchers have in-

cluded firm size as an independent variable in their empirical studies. DeLone [47] argues that firms of different sizes manage their computer operations differently. Demsetz and Strahan's study [12] shows that large bank holding companies (BHCs) are better diversified than small BHCs based on market measures of diversification.

Small and large firms have different advantages and limitations. Small firms implement decisions more quickly, but they must deal with a shortage of management personnel, with personnel recruitment disadvantages, with financial limitations, and with insufficient external and internal information (DeLone [47]). In this context, it is reported that firm size was directly related to the time interval required for IT investment, but inversely related to the relative level of expenditures on computer equipment and inversely related to the involvement of top management in IT investment (Whisler [38]). Therefore, we expect the risk-taking behavior in large scale IT investment may vary according to firm size.

3. Research Model and Hypotheses

3.1 Research Model and Hypothesis

We developed our research model as in Figure 2.

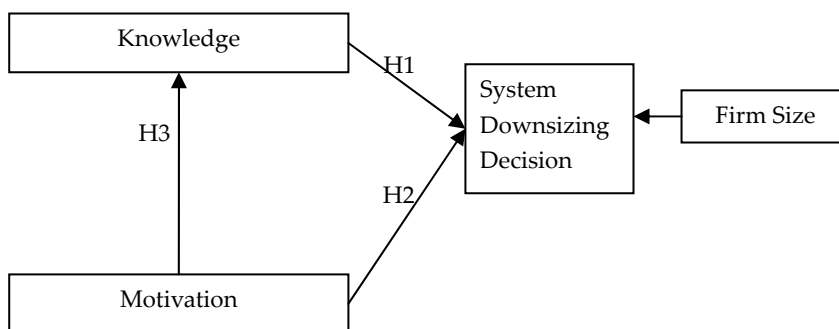


Figure 2. Research Model

Basically, we investigated the influence of two main factors, 'knowledge' on the related risk and 'motivation' of taking related risk, on the organization's large-scale IT investment decisions (e.g. system downsizing). Furthermore, we compare the re-

sults of two groups, small and large businesses, to examine how the size of firm affects on the managerial decision-makings of IT investment.

3.2 Determinants of System-Downsizing Decisions

We hypothesize the central role of a decision-maker's recognition and motivation on the related risk in his/her final decision-making. The negative relation between knowledge and risk-taking decisions (e.g. system downsizing decisions) is traditionally argued in a theoretical vein (Kahneman and Tversky [21]) and the positive effect of risk-taking motivation on the risk-taking decision is also supported by other empirical studies (MacCrimmon and Wehrung [23]).

H1: A higher level of knowledge on the related risks of system downsizing will negatively affect the likelihood of a system downsizing decision.

H2: A higher level of motivation to take the related risk of system downsizing will positively affect the likelihood of a system downsizing decision.

3.3 'Motivation' as an Antecedent of 'Knowledge'

Motivation is defined as a decision-maker's willingness to take a certain action (MacCrimmon and Wehrung [23]). By making risky decisions, decision-makers could expect to drive sensational and innovative outcomes in their organizations, hence risk-seeking decision-makers overestimate the positive side of decision results and underestimate negative returns. This underestimated likelihood of experiencing negative results - in other words, optimistic bias-sometimes induces a distorted recognition of the risks (Schwarzer [33]). Hence, an IS decision-maker who chases innovative changes through system downsizing would be more willing to take the risk because his motivation causes biased understanding toward successful results overlooking underlying risks.

H3: A higher level of motivation to take the related risk of system downsizing will negatively affect decision-maker's knowledge on the related risk.

In the following table, we demonstrate the operational definitions of constructs.

Table1. Operational Definition of Constructs

Construct	Operational Definition	Literature
Knowledge	The IS decision-maker's understanding of risk associated with system downsizing	corbit <i>et al.</i> [46]
Motivation	The IS decision-maker's motivation to take risk associated with system downsizing	MacCrimmon and Wehrung [23]
System Downsizing Decision	The degree of system downsizing in the organization (the first time that phased out downsizing is adopted)	Dedrick and West [11]

4. Research Methodology

4.1 Measurement

We operationalized most constructs in our research model using the items from past research. Survey questionnaires on 'knowledge' are adapted from the IS-adoption literature. 'Motivation' related items are adapted from organizational studies on risk-taking decisions. We used a seven-point Likert type scale, where 1 indicates that the respondent "strongly disagrees" and 7 indicates that the respondent "strongly agrees." The measurements are provided in Appendix A.

In our pilot study, the Cronba alpha values ranged from 0.87 (for Motivation) to 0.89 (for System Downsizing Decision) hence, established reliability or internal consistency of our measurement model.

4.2 Data Collection

Because system downsizing is an organizational decision, we took each organization as our unit of analysis, and measure knowledge and motivation of representative IS decision-makers in organizations. As a pilot study, we collected 50 responses. For the main survey, we collected 80 responses. As a measure of dependent variable, we asked about the degree of system downsizing from legacy to new platforms. System downsizing can be a process involving multiple stages over several projects. In our responses, 52 percent of the organizations adopted phased-out downsizing. In this case, for a precise measure of the influences of explanatory variables on the depend-

ent variable, we requested the respondents to limit their answers to the first occurrence of system downsizing in their organization. The initial decision of downsizing is the most meaningful in the organization, and forthcoming downsizing projects are potentially announced at that time. Therefore, in case that current IS decision-maker is not the one who made the first downsizing decision, we cannot collect data from that company.

All the respondents are top IS managers (63%) or CIOs (37%) who made the initial downsizing decision in their organizations. 70 percent of the respondents have over 10 years of IS management experience. Among the 80 organizations, now only 23 of them keep mainframes as part of IS platform. However there is no company that has never adopted an open system at all. The profiles of respondents are given in Table 2.

Table 2. Profiles of Respondents

Position	# of Res.	IS Experience (Y)	# of Res.	Non-IS Experience (Y)	# of Res.	Unix/NT Experience (Y) ¹	# of Corp	
							Full Downsizing	Partial Downsizing
CIO	30	0~5	6	0~5	68	0~5	48	22
		6~10	23	6~10	10	6~10	10	1
Top IS Manager	50	11~15	23	11~15	2	11~15	2	0
		>15	28	>15	0	>15	0	0
Mean	N/A	Mean	13.25	Mean	2.11	Mean	1,71	0.39
S.D	N/A	S.D	5.59	S.D	3.55	S.D	3.69	1.87

5. Results

5.1 Analysis

We used PLS-Graph ver 3.0 to test our structural equation model because it provides both reliability and validity tests for our measurements, and estimates the relationship among constructs (Wold [40]). We first conducted the confirmatory factor analysis to test our measurement model and then examined our structural equation model for hypothesis test. For the validation of our measurement model, we first

¹ Decision-makers' experience on Unix/NT systems before system downsizing.

checked out convergent validity by examining composite reliability and the average variance of measures. The result was demonstrated in Table 3.

Table 3. Results of Confirmatory Factor Analysis

Measures	Items	Composite Reliability	AVE (Average Variance Extracted)
Knowledge (KNO)	4	0.875	0.640
Motivation (MOT)	4	0.945	0.810
System Downsizing Decision (SDD)	3	0.983	0.951

The composite reliability can be interpreted as Cronba's alpha and, in our model, it is higher than 0.875, which satisfies the recommended value for a reliable construct, 0.7 (Fornell and Larcker [16]). All the AVE values range from 0.640 to 0.951, which also meets the acceptable value, 0.5 (Fornell and Larcker [16]) and implies that the variance is explained mostly by the constructs.

Next, for the discriminant validity test, we investigated the square root of the AVE (Fornell and Larcker [16]). Discriminant validity implies how well the measures of one construct are loaded for it so that it can be discriminated from others. Table 4 shows that the variance between a construct and its own measures are higher than with other measures, and higher than the acceptance level, 0.5, as well (Fornell and Larcker [16]).

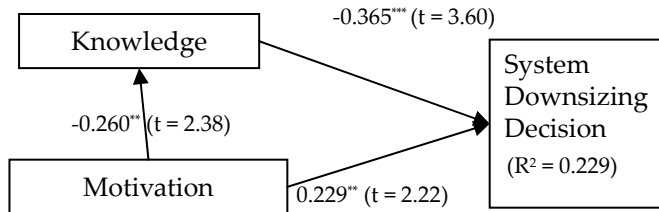
Table 4. Correlation between Constructs

	KNO	MOT	SDD
KNO	0.800		
MOT	-0.141	0.900	
SDD	0.223	0.223	0.965

Note) The numbers in diagonal row are square root of the average variance extracted.

5.2 Hypothesis Test

First, we checked the t-statistics for the standardized path coefficients and calculated p values based on a two-tail test with significant levels of 0.1, 0.05, 0.01 for the full sample of organizations.

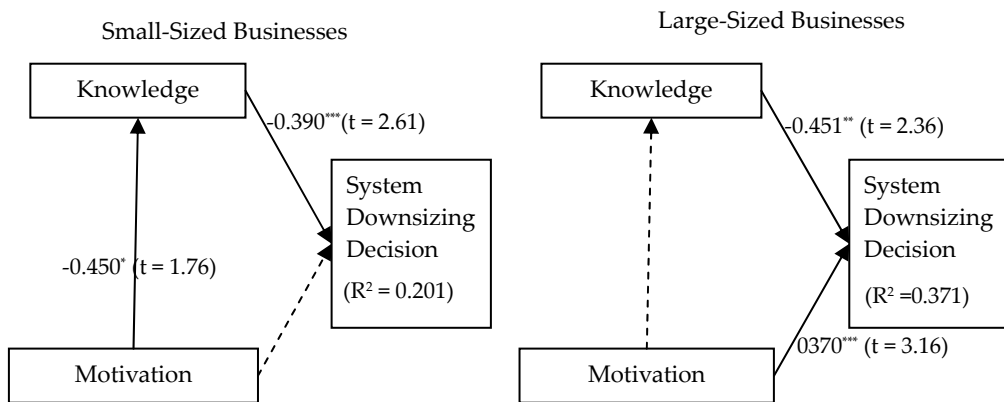


Note) * $P \leq 0.1$, ** $P \leq 0.05$, *** $P \leq 0.01$.

Figure 3. Results of the Structural Equation Model (Full Sample)

The dominant effect of knowledge is significantly captured (H1) in our analysis. Moreover, our model shows not only the direct effect of motivation on the decision-making (H2) but also the indirect effect via recognition (knowledge) on the final decision (H3).

However, after controlling the size of organization, we can observe quite different behaviors in the IT investment decisions. For this sub group analysis, we adopted the number of staff as a proxy of firm size. The criterion for dividing two groups is the staff number of 1000. Among our 80 samples, 41 organizations were classified to small businesses and 39 ones belonged to large businesses.



Note) * $P \leq 0.1$, ** $P \leq 0.05$, *** $P \leq 0.01$.

Figure 3. Results of the Structural Equation Model (Full Sample)

The direct effect of knowledge is observed explicitly by large organizations in term of staff size. However, small businesses do not show significant direct effect of

motivation on their system downsizing decision. To the contrary, the effect of knowledge is more salient in small businesses than in large businesses. Therefore our results show that, regarding large scale IT investment, the effect of motivation is salient in the decisions of large size organizations while the small businesses show more risk-averse behaviors. The results are attributed to the organizations' control system on the IT investment and related resources and capabilities. The larger organizational resources for IT investment, the IT decision makers' decision making behaviors bear more propensity of risk-taking.

6. Discussion

The aim of this study is to investigate how the decision of system downsizing is made from in organizations, which has not been tested empirically to the best of our knowledge. In our survey, we specified the IS decision to downsize an enterprise IS platform because it is a representative large-scale IS project, and it is easily observed because of its recent popularity in Korea. Furthermore, focusing on one representative project, we controlled different characteristics of various IS projects so that it was quite useful for precise measurement of data.

First, we find out that there exists biased recognition of related risk by significant effect of motivation. Each IS decision-maker's individual motivation to take risks significantly affects final decisions. Moreover, we identify the positive effect of motivation is more salient in large-sized organizations while the negative effect of knowledge level is more explicit in small-sized organizations. With the prevalent atmosphere of chasing organization innovation through IT investment and related resource capability, the IT decision-makers in small-sized firm have more aggressive and proactive motivation on taking the IT-investments.

7. Conclusion and Implications

In this paper, based on system downsizing practice, we examined how the IT investment decisions are made. Consistent with their main argument, we found out that an

IS decision-maker's motivation plays an important role in large-scale IT investment decisions. There are so many intervening variables that should be considered to compare the outcomes of IS decision options. Using TCO to compare different vendors, platforms or applications is down-right impossible (Greenbaum [18]). Our results show that a decision-maker's risk propensity also plays an important role with a lack of objective appraisals among alternatives.

The contribution of our study can be summarized in two parts. First, from the academic perspective, we made a comprehensive empirical test of IT investment decisions targeting the actual decision-makers in the IS domain. From prior studies, we observed that a higher degree of the generalization of results could be obtained by taking general students or general administrators as subjects, and by asking general questions unrelated to actual managerial decisions. Moreover, to the best of our knowledge, we cannot find other empirical studies testing investment decision models, especially in the IS domain. Second, from a managerial perspective, our study provides helpful implications of the IS governance tradition in our sample organization. The results show that decisions are significantly affected not only by the objective knowledge of decision makers but also by their motivation. Therefore, we recommend that a more balanced governance structure and serious ex-post evaluation of IS investments should be implemented considering economic and managerial viewpoints.

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Appendix A. Questionnaire Items

All the items are focused on the system downsizing decision and limited to the time when first adoption of system downsizing is taken.

Construct	Measurement	Literature
Knowledge	System downsizing is risky in that (1) it can causes unexpected cost during the IS downsizing project or IS management period. (2) it can deliver low system performance for meeting our business needs. (3) we have little in-house expertise on the new IS platform. (4) we don't have sufficient resources for downsizing (e.g. infra, human-resource and technology).	Corbit <i>et al.</i> [46]
Motivation	When I make a system downsizing decision (1) I have a propensity to take associated risk. (2) I have a positive view of risk-taking decision. (3) I feel it is necessary to take risk for successful results. (4) I want to choose the option that seems to bring about sensational outcomes.	MacCrimmon And Wehrung [23]
System Downsizing Decision	In organizational IS, (1) The ratio of IS applications migrated to Unix/NT systems (2) The ratio of mission critical IS applications migrated to Unix/NT systems (3) The ratio of IS transactions migrated to Unix/NT systems	Dedrick and West [11] (1.0~15%~7.91~100%)