December 2004

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Abstract

The business value of IT has been the focus of the academic and practical field in recent years, along with the massive IT investment. Unfortunately, those studies have not been able to demonstrate the strong alignment between the IT investment and performance. The impact of IT investment on performance is an important research topic that needs to consider the role of key contextual factors and intermediate factors. This study develops an integrated model for IT investment, with the mediating effect of production/coordination performance towards firm performance. In addition, the model is moderated by some factors like ISP (information Systems Planning), business planning alignment, top management support, IT education and training, and process innovation. The empirical result, based on the moderating regression analysis, indicates that the relationship between IT investment and production/coordination performance is significantly related depending on moderating factors. However, production/coordination performance is partially related to firm performance.

Keywords: IT investment, performance measurement, production, coordination, IT deployment

1. Introduction

Increased uncertainty and rapid technology development generate challenge to firm organizations. The turbulent environment provides a technological ripe for various types of information technologies (IT) among participants in these organizations. Given the strategic significance of IT, many organizations are adopting a new class of IT to support organizational needs for fundamental change.

However, a high percentage of organizations that have invested IT as a firm strategy have not achieved their objectives and are having a growing sense of disenchantment about its practicality. This dilemma somewhat relates to inappropriate measurement of its performance. The real contribution of IT investment should be examined to improve firm competitive advantage or organizational performance. Therefore, it is necessary to establish a systematic model to measure performance for the effect of IT investment.

In measuring direct relationship of IT adoption to its performance in the early stage, arguments have remained resulting in opposite idea (Cron & Sobol, 1983). The understanding of intermediate variables becomes necessary to be considered between IT and organizational performance (Barua et al., 1995). However, the problem related to IT investment still remains without intangible activity. The adoption of IT itself doesn't guarantee successful implementation. They need to focus on IT deployment as well as IT itself.

This study is an empirical study of Korean manufacturing firms which have adopted various

types of IT. The research question that guides this study is to figure out integrated performance model for the effect of IT investment: Should any first-order effects in operational level be considered and any intermediate variables to be controlled for precise performance measurement influenced by IT investment? Current studies have shown direct relations or merely investigated several factors to be controlled without any systematic organization of those factors. Beyond the direct evaluation of IT investment on financial performance, this study takes an approach toward the integration of mediating and moderating models, further developing current studies. The research finding, therefore, shows the intrinsic justification of IT investment under various organizational conditions with IT deployment and operational outcome as intermediates.

2. Literature Review

2.1 IT investment and performance

The impact of IT has been the focus of considerable academic attention in recent years. Various models and approaches have been presented in an attempt to address shortcomings of previous research. In the very early stage of those studies has emerged Direct effect model, which indicates a direct link between IS and some measure of performance (Newman & Kozar, 1994; Bender, 1986). An enhanced model using the concept of 'effectiveness' is developed, focusing on the indirect effect of IT by mediating factors (Shin, 1998; Barua et al., 1995; Weill, 1992). Mediating effect model includes complicated factors for indirect influence on IT investment (Desmaris et al., 1997; Bharadwaj et al., 1995). A notion of effectiveness is more embellished by adding other variables to be controlled. IT effectiveness like environment change, CEO/CIO support and firm strategy should be an important variable controlled in the relationship between IT investment and organizational performance in this model (Li & Ye, 1999; Grover et al., 1998; Chan & Huff, 1997; Weil, 1992). IT value is discussed meaningfully in the context of the organization's goals, strategies, culture and environment (Chan et al., 1997; Schein, 1996). Research at the firm-level has demonstrated that IT investment has significant effect on productivity levels, productivity growth, and stock market value of firms (Hitt et al., 2002; Kudyba & Dewan, 2002; Hu & Plant, 2001; Brynjolfsson and Hitt, 2000; Mukhopadhyay et al., 1997).

2.2 IT Deployment

Raymond and Pare (1992) states the importance of an IT deployment issue, while most of related research engage in usage. Along with the higher IT level, IT deployment issue for indirect relationship should be reinforced in terms of contingency approach (Sabherwal & Kirs, 1994; Chan et al., 1997). Some of factors can be CEO support (Sanders & Courtney, 1985), education/training (Mitra & Chaya, 1996; Sircal et al., 2000), alignment of IS and business planning (Mitra & Chaya, 1996; Teo & King, 1996), process innovation (Davenport, 1993; Johannessen et al., 1999).

2.3 Efficiency and Effectiveness on Production and Coordination

The concept of efficiency and effectiveness is important to understand management conversion process on organizational performance. Kim et al. (1999) defines efficiency as the capability to minimize the resource usage and effectiveness as the ability to meet an appropriate goal. Those issues can be placed in production and coordination area to measure performance. Malone and Smith (1984) characterize organizational technology as production and coordination; production as product related activity, and coordination as management of dependencies and flow of physical and information resources. Mitra and Chay (1996) analyze the essential investment on IT leading to the reduction of production/coordination cost as

well as total expense in terms of cost effectiveness. The reduction of coordination cost, production increase and successful innovation enabled by IT investment improves firm performance including forecasting, ease of control, ease of communication, idea creation and active communication (Johannessen et al., 1999; Shin, 1999; Sohal et al., 2001).

3. Research Design

3.1 Research Model

Beyond the simplification of the direct relationship between IT investment and firm performance, this study investigates production and coordination performance for first-order effects, which in turn affects financial performance, ROI or net income, ultimately. The research model also includes intermediate variables like IT deployment activities, observing intangible IT investment as well as tangible investment. Identifying IT deployment activities as conversion variables, we study the effect of IT investment controlled by them; the alignment between IS planning and business planning, CEO support, education/training, process innovation.

3.2 Research Hypothesis

3.2.1 IT investment, Production Efficiency and Effectiveness

Based on previous research, IT investment has meaningful impact on performance. Mitra and Chaya (1996) studies that IT investment reduces production cost, when production is identified as activity related to products. IT adoption, on the other hand, increases production efficiency in process integration and the reduction of product development cycle as well as production effectiveness in strategic factors like enhanced information flow and consumer knowledge (Bryjolfsson and Hitt, 1993). Thus, the first hypothesis of this study is that the level of IT investment influences production efficiency and effectiveness.

H1: The Higher level of the IT investment leads to increased efficiency and effectiveness on production

3.2.2 IT investment, Coordination Efficiency and Effectiveness

Many studies have been conducted for the impact of IT to increase performance in decision-making, planning, forecasting and communication, which in turn enables the reduction of coordination cost (Crawford, 1982; Shin, 1999). Coordination can be identified as a series of information processing in the integration of inter-organizational or intra-organizational economic activities (Shin, 1999). IT also increases quality of information process affecting the nature of decision making. Therefore, the IT investment may increase the coordination efficiency and effectiveness.

H2: The IT investment will increase efficiency and effectiveness coordination.

3.2.3 IT investment, Production Efficiency, Effectiveness and Moderate Variables; Alignment between IS Planning and Business Strategy, CEO Support, Education/Training and Process Innovation

A series of hypotheses will be discussed by adding some useful control variables. According to previous research settings, one of the principal factors through which IT investment can be controlled is the link between IS planning and business planning (Teo & King, 1996). IT shows essential impact on the reduction of production cost, when there is an appropriate fit between them (Chaya, 1996). The second variable to be controlled is CEO support. Organizational factors as well as technological induce the IS implementational success

(Sander & Courtney, 1985). Bruwer (1984) also denotes top decision-makers' support as one of critical success factors for information systems. Accumulated are empirical studies about participating and training for IS success (Bruwer, 1984). In order for user attitude to be favorably changed, education should be reinforced. The integrated synergy level of IT and business process positively influence on business performance (Davenport, 1993). The higher level of process innovation by IT affects more intensified performance. Johannessen et al. (1999) shows two-phased relationship for the strategic use of IT leading to product, service, process innovation, which in turn increases performance.

H3.1 The higher level of IT investment leads to increased efficiency and effectiveness on production mediated by the alignment between IS planning and business strategy.
H3.2 The higher level of IT investment leads to increased efficiency and effectiveness on production moderated by CEO support.
H3.3 The higher level of IT investment leads to efficiency and effectiveness on production moderated by education and training.
H3.4 The higher level of IT investment leads to efficiency and effectives on production moderated by process innovation.

3.2.4 IT investment, Coordination Efficiency, Effectiveness and Moderate Variables; alignment between IS planning and Business Strategy, CEO support, Education/Training and Process Innovation

In addition to the topic of production efficiency and effectiveness, the relational issue between IT investment and coordination performance can be considered (Crawford, 1982; Shin, 1999). Previously defined is Coordination as a series of information processing in the integration of economic activities. Same constructs - the alignment between ISP and BP, CEO support, education/training and process innovation – will be included to control the relationship between IT investment and coordination efficiency and effectiveness (Bruwer, 1984; Sander and Courtney, 1985; Teo & King, 1996).

H4.1 The higher level of IT investment leads to increased efficiency and effectiveness on coordination moderated by the alignment between IS planning and business strategy
H4.2 The higher level of IT investment leads to increased efficiency and effectiveness on coordination moderated by CEO support.
H4.3 The higher level of IT investment leads to efficiency and effectiveness on coordination moderated by education and training.
H4.4 The higher level of IT investment leads to efficiency and effectiveness on coordination moderated by process innovation.

3.2.5 Production Efficiency / Effectiveness, Coordination Efficiency / Effectiveness, Performance

Finally, production/coordination performance can be expected to directly influence firm performance. Along with the hypothesis 1, the IT investment leads to the reduction of production cycle, coordination cost, manufacturing time as well as acquisition of consumer knowledge, which in turn increases the firm performance such as productivity and competitiveness (Shin, 1999; Sohal et al., 2001).

H5 The higher level of production/coordination efficiency and effectiveness leads to increased firm performance.

3.3 Conceptualization/Operationalization of Variables and Indicators

The conceptualization and operationalization of the variables are achieved by selecting from studies previously employed in research settings (Sircar et al., 2000; Mahmood & Mann, 1993; Teo & King, 1996; Mitra & Chaya, 1996; Sanders & Jones, 1992; Shin, 1999; Delone & Mclean, 1992; Mahmood & Mann, 1991; Davenport, 1993). We adopt the measures as long as they satisfy acceptable measurement quality. Table 1 and Table 2 shows conceptualization of each construct and examples of the specific indicators to calibrate. The operationalization of variables is not shown in this paper due to the limited space.

Table 1: Conceptualization of Constructs and Measurement Indicators

Variables	Conceptualization of Variables	Indicators
IT investment	Total investment per year in IT field	No. of computers per person IS expense per person Total no. of persons in IS related departments
Alignment between ISP & BP	Alignment through adjustment between the planning and implementation of business and IS	Level of CEO devotion to strategic IT usage Level of business planning exposed to IS management Level of firm goal affected to IS dept. DM
CEO Support	Level of CEO support for IS	CEO's level of IS priority Level of economic support in IS planning and implementation Level of risk-taking in IS planning and implementation
Education/ Training	A series of process to improve knowledge function and attitude for IS implementation	IT Education time and expense per person Education expense/gross income
Process Innovation	Fundamental process reengineering with IT	Level of process simplification Level of process time reduction by IT Level of understanding total process Level of process integration by IT

It is information technology which enhances the degree of information quality to manage information in effective way. Information technology is narrowly defined as the subsystems of IS, which primarily focuses on technological aspects of information systems such as computer hardware, database, software, network (Turban et al., 1996). In the broad term, information technology is considered as a synonym of information systems, which covers a series of various technology to manage information for the acquirement, storage, process, search and transfer of information (Senn, 1995). Included are IT for areas ranging from utilization and creation of information, supporting decisions, managing and integrating firm resources as well as customer relations, managing data in firm database, networking computer systems in/between organizations, and designing/manufacturing guided by computers (Sohal et al., 2001; Johannessen et al., 1999; Schutzer, 1994). We take the broad definition of information technology in this study, using number of computers, the acquired level of IS human resources and expenses for firm infrastructure as variables for IT investment.

Table 2 : Conceptualization of Constructs and Measurement Indicators

Variables	Conceptualization of Variables	Indicators
Production Efficiency	Level of increase in the rate of input and output in products and services	Level of production cost reduction (labor, materials, manufacturing cost) by IT Level of product development time reduction by IT Level of manufacture time reduction by IT
Production Effectiveness	Effectiveness resulting from products and services	Level of product selection by IT Level of product fit to consumer needs Level of improvement of product quality/function/design by IT
Coordination Efficiency	Level of increase in the rate of input and output in information processing to inter-departmentally or inter-organizationally integrate a series of economic activity	Level of monitoring cost reduction by IT Level of decision-making cost like information process cost by IT Level of information search cost by IT Level of inventory cost by IT Level of contract cost by IT
Coordination Effectiveness	Effectiveness resulting from information processing to inter-departmental or inter-organizationally integrate a series of economic activity	Level of decision-making quality by IT Level of planning ability by IT Level of prediction ability by IT Level of communication improvement Level of improvement in coordination control by IT
Ave. growth rate of Income	Average growth rate of income for three years (AGRI)	Net income increase = (current sale – preceding sale)/preceding sale*100
ROI	Return on Investment	Net income/gross income* gross income/total asset

4. Methodology

4.1. Data Collection

Respondents of the survey are IS managers from middle-sized manufacturing firms registered in the public stock market in 2001. The empirical evidence for this study comes from a random, stratified sample of over 200 out of 630 manufacturing firms and results in 57 useful responses for a 28.5% of respondent rate. Collectively referred to as the information technologies in this study are ERP, intranet/internet, DW/DBMS and CRM in each firm, taking the definition of IT mentioned in 3.3.

4.2. Reliability

Reliability test for each of the constructs is performed to assess the internal consistency of scale items. As shown in Table 3, Cronbach's alphas ranging from 0.79 to 0.91 meet Nunnally's (1978) rule-of-thumb threshold, which is significantly higher than the acceptable level of 0.6. Therefore, the instrument appears to have adequate reliability. No construct was adjusted or removed in the process, confidently assuming that literature review for the selection of constructs was exhaustively conducted.

Table 3: Reliability Estimates

Construct	Scales	Cronbach's alpha
CEO support	3	.9070
IS planning & BP	3	.7963
Education/Training	2	.8463
Process Innovation	6	.8630
Production Efficiency	3	.8534
Production Effectiveness	3	.8439
Coordination Efficiency	6	.7969
Coordination Effectiveness	6	.8991

4.3. Validity

The data was examined using principal components analysis as the extraction technique and varimax as a method of rotation. With six consecutive rotation, four factors with factor loadings greater than 0.6, mostly 0.8, emerged. This verifies convergent validity based on factor scores to keep independency between factors. These factors were interpreted as alignment between information systems planning and business planning, CEO support, education/training and process innovation. Table 4 presents the measure correlation matrix that tests whether it correlates more highly with an item of another variable than with items of its own theoretical variable. An examination of the matrix in Table 5 reveals zero violations of the condition for discriminant validity. Same procedure has been done for mediating variables, not shown in this paper due to the limited space.

Table 4: Discriminant Validity Analysis for moderate variables

	CS	ET	PI	AIB
CEO Support (CS)	.892			
Education/Training (ET)	.215	.921		
Process Innovation (PI)	.041	.374	.856	
Alignment between ISP & BP (AIB)	.347	.173	.347	.902

Table 5: Regression Coefficient of Constructs

Independent Variable	Dependent Variable	Regression Coefficient	R^2
IT investment	Production Performance	**.**722***	.621
IT investment	Coordination Performance	**.**636***	.404

*; p≤ 0.1, **; p≤ 0.05, ***; p≤ 0.01

5. Results

The empirical analysis of the model is performed with a regression analysis. Regression analysis is an appropriate method for specifying and predicting hypothesized correlations among a set of substantively meaningful variables. Special attention is paid on moderate variables affecting interdependency among variables.

The test of hypotheses provides significant support for the research model. Results of the analysis are found in Table 6 for H1, H2, H3.1, H3.2, H3.3, H3.4 and H4.1, H4.2, H4.3, H4.4, and Table 7 for H5. Nine of the eleven hypothesized relationships are statistically significant; no significance in H4.1 and H4.4. To summarize the empirical results, we find evidence that IT investment has a significant impact on production and coordination performance (H1, H2). By adding some moderating factors, more explanatory power applies; the higher level of IT

investment leads to increased efficiency and effectiveness on production moderated by the alignment between IS planning and business strategy (H3.1), CEO support (H3.2), education/training (H3.3) and process innovation (H3.4). Also, the higher level of IT investment leads to increased efficiency and effectiveness on coordination moderated by the CEO support (H4.2) and education/ training (H4.3). However, the interaction effect between IT investment and the alignment between ISP & BP (H4.1) and process innovation (H4.4) on coordination performance doesn't exist. In the link with firm performance, positive relationship exists between production/coordination performance and average growth rate of income for three years, while no significant relationship exists between production/coordination performance and ROI. This can be interpreted that the long-term effects from the IT investment satisfies to three year firm plan, but doesn't show quick positive feedback for short-term ROI (H5).

Table 6: Regression Coefficient with Moderate Variables

Independent Variable	Dependent Variable	Regression Coefficient	Adj. R^2
IT investment IT investment x ISP & BP	Production performance	.430*** .360**	.660
IT investment IT investment x CEO support	Production performance	.368** .420**	.666
IT investment IT inv. x Education/Training	Production performance	.666*** .276**	.667
IT investment IT inv. x Process Innovation	Production performance	.485*** .295*	.630
IT investment IT investment x ISP & BP	Coordination performance	.48 6*** .186	.324
IT investment IT investment x CEO support	Coordination performance	.326* .367*	.422
IT investment IT inv. x Education/Training	Coordination performance	.466** .317***	.462
IT investment IT inv. x Process Innovation	Coordination performance	.722** .722	.393

Table 7: Regression Analysis for production/coordination & firm performance

Independent variable	Dependent variable	Regression Coefficient	R^2
Production performance	Ave. growth rate of income for 3yrs(AGRI)	.523***	.274
Production performance	ROI	-0.082	.007
Coordination performance	Ave. growth rate of income for 3yrs(AGRI)	.461***	.213
Coordination performance	ROI	-.123	.016

*; p≤ 0.1, **; p≤ 0.05, ***; p≤ 0.01

6. Discussion and Conclusion

The business value of IT has been the focus of the academic and practical field in recent years, along with the massive IT investment. Unfortunately, those studies have not been able to demonstrate the strong alignment between the IT investment and performance. The impact of

IT investment on performance is an important research topic that needs to consider the role of key contextual factors and intermediate factors. This study develops an integrated model for IT investment toward firm performance. The empirical result, based on the regression analysis, indicates that the relationship between IT investment and firm performance is respectively related each other with the first order effect of production/coordination performance. Furthermore, some factors like the alignment between IS planning and business planning, CEO management support, IT education and training, and process innovation influence the relationship between IT investment and production/coordination performance.

This study shows managerial implications in IT-initiated firms to measure inclusive effects of their IT investment. First of all, IT investment enhances production efficiency and effectiveness, which in turn affects firm performance. Expected is the increase of growth rate of return through the reduction of production cost and product development time as well as improvement of product quality to meet customer needs enabled by IT investment. Second, IT investment leads to coordination efficiency and effectiveness, which in turn influences firm performance. Information technology affects the physical flow of human capital and various operational activities as well as the management of information, which in turn increases firm performance. This is supported by Crawford (1982) that IT investment enables the reduction of coordination cost by developing active communication both inter-departmentally and inter-organizationally. Third, production/coordination performance resulting from IT investment partially relates to financial performance of firms. The positive relationship between production/coordination performance and firms' long-term performance, such as three year growth rate of income, shows efficiency and effectiveness caused by IT in the long run. On the contrary, the short-term ROI doesn't quite relate to production /coordination performance, which we consider cost increase by IT investment may not be offset in short period of time. Fourth, IT investment enhances production and coordination performance by managing IT deployment. Factors for IT deployment can be CEO support, education/training, alignment between business strategy and information system planning and process innovation. Practitioners should pursue IT deployment to see performance by IT. The expected performance caused by IT investment under well-developed IT deployment situation leads to another IT investment in the next stage.

From a practitioner perspective, our major contribution is showing that, despite the potentially high cost, the average IT implementation is a productive investment with a proper IT deployment plan. These results may aid the overall decision process, regarding adoption and also help set expectations as to what stages in IT investment the benefits are likely to become measurable. We show that just investing in IT is not enough to have a significant impact on firm performance or productivity. Managers must first decide how to deploy IT and then decide where the IT investments should be directed. IT investment aimed at enhancing operational efficiency and effectiveness has a strong positive effect on profitability and productivity of the firms. Finally, whereas the design of our study is to analyze results at the firm level, similar approaches can be employed within firms to compare the relative performance of different installations or perform before and after comparisons

One of the limitations lies in the number of sample, which seems to cause weak explanation of some relationships in regression analysis. Access to middle-sized manufacturing firms in Korea tends to be hard in evoking information. Further research is required with larger sample size, which can show more explanatory values. Recommended is the study involving in long-term periods. The time factor for the evaluation of IT performance is important, since the influence of IT usually doesn't emerge in short term base. Further research is necessary

with appropriate time factor.

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