# RELATIONSHIPS OF IT INVESTMENT STRATEGY AND IT INFRASTRUCTURE WITH BUSINESS PERFORMANCE

Robert Yeh
Department of Management Information Systems, National Chung Cheng University
James J. Jiang
Department of Management Information Systems, University of Central Florida
Houn-Gee Chen
Institute of Technology Management, National Tsing-Hua University
Gary Klein
College of Business and Administration, University of Colorado at Colorado Springs

## ABSTRACT

The relationship between Information technology (IT) investment and business performance has long been the subject of debate by academics and practitioners . Despite the fact that firms nowadays have made substantial investments in information technology, studies in IT investment have often found little persuasive evidence that IT investment created strong leverage on the value of the firm. Although capabilities of IT infrastructure services are one of the most critical issues facing IS managers, previous studies with a focus on IT infrastructure services is very limited. We attempt to explore the links between various IT infrastructure service investment strategies, a firm's IT infrastructure services, and business performance. The result shows that organizations taking IT flexibility strategy strongly respond to having a larger, more capable IT infrastructure while those with utility IT investment strategy have a negative relationship with their IT infrastructure services provided. There is a positive relationship between organizational IT infrastructure services capability and business performance. The existence of a non-significant relationship between IT investment and business performance reveals that increasing IT investments without enhancing IT infrastructure services capability might be responsible for the negative results in business performance despite increased IT expenditure.

Keywords: IT Investment Strategy, IT Infrastructure Services, Business Performance

# INTRODUCTION

Information technology (IT) investment in the U.S. reaches into the hundreds of billions dollars per year with the expectation of positive financial impact. In large organizations, the Chief Information Officer (CIO) is usually responsible for these investment decisions. In spite of the importance of the decisions, more than 60% of these CIOs use "gut instinct" as a decision system (Marion, 1992). Due to the importance of the decisions, researchers and information technology professionals argue that IT investment is an organization's key to competitive advantage and should be aligned to the organizational strategy (Laudon and Turner, 1989; McFarlan, 1984).

The alignment of IT infrastructure to business plans is considered to be critical in achieving success (Duncan, 1995; Henderson and Venkatraman, 1993). Weill and Broadbent (1998) describe IT strategies of alignment ranging from a focus on cost savings to one of providing flexibility. They, and others, portray IT infrastructure as a portfolio of services that enable present and future business endeavors (Earl, 1989; Markus and Soh, 1993; Niederman, Brancheau and Whetherbe, 1991; Weill, 1993; Weill and Broadbent, 1998). This view raises two crucial questions: Will an organization taking flexibility as their IT investment strategy provide more in their portfolio of IT infrastructure services than an organization taking a cost based IT investment strategy? Will the subsequent IT infrastructure services provided by an organization be related to their business performance?

Although capabilities of IT infrastructure services is one of the most critical issues facing IS executives and managers, previous studies with a focus on IT infrastructure services is limited. This may be due to an early lack of an accepted means of assessing the IT infrastructure services (Duncan, 1995). Before research to test IT infrastructure value can begin, we must be able to identify a way to effectively measure the concept. Recently, Weill and Broadbent (1998) proposed an initial measure for an IT infrastructure services construct. With this construct, we attempt to explore the links between various IT infrastructure service investment strategies, a firm's IT infrastructure services, and business performance. The establishment of such links is important in establishing standards and practices of investment for the purposes of benchmarking and strategizing. A firm's IT infrastructure services could be used to pursue corporate strategy in obtaining efficiencies in existing operations, improving the planning process, or opening new markets.

# BACKGROUNDS AND HYPOTHESES

To examine the relationship of IT infrastructure investment strategy with the IT infrastructure services provided by a firm and the relationship between a

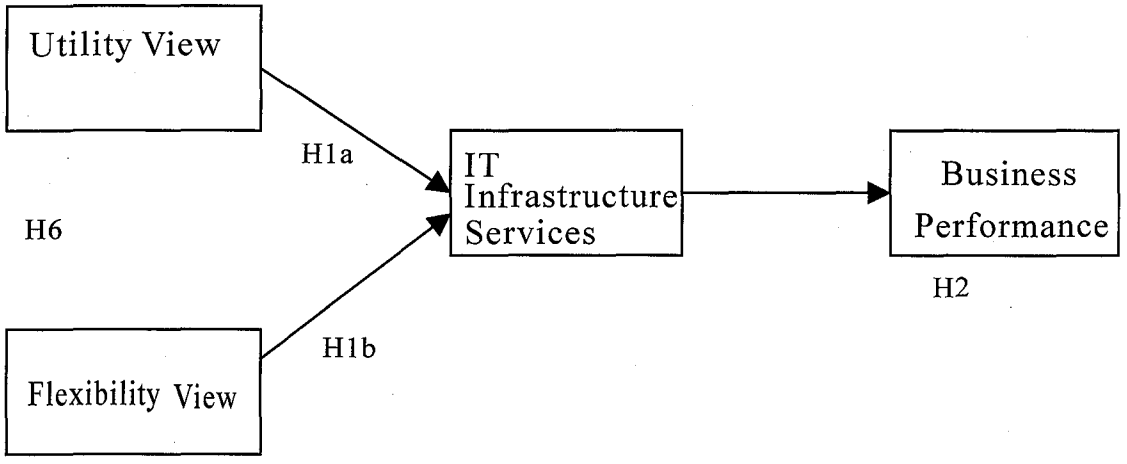


Figure 1: Research Model

firm's IT infrastructure services and its business performance, we develop and test the research model shown in Figure 1. The conceptual measures and hypothesized relations are explained below.

*IT Infrastructure Investment Strategy:* As IT infrastructure is viewed as a fundamental factor that differentiates the competitive performance of firms, IT infrastructure investment becomes significant for the business. Firms in general take different approaches - along a flexibility dimension termed as view - to IT infrastructure investment in order to pursue different strategies (Weill and Broadbent, 1998). The four views of IT infrastructure investment are the None, Utility, Dependent and Enabling views, each of which serves its own specific purposes under particular conditions and represents increasing flexibility requirements for the infrastructure. A "None" view implies that a firm has no firmwide IT infrastructure. Firms with this view are rare. A firm with a "Utility" view focuses on achieving cost savings and does not view IT infrastructure as a strategic resource. A firm with a "Dependent" view invests in IT infrastructure as a response to well-articulated business strategies. An "Enabling" view organization regards IT infrastructure as a business investment to achieve agility and enable new business strategies.

*IT infrastructure services* are a set of shared resources that provide the firmwide foundation for business applications. So IT infrastructure is considered a portfolio of possible services that enable long-term use of IT. The services provided by the IT infrastructure throughout the firm are usually stable over time with gradual improvements to take advantage of new technologies. In contrast, the IT hardware and software required for business processes changes frequently to cope with the competition. The service notion of IT infrastructure is very powerful when firms have to deal with the ever-changing need for these new IT applications (Weill and Broadbent, 1998). It is important to note that while IT infrastructure services represent a financial investment in IT, the two are not

substitute variables.

*Business Performance:* The measurement of the business value of IT investments has been the subject of debate by academics and practitioners [Rai et al. 1997]. Given the complexity of a firm, it seems that there's no single measure that is sufficient to capture all the factors influencing the economic and strategic performance of a firm (Mahmood and Mann 1993). A number of different measures are needed. Weill and Broadbent (1998) suggest the use of a hierarchy of business value measures (including business unit financial value, business unit operational value, and business unit IT application value) to track the relationship between information technology infrastructure investments and different types of business values. For the purpose of this study, organizational performance was assessed on economic performance, marketing achievements, productivity, and qualitative and innovative attainments.

## Hypotheses

Some IS researchers have identified organizations that take different approaches to IT infrastructure investment (Weill, 1993; Weill and Broadbent, 1998). Organizations range from a utility view for cost saving to an enabling view for increasing strategic options. These different views affect an organization's justification of IT investment. In turn, researchers argued that as organizations take flexibility as their IT infrastructure services strategy, greater IT infrastructure capability is provided. Based upon planning formality theory, firms that engage in formal planning over specific criteria pursue the implementation of the criteria more rigorously (Archibald , 1976; Jiang and Klein, 1999). A firm with a specific flexibility criteria for IT infrastructure investment will thus provide a higher extent of IT services to the organization. On the other hand, a firm with a "cost-saving" criteria for IT investment will provide fewer IT services to the organization . Thus, the following two hypotheses are proposed:

**H1a:** The more the IT infrastructure services strategy follows a flexibility criteria, the greater the IT infrastructure services are provided.

**H1b:** The more the IT infrastructure strategy follows a utility criteria, the less the IT infrastructure services are provided.

The exact relationship between the potential economic performance and actual information technology investment remains a matter of conjecture (Brynjolfsson , 1993; Rai, Patnayakuni, and Patnayakuni, 1997).

However, many IS researchers argue that IT infrastructure capacity affects business innovation costs, development time, and time required by competitors to imitate innovation (Mata, Fuerst, and Barney, 1995; Clemons and Row, 1991). Thus, IT infrastructure services capability is viewed as a strategic resource, a potential source of sustainable competitive advantage, and a platform for higher productivity (Keen, 1991; Niederman, et al., 1991; Weill, 1993). According to the resource-based theory of firm, companies invest in areas that together form a resource configuration that provides

competitive advantages (Barney, 1991; Conner and Prahalad, 1996; Wernerfelt, 1984). As such, the IT infrastructure services provided by a firm are an integral part of the firm's attempt to gain competitive advantage and to deal with external and internal challenges. Therefore, we propose the following hypothesis:

H2: There is a positive relationship between the level of the IT infrastructure services provided by an organization and its business performance.

# RESEARCH METHODOLOGY

## Sample

Questionnaires were mailed to Chief Information Officers in the U.S. CIOs were selected because respondents needed an overall picture of IT investments to complete the survey. Addresses and CIO names were obtained from the Compact Disclosure database. Firms were selected based upon size. 1,500 instruments were mailed. Postage paid envelopes for each questionnaire were enclosed. All the respondents were assured that their responses would be kept confidential. A total of 123 questionnaires were returned. About 85 percent of the respondents were male. Over 76 percent of respondents were 41 years/old or above. In addition, the respondents had a high education (more than 50 percent had graduate degrees). More complete demographics are in Table 1.

Table 1: Demographics

*1.* Gender:

| | |
|---|---|
| Male | 104 |
| Female | 15 |
| No response | 4 |
| Total | 123 |

*2.* Education:

| | |
|---|---|
| High School Diploma | 4 |
| Bachelor Degree | 49 |
| Graduate Degree | 68 |
| No response | 2 |
| Total | 123 |

*3.* Number of Information Systems Employees

| | |
|---|---|
| < 10 | 4 |
| * 10 & <= 100 | 28 |
| * 101 & <= 1,000 | 58 |
| * 1,001 | 32 |
| No response | 1 |
| Total | 123 |

*4.* Age:

| | |
|---|---|
| <= 30 years/old | 2 |
| > 30 & <= 40 | 21 |
| * 41 & <= 50 | 55 |
| * 50 & <= 60 | 37 |
| * 60 | 2 |
| No response | 6 |
| Total | 123 |

## Constructs

IT Infrastructure Investment Strategy: Weill and Broadbent (1998) describe IT investment strategy as the justification for firmwide IT infrastructure investment, ranging from a focus on cost saving to one of providing flexibility. The measurement items associated with this dichotomy are listed in Table 2. The instrument asked participants to consider the last two years of IT infrastructure investment cases put to senior management and the subsequent discussions among participating managers. Items one through four are indicators of the utility dimension and items five through seven are indictors of the flexibility dimension.

Although, the scale has been used

Table 2: CFA Results of IT Infrastructure Investment Strategy

| | Loadings | T-test | Alpha |
|---|---|---|---|
| **Utility:** | | | **.63** |
| 1. IT infrastructure is primarily viewed as a utility providing the base IT service at minimum cost. | .65 | 4.58* | |
| 2. The main reason for investing in IT infrastructure is to reduce the total IT costs of the firm. | .55 | 4.73* | |
| 3. In justifying IT infrastructure investment, each project must show clear cost savings. | .58 | 4.94* | |
| 4. In meetings between senior IT managers and senior business unit managers, the most important topic is the cost and quality of IT service. | ** | | |
| **Flexibility:** | | | **.66** |
| 1. In forming business strategies, the business units consider the capabilities of the IT infrastructure. | .77 | 4.34* | |
| 2. Senior managers of the firm perceive a flexible IT infrastructure as providing a competitive advantage. | .63 | .57* | |
| 3. In meetings between senior IT manager and senior business unit managers, the most important topic is the capabilities of IT to enable new business strategies. | ** | | |

Note:* indicates significant at $p < .05$ level.
** indicates item was deleted due to low loading (< .50)

CFA Results:

| | |
|---|---|
| *1.* Adjusted Goodness of Fix Index (AGFI): | .96 |
| *2.* Root Mean Square Residual (RMR): | .04 |
| *3.* Chi-square / d.f. ration: | .95 |
| *4.* Comparative Fit Index (CFI): | .99 |
| *5.* Non-normed Fix Index (NNFI): | .99 |
| *6.* Normed Fix Index (NFI): | .95 |

previously in the literature, we conducted a confirmatory factor analysis (CFA). When conducting a CFA, if the model provides a reasonably good approximation to reality, it should provide a good fit to the data (Fornell and Larcker, 1981). Kline (1998) recommended that a minimal set of model measurement fit indices should include the following statistics: a generalized likelihood ratio for predicting covariance, such as chi-square/degrees of freedom and its significance level; an index that shows the proportion in improvement of the overall fit of the researcher's model compared to the null model, such as the Normed Fit Index (NFI); an index that describes the overall proportion of explained variance, such as the Bentler Comparative Fit Index (CFI) (Bentler, 1989); an index that adjusts the proportion of explained variance for model complexity, such as the Bentler-Bonett Non-Normed Fit Index (NNFI) (Bollen, 1989); and an index based on the standardized residuals, such as the Root Mean Square Residual (RMR) (Joreskog and Sorbom, 1996).

Wheaton, et al. (1977) suggested a chi-square/degrees of freedom ratio should be less than 5. The NFI value shows the proportion that the researcher's model improves the null model. Typically, the null model is an independence model-a model in which the observed variables are presumed to be uncorrelated . According to Kline (1998), an NFI of .80 indicates that the overall fit of the researcher's model is 80 percent better than the null model estimated with the sample data. The Bentler CFI is interpreted in the same way, but it may be less affected by sample size. Kline indicated that favorable values of NFI, CFI, and NNFI are those greater than 0.90; and that the Root Mean Square Residual (RMR) should be less than 0.10. The CFA for the IT infrastructure investment strategy measure resulted in a chi-square/d.f ratio of .95, a CFI of .99, a NNFI of .99, a NFI of .95, and a RMR of .04 . Thus, the measures indicate a good fit for the measurement model.

The internal consistency reliability of the construct is examined by the Cronbach alpha value -- the alpha value will be high if the various items that constitute the construct are strongly correlated with one another. The Cronbach alpha values were .63 and .66 for utility and flexibility, respectively, (below the recommended minimum of .70 (Nunnally, 1978) indicating a slightly low internal consistency reliability of the construct. However, the internal consistency was also examined through a convergent validity test (Campbell and Fiske, 1959). Convergent validity can be assessed by reviewing the t-tests for the factor loading compared to being greater than twice their standard error (Anderson and Gerbing, 1988). The t-test for each indicator loading is also shown in Table 2. The results indicated the construct has high convergent validity since all t-values are significant at the .05 level.

*IT Infrastructure Services:* The specific measurement of IT infrastructure services adopted in this study was developed by Broadbent et. al (1999). Each item was scored using a five-point scale.

All items were presented such that the greater the score, the greater the extent the service was provided by the firm's IT infrastructure. A higher number of services in a firm indicates a higher level of firmwide IT infrastructure capability. The results of a CFA indicated a good fit of the measurement model with chi-square/d.f. ratio = 1.76, CFI = .91, NNFI = .89, NFI = .81, and RMR = .09. Similarly, reviewing the t-tests for the factor loadings shown in Table 3 demonstrated high convergent validity since all t-values are significant at the .05 level. Cronbach alpha values of .83, .88, .84, and .79, for communication services, technical support services, managerial support services, and intranet/internet services, respectively, indicate strong reliability.

*Business Performance:* The specific items used to measure business performance are listed in Table 4 and were used in previous IT related studies (Snow and Hrebiniak, 1980; Jenster, 1986). The overall measure consists of four components: (1) economic performance, (2) marketing achievements, (3) productivity in production, and (4) qualitative and innovative attainments. The questionnaire had respondents identify the extent to which each performance indicator was achieved by their organization vis-a-vis its competitors. For each indicator, the participants were asked to rate their unit's relative performance from "Much worse than our closest competitors" to "Much better than our closest competitors" using a five-point Likert-type scale. Items were presented such that the greater the score, the greater the extent of achievement. The results of a CFA indicated a good fit of the measurement model with chi-square/d.f. ratio = 1.73, CFI = .95, NNFI = .93, NFI = .89, and RMR = .11. Similarly, reviewing the t-tests for the factor loadings shown in Table 4 indicate adequate convergent validity. Cronbach alpha values of .80, .87, .90, and .79 for economic performance, marketing achievements, productivity, and qualitative and innovative management, respectively, indicate strong reliability.

External validity refers to the extent to which the findings can be generalized across times, persons, and settings. The external validity of the findings is threatened if the sample is systematically biased - for example, if the responses were generally from organizations having better /worse business performance. The responses had good distribution since the business performance means (3.60) and medians (3.61) were similar, skewness (.30) was less than 2, and kurtosis (.11) was less than 5 (Ghiselli, Campbell , and Zedeck, 1981). Likewise, no violation held for IT infrastructure services , or IT infrastructure investment strategies.

# RESULTS

The proposed research model suggests that business performance is related to IT infrastructure services and that IT infrastructure is similarly related to the IT investment strategies. To examine these relationships, an Ordinary Least Squares (OLS) approach was used. The regression results were shown in Table 5.

Table 3: CFA Results of IT Infrastructure Services

| | Loadings | T-Test | Cornbach Alpha |
|---|---|---|---|
| **Communication Services** | | | .83 |
| 1. Manage firmwide communications network services | .91 | 11.80* | |
| 2. Manage groupwide or firmwide messaging services | .87 | 11.17* | |
| 3. Manage firmwide or business-unit workstation networks (e.g., LANs, POS) | .65 | 7.37* | |
| **Technical Support Services** | | | .88 |
| 4. Enforce IT architecture and standards | .88 | 11.53* | |
| 5. Recommend standards for one component of IT architecture (e.g., hardware,operating systems, data, communications) | .87 | 11.27* | |
| 6. Implement security, disaster planning, and recovery for business units | .68 | 7.93* | |
| 7. Provide security, disaster planning, and business recovery services forfirmwide installations and applications | .66 | 7.64* | |
| 8. Provide technology advice and support services | .66 | 7.57* | |
| 9. Provide technology education services (e.g., training) | ** | | |
| **Managerial Support Services** | | | .84 |
| 10. Manage, maintain, and support large-scale data-processing facilities | .61 | 6.63* | |
| 11. Perform IS project management | .79 | 9.52* | |
| 12. Perform IS planning for business units | .72 | 8.37* | |
| 13. Manage and negotiate with suppliers and outsourcers | .74 | 8.23* | |
| 14. Provide data management advice and consultancy service | .70 | 8.01* | |
| 15. Manage firmwide or business-unit applications and databases | ** | | |
| 16. Provide management information electronically (e.g., EIS) | ** | | |
| 17. Manage business-unit-specific applications | ** | | |
| **Intranet/Internet Services** | | | .79 |
| 18. Provide firmwide Intranet capability (e.g., information access,multiple system access) | .67 | 7.44* | |
| 19. Develop and manage electronic linkages to suppliers or customers | .63 | 6.88* | |
| 20. Develop a common systems development environment | ** | | |
| 21. Provide multimedia operations and development (e.g., video conferencing) | .56 | 5.99* | |
| 22. Provide firmwide support for groups (e.g., Lotus Notes) | .74 | 5.82* | |
| 23. Develop business-unit-specific applications (usually on a charge-back orcontractual basis) | ** | | |
| 24. Manage firmwide or business-unit data, including standards | ** | | |
| 25. Identify and test new technologies for business purposes | .74 | 8.48* | |

Note:* indicates significant at $p < .01$ level.
** indicates item was deleted due to low loading ( i.e., < .50)

CFA Results:

| | |
|---|---|
| *1.* Adjusted Goodness of Fix Index (AGFI): | .77 |
| *2.* Root Mean Square Residual (RMR): | .09 |
| *3.* Chi-square / d.f. ration:1 | .76 |
| *4.* Comparative Fit Index (CFI): | .91 |
| *5.* Non-normed Fix Index (NNFI): | .89 |
| *6.* Normed Fix Index (NFI): | .81 |

Table 4: CFA Results of the Business Performance Measure

| | Loading | T-test | Cornbach Alpha |
|---|---|---|---|
| **Economic Performance:** | | | .80 |
| 1. Average ROI over the past 3 years | .81 | .953* | |
| 2. Fluctuations in profits | .76 | 8.69* | |
| 3. Record of avoiding major mistakes | .69 | 7.66* | |
| **Marketing Achievements:** | | | .87 |
| 1. Ability to gain market share | .72 | 8.36* | |
| 2. Sales growth for the past 5 years | .80 | 9.54* | |
| 3. Relative competitive rating | .91 | 11.53* | |
| **Productivity in Production:** | | | .90 |
| 1. Ability to achieve low-cost production | .89 | 11.19* | |
| 2. Productivity | .93 | 11.20* | |
| 3. Social responsibility | ** | | |
| **Qualitative and Innovative Management:** | | | .79 |
| 1. Product innovations | .50 | 5.27* | |
| 2. Ability to attract and keep talent & manpower | .69 | 7.87* | |
| 3. Quality of management | .95 | 11.94* | |
| 4. Quality of products and services | .62 | 6.85* | |

Note:* indicates significant at $p < .01$ level.
** indicates item was deleted due to low loading ( i.e., < .50)

CFA Results:

| | |
|---|---|
| *1.* Adjusted Goodness of Fix Index (AGFI): | .83 |
| *2.* Root Mean Square Residual (RMR): | .11 |
| *3.* Chi-square / d.f. ration:1 | .73 |
| *4.* Comparative Fit Index (CFI): | .95 |
| *5.* Non-normed Fix Index (NNFI): | .93 |
| *6.* Normed Fix Index (NFI): | .89 |

The results show that business performance was significantly associated with IT infrastructure services capability (.25), supporting H2. The IT infrastructure services capability of an organization was significantly associated with its flexibility IT investment strategy (.21), supporting H1b. However, the IT infrastructure services capability was not significantly related to the utility IT investment strategy, indicating a lack of support for H1a, though there exists a negative relationship (-.15) as expected. In general, the results of this study confirm the liter-

ature arguments that there are significant relationships between IT infrastructure investment strategy and organizational IT infrastructure services capabilities and between IT infrastructure services capabilities and business performance.

# DISCUSSION

The relationship between IT investment strategy and IT infrastructure services was significant. Organizations taking IT infrastructure flexibility as their investment strategy strongly respond to having a larger, more capable IT infrastructure. On the other hand, organizations with utility IT investment strategy have a negative relationship with their IT infrastructure services provided.

The relationship between IT investment and business performance has been debated among IT researchers. There is little convincing evidence that investment in IT generates positive financial returns (Roach, 1988) or productivity (Brynjolfsson, 1993). Studies in IT investment often found little persuasive evidence that IT investment created strong leverage on the value of the firm (Kauffman and Weill, 1989). Markus and Robey (1988) posit several possible causes including conflicting or unclear definitions of IT investments (although, the dollar amount spent on IT is the most often used research measurement). Restricting the measure to IT infrastructure, however, removes a major confound, the success of applications. According to the 1995 Chaos Report, well over 85% of IS projects fail, either they cannot deliver the desired results or because they encounter significant overruns in schedule or cost. As a result, one should not expect a significant relation between IT investment as measured by total dollars spent and business performance.

From the IT infrastructure services perspective, IS researchers argue that IT infrastructure will enhance business performance (Weill and Broadbent, 1998) . The results of this study support a positive relationship between organizational IT infrastructure services capability and business performance . That is, the results provide another possible explanation of the existence of a non-significant relationship between IT investment and business performance - that spending IT dollars is not sufficient - a firm's infrastructure capability must be pursued. Increasing IT investments without enhancing IT infrastructure services capability might be responsible for the negative results in busi-

Table 5: Regression Results of Research Model

| Dependent Variable | Independent Variables | Coefficients | P-value |
|---|---|---|---|
| **IT Infrastructure Services** | Utility Strategy | -.15 | .10 |
| | Flexibility Strategy | .21 | .01* |
| **Business Performance** | IT Infrastructure Services | .25 | .03* |

Note:* indicates significant at < .05 level.

ness performance despite increased IT expenditures.

IT investment may not benefit poorly managed organizations as they automate dysfunctional management processes. Researchers have argued that organizations failing to redesign management processes while increasing IT investment are likely to see administrative diseconomies of scale (Li and Ye, 1999). Firms need to make greater investment in IT infrastructure services capabilities if they are in dynamic environments or are pursuing externally oriented strategies. In many cases, IT infrastructure capability will determine an organization's capability to respond its market environment. This possible result must also be restricted to cases where strategy matches investment practice.

The IT infrastructure services instrument used in this study can be used to support a firm's self-evaluation of infrastructure including periodic reviews of the relevant services. The instrument may also be used at the industry level so that firms can determine how their IT infrastructure services capability compares with that of their competitors. Future studies should collect data about how IS experiences, problems, and practices with IT infrastructure services vary in successful implementation across organizations . Will the age of the information system departments, firm size, or information intensity of the industry affect the IT infrastructure services provided? The optimal IT infrastructure service capability for an organization under different business strategic positions should also be investigated to assist in IT planning.

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