

◆ Application Papers

## A Structural Model of Intra-Organizational Diffusion of Information Technology: Firm's Database System Adoption

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### Abstract

The objectives of the study are to build a structural model of intra-organizational diffusion of information technology and to test this model. Data were collected from senior managers of the purchasing department through questionnaires and statistically analyzed using the structural equation modeling. The questionnaires were concerning firm's database system adoption. Key findings of the study are as follows. First, buying center dynamics (i.e., buying center decision centrality, participation in buying center, and top-management support) are substantially related to the intra-organizational diffusion. Second, environmental characteristics (i.e., market turbulence, technological turbulence, and competitive intensity) indirectly affect on intra-organizational diffusion via buying center dynamics.

### 1. Introduction

Since intra-organizational diffusion has never been formally defined, a first step in verifying the concept would be to examine its operational definition. Conceptually, intra-organizational diffusion is closely related to "innovation implementation," which has been studied in the innovation process literature (Hage and Aiken, 1970; Rogers, 1983; Zaltman, Duncan, and Holbek, 1973). Intra-organizational diffusion was also dealt with directly or indirectly in various concepts such as "eventual diffusion of innovations" (Moore and Benbasat, 1991), "innovation's becoming ingrained within organizational behaviors" (Zmud, 1982), and "successful implementation of innovations" (Marshall and Vredenburg, 1992). All these concepts focus on the qualitative degree of innovation accepted by organizations. They imply a process of understanding, using, and mastering the adopted technology. Even though these concepts of innovation acceptance can provide part of a theoretical background, few managerial implications for the selling and buying organizations are explored.

Since the interest of sellers centers on securing consistent re-purchase orders through customer satisfaction and a favorable buyer-seller relationship, a quantitative concept, "the

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rate of intra-organizational diffusion" (i.e., how quickly organizational units/members adopt innovations) has strategic implications for selling organizations. By capturing the dynamics and causes of the rate of intra-organizational diffusion, selling firms can predict future orders and focus on buying firms that have higher potential for product purchase. During this process, suppliers can improve on the long-run buyer-seller relationship by continuously adjusting their strategic planning to feedback from buying organizations. In the context of interdepartmental diffusion of microcomputers, Bretschneider and Wittmer (1993) operationalize the level of intra-organizational diffusion as the number of microcomputers per employee. However, this operationalization does not necessarily correspond to "how many employees actually use the microcomputers" since some employees have no access to or use for microcomputers (i.e., they are not potential users) and some microcomputers may lie dormant. Based on this argument, we define the level of intra-organizational diffusion as the percentage of employees who use or have ever used the product to the total number of employees of an organization. *This definition is similar to the width of adoption (Gatignon and Robertson, 1985), the number of people using the product within the adoption unit.*

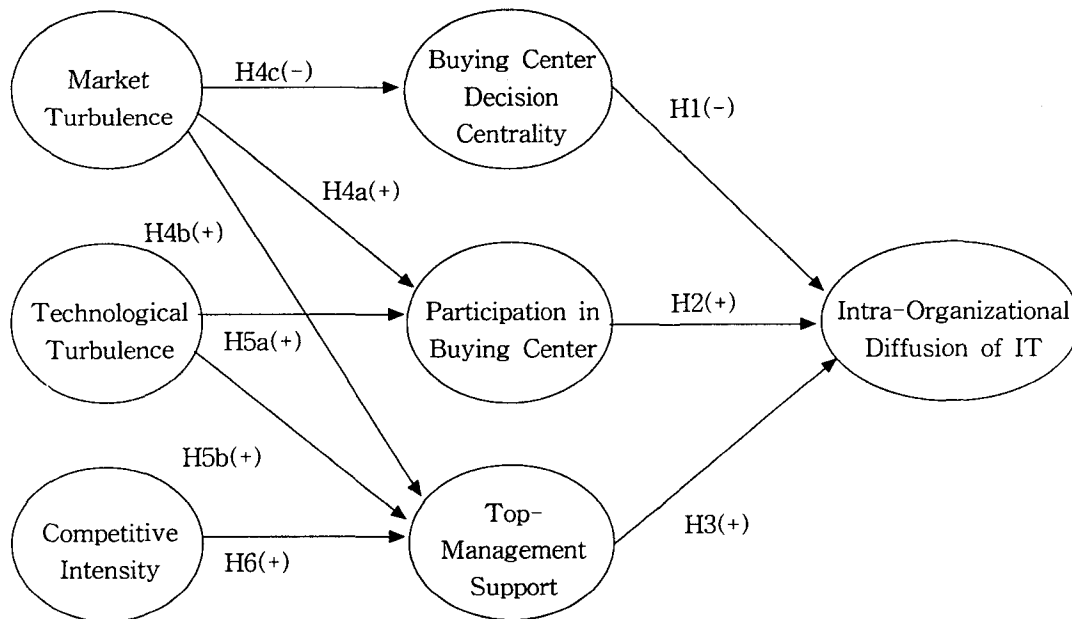
Several studies dealing with "implementation of innovation" from an organization theory perspective (Hage and Aiken, 1970; Zaltman, Duncan, and Holbek, 1973) have focused on the relationship between stages of innovations and organizational structure. Marshall and Vredenburg (1992) analyzed the impact of organizational structure, management support, and product compatibility on successful implementation of telemarketing innovation. Related research efforts in the Information Technology (IT) area analyzed efficiency in implementation of an organization's information system (Ledere and Mendelow, 1990; Moore and Benbasat, 1991) and explored the innovation-organization interaction in software development (Zmud, 1982). Bretschneider and Wittmer (1993) dealt with IT adoption behavior across different sectors and examined the impact of technology characteristics and resource capacity on the IT adoption rates within organizations. These studies, however, focused on the efficient implementation of innovations from the buying organization's perspective with a few explanatory variables. They did not examine relationships between buying and selling organizations, dynamics within organizations, nor the impact of competitive environments on the innovation implementation. No strategic suggestions for selling organizations were reported and, as a result, marketing implications were very limited.

Randles (1983) used a Logistic Internal Influence Diffusion Model, also called the Technological Substitution Model (Fisher and Pry, 1971; Mahajan and Peterson, 1985), to fit and forecast diffusion of computer terminals within organizations. Brancheau and Wetherbe (1990) analyzed the diffusion of spreadsheet software within organizations using social interaction variables such as communication channels and mass media impact. Based on these variables Brancheau and Wetherbe (1990) compared early and late adopters within organizations. Randles' (1983) and Brancheau and Wetherbe's (1990) studies directly applied the innovation diffusion theory developed for the consumer market to the intra-organizational diffusion context. They assume an organization to be the whole society and regard the organization members (employees of a firm) as the potential population to adopt innovations. Because variables and the decision making process, both of which influence intra-organizational diffusion, are quite different from those that affect the

innovation diffusion in consumer markets, Randles' and Brancheau and Wetherbe's analogy is difficult to justify. This is because adoption of innovations within a buying organization depends on continuous interactions among the buying organization, the selling organization and their market environments. The dynamics among these entities provides the motivation to develop a broader framework to guide research on intra-organizational diffusion.

## 2. Buying Center Dynamics

Since purchase decision-makers and product users are often not the same group, the importance of understanding the impact of the purchase decision-making process on intra-organizational diffusion cannot be overemphasized. To explore the effects of "who are (and how much are they) involved in the purchase process" and "how the purchase decision is made" on intra-organizational diffusion, we focus on the characteristics of the *buying center dynamics*. The impact of buying center dynamics on intra-organizational diffusion of IT is presented in Figure 1.



**Figure 1. Impact of Environmental Characteristics of Buying Organization on Intra-Organizational Diffusion of IT**

The buying center, defined as "those individuals who interact for the specific purpose of accomplishing the buying task" (Webster and Wind, 1972, p.35), has been the focal concept in research on the organizational buying behavior as it is the actual purchasing decision unit for the organization (for a recent review of research on buying center, see Spekman and Gronhaug, 1986). Since the composition of buying centers changes over time according to specific purchase needs (Spekman and Gronhaug, 1986; Spekman and Stern, 1979) and firm size (Wind, 1978), buying center dynamics structure, decision process, and functions

have been emphasized and widely studied as the consequence of other variables such as environmental uncertainty (Corey, 1978; Speckman and Stern, 1979), task uncertainty (Cardozo, 1980; McCabe, 1987), and product types (Jackson, Keith and Burdick, 1984). However, with rare exceptions, the influences of buying center dynamics on strategic variables have been more or less ignored. Webster and Wind (1972) mentioned the effects of centralized versus decentralized structure of the buying center on user satisfaction of the organization. Robertson and Wind (1980) used one variable of buying center dynamics conflict among the buying center members as the factor affecting the organizational innovativeness.

While the entire organization's high centralization expedites intra-organizational diffusion, we expect that a high degree of decision centrality in the buying center will have negative impact of intra-organizational diffusion. The reason is as follows. In a highly centralized buying center, the actual purchase decision is made by a very limited number of participants, for example, top-executives and/or purchasing agents (Patton, Puto, and King, 1986). As a result, many other participants in the buying center may not agree with the purchase decision but may have to follow it (Anderson and Chambers, 1985). So after the product is purchased, the majority of participants who did not like the purchase decision do not have enough motivation either to use the product themselves or to encourage other members to use it. This will negatively affect intra-organizational diffusion of the purchased product. Thus,

*H1:* The higher the decision centrality of the buying center, the lower the rate of intra-organizational diffusion of information technology.

Whereas decision centrality is the degree to which purchase decision authority is exercised by a few personnel of the buying center, participation in the buying center is defined as the organization members' actual involvement in the organizational buying task (McCabe, 1987) or the total amount of communication offered to other members in the buying center during the course of the purchase decision (McQuiston, 1989). Prior research has supported the perspective that higher environmental or task uncertainty induces high levels of participation (Spekman and Stern, 1979). Further, it has been noted that participation contributes to successful innovation by inducing more communication and that greater participation in the buying center will give the participants the feeling of contribution and involvement in the purchase process (Gaetner and Nollen, 1989). We expect that these feelings encourage participants to use the product and to share information with others and therefore to expedite intra-organizational diffusion. Formally,

*H2:* The greater the participation in the buying center, the higher the rate of intra-organizational diffusion of information technology.

Two forms of the management style, top-down versus bottom-up, have been widely discussed in the context of organizational learning (Porter, Lawler and Hackman, 1981). Referring to Argyris (1970) and Porter, Lawler, and Hackman (1981), we note that a top-down management style is more instrumental than a bottom-up style to achieve

effective injection of new learning into the organization. This is because a manager favoring a new technology can more easily push his/her subordinates to use the technology than the other way around. It has also been argued that top-down push is more appropriate when training personnel for new skills (Mitchell, 1989) and in implementing corporate strategies (Benrey, 1985). Since intra-organizational diffusion is closely related to organizational learning and implementation of new technologies, we expect that the top-management support (push) for new technologies will expedite intra-organizational diffusion. We therefore posit:

*H3:* The greater the top-management support for new technologies, the higher the rate of intra-organizational diffusion of information technology.

### 3. Environmental Characteristics of the Buying Organization

Because environmental factors such as technological uncertainty and competitive intensity in the buying organizations' industry affect participation in buying centers and management support, they influence intra-organizational diffusion indirectly. We draw on three environmental factors: market turbulence, technological turbulence, and competitive intensity, and examine their indirect impact on intra-organizational diffusion via buying center dynamics and organizational climate. The scheme is given in Figure 1.

*Market Turbulence:* Market turbulence (this is also called demand uncertainty by Robertson and Gatignon, 1986), defined as the rate of change in the composition of customers and their preferences (Jaworski and Kohli, 1993), is expected to influence intra-organizational diffusion through buying center dynamics. Spekman and Stern (1979) and (McCabe, 1987) argue that firms are more likely to facilitate gathering and processing information under more uncertain environments. As a result, the buying center becomes more participative. Combining this assertion to hypothesis 2 (H2) in the previous section, we suggest:

*H4a:* The greater the market turbulence, the greater the participation in the buying center, the higher the rate of intra-organizational diffusion of information technology.

In addition, since rapidly changing market conditions stimulate prompt organizational reactions, market turbulence motivates top-management to attention and to be more supportive of new technologies if they are important strategic investments. Based on this logic and hypothesis 4a (H4a) from the previous section, we posit:

*H4b:* The greater the market turbulence, the greater the top-management support for new technologies, the higher the rate of intra-organizational diffusion of information technology.

While we expect lower levels of intra-organizational diffusion when dealing with high levels of buying center decision centrality (hypothesized in H1), organizations are more likely to resort to more independent buying centers in order to adapt to more turbulent and

dynamic markets. Hence, the indirect effect of market turbulence (via its likely impact on decision centrality of buying centers) is to enhance intra-organizational diffusion. Therefore,

*H4c:* The greater the market turbulence, the lower the buying center decision centrality, the higher the rate of intra-organizational diffusion of information technology.

*Technological Turbulence:* In an environment where the rate of technological change is high, members of organizations have more intensive to participate in the buying center. This is because organizations require diverse information in the buying process in order to adapt to high technological heterogeneity. Also, within a high rate of technological change, top-management is expected to be more supportive of new technology in order to keep pace with competition. Hence, putting these arguments together with previous hypotheses (H2 & H4), we posit:

*H5a:* The greater the technological turbulence, the greater the participation in the buying center, the higher the rate of intra-organizational diffusion of information technology.

*H5b:* The greater the technological turbulence, the greater the top-management support for new technologies, the higher the rate of intra-organizational diffusion of information technology.

*Competitive Intensity:* As noted by Gatignon and Robertson (1989), price competition retards the adoption of technological innovations. According to term, price competition encourages a lower cost standard in the production process, making it hard for the company to buy new technologies that require major resource allocations. In this context, we suggest a focus on the firm's competitive advantage in order to understand the impact of competition on the innovation adoption and intra-organizational diffusion process. That is, if the firm's competitive advantage depends on new technologies that differentiate its products and services from its competitors' (Porter, 1980; Rosenbloom and Cusumano, 1987), then top-management will be supportive and this will expedite intra-organizational diffusion of the innovations (H4). Even in price-competitive markets, technology serves to reduce operating costs (Kotler, Fahey and Jatusrpitak, 1985, p.232). Hence cost-reducing technologies can be expected to be supported by top-management. Therefore,

*H6:* The greater the competitive intensity, the greater the participation in the buying center, the higher the rate of intra-organizational diffusion of information technology.

#### 4. Research Design

*Data Collection and Sample:* A mail questionnaire on a firm's organizationwide database system usage was developed for collecting data. In case the firm uses several different database systems for different purposes, the questionnaire focused on the major system that has been installed most recently. For a pre-test, we randomly selected 30 manufacturing firms from the *Directory of Corporate Affiliation*, and identified a senior

manager of the purchasing (or buying center) department and asked his/her cooperation by telephone interview. Then we sent the pre-test questionnaire to those 30 senior managers and asked them to complete the questionnaire and provide any comments related to the questionnaire. A careful examination of 17 returned questionnaire revealed that virtually all items were well understood by the respondents, and most items had a diverse range of responses. After making some refinements on the questionnaire based on the pre-test results, we finalized the questionnaire for the mail survey.

For the mail survey, we obtained a sample of 350 firms from the Directory of Corporate Affiliation based on the systematic random sampling. After sampling, we checked whether the selected firm had been included in the pre-test sample and replaced nine such firms by others. We identified the staff in charge of purchasing at the senior management-level of each firm. Each individual respondent was contacted in advance by phone and solicited for cooperation and the questionnaire were mailed. To motivate participation, an executive summary of this study was enclosed in the mail. In order to increase response rate, follow-up calls were made and the participants were assured that all responses are confidential and only aggregate results would be presented. Out of 350 questionnaires distributed, 187 were finally returned with usable data, providing 53 percent response rate.

*The Model:* The hypotheses suggest the model proposed in Figure 1. The exogenous constructs of buying center dynamics (i.e., buying center decision centrality, participation in buying center and top-management support) are hypothesized to be related causally to the intra-organizational diffusion (H1 to H3). Furthermore, environmental characteristics such as market turbulence, technological turbulence, and competitive intensity in the buying organizations' industry affect indirectly on intra-organizational diffusion via buying center dynamics and organizational climate (H4-H6).

*Measure:* We developed measures following standard psychometric scale development procedures (Anderson and Gerbing, 1988; Bagozzi and Phillips, 1982). We generated multi-item scales on the basis of previous measures, a review of the relevant literatures, and interviews with marketing and purchasing personnel. Statistical procedures used to validate measures included assessment of items, scale reliability, and convergent and discriminant validity.

The final measures used in this study were purified through the confirmatory factor analyses using LISREL 8 (Joreskog and Sorbom, 1993), as well as traditional method (i.e., exploratory factor analysis and coefficient alpha).

*Buying center dynamics* consist of buying center decision centrality, participation in buying center, and top-management support. To measure these constructs, items were adapted from McCabe (1987) and Porter, Lawler, and Hackman (1981). Three items were used to measure buying center decision centrality and top-management support and four items were used to measure participation in buying center. A confirmatory factor analysis was undertaken and the resultant factor loadings are reported in Table 1.

**Table 1. Factor Loadings of Buying Center Dynamics Measures**

Items	F1*	F2**	F3***
· When a purchasing decision is to be made, how often do you get an approval from someone higher in the organization (including your own boss) before taking action?	.76		
· How often does a high ranking member of this buying group make purchasing related decisions without consulting you?	.78		
· How frequently do instructions come from someone higher in the organization (including your boss) when existing rules and procedures are not adequate to make purchasing decision?	.88		
· How frequently are decisions related to your buying role and responsibilities made without your involvement?		-.76	
· How often are you encouraged to make suggestions concerning the purchasing process?		.85	
· How often do you take an active part in decisions that concern your role as a member of buying group?		.67	
· How frequently are you asked to participate in decisions that involve your role as a member of buying group?		.83	
· Top management in this firm encourage adopting new technologies or trying new products knowing well that some will fail			.75
· Top management in this firm are supportive to implement new technology			.71
· Top management thinks that the firm's competitive advantage depends on new technologies that differentiate its products and services from its competitors.			.83

\*F1 = Buying Center Decision Centrality (Cronbach's Alpha = .84)

\*\*F2 = Participation in Buying Center (Cronbach's Alpha = .88)

\*\*\*F3 = Top-Management Support (Cronbach's Alpha = .79)

*Environmental characteristics* consist of market turbulence, technological turbulence, and competitive intensity. To measure these constructs, items were adapted from Jaworski and Kohli (1993). Four items were used to measure each construct. A confirmatory factor analysis was undertaken and the resultant factor loadings are reported in Table 2.

*Intra-organizational diffusion* was measured based on the single-item measure asking approximate percentage of organizationwide database system usage.



Table 2. Factor Loadings of Environmental Characteristics Measures

Items	F1*	F2**	F3***
· In our kind of business customers product preferences change quite a bit over time	.61		
· New customers tend to have product-related needs that are different from those of our existing customers	.70		
· Our customers tend to look for new product all the time	.82		
· We are witnessing demand for our products and services from customers who never bought them before	.81		
· The technology in our industry changing rapidly		.56	
· Technology changes provide big opportunities in our industry		.76	
· A large number of new product ideas have been made possible through technological breakthroughs in our industry		.84	
· Technological developments in our industry are rather minor		-.80	
· Competition in our industry is cutthroat			.74
· Anything that one competitor can offer, others can match readily			.51
· One hears of a new competitive move almost every day			.84
· Our competitors are relatively weak			-.84

\*F1 = Market Turbulence (Cronbach's Alpha = .84)

\*\*F2 = Technological Turbulence (Cronbach's Alpha = .79)

\*\*\*F3 = Competitive Intensity (Cronbach's Alpha = .76)

## 5. Results

Structural equation modeling via LISREL 8 (Joreskog and Sorbom, 1993) was utilized to test individual hypotheses and ultimately to test the theoretical model. The GFI, CFI, and RMSEA are .94, .95, and .07, respectively. Taken collectively, these indices suggest a reasonable fit with the hypothesized measurement model, even though the chi-square index is significant ( $\chi^2 = 352, p < .01$ ). The standardized estimates are shown in Table 3.

The first three hypotheses posit that buying center dynamics affect intra-organizational diffusion. Specifically, intra-organizational diffusion is negatively related to buying center decision centrality (H1) and positively related to participation in buying center and top-management support (H2 and H3, respectively). The findings support H1 as intra-organizational diffusion is negatively related to buying center decision centrality ( $\beta = -.71, p < .01$ ). The results also support H2 and H3 as intra-organizational diffusion is related positively to participation in buying center ( $\beta = 1.12, p < .01$ ) and top-management support ( $\beta = .84, p < .01$ ).

H4a-H4c states that market turbulence is expected to influence intra-organizational diffusion through buying center dynamics. Specifically, it was hypothesized that participation in buying center and top-management support are related positively to market turbulence (H4a and H4b, respectively).

**Table 3. Effects of Buying Center Dynamics and Environment Characteristics on Intra-Organizational Diffusion\***

Path to	Path from	H0	H0 Sign	Standardized	
				Structural Coefficients	Statistical Significance
IOD	CENTER	H1	-	-.71	$p < .01$
	PART	H2	+	1.12	$p < .01$
	TOP	H3	+	.84	$p < .01$
CENTER	MTUR	H4c	-	-.99	$p < .01$
PART	MTUR	H4a	+	.15	$p < .05$
	TTUR	H5a	+	.06	n.s.
TOP	MTUR	H4b	+	.06	n.s.
	TTUR	H5b	+	.43	$p < .01$
	COMPET	H6	+	.18	$p < .05$

\*: IOD = Intra-Organizational Diffusion of IT; CENTER = Decision Centrality; PART = Participation in Buying Center; TOP = Top-Management Support; MTUR = Market Turbulence; TTUR = Technological Turbulence; COMPET = Competitive Intensity; n.s. = not significant

It has also been hypothesized that buying center decision centrality is negatively influenced by market turbulence (H4c). The results provide support for H4a and H4c, but H4b is not supported. Participation in buying center is positively influenced by market turbulence ( $\gamma = .15, p < .05$ ), but buying center decision centrality is negatively influenced by market turbulence ( $\gamma = -.99, p < .01$ ). The results indicate, however, that market turbulence does not significantly affect top-management support ( $\gamma = .06, n.s.$ ).

H5a and H5b states that technology turbulence is expected to influence intra-organizational diffusion through buying center dynamics. Specifically, it was hypothesized that participation in buying center and top-management support are related positively to market turbulence (H5a and H5b, respectively). The results show mixed support. top-management support is positively influenced by technological turbulence ( $\gamma = .43, p < .01$ ), however, participation in buying center is not affected technological turbulence ( $\gamma = .06, n.s.$ ).

H6 posits that competitive intensity has a positive impact on top-management support. The result support the hypothesis ( $\gamma = .18, p < .05$ ).

In sum, the data supported most of the hypotheses in the model. It was found that buying center dynamics have direct impact on intra-organizational diffusion and environmental characteristics influence intra-organizational diffusion through buying center dynamics.

## 6. Conclusion

Research on intra-organizational diffusion is likely to complement knowledge from prior research on adoption (trial) of innovations across buying organizations. Because multiple parties are involved in the purchase and use of non-standardized products and services within organizations, several questions arise: who are the *real* customers in buying organizations, the purchasing department or actual user group? How can we best serve

different, multiple customer groups? How should marketing efforts be different at various phases (e.g., obtaining product trial versus facilitating multiple adoptions)? How can we speed-up the diffusion process within the organizations? Development of such knowledge will be useful in targeting major customers and in allocating marketing resources. By developing a clearer understanding of the relationship among the factors that influence intra-organizational diffusion such as organizational structure, attitudes and environment, vendors can forecast and target potential high purchase and key customer organizations.

It is imperative that selling organizations understand intra-organizational diffusion of innovations if they wish to develop and leverage favorable relationships with current and potential or business customers (Bitner, 1990). This study, empirically, support how intra-organizational diffusion is affected by the organizational structure and competitive environment, which was conceptually proposed by Pae and Kim (1999).

The proposed framework can be utilized, for example, to suggest how intra-organizational diffusion can be managed (e.g., speeded up) via strategic marketing activities (e.g., customer education and training). Finally, we discussed why higher levels of intra-organizational diffusion are beneficial to the long-run buyer-seller perspective. Further empirical research to test and confirm these propositions is encouraged.

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