Association for Information Systems
AIS Electronic Library (AISeL)

ICIS 2002 Proceedings

International Conference on Information Systems (ICIS)

December 2002

A Framework for Assessing the Impact of Information Systems Infrastructure on Business Effectiveness

Apiwan Born
University of Illinois at Springfield

A FRAMEWORK FOR ASSESSING THE IMPACT OF INFORMATION SYSTEMS INFRASTRUCTURE ON BUSINESS EFFECTIVENESS

Apiwan D. Born
College of Business and Management
University of Illinois at Springfield
Springfield, IL USA
born.apiwan@uis.edu

Abstract

Information systems infrastructure (ISI) was ranked as the most important issue in a 1994-1995 study of key issues in IS management (Brancheau et al. 1996). Yet, to date, little theoretical and empirical work has been done in this area. This study attempts to reconceptualize the ISI construct and its measures. Drawing from the literature, this study envisions ISI as a base of shared technological, human, and organizational capabilities that provide the foundation for business application systems in the form of services to a range of users.

A measure of ISI capability was developed and operationalized through a self-administered mail survey sent to IS executives across the country. A factor analysis revealed that ISI was a multidimensional construct consisting of three underlying dimensions: technological, human, and organizational.

A research model was proposed to assess the main impact of ISI on business effectiveness and the moderating effect of information intensity. Five selected business effectiveness variables were time and cost reduction in systems development, system availability, user satisfaction, improved financial performance, and outstanding financial performance. The results of hypotheses testing revealed that human capability was significantly related to system availability and user satisfaction, and organizational capability significantly influenced all business effectiveness, except system availability. Surprisingly, no significant impact of technological capability on any business effectiveness variables was detected. For the moderating effect, the more information intensive the organization, the greater the impact of ISI on time and cost reduction in systems development and outstanding financial performance. This study concluded that ISI capabilities contribute to business effectiveness. Future research should focus on refining the proposed research model using additional data or different data collection techniques.

1 INTRODUCTION

This study focuses on the structure and dimensionality of information systems infrastructure (ISI) in an organizational environment where computing and communication technologies support multi-participant work. ISI has been primarily investigated from various aspects such as its pattern (Broadbent et al. 1996), its use (Compeau and Higgins 1995; Taylor and Todd 1995), and its value (Hitt and Brynjolfson 1996). This study, on the other hand, proposes a different approach to assess the capability of ISI by examining its systemic property in an organizational context.

The purpose of this study is two-fold. First, the domain and definition of ISI needs to be made explicit. Lack of clear meaning of ISI may hinder better understanding of what it is and how to measure it. Second, the potential impact of ISI on business effectiveness needs to be identified. Decreasing costs and increasing speed and storage capacity of information technology (IT) has driven companies to purchase and upgrade their infrastructure. Since investing in new technology without realizing its impact can be a waste of resource, there is a need to find ways to assess this impact.

2 RESEARCH QUESTIONS

ISI means different things to different people. Several researchers view it as a collection of technological resources that provide the foundation for computer-based application systems (McKay and Brockway 1989; Weill 1993). Others include planning, policy, skill, and culture in the description of ISI (Darnton and Giacoletto 1992). While the precise definition and value of ISI is difficult to determine (Duncan 1995), most researchers agree that infrastructure affects not only industries but also employees at all organizational levels (Daft 1998; Malone and Rockart 1993). The above views have led to three main research questions. First, what is a useful definition of information systems infrastructure. Second, what is the impact of ISI on business effectiveness? Apte and Mason (1995) mention that the performance of organizations with unequal degrees of information intensity tends to be different even though they use the same technology. Information intensity appears to be a variable that is likely to moderate the impact of ISI. Thus, the third research question that needs to be addressed is: to what extent does the degree of information intensity moderate the effect of ISI on business effectiveness?

3 LITERATURE REVIEW

A clear definition of ISI has been lacking, and little has been done to develop a tool for evaluating the value of ISI. To begin with, ISI needs to be defined. Several researchers viewed infrastructure as a combination of process and structure. Andersen (1995) pointed out that infrastructure could be defined as a structure, technical or information requirements, or a process, information processing. Star and Bowker (1995) viewed infrastructure as consisting of social (i.e., process) and informatic (i.e., structure). Benjamin and Scott-Morton (1992) distinguish hard infrastructure (i.e., structure) from soft infrastructure (i.e., process) by saying that hard infrastructure is a set of technologies deployed to support various functions in the organization, and soft infrastructure refers to a set of visions, policies, and rewards guiding the use of hard infrastructure.

Not until recently has the human factor been added into the domain of ISI. Davenport (1994) points out that people play a major role in the success of IS. Darnton and Giacoletto (1992) include information management personnel as part of ISI. Ross et al. (1996) argue that three assets contributing to a long-term strategic advantage include "technical, human, and relationship (between IT and business unit management) assets." The concept of ISI is based on the premise that technology is not beneficial if no one uses it. Policies and procedures guiding the use of technology need to be implemented through people. Unfortunately, the human factor is often considered only as an afterthought. The people-related issues such as who will maintain the system and who will train users are brought to attention after system implementation. Ignoring the human factor can cause system delay or failure. Therefore, it is critical to include the human factor in the ISI construct.

3.1 Information System Infrastructure

This study found 186 articles related to ISI in several leading IS/IT journals published between 1987 and 2000. To gain better understanding, the main concepts in those articles were gathered and categorized into three aspects: technological, organizational, and human. These aspects are consistent with Grant's (1991) three categories of key IT-based resources including physical technology components, human resources, and intangible organizational resources. Technological issues (e.g., hardware, software, telecommunications, network, and database) and organizational issues (e.g., roles, plans, rewards, policies, and teams) together accounted for 89 percent of the total articles selected. Although the human resource was considered as a critical component of ISI, only a few of the articles found (11 percent) focused on human-related issues such as skill, experience, and expertise.

Drawing upon the literature, the working definition of ISI is derived as

> *a base of shared technological, human, and organizational capabilities that provide the foundation for computer-based business application systems in the form of services to a range of users*

Based on this definition, this study identifies three factors underlying ISI: technological, human, and organizational capabilities.

Technological capability refers to the capability of IT including computing, communication, and database technology available and sharable among business units (Broadbent and Weill 1993; Ross et al. 1996). Technological capability is provided in a form of reliable services and usually coordinated by the IS unit (Weill et al. 1996). Unlike IT investments and applications that perform business processes in a specific business function, technological capability can be shared across boundaries and enables better processes (Broadbent et al. 1999). Five technological capability dimensions adapted from Broadbent and Weill (1993) and Broadbent et al. (1996) are explained below.

First, *application development* refers to computer hardware and software that enables business applications in different functional areas. Second, *communication technology* such as electronic mail, voice mail, and group collaboration systems facilitate sending and receiving messages within and outside the organization. Third, *database and security* refers to development, maintenance, and ensuring security of the organization's databases. Fourth, *technical support services* include help desks, special units that provide recommendations for new technology, and multimedia services. Fifth, *Web technology* includes the Internet and its technology used for developing Web sites and applications.

Human capability refers to the ability of information management personnel to develop and maintain business applications, to understand business functionality, and to communicate with each other. This ability can be evaluated by the level of skills those people possess. Since information management personnel include both IS and non-IS staff, this study divides human capability into two dimensions: *IS staff skills* and *non-IS staff skills*. Deriving from the previous literature, this study proposes that IS and non-IS personnel possess four skill sets at different degrees. First, technical specialties skill is the ability to perform specialized IT-related tasks (Lee et al. 1995). Second, technology management is concerned with where and how to deploy IT effectively to achieve business goals (Cash and Konsynski 1985). Third, business functional skill includes knowledge of and ability to learn business functions (Rouse and Hartog 1988). Finally, interpersonal skill is the ability to perform work well with other people (Schermerhorn et al. 1994).

Organizational capability refers to the ability of an organization to manage and coordinate its members. The concept of organizational capability draws upon the structural aspect of the social system including rules and norms designed to regulate individuals' behaviors in order to achieve business goals (Holsapple and Luo 1996). Structural factors create capability for decision makers to value information obtained from business applications and use it effectively. Based on the IS strategic management literature, five of the factors binding technology and human components together are reward, training, policy, leadership, and teamwork. Definition of each factor is given below.

First, *reward* is the extent to which incentives including non-financial and indirect forms of financial compensation, are offered (Drucker 1990). Second, *training* refers to the extent to which resources are available for training and education relevant to current and future technologies used in the business (McLeod 1995). Third, *IS policy* is the extent to which existing formal policies and standards regulate design, development, and utilization of IS (Van Buren and Werner 1996). Fourth, *IS leadership* is the extent to which executives assume responsibility for resources and manage interdependency among stakeholders (Strassman 1997). Fifth, *teamwork* is the extent to which self-managing teams are emphasized and used in IS-related activities.

In conclusion, it is appropriate to view ISI as a multidimensional construct, and each dimension is assumed equally important. The main advantage of the aggregation construct is its simplicity and ability to capture the underlying meaning of ISI. As Shemwell and Yavas (1999) point out, "assuming that the observable indicators share common variance, summing or averaging across multiple indicators tends to smooth out random error, and is thus more reliable than single indicators." It is also convenient to assume that each dimension contributes equivalently to establish a foundation for business applications used in an organization.

3.2 Information Intensity

Information intensity, viewed as a moderator variable in this study, is defined as "the level of information used in supporting business processes" (Turban et al. 2001, p. 99). Service organizations such as banks and insurance companies whose businesses depend heavily on information are expected to have higher levels of information intensity than manufacturing organizations such as oil refineries and coal mining. In addition, as IS/IT increasingly plays a strategic role, information intensity tends to become increasingly critical (Porter and Millar 1985). Decisions regarding the use of IS/IT are also influenced by the value of information to a firm's competitiveness (Grover et al. 1994). Therefore, it is logical to conclude that organizations with a higher level of information intensity have higher demands for ISI capability.

At the value chain level, information intensity is determined by the information content of a process dimension and a product/service dimension (Porter and Millar 1985). Based on these dimensions and an interview with five IS/IT executives, this study develops a set of questions used for assessing the level of information intensity. A few examples of those questions are:

- Does your production process rely heavily on information and information systems?
- Does your product/service require extensive user training after sales?
- Does your product/service operation involve substantial information processing?

3.3 Business Effectiveness

Dependent variables contain short-term and long-term performance. The short-term variables comprise of time and cost reduction in systems development, system availability, and user satisfaction. An organization with extensive ISI capability is expected to help reduce cycle time and operational cost in developing IS, enable application systems to be available without downtime, and lead to satisfied users.

Two long-term variables are improved and outstanding financial performance. Over time, ISI capability is expected to improve the organization's bottom line including return on investment (ROI) and return on assets (ROA). Beyond the goal of self-improvement, superior capability of ISI is projected to enable the organization to outperform its competitors in the long run.

4 PROPOSED RESEARCH MODEL

The research model proposed in this study has its roots in the extensive body of organizational studies that explore the linkage of technology, structure, and strategy to performance. This model attempts to explain how technology, people, and process establish a foundation for supporting business applications and how infrastructure impacts business effectiveness. Organization theory that studies structure, function, and performance of an organization as well as the behavior of groups and individuals within the organization provides significant insight and understanding of this impact (Pugh 1973).

The benefits of ISI are still mostly anecdotal and not well captured in the literature. Discrepancies in previous findings lead to inconclusive determination of its impact on organizations. As the infrastructure generates options such as different types of IS for the organization, the different choices managers make lead to the variation in observed outcomes (Gurbaxani and Whang 1991). This argument is useful in establishing a connection between ISI and business effectiveness, but not meaningful for making predictions or prescriptions.

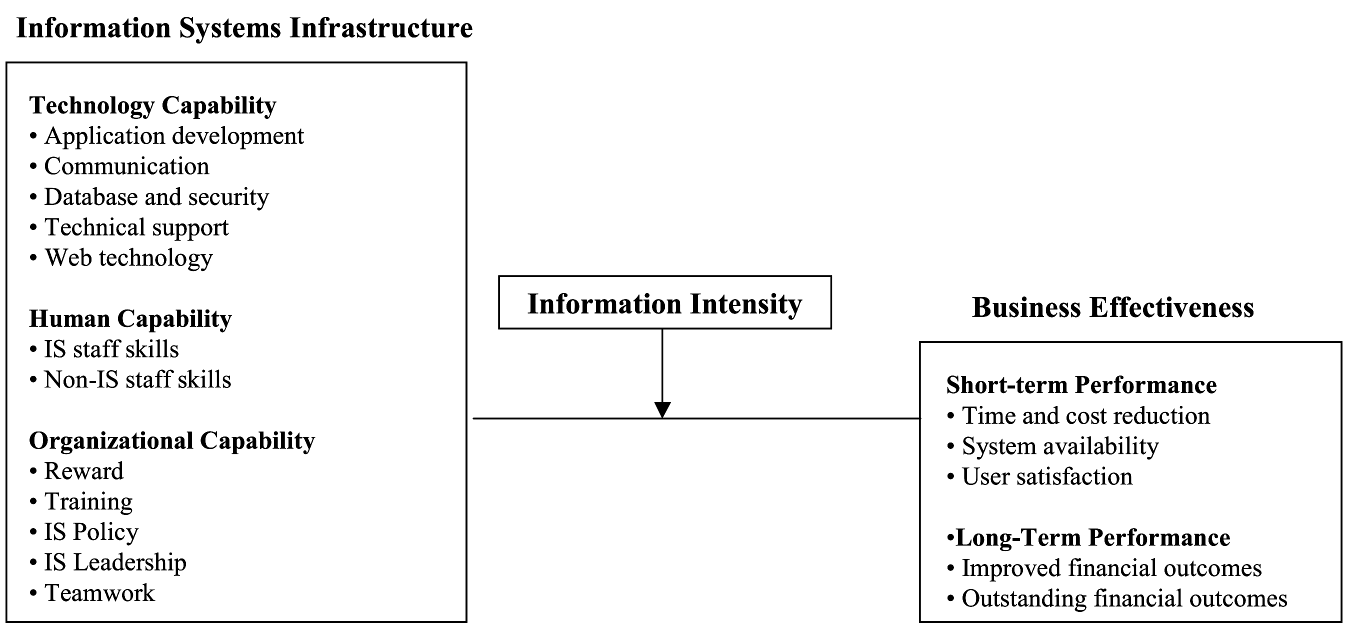

Figure 1. Proposed Research Model

The main thesis of this model (Figure 1) is that there is a positive relationship between the three ISI dimensions and the five business effectiveness variables. In the meantime, this relationship can be moderated by the degree of information intensity associated with each organization. Next, several hypotheses posed by this model are described.

5 HYPOTHESES

Based on the proposed research model, the first 15 hypotheses depicting the direct relationship or main effect are derived as follow.

H1-H5: More extensive technological capability will be associated with a higher degree of each of those five short-term and long-term business effectiveness variables.

H6-H10: More extensive human capability will be associated with a higher degree of each of those five short-term and long-term business effectiveness variables.

H11-H15: More extensive organizational capability will be associated with a higher degree of each of those five short-term and long-term business effectiveness variables.

This study argues that the impact of ISI on business effectiveness is moderated by the degree of information intensity. Given a certain level of ISI capability, higher information intensive organizations will perform better than lower information intensive organizations (Apte and Mason 1995). For example, suppose an insurance company (i.e., high information intensive organization) and a car manufacturer (i.e., low information intensive organization) have high levels of ISI capability; the impact of ISI is expected to be greater on the former than the latter. This is because it is easier for an activity with a higher degree of information intensity to be performed by information technology at a more efficient time and location, thus resulting in better quality (Apte and Mason 1995). Therefore, it is expected that information intensity will moderate the impact of ISI on business effectiveness hypothesized below.

H16-H20: The effect of ISI capability on each of the five business effectiveness variables will be stronger in organizations that have a higher degree of information intensity than those that have a lower degree of information intensity.

6 RESEARCH DESIGN

The proposed research model needs to be validated and to ensure its reliability. Interviews with two IS managers and three professors were conducted to seek a better understanding of the construct's domain and measurement items. The interview results provided useful input for developing a survey instrument.

A sample was chosen randomly from the 1998 *Directory of Top Computer Executives* (published twice a year by Applied Computer Research, Inc.). This directory was used as the sampling frame. Organizations in this directory were listed in Fortune 1000 and Information Week 500. The unit of analysis is the business unit. If the respondents chosen are at the low level of organizational hierarchy, bias could be present by having functional workers responding to organizational-level variables (Malhotra and Grover 1998). For this study, respondents are IS executives or chief information officers (CIO) who are typically viewed as top managers rather than functional managers because of the nature of their tasks such as participating in strategic planning and decision making. As a consequence, the bias introduced by mismatch between the unit of analysis and the respondent level appears to be minimal.

7 SURVEY ADMINISTRATION

Measures of constructs in the proposed model were operationalized through a self-administered mail survey. A total of 1,250 questionnaires were mailed to randomly selected subjects from the directory. Two follow-up phone calls accounted for invalid respondents including individuals who were no longer with the companies, incorrect phone numbers, and invalid addresses (30.50 percent). Based on extrapolation, the recalculated number of valid potential respondents was 870, thus the total of 110 returned questionnaires represented a 12.64 percent response rate. Five questionnaires were discarded due to missing data, and the remainder were used in the subsequent analyses.

8 RELIABILITY AND VALIDITY

Scales used in this study were tested for internal consistency reliability. After coding and screening data, Cronbach alpha values are calculated for each of those constructs in the proposed model. An acceptable alpha value is 0.7 or greater, but 0.6 is considered occasionally acceptable, especially for an exploratory study (Nunally 1978).

The results of factor analysis together with the reliability coefficient associated with each factor are presented in Table 1. Technological, human, and organizational capabilities are measured by 21, 15, and 18 Likert-type items, respectively. A principal component factor analysis with VARIMAX rotation resulted in five factors for technological capability, two factors for human capability, and five factors for organizational capability. Cronbach alpha values of all factors are .68 and greater, which is considered acceptable.

Table 1. Summary of Reliability and Dimensionality of Three Dimensions of ISI

Construct and Dimensionality	Number of Factors	% Variance Explained	Cronbach's Alpha
Technological Capability			
Factor 1: Maintenance and security	5	15.81	.84
Factor 2: Standards enforcement	4	14.87	.82
Factor 3: IT supported services	5	13.62	.85
Factor 4: Internet-related services	4	13.59	.87
Factor 5: Application development	3	10.87	.85
Human Capability			
Factor 1: Non-IS staff capability	8	27.00	.85
Factor 2: IS staff capability	7	25.25	.85
Organizational Capability			
Factor 1: Resources availability	5	20.29	.89
Factor 2: Role of IS executives	4	15.05	.75
Factor 3: IS policies and standards	3	14.05	.86
Factor 4: Planning and monitoring	4	11.57	.80
Factor 5: Reward	2	10.45	.68

The information intensity dimension contained nine items. All items in this measure were adopted from the previous literature (Porter and Millar 1985) that identified information intensity as a unidimensional construct. A confirmatory factor analysis extracted a single factor that explained 40.69 percent of the total variance, and high factor loadings (greater than .35) were exhibited in all items.

Table 2. Summary of Reliability and Dimensionality of Short- and Long-term Performance

Construct and Dimensionality	Number of Factors	% Variance Explained	Cronbach's Alpha
Short-term Performance			
Factor 1: Time and Cost Reduction	4	25.09	.86
Factor 2: User Satisfaction	4	24.04	.79
Factor 3: Availability of Information Systems	3	20.29	.77
Long-term Performance			
Factor 1: Outstanding Financial Performance	3	36.92	.89
Factor 2: Improvement in Financial Performance	4	31.18	.66

Business effectiveness is measured in terms of short-term and long-term performance. The VARIMAX rotated factor solution revealed three and two underlying factors for short-term performance and long-term performance, respectively (see Table 2). All of the factors have an acceptable level of reliability with Cronbach's alpha values of .66 and greater.

A scale being considered reliable does not necessarily mean that it is valid. The purpose of construct validation is to verify that the construct measures what it is supposed to measure (Churchill 1979). Two indicators typically used for identifying construct validity are convergent and discriminant validity. Convergent validity is determined by high correlations between measures of the same construct using different methods. Discriminant validity is determined by low correlations between measures of different constructs using the same or different methods.

A factorial validity technique recommended by Allen and Yen (1979) was performed. The results demonstrate convergent validity where each item loads high on one factor and one factor only. For discriminant validity, evidence from the correlation matrix indicates that measures of constructs that theoretically should not be related to each other show low correlation coefficients. Therefore, it can be concluded that the instrument in this study measures what it purports to measure.

9 DEMOGRAPHIC ANALYSIS

Respondents of this survey currently work with for-profit organizations with more than 50 IS employees, located in the United States. The majority of the respondents hold senior positions such as president (1.92 percent), vice president (26.92 percent), and CIO (11.54 percent). Demographic data collected includes distributions of business units categorized by industry and by primary business activity. Of all of the samples, 32.4 percent are manufacturing and 67.6 percent are service. The top three primary business activities are insurance, real estate, or legal business (14.3 percent), transportation (9.5 percent), and wholesale and retail (7.6 percent). Among these organizations, the average number of employees is 1,660, which is considered a large size.

The remainder of this section will discuss hypotheses testing. Proposed hypotheses are divided into two groups: main effect (H1–H15) and moderator effect (H16–H20).

9.1 Hypotheses Testing: Main Effect

Regression analysis was conducted to test hypotheses H1 through H15, which hypothesized a relationship between the three independent variables: technological capability (X_1), human capability (X_2), and organizational capability (X_3) and each of the five dependent variables (Y_1 through Y_5). All three independent variables were entered into a regression model at the same time. The results of regression analysis are discussed below.

The results of regression analysis support six out of the 15 hypotheses posed (H7, H8, H11, H13, H14, and H15). The regression models of all significant relationships between ISI capabilities and business effectiveness variables together with regression coefficients and coefficients of determination are summarized as follows:

Time and Cost Reduction in Systems Development = *f* (Organizational Capability)
β_{org} = .51, R^2 .24

System Availability = *f* (Human Capability)
β_{hum} = .49, R^2 = .13

User Satisfaction = *f* (Human Capability, Organizational Capability)
β_{hum} = .21, β_{org} = .47, R^2 = .38

Improved Financial Performance = *f* (Organizational Capability)
β_{org} = .49, R^2 = .34

Outstanding Financial Performance = *f* (Organizational Capability)
β_{org} = .71, R^2 = .13

Organizational capability has significantly influenced all business effectiveness, except system availability. In particular, organizational capability greatly explains the variance in improved financial performance ($R^2 = .34$). Human capability has a significant impact on system availability and user satisfaction, but only 11 percent of the variance of system availability is explained. Human and organizational capabilities together explain 38 percent of the variance of user satisfaction when organizational capability ($\beta_{org} = .47$) has a higher association with user satisfaction than human capability ($\beta_{hum} = .21$). Finally, no significant impact of technological capability is found on any dependent variables.

9.2 Hypotheses Testing: Moderator Effect

Regression analysis was conducted to test hypotheses H16 through H20. Information intensity was introduced into the regression equation to take into account the degree of information intensity of products or services. Sharma et al. (1981) suggest a step-by-step technique to determine the effect and type of a moderator.

Step 1: Determine whether a significant interaction exists between a hypothesized moderator, information intensity, and each of the predictor variables by using the following equations.

$$Y_i = \alpha + \alpha_1 TC + \beta_2 (TC * II)$$
$$Y_i = \alpha + \beta_1 HC + \beta_2 (HC * II)$$
$$Y_i = \alpha + \beta_1 OC + \beta_2 (OC * II)$$

Where:

Y_1 = Time and Cost Reduction	*TC = Technological Capability*
Y_2 = System Availability	*HC = Human Capability*
Y_3 = User Satisfaction	*OC = Organizational Capability*
Y_4 = Improved Financial Performance	*II = Information Intensity*
Y_5 = Outstanding Financial Performance	

A regression model was used to study the predictive ability of those three predictors on business effectiveness. For example, the main effect of technological capability was entered first into the regression equation and followed by the incremental effect of information intensity in conjunction with technological capability. The findings indicated that none of the interaction terms were significant ($\beta_2 = 0$), so the next step continues.

Step 2: Determine whether information intensity is related to the criterion or predictor variable. The correlation matrix shows no correlation between those variables.

Step 3: Split the total sample into subgroups on the basis of the moderator variable. Two groups (high and low intensity) were generated by a median split. A test of significance of differences in predictive validity across subgroups was conducted. Significant differences between two subgroups in R^2 were found in all dependent variables, except outstanding financial performance. The conclusion is that information intensity is a *homologizer variable* between ISI capability and those four dependent variables.

Regression analysis reveals that only two dependent variables, time and cost reduction and outstanding financial performance, contain significant interaction terms: (*HC x II*) and (*TC x II*), respectively. Therefore, H16 and H20 are the only two hypotheses supported by the survey data.

The results of hypotheses testing summarized in Table 3 will be discussed in the next section.

10 DISCUSSION AND CONCLUSION

Information technology creates tremendous opportunities for organizations to respond to changes in the business environment. Unfortunately, ISI is the bottleneck keeping such opportunities from becoming reality at most business organizations (Slater 1999). Limited technology availability, lack of qualified personnel, and lack of policy and standard procedures are obstacles that prevent organizations from capitalizing their opportunities. This study recognizes the above problems and attempts to provide guidelines and possible solutions.

Table 3. Summary of Hypotheses Testing Results

✓ = Hypothesis Supported

	Business Effectiveness				
Variable	**Time and Cost Reduction**	**System Availability**	**User Satisfaction**	**Improved Performance**	**Outstanding Performance**
MAIN EFFECT Technological Capability	**H1**	**H2**	**H3**	**H4**	**H5**
Human Capability	**H6**	✓ **H7**	✓ **H8**	**H9**	**H10**
Organizational Capability	✓ **H11**	**H12**	✓ **H13**	✓ **H14**	✓ **H15**
MODERATOR EFFECT Information Intensity	✓ **H16**	**H17**	**H18**	**H19**	✓ **H20**

Unlike previous measures that narrowly gauged only the number of IT services or the value of IT investment, this study treats ISI as a multidimensional construct. Principal component-based factor analysis reveals that ISI consists of three distinct but interdependent dimensions: technological, human, and organizational. Data from the survey provided empirical support for the reliability and validity of the measure of those three dimensions. However, lack of strong supporting evidence that these dimensions are additive prohibited the use of their summation score. Data analysis can be reported at only the category level, rather than at the overall infrastructure level.

Regression analysis showed that human and organizational capabilities are significantly related to short-term and long-term business effectiveness. Recent studies in the IS area have begun to recognize the relationship between ISI and financial performance (Brooks 2000). This study reveals that human capability significantly influences system availability and user satisfaction, and organizational capability affects all business effectiveness variables, except system availability.

Human capability has a greater impact on user satisfaction in high-information intensive organizations than in low-information intensive organizations. This finding seems to support the trend that many high-information intensive organizations are increasingly focusing on empowerment. They have begun to realize that the creation of an environment in which the employees can achieve their potential as they help the organization achieve its goals is one way to satisfy customers through content employees.

This study indicates that organizational capability is critical in both high- and low- information intensive organizations. Detailed analysis reveals that the role of IS executives is directly associated with time and cost reduction in systems development, user satisfaction, and improved performance, and outstanding performance. This result supports Brooks' argument that an effective leadership role generates internal services and contributes to improvement and excellence in financial results.

11 LIMITATIONS

Four limitations are recognized in this study. First, generalizability of the results will necessarily have to be limited to large, for-profit organizations similar to the sample in this study. Second, small sample size may have reduced statistical power and led to unreliable maximum likelihood estimates of parameters in regression analyses. Furthermore, significant but weak effects may not have been detected because of reduced statistical power. Third, an exclusion of organization-specific and environmental factors (e.g., size and rate of technology advancement) that affect business effectiveness can pose a limitation. To examine this possibility, for instance, size measured by the total number of employees was included as an additional predictor variable. The results indicated that the impact of size was not significant, which suggested that the findings in this study were not biased by the exclusion of organization size. Fourth, one of the important question is whether ISI is an abstraction or something concrete that can be observed. This study assumes that ISI capability exists and can be measured by aggregating three dimensions:

technological, human, and organizational. By using a formal questionnaire instrument, this study limits itself to only observing a tangible part of these three dimensions. However, it should be realized that those dimensions, especially human and organizational capability, may have an intangible part that has not been observed. The results of this study, therefore, need to be used with recognition of this limitation.

12 CONTRIBUTIONS AND FUTURE DIRECTIONS

Building an effective ISI has been a critical IS management issue since the beginning of the 1990s. ISI was ranked as the most important issue in a 1994-1995 study (Brancheau et al. 1996), up from number five in the 1990 study (Niederman et al. 1991). Previous studies do not provide a comprehensive understanding of this construct because they examine only certain aspects such as flexibility (Duncan 1995), *reach* and *range* (Keen and Cummins 1994), and return on investment (Hitt and Brynjolfson 1996). Most studies have placed a heavy emphasis on technology and overlooked the importance of human and organizational mechanisms. Balancing between technological and non-technological components of the infrastructure, this study contributes to existing knowledge by proposing a framework for measuring the effects of ISI on business effectiveness. The results related to the hypotheses are valid enough and usable; however, to validate the framework, more research is needed.

For practitioners, this study attempts to emphasize that technology is not the solution for all business problems. ISI needs to be viewed as a valuable asset that comprises not only IT but also the human and organizational factors, which influence business effectiveness in both the short and the long run. This implies that ISI capability serves not only current needs but also future requirements of the organization.

For future research, the proposed model needs to be refined using additional data from similar sampling frames or different data collection techniques. The concept of ISI still needs to be further examined. Since the capability of ISI changes over time (Duncan 1995), using a snapshot survey may not provide the insights of that change. For example, the company that has adopted a new technology for a year may not realize any change in its bottom line, whereas another company using a similar technology for a few years has may have already seen an improvement. The reason why the latter company can capitalize its infrastructure is because it has gradually developed skills and established organizational mechanisms to advance its performance. To capture a long term impact of ISI, a longitudinal study or a case study of ISI will be necessary.

13 REFERENCES

Allen, M. J., and Yen, W. M. *Introduction to Measurement Theory*. Pacific Grove, CA: Brooks/Cole Publishing, 1979.

Andersen, E. *Evolving an Organizational Information Infrastructure: Transitions to Client-Server in the Transportation Industry*. Unpublished Doctoral Dissertation, Harvard University, Boston, 1995.

Apte, U. M., and Mason, R. O. "Global Disaggregation of Information Intensive Services," *Management Science* (4), 1995, pp. 1250-62.

Benjamin, R. I., and Scott-Morton, M. S. "Reflections of Effective Application of Information Technology in Organizations," in F. H. Vogt (ed.), *Personal Computer and Intelligent Systems: Information Processing*. Amsterdam: Elsevier Science Publishers, 1992, pp. 131-139.

Brancheau, J. C., Janz, B. D., and Wetherbe, J. C. "Key Issues in Information Systems Management: 1994-1995 SIM Delphi Results," *MIS Quarterly* (20), 1996, pp. 225-242.

Broadbent, M., and Weill, P. "Improving Business and Information Strategy Alignment: Learning from the Banking Industry," *IBM Systems Journal* (32), 1993, pp. 162-179.

Broadbent, M., Weill, P., and Clair, D. "The Implications of Information Technology Infrastructure for Business Process Redesign," *MIS Quarterly* (23), 1999, pp. 159-82

Broadbent, M., Weill, P., O'Brien, T., and Neo, B. "Firm Context and Patterns of IT Infrastructure Capabilitym" in J. I. DeGross, S. L. Jarvenpaa, and A. Srinivasan (eds.), *Proceedings of the Seventeenth International Conference on Information Systems,* Cleveland, OH, 1996, pp. 174-194.

Brooks, R. "Why Loyal Employees and Customers Improve the Bottom Line," *Journal for Quality and Participation* (23), 2000, pp. 23, 40-44.

Cash Jr., J. I., and Konsynski, B. R. "IS Redraws Competitive Boundaries," *Harvard Business Review* (53), 1985, pp. 134-142.

Churchill, G. A. "A Paradigm for Developing Better Measures of Marketing Constructs," *Journal of Marketing Research* (6), 1979, pp. 64-73.

Compeau, D. R., and Higgins, C. A. "Computer Self-Efficacy: Development of a Measure and Initial Test," *MIS Quarterly* (19), 1995, pp. 189-211.

Daft, R. L. *Organization Theory and Design* (4th ed.). Cincinnati, OH: South-Western Publishing Company, 1998.

Darnton, G., and Giacolette, S. *Information in the Enterprise: It's More Than Technology*. Salem, MA: Digital Press, 1992.

Davenport, T. H. "Saving IT's Soul: Human-Centered Information Management," *Harvard Business Review* (72), 1994, pp. 119-31.

Drucker, P. F. "The Emerging Theory of Manufacturing," *Harvard Business Review* (68), 1990, pp. 94-105.

Duncan, N. B. "Capturing Flexibility of Information Technology Infrastructure: A Study of Resource Characteristics and Their Measure," *Journal of Management Information Systems* (12), 1995, pp. 37-57.

Gurbaxani, V., and Whang, S. "The Impact of Information Systems on Organizations and Markets," *Communications of the ACM* (34), 1991, pp. 59-73.

Grant, R. M. "The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation," *California Management Review* (33), 1991, pp. 114-135.

Grover, V., Cheon, M. J., and Teng, J. "A Descriptive Study on the Outsourcing of Information Systems Functions," *Information and Management* (27), 1994, pp. 33-44.

Hitt, L. M., and Brynjolfsson, E. "Productivity, Business Profitability, and Consumer Surplus: Three Different Measure of Information Technology Value," *MIS Quarterly* (20), 1996, pp. 121-142.

Holsapple, C. W., and Luo, W. "A Framework for Studying Computer Support of Organizational Infrastructure," *Information & Management* (31), 1996, pp. 13-24.

Keen, P. G. W., and Cummins, J. M. *Networks in Action: Business Choice and Telecommunications Decisions*. Belmont, CA: Wadsworth, 1994.

Lee, D. M. S., Trauth, E. M., and Farwell, D. "Critical Skills and Knowledge Requirements of IS Professionals: A Joint Academic/Industry Investigation," *MIS Quarterly* (19), 1995, pp. 313-350.

Malhotra, M. K., and Grover, V. "An Assessment of Survey Research in POM: From Constructs to Theory," *Journal of Operations Management* (16), 1998, pp. 407-25.

Malone, T. W., and Rockart, J. F. "How Will Information Technology Reshape Organizations? Computers as Coordination Technology," in S. P. Bradley, J. A. Hausman, and R. L. Nolan (eds.), *Globalization, Technology, and Competition: The Fusion of Computers and Telecommunications in the 1990s*. Boston: Harvard Business School Press, 1993, pp. 37-55.

McKay, D. T., and Brockway, D. W. "Building I/T Infrastructure for the 1990s," *Stage by Stage* (9), 1989, pp. 1-11.

McLeod Jr., R. *Management Information Systems: A Study of Computer-Based Information Systems*. Englewood Cliffs, NJ: Prentice Hall, 1995.

Niederman, F., Brancheau, J. C., and Wetherbe, J. C. "Information Systems Management Issues for the 1990s," *MIS Quarterly* (15), 1991, pp. 454-500.

Nunally, J. *Psychometric Theory*. New York: McGraw Hill, 1967.

Porter, M., and Millar, V. "How Information Gives You Competitive Advantage," *Harvard Business Review* (63), 1985, pp. 149-60.

Pugh, D. S. "The Measurement of Organization Structures: Does Context Determine Form?," *Organizational Dynamics* (1), 1973, pp. 19-34.

Ross, J. W., Beath, C. M., and Goodhue, D. L. "Develop Long-Term Competitiveness Through IT Assets," *Sloan Management Review* (38), 1996, pp. 31-45.

Rouse, R. A., and Hartog, C. "The New MIS Professional—Part I," *Journal of Systems Management* (39), 1988, pp. 6-10.

Schermerhorn, J. R., Hunt, T. J., and Osborn, R. N. *Managing Organizational Behavior*. New York: John Wiley and Sons, 1994.

Sharma, S., Durand, R. M., and Gur-arie, O. "Identification and Analysis of Moderator Variables," *Journal of Marketing Research* (18), 1981, pp. 291-300.

Shemwell, D. J., and Yavas, U. "Measuring Service Quality in Hospitals: Scale Development and Managerial Applications," *Journal of Marketing Theory and Practice* (7), 1999, pp. 65-75

Slater, D. "The Corporate Skeleton," *CIO Magazine*, 1999, pp. 23-26.

Star, S. L., and Bowker, G. C. "Work and Infrastructure," *Communications of the ACM* (38), 1995, pp. 41ff.

Strassman, P. "The Price of Uncertain Leadership," *Computerworld* (31), 1997, p. 72.

Taylor, S., and Todd, P. "Assessing IT Usage: The Role of Prior Experience," *MIS Quarterly* (19), 1995, pp. 561-570.

Turban, E., McLean, E., and Wetherbe, J. *Information Technology for Management: Transforming Business in the Digital Economy*. New York: John Wiley and Sons, Inc., 2001.

Van Buren, M. E., and Werner, J. M. "High Performance Work Systems," *Business and Economic Review* (43), 1996, pp. 15-27.

Weill, P. "The Role and Value of Information Technology Infrastructure: Some Empirical Observations," in R. Banker, R. Kauffman, and M. A. Mahmood (eds.), *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage.* Hershey, PA: Idea Group Publishing, 1993.

Weill, P., Broadbent, M., and St. Clair, D. "IT Value and the Role of IT Infrastructure Investments," in J. N. Luftman (ed.), *Competing in the Information Age: Strategic Alignment in Practice*. New York: Oxford University Press, 1996, pp. 361-384.