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INFORMATION TECHNOLOGY AND ORGANIZATIONAL STRUCTURE REVISITED: IMPLICATIONS FOR PERFORMANCE

Louis Raymond
Universite du Quibec a Trois-Rivieres

Guy Pare
Florida International University

Francois Bergeron
Universite Laval

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Louis Raymond
Département d'administration et d'économique
Université du Québec à Trois-Rivières

Guy Paré
Department of Information and Management Science
Florida International University

François Bergeron
Faculté des sciences de l'administration
Université Laval

ABSTRACT

While the relationship between information technology (IT) and organizational structure has long been a focus of research from a descriptive and prescriptive point of view, few solid results have been found as of yet linking this relationship to enterprise level performance. This can be attributed to problems related to the definition and measurement of IT, performance and "fit" between technology and structure. In trying to overcome some of these problems, an empirical study was conducted among 108 small and medium-sized manufacturing firms, using a comprehensive instrument to measure IT sophistication in lieu of individual criterion variables. Controlling for organizational size and environmental uncertainty, it was found that IT sophistication is positively related to structural sophistication, IT sophistication is positively related to organizational performance, and the relationship between IT sophistication and structural sophistication is stronger among high-performing firms than among low-performing firms.

1. INTRODUCTION

The relationship between information technology (IT) and organizational structure has long been an object of study, both by information systems researchers (Olson and Chervany 1980) and by organization theorists (Pfeffer and Leblebici 1977). With regard to the effects of IT use on structure, Swanson (1987, p. 199) concluded after a review of the literature that "the general picture is one of substantial confusion and contradiction." Bakos (1987, p. 14) added that this conclusion was also applicable to the link between IT and organizational performance, as "the evidence from the organization theory and strategy disciplines suggests that any such link would depend on the particular organizational and environmental contingencies."

The fact that such a fundamental area of information systems research has produced mostly mixed and inconclusive results can be attributed to several problems. One is related to the definition and measurement of information technology, as most studies have taken a piecemeal rather than comprehensive approach by arbitrarily selecting individual variables (e.g., hardware decentralization, IT investment) as indicators or surrogates of IT sophistication (Weill and Olson 1989b). The same can be said of the organizational performance construct in IS research, where confounding factors add to the difficulty in measuring and isolating the effects of technology. Performance has been left out of many research designs, has been replaced by surrogate dependent variables such as satisfaction and usage (Crowston and Treacy 1986), or has been included only in individual case studies (done for the most part in the area of IT for competitive advantage).

Many research results on the organizational impacts of IT are thus far from being comparable, systematic and valid

(Bakos 1987). Aside from these purely methodological issues, many studies also exhibit theoretical problems related to the absence of a strong reference discipline or a general theoretical context (Swanson 1987). In particular, neglecting the theoretical analysis of the concept of "fit" in contingency theory has prevented contingency research into IT impacts from building a cumulative research tradition (Iivari 1992).

This paper presents the results of an empirical investigation that attempted to overcome some of these problems. Based on Bakos' simple framework for the organizational impacts of information technology (Figure 1), a research model was designed and hypotheses were tested through a study of small and medium-sized manufacturing enterprises. Aiming to broaden and strengthen the foundations of information systems in organization theory, more specifically in contingency theory, and using aggregate measures previously validated, this study sought to answer the following research questions in a comprehensive and systematic manner: What is the link between information technology and organizational structure? What is the link between information technology and enterprise level performance? What is the link between technology-structure "fit" and performance?

2. RESEARCH MODEL AND HYPOTHESES

A pictorial representation of the research model is shown in Figure 2, hypothesizing relationships between the sophistication of the organizational structure, the sophistication of information technology, and organizational performance. In the literature, the most important and consistent dimensions of structure are found to be centralization, formalization and complexity (Ford and Slocum 1977; Miller et al. 1991). Firms whose structure is more decentralized, formalized and complex thus exhibit greater *structural sophistication* than others (Miller 1987).

A number of researchers have attempted to characterize information technology and in particular to identify different criteria of systems "maturity" or "sophistication" (Benbasat, Dexter and Mantha 1980; Cheney and Dickson 1982; Lehman 1985; Montazemi 1987; Raymond 1988; Saunders and Keller 1983; Srinivasan and Kaiser 1987). Most of these studies have used Nolan's "stages of EDP growth" model (1973, 1979) as a theoretical foundation, and hence included variables approached from the two perspectives of IS usage (e.g., type of technology used, nature of the applications portfolio) and IS management (e.g., organization, planning and control of IS). Such conceptualizations, however, are rather piecemeal in their approach by arbitrarily choosing individual variables as indicators of IT sophistication. Such selection limits both the validity of the construct and the amount of variance explained (Weill and Olson 1989a).

Until recently, however, there was no recognized comprehensive characterization of IT in terms of the sophistication of its use and management in organizations, and thus no validated instrument for empirical research or diagnostic purposes. A first attempt at conceptualizing IT sophistication and validating an instrument to measure this concept in the specific context of small and medium-sized enterprises was made by Raymond and Paré (1992). These researchers defined IT sophistication as "a construct which refers to the nature, complexity and interdependence of IT usage and management in an organization" (p. 7). As shown in Figure 3, this construct is multi-dimensional and includes aspects related to technological support, information content, functional support, and management practices. It is used here to obtain a standardized aggregate measure of overall *IT sophistication*, and also two sub-measures corresponding to the *IT usage* and *IT management* dimensions of sophistication.

2.1 Information Technology and Organizational Structure

The centralization-decentralization issue was the first to be taken up by researchers based on the premise, in the words of Ein-Dor and Segev (1982, p. 66), that "different MIS structures naturally fit different organizational contexts" and that "success depends on the extent to which the particular values fit the organizational environment." However, as noted above, empirical confirmation of this premise has yet to be achieved in an unequivocal manner.

Information technology is thought to induce decentralization of control and delegation of decision authority by facilitating the dissemination and sharing of information throughout all levels and units of the firm (Leifer 1988; Pfeffer and Leblebici 1977). Various applications of IT can lead to increased formalization by requiring formal representations of the object systems and decision processes that are to be supported (Huber 1984). IT use can induce structural complexity, i.e., a more differentiated and specialized structure, by increasing the deployment of specialists required to carry out systems development, operation and control activities (Blau et al. 1976; Robey 1981).

A reverse causality is also likely. Decentralized firms are more likely to establish a decentralized IS function and implement distributed hardware and software applications (Ahituv, Neumann and Zviran 1989; Ein-Dor and Segev 1982). Formalized organizations are those in which more

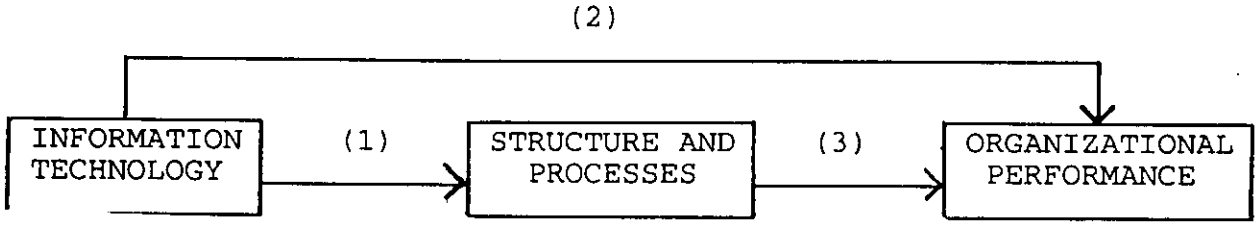

Figure 1. Three Areas for Research on IT Impacts (Bakos 1987)

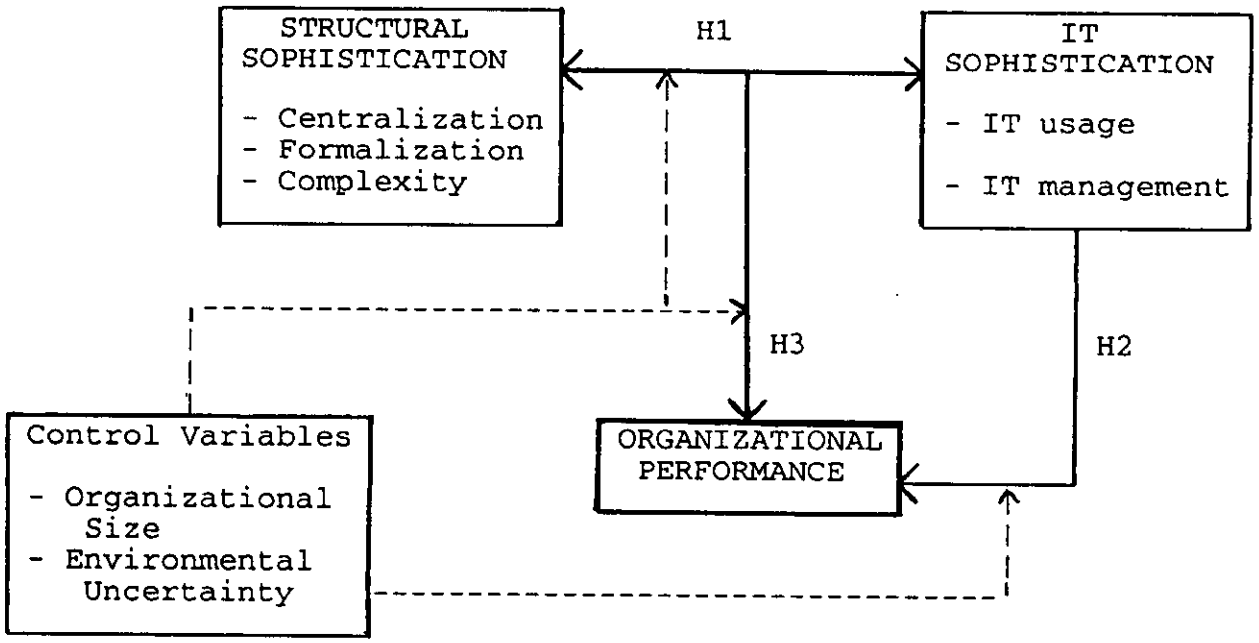

Figure 2. Research Model and Hypotheses

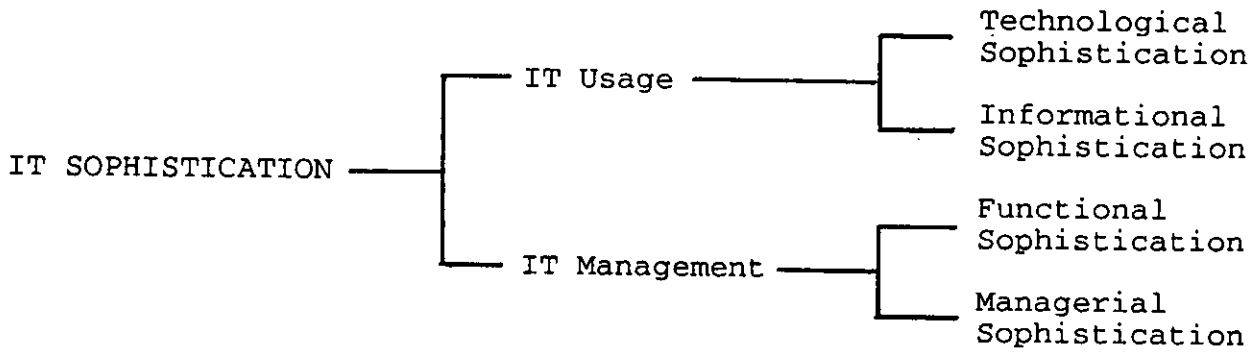

Figure 3. Conceptualization of IT Sophistication (Raymond and Paré 1992)

management techniques such as inventory control, quality control, project management and financial analysis are applied; in turn, these require more sophisticated information support (Raymond 1990) and information resources management (Olson and Chervany 1980). Complexifying structure implies more elaborate coordination, control and communication mechanisms; this in turn requires an infrastructure that only information technology can provide (Robey 1981; Leifer 1988).

Given the preceding considerations, the theoretical existence of a fundamental link between information technology and organizational structure should be maintained and is expressed in the following hypothesis:

H1: *IT sophistication and structural sophistication will be positively and mutually related.*

The research model shows this relationship to be reciprocal. Given the nature of organizational design in post-industrial enterprises, assuming unidirectional causality is too simplistic (Huber 1984; Leifer 1988; Swanson 1987) and results in ill-defined concepts of fit (Iivari 1992).

2.2 Information Technology and Organizational Performance

As stated by Crowston and Treacy (1986, p. 299), "implicit in most of what we do in MIS is the belief that information technology (IT) has an impact on the bottom line of the business." However, IS research has never been able to fully demonstrate the impact of IT on organizational performance, as inconclusive results were obtained in most empirical studies, including both large and small enterprises in the manufacturing and service sectors (Bender 1986; Cragg and King 1992; Cron and Sobol 1983; Floyd and Wooldridge 1990; Harris and Katz 1988; Turner 1982, 1985; Yap and Walsham 1986). One exception is Garsombke and Garsombke (1989), who found computerization to be a significant predictor of performance in small manufacturing firms.

More positive results are found in the research stream on strategic information systems for competitive advantage. Here, through individual business cases, IT has been shown to impact performance by reducing operation and transaction costs, differentiating products and services, and increasing market share (see Wiseman 1988, for an overview). There has been a lingering debate, however, on the actual meaning of competitive advantage (Benjamin, De Long and Scott Morton 1988) and on whether such an advantage can be durable (Clemons 1986).

The inconclusiveness of prior studies can be attributed to methodological problems related to the measurement of information technology and performance, and to uncontrolled confounding factors (Weill and Olson 1989a, 1989b). Also, results obtained from case studies cannot easily be compared or generalized. Hence, the theoretical effect of using and managing IT in a more sophisticated manner should still be confirmed empirically, with the second hypothesis stated as follows:

H2: *IT sophistication will be positively related to organizational performance.*

2.3 Technology-Structure Fit and Organizational Performance

The concept of congruence, match or "fit" between an information system and its organizational context has long been considered to play a determining role in information systems success (Wetherbe and Whitehead 1977; Markus and Robey 1983). However, the use of contingency theory in technology-structure studies has been the subject of criticism, both by organization theorists (Fry 1982; Schoonhoven 1981) and by IS researchers (Weill and Olson 1989a).

Others have countered that it is too early to assess contingency theory, given the flaws in the way previous empirical studies have defined fit and measured its effect on performance (Van de Ven and Drazin 1985; Venkatraman 1989a). Iivari uses the same argument in showing that the empirical literature on the organizational congruency of IS has been dominated by the "selection" approach to fit (IT $\rightarrow$ structure $\rightarrow$ performance), where performance is usually omitted from the research setting (e.g., Ahituv, Neumann and Zviran 1989; Ein-Dor and Segev 1982; Olson and Chervany 1980). This author concludes that taking an alternative "interaction" approach ((IT $\leftrightarrow$ structure) $\rightarrow$ performance) could provide a more complete understanding.

Using this last approach, organization theorists were able to confirm that high-performing organizational subunits matched a decentralized and differentiated structure with nonroutine (as opposed to routine) operations technology (Argote 1982; Alexander and Randolph 1985). While no such results can be found in the IS literature, one can make similar assumptions.

Once the firm makes strategic choices on information technology, matching structures must be defined if the resulting performance and productivity gains are to be high. For instance, the attainment of benefits from new IT activities such as EDI and expert systems is conditioned upon

the establishment of specialized subunits, the hiring of expert staff, and the creation of mechanisms to coordinate their efforts (Bergeron and Raymond 1992; Sipior and Garrity 1992). Conversely, appropriate structures can foster the growth of IT use and facilitate its management. For example, structurally sophisticated firms are more apt to implement the strategies required to manage the risks and reap the competitive benefits associated with end-user computing (Alavi and Weiss 1985; Henderson and Treacy 1986). These assumptions lead to the following hypothesis:

H3: *The relationship between IT sophistication and structural sophistication indicated by Hypothesis 1 will be stronger among high-performing firms than low-performing firms.*

This last hypothesis conforms with the interaction or matching approach to technology-structure fit (Van de Ven and Drazin 1985; Venkatraman 1989a).

2.4 Other Contingency Variables

Organization theorists have assumed that three other variables consistently play an important role in technology-structure relationships; these are organizational size, environmental uncertainty and industrial sector (Ford and Slocum 1977; Miller et al. 1991). Attewell and Rule (1984) have also noted the mediating role of contextual variables in IT impact research. The first such variable, size, has long been the subject of debate in organization theory as to its effects on structure versus technology. One result of note here is Hickson, Pugh and Pheysey's (1969) finding of a weaker link between technology and structure in large firms. This was attributed to greater structural constraints that make technological effects less likely to manifest themselves in large organizations. Carter (1984) found size to moderate the impact of computerization on the structure of newspaper organizations. Size has also been linked to the IS structure or IT sophistication characteristics of the organization (Ein-Dor and Segev 1982; Lehman 1985; Raymond 1990; Turner 1982).

Environmental uncertainty has also been hypothesized to be a determinant of structure, and the congruence between the two to affect organizational effectiveness (Duncan 1972). However, empirical investigations have produced disparate findings in this regard, both in large (Argote 1982) and in small firms (Covin and Covin 1990; Miller and Droge 1986). Increased environmental heterogeneity and instability is seen as making the use of IT both necessary and justified (Pfeffer and Leblebici 1977) and causing information acquisition to be more continuous, more variant and wide-ranging (Huber 1984). Also, the management of information systems becomes more problematic as information requirements become more complex and technology becomes more elaborate (Lederer and Mendelow 1990).

Considering the industrial sector, i.e., manufacturing versus service, Miller et al. (1991) indicate that service organizations have narrower ranges on both technology and structure variables and thus tend to exhibit weaker technology-structure relationships. Hence, given the potential for added contingency effects from these three variables, they should be accounted for in the research design (Bakos 1987). Note that while size and uncertainty were explicitly included as control variables in the research model and measured (Figure 2), sector was considered here as a methods variable, its effect being removed by limiting the sample to manufacturing organizations.

3. METHODOLOGY

3.1 Sample and Data Collection

Using a government list of all the small and medium-sized manufacturing firms in the province of Quebec, Canada, a questionnaire was mailed to the CEOs of 1,000 firms. Stratified random sampling was used to obtain a representative sample in terms of size, region and industry. Very small enterprises (less than twenty employees) were excluded to increase the probability of sampling organizations in which some form of computer-based support was present. Questionnaires were received from 180 firms for a response rate of 18%; of these, 51 indicated they did not use IT and were thus excluded from the sample. Of the remaining 129 firms, twenty-one were also excluded as they reported having more than 249 employees (this being the size criterion used by the U.S. Small Business Administration for the manufacturing sector). Note that the somewhat low response rate was to be expected, given the small business context. The disdain of owner-managers for anything that smacks of "red tape" is here a more plausible explanation for non-response than the characteristics of the sample or the nature of the question under study (Assael and Keon 1982). The organizational profile of the 108 firms in the sample is presented in Table 1.

The CEO was asked to complete the first part of the questionnaire, notably regarding organizational size, structure, environmental uncertainty and performance. He or she was then asked to pass the questionnaire on to the individual having the greatest responsibilities for the IT function within the organization, which could be a vice-president or functional manager, a controller, an accountant or an analyst-programmer. This individual was asked to complete the second part of the questionnaire pertaining to

Table 1. Profile of the Sampled Organizations (n = 108)

	Mean	Median	Minimum	Maximum
Number of employees	64.5	50	19	230
Annual sales (million $)	7.2	5	0.6	58
IT experience (years)	5.3	5	0.6	25

Industry: wood (16.7%), metal products (11.1%), printing (11.1%), food (10.2%), electrical products (8.3%), furniture (7.4%), clothing (5.6%), machinery (4.6%), plastics (4.6%), mineral products (3.7%), chemical products (2.8%), other (14.0%)

the firm's IT sophistication. Firms in which there was no form of computer-based support were instructed to check a box on the front page of the questionnaire and return it unanswered in the accompanying stamped and pre-addressed envelope.

3.2 Measurement of IT Sophistication

Information technology has been operationalized in most IS contingency models in terms of the type of system to which it is applied and in terms of the technical sophistication of these systems (Weill and Olson 1989a). For instance, Saunders and Keller (1983, p. 118) referred to the "sophistication of the mix of applications provided by the IS function" while Lehman examined the characteristics of the technology itself such as the nature of the hardware and software tools found in the organization. Other researchers have operationalized IT from an organizational rather than technological perspective, looking at the infrastructure put in place to organize the IS function (Olson and Chervany 1980) and at the managerial practices employed to plan and control the implementation and use of IT (Srinivasan and Kaiser 1987).

As mentioned earlier, Raymond and Paré were first in attempting to develop and validate a comprehensive measure of information technology sophistication. Figure 4 presents the criterion variables chosen to characterize each dimension of the construct. These variables were chosen on the basis of their fundamental nature as descriptors of IT usage and management, their relevance to the specific context of small manufacturing firms, and their having previously been examined in empirical research. Importantly, preliminary findings support the theoretically appealing breakdown of IT sophistication into technology, information, function and management. Results on the reliability, content, construct and predictive validity of the measure can be found in Raymond and Paré.

3.3 Measurement of Structural Sophistication

Remembering the three fundamental dimensions of organizational structure to be centralization, formalization and complexity, structural variables were chosen to adequately reflect each. The first dimension was evaluated by the size of the firm's managerial hierarchy (managers/all personnel). This ratio is particularly relevant for smaller enterprises, as it a good indicator of both the decentralization of control and the delegation of decision-making authority from the owner-manager to other individuals in the organization (Blau, Heydebrand and Stauffer 1966).

The Aston studies (Pugh et al. 1969) provide a primary measure of formalization, using scales that indicate the extent to which rules, procedures and activities are written. The second dimension was also evaluated by the organizational deployment of professionals such as accountants and engineers (excluding managers, /all personnel). Miller et al. include professionalization (with size, performance and industrial sector) among the contingency variables playing the most important roles in technology-structure relationships.

The third dimension of structure, complexity, is more plurivocal, including aspects of coordination, specialization (or horizontal differentiation) and vertical differentiation. Coordination was measured here by the size of the firm's administrative apparatus (clerical/all personnel), which is a bureaucratic mechanism to deal with organizational complexity (Blau, Heydebrand and Stauffer 1966). Specialization was gauged by the division of labor, i.e., the number of distinct job titles in the organization chart (Paulson and Stump 1979). Differentiation was measured by the vertical span, i.e., the number of hierarchical levels in the firm between the CEO and direct employees in the production function (Pugh et al. 1969).

Dimension	Sub-dimension	Criterion Variable
IT USAGE	Technological Sophistication	Diversity of IT used Hardware decentralization Diversity of development tools Human-machine interface quality Processing mode
	Informational Sophistication	Applications portfolio Integration of applications
IT MANAGEMENT	Functional Sophistication	IS personnel specialization Role of the IS function Decisional level targeted Type of development Position of the IS function User participation
	Managerial Sophistication	Organizational objectives Top-management implication IT budget IT adoption process Presence of consultants IT planning process Control of IT Evaluation of IT

Figure 4. Dimensions of IT Sophistication and Criterion Variables (adapted from Raymond and Paré 1992)

3.4 Measurement of Organizational Performance

The concept and measurement of organizational performance have long been a subject of debate in business research (Venkatraman and Ramanujan 1986). In most IS studies, the assessment of performance has been based on an objective approach, using a set of financial ratios such as return on investment (ROI) and return on assets (ROA) or volume measures such as revenue and sales growth (Weill and Olson 1989a). Such accounting measures have been criticized because they focus only on the economic dimensions of performance, neglecting other important goals of the firm; also, the data are often unavailable or unreliable (Dess and Robinson 1984). This is particularly true in the small business context where these data are either not provided or have been subject to managerial manipulation by the owner for a variety of reasons, such as the avoidance of corporate and personal income taxes (Sapienza, Smith and Gannon 1988).

To relieve this measurement problem, strategic management researchers have proposed an alternative approach, based on subjective measures of organizational performance (Dess and Robinson 1984). Both Venkatraman (1989b) and Miller (1987) used such an approach to examine the relationship between strategy and performance. As the latter's instrument was validated in a small business context, it was deemed to be appropriate for the present study. The CEO was thus asked to indicate on 7-point Likert scales how his or her firm performed relative to the industry average or to other firms in the same market during the last five years, in terms of long run profitability, growth of sales, financial resources (liquidity and investment capability), and public image and client loyalty.

3.5 Measurement of Organizational Size and Environmental Uncertainty

Organizational size was obtained by computing the natural logarithm of the number of full-time employees, as this variable can sometimes be quite skewed (Paulson and Stump 1979). Environmental uncertainty was measured by using an instrument validated in a small business context by Miller and Droge (1986), in which the CEO is asked to indicate on 7-point Likert scales the degree of change and unpredictability in the firm's markets, competitors and production technology.

Table 2. Rotated Loadings of the Structural Variables (n = 108)

	Structural Sophistication Factors	
structural variable	Human Resources	Formal Structure
managerial hierarchy	.78	
formalization		.64
professionalization	.65	
administrative apparatus	.73	
division of labor		.53
vertical span		.83
% of variance	28.3%	23.9%
eigenvalue	1.7	1.4

Table 3. Means of the Research Variables

Variable (range)	All firms (n = 108) mean	High[a] performance (n = 37) mean	Low performance (n = 32) mean	(High versus Low) t
Organizational Size (ln [20-249]	3.90	3.98	3.82	0.99
Environmental Uncertainty (1-7)	4.26	3.94	4.50	-2.49*
Human Resources [b]	0.00	0.05	0.02	0.10
managing hierarchy (0-1)	0.10	0.10	0.09	0.24
professionalization (0-1)	0.04	0.03	0.04	-0.19
administrative apparatus (0-1)	0.11	0.10	0.11	-0.04
Formal Structure [b]	0.00	0.13	-0.10	0.95
formalization (0-6)	2.49	2.40	2.56	-0.42
division of labor (1-12)	4.10	3.83	3.69	1.95
vertical span (1-6)	3.15	3.22	3.06	0.69
IT Sophistication [c]	0.00	-0.00	-0.28	1.42
IT Usage [c]	0.00	-0.04	-0.23	0.96
IT Management [c]	0.00	0.00	-0.27	1.24
Organizational Performance (1-7)	4.72	5.54	3.71	17.85***

[a]High/Low performing firms: upper/lower third on Organizational Performance score

[b]Standardized factor scores (mean = 0, standard deviation = 1)

[c]Standardized by the mean and s.d. for the total sample

*$p < 0.05$ ***$p < 0.001$ (2-tailed t-test)

4. RESULTS AND DISCUSSION

Due to the aggregate view in which the research hypotheses are stated, a principal components analysis of the structural variables was first performed, seeking defined (a posteriori) rather than inferred (a priori) dimensions of structural sophistication. As shown in Table 2, a two-factor solution emerged after orthogonal rotation, explaining 52.2% of variance.

The first factor combines the structural variables that relate to the deployment mix of the organization's human resources to direct and support business operations, including line, staff and clerical resources. The second factor captures variables depicting the formal structure into which these human resources are deployed, including how the structure is differentiated and formalized. Following Miller, the departure of these results from previous findings (Child 1972; Pugh et al. 1969) can be attributed to the small firm context in which the study was conducted and to the inclusion of additional variables measuring formalization and complexity, namely professionalization, administrative apparatus and vertical span. Also, given prior results on the simpler structure of small organizations (Blau, Heydebrand and Stauffer 1966; Mintzberg 1979; Paulson and Stump 1979), the two factors seem to have adequate face validity.

The research hypotheses were then tested with the two structural sophistication factors as aggregate variables, using the standardized factor scores obtained from the principal components analysis. Hypotheses 1 and 2 were tested by computing zero-order and partial product-moment correlation coefficients. Following an interaction approach, such as used by Argote (1982) and Miller (1987), Hypothesis 3 was tested by forming sub-samples based on organizational performance, comparing correlation and regression results with Z and Chow tests. To be regarded as high (or low) performing, a firm had to have a performance score ranking it in the upper (or lower) third of the total sample. Table 3 presents the means of the research variables, including their breakdown for the two sub-samples. One can note initially that, apart from the performance variable itself, the only significant difference between the high and low performing firms is in regard to their environment, where the latter perceive greater uncertainty.

4.1 Hypothesis 1

The results presented in Table 4 show definite empirical support for the first hypothesis, linking IT to organizational structure. Irrespective of organizational size and environmental uncertainty, structural sophistication and IT sophistication are seen here to be clearly related. However, this relationship appears to be stronger on the formal rather than the human dimension of structure, as neither the level of professionalization nor the administrative apparatus correlate significantly with IT sophistication.

One could venture that increased sophistication in the use and management of information resources, while associated to an increased managerial hierarchy, is sought as an alternative or substitute to increasing professional and clerical resources. For instance, managers who receive more and better decision and office support from IT would not require added staff. Similarly, more IT-based support for operations would also prevent growth-related increases in administrative personnel.

Looking at the right-hand column of Table 4, one can also note that none of the structural variables, with the exception of division of labor, significantly relate to organizational performance. This could be interpreted as an initial indication of the purely contingency role assumed here for organizational structure in regard to performance, as opposed to the determinant role of information technology. However, as suggested by Bakos (1987, p. 13), the problem of the link between structure and performance "is best left to organization theorists."

4.2 Hypothesis 2

Shown in the two right-hand columns of Table 5 are the zero-order and partial correlations of IT sophistication with organizational performance. As indicated by the zero-order coefficients, IT and performance seem to be unrelated. However, when the effects of size, uncertainty and structure are removed from this relationship, its significance does appear, confirming the second research hypothesis. Greater sophistication in the use of IT, i.e., more advanced hardware and software technologies and a more diversified and integrated applications portfolio, is significantly associated to better performance. This is less evident for the management of IT in terms of a better organized IS function and more sophisticated IS planning and control practices. The significant effect of IT usage, as opposed to IT management, could be attributed to its more immediate impact on the firm's value chain (i.e., the purposes for which IT is applied).

When compared with the mixed results of previous studies on the enterprise level impact of IT, this confirmation of the emerging role of information technology as a determinant of organizational performance also brings to light the importance of size and environmental uncertainty as crucial contingency factors. The correlations shown in the two left-hand columns of Table 5 indicate that both of these variables are significantly related to IT sophistication. Firms of greater size and firms who perceive their environment to be more uncertain tend to be more sophisticated in their use and management of IT. Adoption of this technology to increase information processing capabilities can thus be the firm's main response to increasing complexity, brought about internally by growth or externally by changes in the environment.

Table 4. Partial Correlations of Structural Factors and Variables with IT Sophistication and Organizational Performance, Controlling for Organizational Size and Environmental Uncertainty (n = 108)

Structural Factor structural variable	IT Usage	IT Management	IT Sophistication	Organizational Performance
Human Resources	.184*	.223*	.214*	.079
managerial hierarchy	.213*	.251**	.251**	.091
professionalization	.091	.122	.114	.052
administrative apparatus	.068	.103	.076	-.029
Formal Structure	.362***	.430***	.452***	.113
formalization	.332***	.398***	.406***	-.048
division of labor	.252**	.171*	.249***	.189*
vertical span	.178*	.294***	.270**	.077

*p < 0.05 **p < 0.01 ***p < 0.001

Table 5. Correlations of IT Sophistication with Organizational Size, Environmental Uncertainty and Organizational Performance (n = 108)

	Zero-Order			Partial[a]
	Organizational Size	Environmental Uncertainty	Organizational Performance	Organizational Performance
IT Sophistication	.391***	.175*	.137	.188*
IT Usage	.295***	.168*	.135	.176*
IT Management	.381***	.117*	.092	.103

[a]Controlling for Organizational Size, Environmental Uncertainty, Human Resources, and Formal Structure

*p < 0.05 **p < 0.01 ***p < 0.001

4.3 Hypothesis 3

The third research hypothesis assumed stronger IT-structure relationships in high-performing firms than in low-performing ones. Looking at Table 6, one finds five out of six possible IT-structure correlations to be significant in the first group, whereas none are significant in the second group. The Z-test statistics, comparing correlation coefficients of the two groups, indicate the congruent relationships to be stronger on the formal rather than human dimension of structure. These results are after removing the effects of size and environmental uncertainty.

A complementary test of Hypothesis 3 compares stepwise regression analyses of the high and low-performing groups, using IT sophistication as the dependent variable with size, uncertainty and the two structural sophistication factors as the independent variables. As shown in Table 7, 37% of the variance in overall IT sophistication is explained in the high-performing firms versus 21% in the low-performing ones. A lesser discrepancy is found on the IT usage dimension (19% versus 12%) but a greater one exists for the IT management dimension (40% versus 14%). The results of Chow's F-test of the constancy of the regression coefficients confirm the significance of these differences for IT sophistication and IT management, but not for IT usage. Note also the preeminence of the formal as opposed to the human dimension of structure in explaining IT sophistication variance in high-performing firms, in line with the preceding results on Hypotheses 1 and 3.

There is thus partial support for Hypothesis 3. A significantly closer relationship between overall IT sophistication and formal structural sophistication was found here to characterize successful organizations, as opposed to unsuccessful ones. It would seem that more sophistication in the IT management function and practices, when matched with an appropriately formalized and differentiated organizational structure, further contributes to performance. More tentatively, matching sophisticated IT use and management with the appropriate deployment of human resources in the organization would also be a contributing factor.

4. RESULTS AND DISCUSSION

Due to the aggregate view in which the research hypotheses are stated, a principal components analysis of the structural variables was first performed, seeking defined (a posteriori) rather than inferred (a priori) dimensions of structural sophistication. As shown in Table 2, a two-factor solution emerged after orthogonal rotation, explaining 52.2% of variance.

The first factor combines the structural variables that relate to the deployment mix of the organization's human resources to direct and support business operations, including line, staff and clerical resources. The second factor captures variables depicting the formal structure into which these human resources are deployed, including how the structure is differentiated and formalized. Following Miller, the departure of these results from previous findings (Child 1972; Pugh et al. 1969) can be attributed to the small firm context in which the study was conducted and to the inclusion of additional variables measuring formalization and complexity, namely professionalization, administrative apparatus and vertical span. Also, given prior results on the simpler structure of small organizations (Blau, Heydebrand and Stauffer 1966; Mintzberg 1979; Paulson and Stump 1979), the two factors seem to have adequate face validity.

The research hypotheses were then tested with the two structural sophistication factors as aggregate variables, using the standardized factor scores obtained from the principal components analysis. Hypotheses 1 and 2 were tested by computing zero-order and partial product-moment correlation coefficients. Following an interaction approach, such as used by Argote (1982) and Miller (1987), Hypothesis 3 was tested by forming sub-samples based on organizational performance, comparing correlation and regression results with Z and Chow tests. To be regarded as high (or low) performing, a firm had to have a performance score ranking it in the upper (or lower) third of the total sample. Table 3 presents the means of the research variables, including their breakdown for the two sub-samples. One can note initially that, apart from the performance variable itself, the only significant difference between the high and low performing firms is in regard to their environment, where the latter perceive greater uncertainty.

4.1 Hypothesis 1

The results presented in Table 4 show definite empirical support for the first hypothesis, linking IT to organizational structure. Irrespective of organizational size and environmental uncertainty, structural sophistication and IT sophistication are seen here to be clearly related. However, this relationship appears to be stronger on the formal rather than the human dimension of structure, as neither the level of professionalization nor the administrative apparatus correlate significantly with IT sophistication.

One could venture that increased sophistication in the use and management of information resources, while associated to an increased managerial hierarchy, is sought as an alternative or substitute to increasing professional and clerical resources. For instance, managers who receive more and better decision and office support from IT would not require added staff. Similarly, more IT-based support for operations would also prevent growth-related increases in administrative personnel.

Looking at the right-hand column of Table 4, one can also note that none of the structural variables, with the exception of division of labor, significantly relate to organizational performance. This could be interpreted as an initial indication of the purely contingency role assumed here for organizational structure in regard to performance, as opposed to the determinant role of information technology. However, as suggested by Bakos (1987, p. 13), the problem of the link between structure and performance "is best left to organization theorists."

4.2 Hypothesis 2

Shown in the two right-hand columns of Table 5 are the zero-order and partial correlations of IT sophistication with organizational performance. As indicated by the zero-order coefficients, IT and performance seem to be unrelated. However, when the effects of size, uncertainty and structure are removed from this relationship, its significance does appear, confirming the second research hypothesis. Greater sophistication in the use of IT, i.e., more advanced hardware and software technologies and a more diversified and integrated applications portfolio, is significantly associated to better performance. This is less evident for the management of IT in terms of a better organized IS function and more sophisticated IS planning and control practices. The significant effect of IT usage, as opposed to IT management, could be attributed to its more immediate impact on the firm's value chain (i.e., the purposes for which IT is applied).

When compared with the mixed results of previous studies on the enterprise level impact of IT, this confirmation of the emerging role of information technology as a determinant of organizational performance also brings to light the importance of size and environmental uncertainty as crucial contingency factors. The correlations shown in the two left-hand columns of Table 5 indicate that both of these variables are significantly related to IT sophistication. Firms of greater size and firms who perceive their environment to be more uncertain tend to be more sophisticated in their use and management of IT. Adoption of this technology to increase information processing capabilities can thus be the firm's main response to increasing complexity, brought about internally by growth or externally by changes in the environment.

Table 4. Partial Correlations of Structural Factors and Variables with IT Sophistication and Organizational Performance, Controlling for Organizational Size and Environmental Uncertainty (n = 108)

Structural Factor structural variable	IT Usage	IT Management	IT Sophistication	Organizational Performance
Human Resources	.184*	.223*	.214*	.079
managerial hierarchy	.213*	.251**	.251**	.091
professionalization	.091	.122	.114	.052
administrative apparatus	.068	.103	.076	-.029
Formal Structure	.362***	.430***	.452***	.113
formalization	.332***	.398***	.406***	-.048
division of labor	.252**	.171*	.249***	.189*
vertical span	.178*	.294***	.270**	.077

*p < 0.05 **p < 0.01 ***p < 0.001

Table 5. Correlations of IT Sophistication with Organizational Size, Environmental Uncertainty and Organizational Performance (n = 108)

	Zero-Order			Partial[a]
	Organizational Size	Environmental Uncertainty	Organizational Performance	Organizational Performance
IT Sophistication	.391***	.175*	.137	.188*
IT Usage	.295***	.168*	.135	.176*
IT Management	.381***	.117*	.092	.103

[a]Controlling for Organizational Size, Environmental Uncertainty, Human Resources, and Formal Structure

*p < 0.05 **p < 0.01 ***p < 0.001

4.3 Hypothesis 3

The third research hypothesis assumed stronger IT-structure relationships in high-performing firms than in low-performing ones. Looking at Table 6, one finds five out of six possible IT-structure correlations to be significant in the first group, whereas none are significant in the second group. The Z-test statistics, comparing correlation coefficients of the two groups, indicate the congruent relationships to be stronger on the formal rather than human dimension of structure. These results are after removing the effects of size and environmental uncertainty.

A complementary test of Hypothesis 3 compares stepwise regression analyses of the high and low-performing groups, using IT sophistication as the dependent variable with size, uncertainty and the two structural sophistication factors as the independent variables. As shown in Table 7, 37% of the variance in overall IT sophistication is explained in the high-performing firms versus 21% in the low-performing ones. A lesser discrepancy is found on the IT usage dimension (19% versus 12%) but a greater one exists for the IT management dimension (40% versus 14%). The results of Chow's F-test of the constancy of the regression coefficients confirm the significance of these differences for IT sophistication and IT management, but not for IT usage. Note also the preeminence of the formal as opposed to the human dimension of structure in explaining IT sophistication variance in high-performing firms, in line with the preceding results on Hypotheses 1 and 3.

There is thus partial support for Hypothesis 3. A significantly closer relationship between overall IT sophistication and formal structural sophistication was found here to characterize successful organizations, as opposed to unsuccessful ones. It would seem that more sophistication in the IT management function and practices, when matched with an appropriately formalized and differentiated organizational structure, further contributes to performance. More tentatively, matching sophisticated IT use and management with the appropriate deployment of human resources in the organization would also be a contributing factor.

Table 6. Partial Correlations Between Structural Factors and IT Sophistication are Greater in the High-Performing and Low-Performing Firms, Controlling for Organizational Size and Environmental Uncertainty

	Structural Sophistication Factors	
	Human Resources	Formal Structure
HIGH-PERFORMING FIRMS (n = 37)		
IT Sophistication	.302*	.519***
IT Usage	.292*	.380*
IT Management	.222	.538***
LOW-PERFORMING FIRMS (n = 32)		
IT Sophistication	.148	.194
IT Usage	.093	.228
IT Management	.202	.030
Z[a]		
IT Sophistication	0.64	1.49[b]
IT Usage	0.82	0.66
IT Management	0.08	2.26*

[a]Positive Z scores indicate that the correlations between Structural Factors and IT Sophistication are greater in the high-performing firms than in the low-performing firms (Guilford and Fruchter 1973, pp. 166-167).

[b]p < 0.1 *p < 0.05 ***p < 0.001

Table 7. Stepwise Multiple Regressions of Organizational Size, Evironmental Uncertainty and Structural Factors on IT Sophistication for All Firms (n = 108), High-Performing Firms (n = 37) and Low-Performing Firms (n = 32)

	Regression coefficient (betas)[a]						Chow's F[b]
	Org. Size	Env. Uncert.	Human Resources	Formal Structure	R^2	F	High vs. Low-Perf.
IT SOPHISTICATION							
All firms	.17	.12	.07	.56***	.37	47.3***	
High-performing	.11	.08	.22	.61***	.37	20.5***	
Low-performing	.20*	.17	.14	.17	.21	8.0**	2.46[c]
IT USAGE							
All firms	.11	.12	.08	.45***	.20	26.9***	
High-performing	.03	.02	.25	.44***	.19	8.3**	
Low-performing	.35*	.28	.09	.20	.12	4.1*	0.46
IT MANAGEMENT							
All firms	.17	.06	.08	.53***	.28	42.1***	
High-performing	.16	.07	.14	.63***	.40	23.5***	
Low-performing	.38*	.00	.20	.03	.14	5.0*	3.60*

[a]A non-significant beta indicates that the variable did not enter in the stepwise regression equation.

[b] Test of the constancy of the regression coefficients (Huang 1970), pp. 104-112).

[c]p < 0.1 *p < 0.05 **p < 0.01 ***p < 0.001

5. LIMITATIONS

A first limitation of this study relates to the use of a single perceptual measure of organizational performance. More support for the research hypotheses could have been provided if alternative factual measures such as return on investment and net growth, their own limitations notwithstanding, had been available. The IT sophistication measure also requires further validation, particularly in terms of construct validity, as the size of the sample precluded the use of confirmatory factor analysis for this purpose. In regard to the nature of the sample (small and medium-sized enterprises, manufacturing sector), to the use of mail questionnaires for data collection purposes and to the cross-sectional (as opposed to longitudinal) nature of the study, the usual limitations on generalization and causality also apply here.

6. CONCLUSION

The results presented in this paper have broadened and strengthened the foundations of previous technology-structure research by confirming, in a comprehensive and systematic manner, the positive relationship between IT sophistication and structural sophistication. This investigation is also one of the first to provide conclusive empirical evidence for the positive impact of information technology on enterprise level performance across a large number of business organizations. Another important research contribution resides in giving empirical credence to the significant performance implications of the "fit" between information technology and organizational structure.

These findings imply that IS researchers can follow-up on Iivari's (1992, p. 25) proposition, "taking a positive attitude toward the prospects for future contingency theory research into information systems," to build a cumulative tradition. Following Van de Ven and Drazin, this should specifically include more of a "systems" approach to the contextual fit of information technology, integrating multiple contingencies and multiple characterizations of IT and performance. For instance, one construct that has not been included in the research model is strategy. The strategy-technology and strategy-structure contingencies also have implications for performance (Vitale, Ives and Beath 1986; Miller 1987) and should thus be included in future research designs.

Given the inclusion of performance as a dependent variable in the research, normative implications can also be drawn for practitioners looking to render IT usage and management more effective in organizations. For instance, inadequate small business performance could be diagnosed when a growth-related increase in structural sophistication, such as a larger managerial hierarchy or greater specialization, is not matched by a sufficient increase in IT sophistication. Inversely, such inadequacy could be prevented if IT adoption and implementation plans include structural considerations. Finally, comprehensive IT measurement instruments such as the ones used in this study could help in pointing out where these mismatches do or can occur and in providing guidance as to the type of solution that is needed.

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