Measuring Environmental Uncertainties in a Study of the Impact of Information Technology on Organizational Communication Patterns

Seokjoong Yoon* Ephraim R. McLean** Merwyn L. Elliot***

*Department of Computer Information Systems, Georgia State University
**Department of Decision Sciences, Georgia State University

Abstract

Uncertainty, caused by the unpredictability of external environments, has been shown to have a number of effects on the structure and communication patterns of organizations. However, uncertainty can also be a consequence of actions taken within the internal environment of a company. Additionally, the adoption of information technology (IT), with broad “reach” and “range,” can similarly affect the functioning of an organization. This study attempts to measure and assess the impact of these three variables -- environmental uncertainty, both external and internal, intensity of IT usage; and organizational communication patterns. Five Korean companies as well as three American companies operating in Korea are used as research sites and significant results are obtained.

1. Background

Organizations of the 1990s are facing an environment which is more turbulent than ever before [19,21]. This environmental turbulence is rooted in changes in the social, political, technical, and economic domains which surround an organization. The bad news is that organizations which cannot keep abreast of these changes die; but the good news is that the same environmental turbulence opens up new opportunities to those organizations that are prepared for them.

To maintain its managerial competencies, each organization must fundamentally redesign its strategy, structure, and management practices, recognizing that the ultimate goal of such organizational redesign should not be restricted merely to a reactive response to environmental changes. Confronting the advent of broader-scale globalization and more serious international competition, the organization of the 1990s must recognize these changing boundaries, and be ready to play a proactive role in creating its own environment. In order to meet these new requirements, organizations of the 1990s need to be reshaped from top to bottom; i.e., be completely transformed [6].

A number of authors have described the nature of this organizational transformation [4,12,19,21] and propose a new form of modern industrial organization [6,17]. The main theme of these authors is how organizations can escape from function-oriented departmentalization (i.e., functional differentiation) through the elimination of middle management layers and the arrangement of organizational specialties around key processes. As organizations face more diverse kinds of environmental uncertainties, employees within these organizations must deal with autonomous and real-time decision making more intensely than ever before. Hence, organizations need to empower their employees by passing decision-making authority down to lower levels of management; but organizations also need to provide lateral and/or interorganizational communication channels to make this empowerment effective.

In light of this, an obvious question is “How is information technology supporting the transformation of organizations in the 1990s?” Many claim that IT is the key facilitator and/or enabler of organizational transformation, leading to drastic improvements in organizational performance [4,21,23]. This IT-driven organizational transformation includes 1) the formulation of strategic alliances (i.e., information partnership by means of shared data) among suppliers, customers, and even competitors; 2) the transition from vertical integration to value-adding partnerships; 3) the addition of capability-based competition to time-based competition; and 4) an orientation toward quality based on customer preferences and satisfaction.

Nevertheless, controversy still remains over IT’s role and effectiveness. Some contend that IT is the backbone of modern industrial organizations and thereby is causing fundamental changes within organizations. An opposite perspective treats the rethinking processes, the attitudes, and the practices of management as the key factors in organizational transformation, and gives secondary attention to IT [12,14]. There is even some suspicion that IT may have an adverse effect on organizational life through the deskilling of employees, the impersonalization of the work environment, and in
threats to job security; and that it has nothing to do with
the overall performance enhancement of organizations.

In order to reap the real benefits of organizational
transformation and to avoid the misdirection of
management effort, we need to have a more
comprehensive understanding of the procedures of
organizational transformation and the role of IT within
these procedures. Yet, the current literature in the IS
field has little empirical evidence on the specific changes
brought about by IT in organizations facing rapidly
changing environments. Despite much practitioner
interest in this issue, the current IS literature on
organizational transformation is fragmented, somewhat
misleading, and does not articulate IT’s role in, and
contribution to, successful organizational transformation.
Most of the research still treats the subject at an abstract
level. Few studies provide explanations of success -- or
failure -- supported by sound organizational theory or by
valid empirical evidence.

Adopting an ecological view of organizations, this
study proposes an approach to investigating the role of IT
in the context of the process through which an
organization realigns its internal characteristics with
changes in its environment. The grounding argument is
that, in the road leading to the eventual success of
organizational transformation and thus to improved
organizational performance, there are factors within
either the external or internal environment that requires
different degrees of IT involvement. In contrast to most
of the IT value-assessment research, which attempts to
show IT’s contributions through a direct link between IT
investment and firm performance, this study proposes to
scrutinize the role of IT by identifying the micro-level
changes evoked by IT usage.

In organization theory, an organization’s environment
has been identified as a major determinant of the amount
of uncertainty perceived by the organization and thus
envoking a substantial influence on its behavior
[2,10,16,24]. Organizational communication patterns are
also identified as factors that are important in order to
sustain effective organizational functioning [20].

Organizational transformation proponents of the
1990s treat environmental uncertainty as a key stimulus
of transformation [19,21]. Organizational communication
patterns (i.e., enhanced horizontal communications) as
major components of successful transformation [6,23],
and IT as a key enabler and facilitator of this
transformation [4,21]. This triangular relationship
among environmental uncertainty, organizational
communication patterns, and IT is shown in Figure 1.

In addition, this study examines IT’s role regarding
operational-level managers who perform functional tasks
within their organizations. Organizations of the 1990s
call for more aggressive environmental scanning and
rapid decision making on the part of lower-level
managers [6,19]. With the shrinkage of the middle
management layer, successful organizations are
empowering their lower-level managers, moving them to
the front line of operations, and encouraging them to go
beyond traditional organizational boundaries [23]. Upon
the integration of individual functional units into core
organizational processes, managers are being called upon
to perform a new role of continuous negotiation with
others [22]. As a result, organizational transformation is
successful when the operational managers adopt these
new leadership roles consistent with the overall
organizational strategy, and when organizational
resources are deployed in support of these managers [9].
Therefore, it is meaningful to try to identify the role of IT
-- a key resource in today’s organizations -- in terms of
facilitating the performance of operational managers.

As a first step in identifying the changes evoked by IT
within organizations, this study raises the following
research question: What is the relationship among
environmental uncertainty, IT intensity, and
organizational communication patterns at the functional
unit level within organizations? The purpose of this
study is thus two fold: 1) to identify the nature of the
environmental uncertainties which may affect IT’s ability
to empower employees at the lower levels of
management, and 2) to investigate IT’s impact on
organizational communication patterns under varying
degrees of environmental uncertainty.

Figure 1. The Basic Model

The next section describes the way organizational
theory has conceptualized environmental uncertainty and
the manner in which this study measures it. This is
followed by a description of the research model and of
the research method used to test it. The results of the
statistical analysis as well as concluding remarks are
provided at the end.

2. Measuring environmental uncertainty

In organization theory, the external environment has
long been considered the major source of uncertainty
which most organizations must face in order to be
effectively, and thus is taken as the key determinant which affects, perhaps more than any other factor, the structure, internal processes, and managerial decision making within the organization. For any study adopting an open-system view of organizations, the delineation of the environmental boundaries that an organization needs to span is an important first step. Yet few studies have articulated the separation of organizations from their external environment in a clear manner. However, considering the ever-changing nature of the environment, it is extremely difficult to develop such a comprehensive and universal description of this environment which can be applied over time. As a result, the relationship between the organization and its environment is one of the most widely discussed, and yet least understood, concepts in the field of organizational analysis.

Among the several attempts made in organization theory to identify the effect of the environment -- or environmental uncertainty -- on organizational structure, the first widely recognized typology was developed by Emery and Trist [8], who presented four types of environments based on the degree of interconnectedness and the extent of change in the environment. In their study, environments were arranged on a continuum, in ascending order of change and uncertainty, from placid-randomized, to placid-clustered, to disturbed-reactive, to turbulent field. Their major argument was that each type of environment required a different form of organization structure. Hall [11] also distinguished between the general environment, which affects all organizations, and the specific environment, which consists of those external entities that interact directly with the particular organization in question. The specific environment, which is also described as the organizational set, the task environment, or the relevant environment -- all referring to those external actors or conditions relevant, or potentially relevant, to organization goal setting and goal attainment -- has received most of the theorists' attention and been treated as the primary set of forces to which the organization must respond.

Several attempts have been made to characterize the task environment in organizational studies. Dill [5] characterized the task environment of two Norwegian firms as heterogeneous or homogeneous, and stable or shifting. He found managers perceived greater decision-making autonomy in heterogeneous and shifting environments than in homogeneous and stable ones. Burns and Stalker [2] also suggested that the stability of an organization's environment is important in determining an organization's structure. Observing 20 British and Scottish firms, they identified two types of organization -- mechanistic, characterized by formalization, centralization within a hierarchy, and vertical communication; and organic, characterized by less formalization, decentralization over a network, and lateral communication. The mechanistic form was more effective in stable task environments, while the organic was more effective in rapidly changing ones.

Thompson [24] proposed a different view by suggesting that it may not be the degree of heterogeneity or stability per se that is important, but rather the uncertainty (i.e., unpredictability) that these two environmental factors create for the organization. He emphasized that both technology and environment should be considered together when an organization estimates the degree of uncertainty it must deal with; it will then determine its internal design accordingly. According to Thompson, an organization, to achieve a desired level of outcome, must seal off its core technology from environmental uncertainty by reducing this uncertainty through boundary spanning of the task environment; thus, its internal structure must support these boundary-spanning activities.

Lawrence and Lorsch [16], like Thompson, considered environmental uncertainty to be a key variable in structuring organizations. Characterizing the environment as either diverse or homogeneous, based on the amount of uncertainty perceived by the organizational subunits, they presented the idea that the state of differentiation in the effective organization was consistent with the diversity of the parts of the environment, while the state of integration was consistent with the environmental demand for interdependence. They also found that, since the states of differentiation and integration were inversely related, the effective organization had integrating devices consistent with the diversity of the environment, in such a manner that the more diverse the environment, and the more differentiated the organization, the more elaborate the integrating devices. Despite the significant contribution of their work to organization theory, a criticism has been made that their data-collection instrument did not correlate with the characteristics of the environment, as ought to be the case in a contingency theory of organizations. What they actually measured was task uncertainty which is created inside of organizations as a result of external environmental uncertainty.

Among the works in organization theory attempting to analyze environmental components, thus providing a measurement scheme of an environment, two studies have received the most attention. Developing a list of factors and components comprising an organization's internal and external environment, Duncan [7] identified two dimensions of the environment: 1) the simple-complex dimension, which is defined as the number of factors taken into consideration in decision making; and 2) the static-dynamic dimension, which is the degree to which the factors in the decision unit's environment...
remain the same over time or are in a continual process of change. Results indicated that individuals in decision units with dynamic-complex environments experience the greatest amount of uncertainty in decision making. It was also found that the static-dynamic dimension of the environment is a more important contributor to uncertainty than the simple-complex dimension.

Using Duncan’s list of factors and components comprising the environment, Tung [25] provided a typology of organizational environments which consists of complexity, rate of change, and routineness of problem/opportunity states. Tung first pointed out that Duncan’s instrument on perceived environmental uncertainty was not sufficient, in the sense that it considered neither the manageability of complexity nor the predictability of rate of change. To overcome these shortcomings, Tung’s study assigned a higher weight to the factors and components identified within the external environment than to those identified within the internal environment. The rate of change was found to be the most important single contributor to variations in perceived environmental uncertainty. Complexity was found to have the most significant impact on variations in departmental structure.

Although both works laid a substantial foundation within organization theory for analyzing environmental uncertainty, the drastic changes in today’s environments, leading to fundamental changes in organizations’ functioning, suggests that these frameworks are no longer sufficient. First, Duncan and Tung ignored the impact of an organization’s own strategy on the amount of perceived environmental uncertainty. Their instruments treated the environment as a single entity and did not reflect the relative importance perceived by decision makers across different environmental factors and components. Within a given industry, different firms may play different roles based on their own strategy: one may lead in market or product innovation, the prospector; one may be a close follower, the analyzer; or one may pursue operational efficiency, the defender [18]. Under these circumstances, decision makers within each organization, especially operational managers of individual functional units, will focus on their own strategy-oriented environment rather than considering the environment as a whole [30]. Production managers in “defenders” firms may place less importance on the complexity and the rate of change in the technology component of the environment than those of “prospectors” firms, and feel that the market is less turbulent in general (i.e., interfirm differences). Also, there may be inter-unit differences in terms of the amount of perceived task uncertainty which accrues from the nature of the tasks which are performed within the different functional units. For example, it is reasonable to assume that managers who provide accounting services care less about customer satisfaction than those who perform marketing roles, and that they feel that their tasks are more certain (i.e., less uncertain).

So it is reasonable to decompose the environment into sectors, each of which may have a distinct influence on policy-making and organizational actions [1,3]. Bourgeois [1] decomposed the environment into two parts: a general environment composed of social, demographic, and economic sectors; and a task environment composed of competitor, supplier, and customer sectors. Later, Daft et al. [3] developed a measure of the amount of perceived strategic uncertainty by incorporating the rate of change, the complexity, and the relative importance of each across six environmental sectors: competition, customer, technological, regulatory, economic, and sociocultural. This instrument by Daft et al. nicely reflects both the interfirm and the inter-unit differences discussed above.

Among the environment conceptualizations proposed so far, all of them have taken a largely reactive stance by viewing the environment as a deterministic force to which organizations respond [1]. However, today's environments require organizations to rethink the ways they compete in the market place; and, breaking with traditional management practice, emphasize a proactive role for management, especially at lower levels [6,23]. In other words, even an organization within a relatively stable external environment may want to adopt an organic structure in order to gain a competitive edge, by aligning its internal components with the key processes of its customers. These internal changes can by themselves increase the task interdependence within the organization, increase the task uncertainties faced by individual decision makers within the functional units, and increase the overall amounts of both internal and external environmental uncertainty perceived by these decision makers.

An organization’s ability to adapt to its environment, as described by Miles and Snow [18], emphasizes the importance of internal structure and processes in gaining a competitive edge in its industry. Huber et al. [13] provided empirical support for the idea that internal organizational forms can themselves influence the perceptions of environmental uncertainty. However, Tung's conceptualization of the environment [25], which is based on Duncan's list of factors and components [7] does not incorporate the aspects of change evolving from changes within the organization. The work by Daft et al. [3] also focused only on the external environment, and failed to recognize the external uncertainties which were caused by internal changes within the organization.

In an attempt to overcome these limitations, this study develops a model which incorporates both the relevant
external environmental factors and the internal changes which occur within organizations. "Environment" thus has two parts: one outside of the organizational boundaries, i.e., the external environment, and the other inside of the organizational boundaries, i.e., the internal environment. "Environmental uncertainty" is then the combination of uncertainties from these two sources: external and internal.

Environmental uncertainty from external sources is similar to what is called "perceived strategic uncertainty" in the work of Daft et al. [3] and represents the amount of uncertainty which is caused by changes in the task environment and which is perceived by a decision maker when he scans the task environment to make strategy-oriented and task-related decisions. As a result, environmental uncertainty from external sources reflects the rate of change, the degree of unpredictability, and the relative importance of the individual sectors within the task environment.

On the other hand, environmental uncertainty from internal sources represents the amount of uncertainty which is caused by changes in the internal states of the organization (e.g., work-flow redesign through formulation of work teams, re-engineering of business processes, etc.) and which is perceived by a decision maker when he collaborates with other interdependent parts of the organization in order to make decisions consistent with these changes. Thus, environmental uncertainty from internal sources is called "task uncertainty -- the difference between the amount of information required to perform task-related decision making and the amount of information already possessed by an individual decision maker in an organization" [10].

Environmental uncertainty from external sources and from internal sources are not mutually exclusive. Rather, they interact to determine the overall amount of perceived uncertainty. For example, a warehouse manager of a retailing company may understand that his company exists in a somewhat turbulent environment and perceives a certain degree of uncertainty from external sources. Yet he derives most of his uncertainties from his direct contacts with suppliers and distributors (first-order increase from external sources). Since his work is not designed to be interdependent with others in the company, such as marketing (i.e., perceived low uncertainty of internal sources), he may not appreciate the value he is adding -- or must add -- in order to achieve customer satisfaction. Now assume that the company ties his job closely to others in marketing and distribution through an integrating mechanism like IT; this makes him perceive that his work is getting more interdependent and complicated (first-order increase from internal sources). He now realizes how his work is related to customer satisfaction and how important it is for him to have warehousing and shipping responsive to customers' demands. Now when he scans the external environment, he will be much more aware of what is happening in the customer sector and will perceive more uncertainty (second-order increase from external sources). At the same time, in order to collect more information on the customer sector, he will have to contact the marketing manager more frequently and thus will perceive that his job is getting even more interdependent and complicated (second-order increase from internal sources). As a consequence, the overall amount of perceived environmental uncertainty, both external and internal, gradually increases.

Environmental Uncertainty from External Sources

Low

High

Environmental Uncertainty from Internal Sources

Low

High

Figure 2. Sources of Environmental Uncertainty

Figure 2 depicts the two dimensions of environmental uncertainty employed in this study and represents the interaction of the two. Functional units in cell I are those which perceive their environments to have low uncertainty and thus can make decisions quite independently. On the other hand, cell IV represents functional units whose environments are perceived as being highly uncertain, requiring a high degree of interdependence with other units of the organization. Cell II and Cell III represent functional units which have not yet experienced second-order increases in uncertainty from external and/or internal sources, and are therefore in transition from Cell I to Cell IV.

3. The research model

Figure 3 shows the research model for this study; it is based on organizational contingency theory. Each rectangle represents the basic components of the model -- environmental uncertainty, IT intensity, and organizational communication patterns -- with the variables for each of the components shown within the rectangles.
One of the main propositions in contingency theory is that the environment and the resulting strategy of an organization are major sources of perceived uncertainty, and thus are two key determinants of organizational structure and processes [9, 18]. It is also hypothesized that the greater the environmental uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance. In this context, IT is generally introduced as an information processor which reduces the amount of decision-making uncertainty [27] by increasing the organization’s capacity to process information [10].

The third component of the research model is the organizational communication patterns used by individual managers. To be effective, operational managers within organizations undergoing transformation must be able to deal with environmental uncertainty. Decision makers within each functional unit must be able to gather, process, and export information, as well as receive feedback from other information sources [24]. As an organization’s environment becomes less predictable and more complex, the amount of communication among its people and with the outside world increases. In addition to that, the patterns of communication change as the environment changes. The amount and/or characteristics of the environmental uncertainty perceived by functional units influence the coordination modes that are adopted [28] and determine the nature of the communication patterns used within the organization [2, 26]. A functional unit’s communication patterns are important determinants of its ability to deal with uncertainty, and thus to achieve increased effectiveness [20]. These communication patterns can be either horizontal, that is, connections among peers either directly or indirectly, or vertical, that is, with little direct contact among peers and most of the communication mediated by superiors. It is believed that horizontal communication patterns are more supportive of individuals as problem solvers since these patterns increase the opportunity for feedback and error correction, and for generating and synthesizing different points of view. As a consequence, horizontal communication patterns can deal with task-related uncertainty more effectively than vertical communication patterns [2].

The bidirectional arrows in the research model imply that there are positive relationships between each of the component pairs of the model.

4. The research approach

4.1. Data collection

A field survey, using self-administered questionnaires, was conducted with five leading electronics companies in Korea. Also, three American computer manufacturers, operating in Korea, participated in the study. Two of these companies were fully American-owned and the third was a joint-venture with a Korean company. Operational-level managers, with responsibilities in the areas of financial management, administration, R&D, planning, production, and marketing were randomly selected and asked to participate in the survey. In deciding who should be considered as an “operational-level manager” the following criteria were used: 1) managers who have decision-making authority over the routine daily tasks that are performed by the manager directly or by the manager’s subordinates; 2) those who have been with the company for about 7 years on average (or have a comparable amount of work experience since graduation from college); and 3) those who are considered “exempt employees” (i.e., they cannot join the employee union).

One company was chosen as a benchmark and operational managers who satisfied the above criteria were selected from several different functional areas. In the remaining companies, organizational charts were examined to select managers at the comparable levels to ones in the benchmark company. Out of 120 questionnaires sent to the eight companies, 107 questionnaires were returned from the pre-identified operational managers, for a 89% response rate. After discarding 9 incomplete questionnaires and 13 containing problematic responses, the remaining 85 responses were usable for data analysis, for a final response rate of 71%.

4.2. Instrument design

The instrument used in this study explored the three research components — environmental uncertainty,
organizational communication patterns, and IT intensity. The initial instrument was reviewed by two IS faculty members and one faculty member in management. Three Korean Ph.D. candidates attending American universities then independently translated the instrument into Korean. These three versions were combined into a final version after going through extensive discussions to resolve any disagreements. As a pilot, five operational managers from different companies were asked to fill out the questionnaire. Unclear and awkward terms were modified to improve clarity and additional discussions were held to see if the scales were measuring what they were intended to measure.

4.3. Variable and measures

Perceived strategic uncertainty (PSU) and task uncertainty (TU) were the two variable used to measure environmental uncertainty from external sources and from internal sources, respectively. Seven external environmental sectors -- competition, customer, technological, regulatory, economic, labor supply, and other suppliers -- were developed with corresponding descriptions for each sector. Adapting the instrument from Daft et al. [3], respondents were asked to judge the rate of change, that is, the extent to which companies, problems, trends, issues, or opportunities change quickly and unpredictably from year to year, and importance, that is, the extent of each sector's relevance to the respondents' decision making.

Since the unit of analysis of this study was operational managers, it was feared that some may have only limited exposure to their external environment. Therefore, to avoid any potential biased judgments due to respondents' lack of knowledge about their environment and/or the inability to judge this environment, respondents were offered the choice, "unable to judge" for any individual sector where they felt a difficulty to rate either the "rate of change" or the "importance." As noted above, 13 out of the 107 responses (i.e., 12%) included more that one environmental sector where they expressed an inability to rate the environmental sectors. Adapting Van de Ven and Ferry's measures [29], the degree of horizontal communication (DHC) was operationalized across three dimensions: 1) report-based communications (e.g., written reports, memos, e-mail, or fax); 2) conversation-based communications (e.g., face-to-face discussions or telephone); and 3) group-meeting-based communications. For each of these dimensions, three Likert-scale questions were asked concerning the frequency of communication dealing with task-related decision making with 1) peers in the same department; 2) people within other departments in the same company; and, 3) people outside of the company. Responses were added to get a DHC score for each communication dimension and then all nine of the questions were summed to obtain a final DHC score.

5. Results of the Data Analysis.

In Figure 4, the amount of environmental uncertainty
from external sources (EXTUCT) and internal sources (INTUCT) from all respondents were plotted over the hypothesized dimensions depicted in Figure 2. The distribution of points in the scatter diagram is encouraging. Even though a correlation between external and internal uncertainty ($r = 0.2856$) does exist, the observations are fairly evenly distributed across the four dimensions, implying that 1) higher uncertainty in the external environment does not necessarily lead to higher uncertainty in the internal environment, or vice versa; and 2) these two dimensions may interact, but they are clearly separate constructs. Consequently, for any study identifying functional-unit-level changes caused by uncertainties in organizations undergoing transformation, it seems reasonable to consider both aspects of environment at the same time.

As discussed earlier, the nature of tasks assigned to operational managers (i.e., inter-unit differences) and the strategy chosen by an organization (i.e., inter-firm differences) provide a logical basis for the above assertion. In addition, an ANOVA test was performed to see if these two factors really did evoke a difference in the amount of environmental uncertainties. Figure 5 shows that the functional roles played by the operational-level managers (i.e., financial management, administration, R&D, planning, production, and marketing), are significantly related to the mean difference in the amount of external, internal, and total uncertainty. Additional regression analysis shows that, by setting the group of marketing managers as a baseline (with an alpha level of 0.05), managers in administration perceive a significantly lower amount of external environmental uncertainty, while those in production perceive a significantly higher amount. Also, managers in administration and R&D perceive a significantly lower amount of internal environmental uncertainty; that is, they work much more independently than do marketing managers.

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>R-Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Uncertainty</td>
<td>0.2991</td>
<td>6.74</td>
<td>0.0001</td>
</tr>
<tr>
<td>Uncertainty: External Sources</td>
<td>0.2705</td>
<td>5.86</td>
<td>0.0001</td>
</tr>
<tr>
<td>Uncertainty: Internal Sources</td>
<td>0.1731</td>
<td>3.31</td>
<td>0.0092</td>
</tr>
</tbody>
</table>

Figure 5. Results of ANOVA Tests for Mean Difference across Different Functional Roles

In contrast, no significance differences in the levels of uncertainty across the different firms were observed, which may suggest that, at least in the Korean setting, 1) all of the sample companies are competing with a similar competitive strategy, or 2) the particular strategies of the participating organizations may not have been promulgated down to the operational levels.

The correlation matrix shown in Figure 6 shows that the main hypotheses of this study, that is, that a positive relationship exists between each pair of components in the research model, have been all accepted at a significance level of 0.05.

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**Figure 4. Distribution of Environmental Uncertainties across the Hypothesized Dimensions**

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**Figure 5. Results of ANOVA Tests for Mean Difference across Different Functional Roles**

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Environmental uncertainty and corresponding organizational designs have long been major issues in organization theory. A key question has been how an organization should be designed so as to reduce the amount of decision-making uncertainty around it and this produce the desired outcomes in a more efficient manner [24]. Often, the amount of uncertainty depends upon what a particular organization wishes to achieve. This observation has brought about a school of thought known as contingency theory [2,16] which emphasizes the multivariate nature of organizations and attempts to interpret and understand how they operate under varying conditions. Organizations of the 1990s are facing environments which are changing more rapidly than before. For any study attempting to investigate IT's role and the corresponding organizational changes, a careful and thorough understanding and analysis of the environment is essential. However, the terms "environment" and "environmental uncertainty" have been used in an inconsistent manner in different studies, and so the exact characteristics of the environment still remain vague.

Second, most researchers preclude the possibility of environmental uncertainty being a dependent variable that is subject to manipulation by the organization; nevertheless, these manipulations seem to be happening in many of today's more proactive organizations, particularly with the support of IT. Current IT applications go far beyond simple information processing. They add a great deal of turbulence to the existing environment by themselves; they modify the fundamental interdepartmental and interorganizational relationships; and they make possible new ways of competing in the marketplace. The dramatic improvements in the power and cost of IT in recent years, especially in the areas of communication networks, multimedia, optical scanning, hypermedia, expert systems, and workstations, have brought an expanded dimension to organizational communication and coordination patterns as well as a broader range of boundary-spanning support.

Third, the environment is treated as a single entity in most studies, and its interaction with strategy -- which is a key vehicle for an organization to differentiate itself from others in the marketplace and thereby gain a competitive edge -- is ignored.

Finally, but most importantly, uncertainty resulting from changes in the internal states of organizations has not received sufficient attention in the literatures of either IS or organizational studies. As a result, the way environment is conceptualized and measured in most studies is too narrow. The need for a new perspective characterizing both the environment and environmental uncertainty is essential. The results of this study, discussed in the previous section, suggest such a richer characterization.

A significant relationship was also found between the internal environmental uncertainty, as measured by the
degree of task interdependency, and the degree of horizontal communication. This implies that operational managers’ behavior is based primarily on what they need to do for the job at hand rather than on what they believe to be happening in the marketplace. Thus it is unreasonable for top management to expect that operation managers will form informal and cooperative groups spontaneously as a consequence of perceiving higher external uncertainty. Management needs to redesign the work processes so that operational managers begin to scan more aspects of the external environment and thereby encompass it in their task-related decision makings. This implies that a more effective transition path of moving from I to IV in Figure 2 may not be through III but through II. In other words, it would be more reasonable to expect a second-order increase in external uncertainty after obtaining a first-order increase in internal uncertainty (e.g., through work-flow redesign), and not the other way around.

The insignificant relationship between external uncertainty and horizontal communication patterns found in this study is somewhat at odds with other studies. A possible explanation for this failure to find a significant relationship may be due to the different measures used, and the unit of analysis or the non-U.S. setting. Most of the other studies have used senior-level American managers as the unit of analysis. They perform more frequent and more extensive external environmental scanning than do lower-level managers. These senior managers are whom Miles and Snow [18] described as domain coalitions -- key personnel in the organizational planning and decision-making processes. In traditional organizations, the perceptions of the external environment are delivered down the management hierarchy to operational managers [10]. The findings of this study show that operational managers use horizontal communication only to reduce the amount of uncertainty which is directly related to their jobs. They appear to be less interested in the uncertainty in the external environment since they are not a part of corporate policy making and planning. Consequently, it may be desirable to let operational managers become more involved in corporate decision-making processes so that all levels of the organization can act quickly and spontaneously to changes in the external environment.

This study also shows that IT usage is positively related to both the amount of environmental uncertainty and to horizontal communication patterns. However, a more careful look at the correlation matrix identifies what might be called a dimension conflict. Environmental uncertainty is related significantly to conversation-based and group-meeting-based communications, which is consistent with what has been reported in the organization theory literature, while IT is significantly related to report-based communication. A more detailed analysis needs to be made to identify the exact nature of the impact of IT (e.g., a moderator role? a mediator role?) on organizational communication patterns based on the varying degrees of environmental uncertainty.

This study has proposed a triangular relationship among environmental uncertainty, IT intensity, and organizational communication patterns and suggests an approach of measuring environmental uncertainty that includes both external and internal aspects. Furthermore, it points the way to where more detailed studies of the role of IT can be undertaken, a role that must take into account both the environments that the organizations will face and the internal structures and processes that will evolve.

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