How Work System Formalization and Integration Impact IS Funcation Performance in Manufacturing Firms

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ABSTRACT

The development of successful IS practices relies on the existence of well documented, formal work system practices and the existence of cross-functionally integrated of work teams. In manufacturing firms, formal work system practices serve as a public repository of organizational knowledge, including key manufacturing policies, procedures, and definitions. Cross-functional work teams provide the vehicle by which new work system practices may be quickly created and implemented throughout the firm. Study results indicate that firms with high levels of manufacturing work system formalization and integration have higher levels of IS strategic planning effectiveness, IS responsiveness to organizational computing demands, and IS end-user training effectiveness. Perceptions of IS performance were also higher for firms with greater work system formalization. Data were collected from 265 senior manufacturing managers who were selected because their perspective of IS performance was desired and because manufacturing units are an important user of the services. ANOVA was used to test our hypotheses.

Keywords: Information System Development, Work System Formalization, Work System Integration, IS Strategic Planning Effectiveness, IS Responsiveness, End-User Training, IS Performance

1.0. INTRODUCTION

Today's global manufacturing environment has significantly impacted the basis of competition for U.S. firms (Nam et al., 2004). Many U.S. manufacturers have sought to improve the effectiveness of production processes and capabilities through the implementation of IT-reliant work systems. A work system is defined as "a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal and external customers" (Alter, 2003). Thus, an IT-reliant work system must capture key organizational knowledge for its information-based technologies and systems to improve the speed and quality of decision processes.

In the case of manufacturing firms, the purpose of information-based technologies and systems is therefore to support the activities of the production work system. While the boundary between a firm's work systems and its information systems may overlap and blur with time, the development of successful IS practices remains a critical outcome the IS function must achieve in support of this requirement. An important prerequisite for the development of successful IS practices is the existence of well-documented, formal work system practices (Alter, 2003).

Formal work system practices provide a vital reference, serving as a public repository of organizational knowledge (i.e., key manufacturing policies, procedures, definitions, etc.), which are necessary to develop supportive IS practices (Lee & Choi, 2003). Cross-functional work teams provide the integration mechanism by which new work system practices may be more quickly created, disseminated, and then implemented throughout the firm (Bailey, et al. 2001). The integration of the work system provides a basis for employees to resolve differences related to the common meaning and definition of manufacturing work system practices, thus accelerating this process (Rondeau et al., 2000).

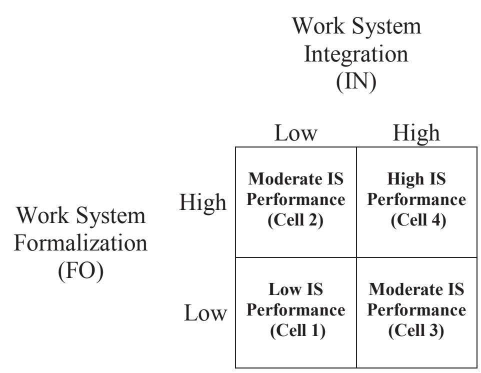
The central tenet of this study is therefore that firms demonstrating both high work system formalization and integration will provide a consistent and stable basis upon which to build effective IS practices. Such firms should be perceived to have higher levels of IS strategic planning effectiveness, IS responsiveness to organizational computing demands, and IS end-user training effectiveness. Perceptions of IS performance are also expected to be higher. For this study, data were collected from 265 senior manufacturing managers who were selected because their broad perspective of their firm's work system and IS practices of interest was desired. Ultimately, their perceptions matter most because they may choose to pay for IS services or to outsource, downsize, or replace their IS function's services. The ANOVA procedure is used to test our research hypotheses.

2.0. RESEARCH MODEL, LITERATURE REVIEW, AND HYPOTHESES DEVELOPMENT

This research proposes IS practices will be higher for firms demonstrating more formal work system practices and greater work system integration. The matrix given in Figure 1 shows that firms may be classified into one of four cells by level of work system formalization (i.e., low or high) and level of work system integration (i.e., low or high). Manufacturing firms classified within ***Cell 1*** (i.e., low IS function success) possess low levels of both work system formalization and integration. They may have less need for information processing and therefore have a lower IS requirement. In contrast, firms classified within ***Cell 4*** (i.e., high IS function success) possess high levels of both work system formalization and integration characteristic of a post-industrial environment. These firms should have an information-rich, internal environment that is capable of flexible resource deployment.

Firms in ***Cells 2*** and ***3*** should demonstrate moderate levels of IS function success. These firms will possess either a high level of work system formalization and low

Figure 1. Research model



work system integration (i.e., Cell 2) or a low level of work system formalization and high work system integration (i.e., Cell 3). Those demonstrating high formalization and low integration may require standard information products and services requiring little or no customization. Those demonstrating low formalization and high integration may require non-standard information products and services requiring extensive customization. These firms are therefore expected to exhibit moderate levels of perceived IS effectiveness.

2.1. Work System Formalization

Formalization may take the shape of written operating procedures, quality improvement methods, employee handbooks, and other documents that direct employee action towards customer requirements (Price & Mueller, 1986). Without documentation, standard operating procedures and work methods are subject to misinterpretation. Over time, organizations may forget their purpose, including the reasons why they were developed. When formalized, the full meaning and benefits of the written documentation can be shared freely between departments, across plants, and throughout the firm (Argotte & Epple, 1990; Levitt & March, 1988).

2.2. Work System Integration

Integration is the process of blending elements of the organization into a united whole. When organizations face a complex and uncertain environment, they are more likely to use integrative devices such as task forces, committees, or liaisons to increase their chances for success (Germain et al., 1994; Miller and Droge, 1986). As management struggles to gather and process more information and make increasingly complex decisions, they delegate decision-making to lower-level work groups. The increased interdependence of workers that results gradually diminishes existing job and work group boundaries, increases individual task meaningfulness, and expands information exchange (Romme, 1997; Susman & Dean, 1992).

2.3. IS Strategic Planning Effectiveness

Senior management assessments of IS strategic planning effectiveness should accommodate: 1) senior managers' preference to discuss IS strategy in ways that more generally relate IS strategy to business strategy (Hirschheim & Sabherwal, 2001) and 2) their need to relate IS strategy to its impact on customers and the marketplace in general (Henderson & Venkatraman, 1999). The final IS plan must therefore project a clear vision of the IS organization's role, IS goals and objectives, and the ways the firm's information technologies and systems should operate to be effective in a manner understood by senior management (Rockart & Hofman, 1992; Teng et al., 1994).

High work system formalization is critical for more effective IS strategic planning because potential misinterpretation of work system support requirements (and risk) is decreased due to specific, well-defined, and widely distributed work system documentation (Palmer & Dunford, 2002; Segars & Grover, 1999). High work-system integration is also critical in that it helps firms understand the relationship between existing and emerging work practices (Suchman, 2002). Effective IS planning requires the existence of formal knowledge to insure IS plans incorporate critical work practices in proposed solutions. It also allows the politics and personalities of the enterprise to be considered in these solutions (Hodge, 1989). Thus, we hypothesize:

H1: *Firms scoring high in both Work System Formalization and Integration (i.e., Cell 4) will score higher in IS Strategic Planning Effectiveness than firms scoring low in both Work System Formalization and Integration (i.e., Cell 1).*

2.4. IS Responsiveness to Organizational Computing Demands

A lack of responsiveness to user issues, questions, and concerns by the IS function is commonly cited as one of the primary reasons behind IS downsizing and outsourcing initiatives. Many users experience frustration when their IS function fails to properly prioritize requirements and deliver useful results on time and within budget. As such, these IS functions are often the focus of intense user dissatisfaction and the target of poor user performance evaluations (Doll & Doll, 1992; Due, 1992; Powell, 1993; Rowley & Smiley, 1993).

An IS function within firms with high work system formalization and integration should be perceived to be more responsive to users. High work system formalization establishes a well-documented, stable work environment. This better supports the development of more efficient, standardized computing support services. High work system integration enables the rapid prioritization of work system goals and objectives, clarifying the importance of related IS support requests. This better supports the development of a more appropriate IS response, based on the relative importance of organizational computing needs, to be generated. Thus, we hypothesize:

H2: *Firms scoring high in both Work System Formalization and Integration (i.e., Cell 4) will score higher in IS Responsiveness to Organizational Computing Demands than firms scoring low in both Work System Formalization and Integration (i.e., Cell 1).*

2.5. IS Effectiveness in End-User Training

Effective end-user education and training involves teaching general problem solving approaches, including abstract reasoning and specific technical skills (Nelson, 1991). Attaining this is critical in an IS environment where cognitive skills, that are necessary for continued learning, vary greatly among participants and may, on-the-average, be less than desired (Harrison & Rainer, 1992). Effective end-user education and training can enable the rapid acceptance of new technologies and software, empower users to experiment more freely, and motivate them to deploy new technologies more quickly (Kappleman & Guynes, 1995).

High work system formalization enables the definition of specific worker skills and abilities required to perform business processes. This specificity better supports the identification of key information technologies, including the IT user training solutions required for workers to use these technologies effectively. High work system integration allows for common agreement on the content of business processes and type of IT user training that may be needed. This better supports the definition of both formal coursework and on-the-job learning experiences. Thus, we hypothesize:

H3: *Firms scoring high in both Work System Formalization and Integration (i.e., Cell 4) will score higher in End-User Training Effectiveness than firms scoring low in both Work System Formalization and Integration (i.e., Cell 1).*

2.6. IS Performance

Management's satisfaction with IS performance depends on the ability of IS to facilitate better decision-making (Raghunathan & Raghunathan, 1996). End-users recognize the benefits of the services provided by IS, especially how these services lead to faster and better decisions in highly competitive situations (Rondeau et al., 2003). The challenge faced by the IS function is to develop clear, objective measures of IS performance (Costea, 1990). High work system formalization can create a more predictable user environment, enabling IS managers to be more effective in anticipating users' IS product and service needs. High work system integration allows users to work out their differences related to business requirements before attempting to translate them to IS requirements. Thus, we hypothesize:

H4: *Firms scoring high in both Work System Formalization and Integration (i.e., Cell 4) will score higher in IS Performance than firms scoring low in both Work System Formalization and Integration (i.e., Cell 1).*

3.0. INSTRUMENT DEVELOPMENT AND DATA COLLECTION

Work system formalization (FO) and integration (IN) items were developed based upon a review of the manufacturing literature. Items designed to measure IS strategic planning effectiveness (SP), IS responsiveness to organizational computing demands (RD), and end-user training effectiveness (UT) were developed from a review of the appropriate IS literature. Items designed to measure IS performance (IP) were adapted from an instrument by Ragunathan & Ragunathan (1996). All items are measured on a five point Likert scale. Structured interviews were conducted, a pre-pilot test done, a pilot study done, and a large-scale study that targeted executive-level manufacturing managers. These steps were taken to

Table 1. Factor analysis for the scales

Item #	Manufacturing Work System Integration (IN)	IS Performance (IP)	Manufacturing Work System Formalization (FO)	IS Responsiveness to Organizational Computing Demands (RD)	IS Strategic Planning Effectiveness (SP)	IS End-User Training Effective-ness (UT)
	Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy = 0.92. Only factor loadings above 0.40 are shown.					
IN1	0.89					
IN2	0.88					
IN3	0.84					
IN4	0.80					
IN5	0.75					
IN6	0.74					
IN7	0.69					
IP1		0.80				
IP2		0.79				
IP3		0.76				
IP4		0.75				
IP5		0.68				
FO1			0.82			
FO2			0.80			
FO3			0.78			
FO4			0.76			
FO5			0.57			
FO6			0.56			
RD1				0.81		
RD2				0.80		
RD3				0.80		
RD4				0.65		
RD5				0.63		
SP1					0.76	
SP2					0.76	
SP3					0.73	
SP4					0.72	
SP5					0.72	
UT1						0.82
UT2						0.75
EV[1]	4.90	3.76	3.71	3.68	3.54	1.65
%[2]	16.32	12.54	12.36	12.26	11.81	5.50
CP[3]	16.32	28.86	41.22	53.48	65.29	70.79

ensure the content validity, reliability, and brevity of the instruments as well as internal and external validity.

Data were obtained as part of a mail survey designed to capture both IS and manufacturing data. All firms selected had at least 250 employees within US SIC codes 25 and 34 to 38 (see Table 1). The mailing yielded 265 responses: an effective response rate of 4.3%. While less than desired, the makeup of the respondent pool was considered adequate. 44.9% of the respondents reported a job title of president, CEO, vice president, or general manager. 30.6% said that they were plant managers, directors, or senior managers. 20.4% were managers and 4.1% did not provide job title information. Tests of non-response bias indicated no statistically significant difference between the firms on the mailing list and the responding firms for either SIC code or firm size (number of employees).

4.0. STUDY RESULTS

4.1. Results of the Measurement Model

The items for all work system and IS dimensions were submitted to exploratory factor analysis. Principal component was selected for the extraction procedure with varimax factor rotation. Results are given in Table 2. Most factor loadings were 0.60 or 0.70 or better with two manufacturing work system formalization items being 0.50 or better. While formalization items F03 and F06 factor loadings were less than desired, they were considered important to this research and were thus retained. Factor loads below 0.40 are not shown with no significant cross loads, implying convergent and discriminant validity. All of the factors were composed of a single dimension. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.92.

Table 2. Statistical attributes of the factors

	Scale	# of Items	Mean	Standard Deviation	Reliability
FO	Work System Formalization	6	3.93	0.86	0.92
IN	Work System Integration	7	3.96	0.79	0.85
SP	IS Strategic Planning Effectiveness	5	3.14	0.99	0.92
RD	IS Responsiveness to Organizational Computing Demands	5	3.34	0.91	0.90
UT	End-User Training Effectiveness	2	3.05	1.03	0.77
IP	IS Performance	5	3.16	0.99	0.90

Table 4. Analysis of variance results

Work System Formalization (FO)	Work System Integration (IN)		Source of Variation	F-Value	Significance of F
	Low	High			
IS Strategic Planning Effectiveness (SP)					
High	3.23	3.56	Main Effect	18.551	0.000
			FO	37.235	0.000
Low	2.56	2.79	IN	5.529	0.019
			Two-Way Interaction	0.179	0.672
I. S. Responsiveness to Organizational Computing Demands (RD)					
High	3.28	3.65	Main Effect	9.219	0.000
			FO	13.582	0.000
Low	2.99	3.11	IN	4.756	0.030
			Two-Way Interaction	1.119	0.291
End-User Training Effectiveness (UT)					
High	3.11	3.54	Main Effect	23.741	0.000
			FO	47.027	0.000
Low	2.43	2.56	IN	5.278	0.022
			Two-Way Interaction	1.478	0.225
Information Systems Performance (IP)					
High	3.24	3.34	Main Effect	3.735	0.012
			FO	8.595	0.004
Low	2.87	2.96	IN	0.549	0.460
			Two-Way Interaction	0.004	0.951

Note: IS construct means for firms classified within each FO and IN, low or high cell combination are provided in the left side of this table. Overall IS construct means are shown in Table 2.

Table 3 gives the means, standard deviations, and reliability estimates (Cronbach, 1951) for the IS dimensions. All factor reliabilities are above 0.80 or 0.90 except for end-user training effectiveness, which is 0.77. The final instruments are short and easy to use. Each scale has seven or fewer items, and the total number of items across all scales is only thirty. Due to manuscript space limitations, the instruments have not been included but are available from the authors. The instruments meet generally accepted validity and reliability standards for exploratory research.

Figure 2. Respondents classified by cell

Note: A total of 265 respondents were split into High or Low cells by FO and IN factor means.

		Work System Integration (IN) Low	Work System Integration (IN) High
Work System Formalization (FO)	High	**45 (17%)** **(Cell 2)**	**114 (43%)** **(Cell 4)**
	Low	**55 (21%)** **(Cell 1)**	**51 (19%)** **(Cell 3)**

4.2. Approach to Hypothesis Testing

The division of the sample into the cells shown in Figure 1 depends on the calculation of overall construct means for FO and IN, which are given in Table 3. Individual responses were then classified into the four cells shown in Figure 1 by comparing them to these overall means. If a respondent's FO and IN score was above the construct mean, it would be considered to be above average in terms of its formalization or integration. If a respondent's FO and IN score was below the construct mean, it would be considered to be below average in terms of its formalization or integration. SPSS was then used to conduct analysis of variance (ANOVA) tests to determine whether the dimensions of the IS environment varied significantly among the four cells. Figure 2 shows the final classification of respondents into four cells.

4.3. Results of Hypothesis Testing

The results shown in Table 3 support hypotheses 1, 2, and 3 as discussed earlier as well as the corollaries to these hypotheses. Firms that are high in both FO and IN have higher levels of the SP, RD, and UT than firms that are low in both FO and IN. The F values for the main effects for SP, RD, and UT indicates statistically significant differences in the group means at the $p<0.01$ level. Hypothesis 4 was only partially supported with firms having high FO also having higher levels of IP than firms that are low in FO. The F value for FO effects for IP indicates statistically significant differences at the $p<0.01$ level while the F value for IN effects for IP indicates no statistically significant differences. Therefore, hypothesis 4 was not supported relative to IN effects on high or low levels of IP.

There were no significant interaction effects found in the analyses. This result indicates general support for the argument that manufacturing firms with highly formalized and integrated work systems tend to have high levels of these information systems variables, including IS performance. These results are statistically significant at $p<0.01$ or $p<0.05$ in all cases except IS Performance. In this case, FO generates a significant difference at the $p<0.05$, but IN does not.

One explanation for this may be that manufacturing IS users may view information technologies as tools to assist them in performing standardized work. What may be most important is how closely the IS function replicates and supports formalized work system practices. Senior manufacturing managers may simply view the IS function as a tool builder/provider and not a participant in work system integration efforts intended to improve these practices. Thus, their perceptions of IS performance may be more closely associated the IS functions ability to replicate formalized work system practices than with its involvement in work system integration efforts.

A second explanation is that a relationship does exist between manufacturing work system integration and IS performance, but it may be indirect in nature. Work system integration may directly impact other manufacturing or IS related variables which may in turn directly impact IS performance. For example, IS strategic planning effectiveness, IS responsiveness to organizational computing demands, and end-user training effectiveness have all been hypothesized to impact IS performance in the IS downsizing, IS outsourcing, IS satisfaction, and end-user training literatures.

5.0 CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

This study explores the contingent nature of a firm's IS environmental variables in the context of work system formalization and integration. Study results indicate that more formal work system knowledge is needed to develop more effective IS practices. Greater work system integration complements and supports the development of formal work system knowledge. Firms exhibiting both greater work system formalization and integration aide their IS functions in maximizing their effectiveness.

One important implication of these findings is that manufacturing user departments should create formal policies, procedures, instruction manuals, and other forms of documentation to reduce the ambiguity of their IS support requirements. A second implication is that manufacturing user departments should seek to become more cross-functionally integrated to insure that IS support requirements reflect common organizational needs and definitions. Doing both should increase the speed at which IS support requirements may be defined and implemented in support of manufacturing work system requirements. Study results lend support for the assertion that IS departments located in firms with low work system formalization and low work system integration may be predisposed to poor perceptions of IS performance.

These IS departments may find help in the form of modern knowledge management technologies (KMT). KMTs allow work system practices to be captured, cataloged, organized, saved, and retrieved much more easily. They also allow users to share work system knowledge and contribute to its ongoing development on a real-time basis. Thus, IS functions located within manufacturing firms characterized by low work system formalization and/or integration may find benefit through the introduction of such technologies.

5.1. Limitations

The results of any research study and its generalizability have to consider limitations. Though precautions have been taken to avoid obvious limitations, it is impossible to avoid all such concerns. Both the dependent and independent variables in this study have been measured through a single respondent, which may introduce response bias. The assumption is that senior manufacturing managers have knowledge of their firms FO, IN, and IS practices.

The amount of data captured in this study and the need to collect data from top managers have created a low response rate. To ensure that response/non-response bias is not an issue, tests were done to compare attributes of these groups. The IS variables measured in this research are not exhaustive. In addition, they focus mainly on the internal aspects of the organization and not on the external links with suppliers and customers. Finally, one factor, end-user training effectiveness has only two items, which casts doubt on the reliability of this measure.

5.2 Future Research

Clearly, future research can attempt to address each of the procedural problems identified in the limitations section. Furthermore, the inclusion of additional work system or IS variables that focus on the relationship between an organization and its IS function could be important. For example, such studies could examine the impact of work system variables on other IS-related practices not addressed here such as IS development approaches or end-user computing practices. Other studies could further address the impact knowledge management software could have on improving work system formalization and its subsequent impact on IS development practices.

6.0 REFERENCES

Alter, S. (2003). The IS core – XI: Sorting out issues about the core, scope, and identity of the IS field. Communications of the AIS 2003(12), 607-628.

Argotte, L., and Epple, D. (1990). Learning curves in manufacturing. *Science* 247, 920-924.

Bailey, T., Berg, P., and Sandy, C. (2001). The effect of high-performance work practices on employee earnings in the steel, apparel, and medical electronics and imaging industries. *Industrial and Labor Relations Review* 54 (2A), 525-543.

Costea, I. (1990) The struggle for integration. *Information Strategy: The Executive's Journal* Summer, 38-42.

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika* 16, 297-334.

Doll, W., and Doll, M. (1992). Downsizing at CBS/FOX video. *Information & Management* 23, 123-139.

Due, R. (1992). The dangers of downsizing: Many hidden costs do exist. *Information Systems Management*, Summer, 65-67.

Germain, R., Droge, C., Daugherty, P. (1994). The effect of just-in-time selling on organizational structure: An empirical investigation. *Journal of Marketing Research* 31, 471-483.

Harrison, A., and Rainer, R. (1992). The influence of individual differences on skill in end-user computing. *Journal of Management Information Systems*, 9(1), 93-111.

Henderson, J., and Venkatraman, N. (1999). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, 38(2&3), 472-484.

Hirshheim, R., and Sabherwal, R. (2001). Detours in the path toward strategic information systems alignment. *California Management Review* 44(1), 87-108.

Hodge, R. D. (1989). Integrating systems. *Journal of Systems Management*, 40(8), 18-20.

Kappelman, L., and Guynes, C. (1995) End-user training and empowerment: lessons from a client-server environment. *Journal of Systems Management* 46(5), 37-41.

Lee, H., and Choi, B. (2003). Knowledge management enablers, processes, and organizational, performance: An integrative view and empirical examination. Journal of Management Information Systems 20(1), 179-228.

Levitt, B., and March, J. (1988). Organizational learning. Annual Review of Sociology 14, 319-340.

Miller, D., and Drodge, C. (1986). Psychological and traditional determinants of structure. *Administrative Science Quarterly* 31, 539-560.

Nam, A., Vonderembese, M., and Koufteros, X. (2004). The impact of organizational culture on time-based manufacturing performance. *Decision Sciences* 35(4), 579-607.

Nelson, R. (1991). Educational needs as perceived by IS and end-user personnel: A survey of knowledge and skill requirements. *MIS Quarterly*, 15(4), 503-525.

Palmer, I., and Dunford, R. (2002). Out with the old and in with the new? The relationship between traditional and new organizational practices. The International Journal of Organizational Analysis 10(3), 209-225.

Powell, J. (1993). Rightsizing the IS department. *Information Systems Management* 10(2), 81-83.

Price, J., and Mueller, C. (1986). *Handbook of Organizational Learning*, Pitman Publishing, Inc., Marshfield, MA.

Raghunathan, B., and Raghunathan , T. (1996). *Strategic Orientation of Information Systems* The construct and its measurement. White Paper, The University of Toledo, College of Business, IMES Department.

Rockart, J., and Hofman, J. (1992) Systems delivery: evolving new strategies. *Sloan Management Review* 33(4), 21-31.

Romme, A. (1997). Organizational learning, circularity and double-linking. *Management Learning* 28(2), 146-160.

Rondeau, P., Ragu-Nathan, T., & Vonderembse, M. (2003). Exploring work system practices for time-based manufacturers: their impact on competitive capabilities. Journal of Operations Mangement 18(5), 509-529.

Rondeau, P., Ragu-Nathan, T., & Vonderembse, M. (2003). The information systems environment of time-based competitors. Omega: The international journal of management science, 31(4), 253-268.

Rowley, T., and Smiley, J. (1993). Rightsizing for an effective IS department. *Information Strategy: The Executive's Journal* 9(3), 3-9.

Segars. A., and Grover, V. (1999). Profiles of strategic information systems planning. Information Systems Research 10(3), 199-232.

Suchman, L. (2002). Practice-based design of information systems: Notes from the hyperdeveloped world. The Information Society 18, 129-144.

Susman, G. and Dean, J. "Development of A Model for Predicting Design for Manufacturing Effectiveness," In: *Integrating Design for Manufacturing for Competitive Advantage*, Susman, G. (Ed.), New York: Oxford University Press, 1992, pp. 207-227.

Teng, J., Grover, V., and Fiedler, K. (1994). Re-designing business processes using information technology. *Long Range Planning* 27(1), 95-106.

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