The Adoption of New Technology: The Case of Object-Oriented Computing in Software Companies

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***Abstract*—This study examines the adoption of new technologies within organizations. The significance of this research is to broaden the understanding of technology adoption within organizations by focusing on adoption at the individual level. The key research question that is examined is: "What factors contribute to the adoption of new technology by individuals within firms?" A model is presented to distinguish adopters from nonadopters based on four sets of constructs: 1) the characteristics of the individual; 2) individual's perception of group characteristics; 3) individual's perception of company characteristics; and 4) individual's perception of technology. Unlike previous studies that focus only on top management in firms, this study examines adoption at the level of middle managers, engineers, and technical personnel, i.e., those individuals who are more likely to actually use this technology in the workplace.**

The study links previously studied elements of adoption and diffusion of innovations to the specific case of a relatively recent innovation for organizations. As an example, an empirical examination of adoption of object-oriented technology (OT) in software companies is conducted. This technology is a software development technique that uses pretested and routine methods or "objects" to design, construct, and assemble software programs. It is a new way of thinking about software based on abstraction that exists in the real world.

The results of this study show that individual characteristics, perception of group characteristics, and company characteristics are significantly related to OT adoption, but the individual's perception of the technology is not.

The proposed model predicts adopters of new technology, such as OT, with 86% accuracy. The results suggest the factors that top management need to focus on in order to facilitate new technology adoption in firms.

***Index Terms*—Adoption of innovations, object-oriented technology adoption, technology adoption.**

I. Introduction

OVER the last 20 years, many of the changes in organizations have been predominantly driven by two factors: globalization and technology. In today's competitive global environment, many organizations are facing tremendous competitive pressures, and others are experiencing exponential growth and a high frequency of introduction of new technologies each year. Changing technologies have increasingly played a critical role in shaping and influencing the success of companies in many industries.

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To be successful in this competitive environment, companies continually seek a strategic advantage by adopting new technologies. Often these technological innovations produce not only procedural benefits but also lead to ultimate cost benefits, a necessary ingredient in highly competitive industries.

Effective adoption of technology in organizations has, therefore, become a major managerial concern. It is thus critical for top management in firms to have a clear understanding of the factors that lead to the adoption of new technologies within companies. With such knowledge, an environment can be created within firms to foster the adoption of new technologies.

The objective of this research is to provide a generalized model and a more comprehensive understanding of factors that are pertinent to adoption of new technologies within firms. The key research question that is investigated is: "What factors contribute to the adoption of new technology by individuals within firms?" To address this question, this study examines factors, at the individual level, which influence the adoption of new technology within firms. It then proposes a model based on these factors to separate adopters from nonadopters of new technology.

The purpose of this research is to also provide a better understanding to managers on the factors that are pertinent to successful adoption of new technologies. This will enhance their ability to develop effective strategies for introducing new technologies in their functional groups and influence the adoption of each technology.

We choose to examine the adoption of a new technology in a highly competitive industry *viz* the software industry. In this industry, in order to gain strategic advantage over competitors, many computer professionals are striving to quickly build systems that are useful and bug free. One such tool for this purpose is object-oriented technology (OT). Over the past several years, object-oriented technology has evolved in diverse segments of the computer sciences as a means of developing and managing the complexity inherent in many different kinds of systems. This study chooses OT as an example of a recent technology adoption by software firms.

1) What is OT?: Software engineers today are faced with the task of creating complex systems in the presence of scarce computing and human resources. OT is a programming method which allows the reuse of pretested software programs and ultimately enables ease of maintenance, operation, and extension of the software. It was first introduced during the migration of the mainframe to the client/server environment. It is a tool used for developing software applications in a client/server environment. OT is a programming method that begins with examining the problem domain and allows the reuse of pretested software programs and ultimately enables ease of maintenance, operation, and extension of the software. In [97], Simpson states that this methodology is sold commercially under different names, and some of the well-known branded products include Rumbaugh's object modeling technique (OMT), Shlaer/Mellor's object-oriented systems analysis (OOSA), and the Booch method. Simpson indicates that these tools were pioneered by Rumbaugh, Shlaer, Mellor, and Booch [97].

The fundamental object-oriented concept is concerned with the life cycle of a software program, and provides a practical methodology for its application to large projects [12]. The migration from developing for mainframe to developing client/server applications means coming to grips with the fundamentals of object-oriented programming, and that includes adopting a whole new methodology for problem analysis and software design.

The implementation of OT impacts software development throughout its life cycle, including problem definition and system analysis, design, configuration management, testing, support, database selection, and project management. The object model has proven to be a very powerful and unifying concept that helps to manage the complexity. OT allows software engineers to reuse programs, thereby enabling ease of maintaining the software. Reusability leads to cost reduction.

OT is projected to play an increasingly important role in internally developed client/server applications. The popularity stems from the flexibility of OT that can be used with a variety of object-based and object-oriented programming languages, namely, Smalltalk, Object Pascal, C++, the Common Lisp Object System (CLOS), and Ada. With this flexibility, OT promises to deliver powerful applications based on components that can be reused, and it becomes a whole new object-oriented programming architecture that dramatically changes the structural components of an application.

Many proponents of OT, including Bradley [12], assert that OT offers great potential benefits. They claim that to maximize these benefits, designers and organizations must be prepared to address more far-reaching decisions than simply which software programming language to choose.

While many software companies have adopted the OT, others have not [13]. Despite the many technical advantages of OT, not all individuals within software companies have adopted it. The question arises, what factors influence the adoption of a technology such as OT? This is the subject of our investigation.

In the software industry, the growing trend to disperse the responsibility for software development among organizational units and the pressure of rapid application development lengthen the list of development hurdles. Therefore, it is advisable to involve all parties concerned in the technology decision process, like MIS, R&D, marketing and sales, or engineering, including somebody above the project manager, to have a long-term vision so that the adoption is driven from the top. On the other hand, involving those who will actually use the new technology is also important. Understanding the factors that influence the adoption by users of new technology is essential.

Many of the studies of technology adoption within organizations are, however, segmented and application specific. For example, the materials requirements planning system (MRP) study by Cooper and Zmud [22], the automated teller machine (ATM) study by Hannan and McDowell [46], and other end-user computing studies such as computer innovation by Brestschneider and Wittmer [14] and laptop adoption by Gatignon and Robertson [38]. However, Rai and Howard [89] found that segmentation and application specifics do not improve generalization of findings.

Integrating new technology with organizational structures, strategies, and processes has been an important issue for the past two decades. In their study in computer-aided software engineering (CASE) innovation, Rai and Howard [89] integrated new technology with structure, strategies, and process of the firm by examining four important dimensions of organization context such as organizational structure, management process, management support, and the nature of the corporate systems. Their objective was to identify a generalized model for adoption.

Chau and Tam [19] also pointed out that many researchers on the subject recognize that their theories have to be refined due to conflicting results on innovation adoption. Some of these researchers have suggested that the subject should be studied within appropriate contexts and variables tailored to the specificity of the innovation. Therefore, in their study on factors affecting the adoption of open systems, in an extension of the study performed by Tornatzky and Fleischer [102], Chau and Tam [19] examine seven factors. These factors represent three contexts: 1) external environment; 2) characteristics of the open systems technology innovation; and 3) organizational technology. However, they purposely exclude variables such as organizational structure and culture in the research model.

To supplement previous studies, Lai and Guynes [61] examined exclusively a particular set of factors via organizational characteristics. Similar to the research work of Grover [41] and Chau and Tam [19], they concentrated their study on top management in firms.

Unlike previous studies, our study on OT adoption incorporates many suggestions from the literature and additionally examines other sets of factors that may impact adoption. These include the characteristics of the adopting individuals, the individual's perception of their functional group, as well as the organization, and their perceptions of technology. Also, unlike previous studies that focus only on top management in firms, this research focuses on adoption at the level of middle managers, engineers, and technical personnel, i.e., those individuals who are more likely to actually use this technology in the workplace.

The innovation we have chosen to investigate *viz* OT, is an information systems (IS) innovation. Swanson [98] in his study on IS innovations among organizations categorized three types of IS innovations: Type I—IS core; Type II—administrative core; and Type III—the technical core. He indicates that Type III innovations are important to address the contribution of IS to the larger organization. Lai and Guynes [61] shared the same view and considered his study to be important because of limited explanations of traditional diffusion of innovation theory to this type of technology adoption. Similarly, Chau and Tam [19] support the need for a more context-based model of innovation adoption.

In recognizing the importance of research work in this area, in this study, we empirically test a proposed adoption model for the case of OT adoption in firms, a Type III technical innovation [98]. The respondents selected for this study come from a variety of functional groups and are at different levels of management.

Thus, the significance of this research is fivefold.

1) It broadens the understanding of technology adoption within organizations by focusing on adoption at the individual adopter level within the organization.
2) It examines a variety of variables that are significant in adoption of technology: individual adopter related; group related; company related; and technology related variables.
3) It proposes a model incorporating these variables to separate adopters from nonadopters.
4) It identifies the variables that are significant predictors of adoption.
5) It provides an empirical basis for understanding organizational adoption of OT.

Results from this study can enhance the ability of senior managers to develop effective strategies for introducing new technologies within firms by focusing on those factors that impact technology adoption. This in turn can be a strategic advantage for firms in a competitive environment.

In Section II we examine the literature that can aid us in this investigation.

II. Literature Review

Adoption and innovation processes have been a long-standing concern of organizational theorists and researchers [16], [26], [27], [86], [93], [101], [103]. Innovation theorists and researchers have concentrated both on the precedents and correlates of the formal adoption decision [29], [91], [93]. Others have concentrated on the adoption process, individual, and workgroup innovations. More recent research centers on identifying factors that are pertinent to innovation adoption and associates those factors with the innovation diffusion process. The objective of these recent studies is to provide specific strategies for facilitating the adoption process.

The adoption process model, first introduced by Rogers [93], places emphasis on the fact that an individual goes through a series of steps (knowledge, persuasion, decision, implementation, and confirmation) in adopting a new innovation. It is based on the fundamentals of diffusion theory. However, Bayer and Melone [10] claim that this classical diffusion theory does not provide a sufficient theoretical basis for measuring the adoption of technologies. They, in turn, recommended the modification of the traditional diffusion theory and suggested the use of multi-item measures for adoption. This suggestion has lead to an expansion of research on technology adoption, with several authors expanding on classical diffusion theory.

In their study of individual innovations, Farr and Cameron [34] concluded that an individual's self-efficacy beliefs will influence a person's decision to put forth the effort to innovate at work. They consider experience or knowledge of innovative possibilities, and creativity skills as important dimensions needed for implementing changes. Although they emphasized the individual as the unit of analysis, they showed how social factors, such as leadership style, and organizational support also influence the individual's effort to innovate. Thus, although we examine individual adoption in this study, we also look at organizational factors.

In the area of work group innovation, while West [109] recognized that the existing body of literature is relatively small, King and Anderson [58] emphasized that only a few studies attempt to apply models from the study of individual creativity. For instance, they cited that Amabile's [4] social psychological model of individual creativity has been applied to study small groups, while Nystrom's [77] extends the use of Wallas' [105] model of the creative process to small, informal working groups. The applicability of these models to group adoption is not examined. In Amabile's model, King and Anderson pointed out that there was no indication of how the levels of the components' of motivation task skills and creative thinking skills may be determined for groups. The question remains whether workgroup innovation is "simply a matter of aggregating those of all the individual members?" Nystrom's use of Wallas' model is also considered problematic since his concern was purely on thought processes that did not relate to how a group could "incubate" an innovative idea. The results of these studies point to the complication of the innovation processes that pertains to an organization since it involves a number of individuals, each of whom plays a different role in the innovation decision [93].

Kimberly *et al.* [57] found that previous research on work group innovation explains that patterns of diffusion of an innovation within an organization are the aggregation of individual adoption decisions. To understand patterns of diffusion, they indicate that one needs to understand the mix of factors that affect adoption decisions at the level at which those decisions get made. They concluded in their study that the decision process at the group level is much more complicated than the binary "adopt versus not adopt," since it involves a population across the organization.

King and Anderson [58] also categorized workgroup studies into two distinct levels of approach—organizational and individual. In addition, O'Connor *et al.* [78] suggested a need for understanding individual behavior when examining adoption of innovations within organizations.

Therefore, individuals within organizations need to be studied to illuminate the process of adoption by the group. The focus of this research is thus on understanding the factors that influence response of individuals within firms to new technology. This research on OT is an attempt to study adoption within organizations at this individual level. A multivariate design approach is therefore needed to examine the impact of the various group characteristics that may influence innovation.

Recent studies to address factors that affect technology adoption, while expanded beyond the traditional diffusion theory, are still incomplete. Despite this, results from these studies can provide insights to help understand technology adoption.

Among these recent studies, Chau and Tam [19] focused on identifying factors that affect the actual adoption in their study of adopting open systems. The results provide insights on organizational adoption of complex technological innovations that affect all areas of a corporate IS infrastructure. However, their study is exploratory in nature and incomplete, and they suggested that future research should encompass variables such as organizational structure and culture. We intend to incorporate those in our study.

Other recent researchers have examined the association between contextual factors and innovation diffusion process as well as the strategies that facilitate the process. For example, Rai and Patnayakuni [90] enhanced the study by Zmud [111] on the relationship of "technology-push" and "need-pull" factors that affect the selected contextual factors by examining the organizational context. They found that there is a clear tension between the effects of those pull and push factors on computer-aided software engineering (CASE) adoption. While the push–pull factors are new terms, the underlying variables under the organizational context are similar to those that were previously studied. However, other variables that are likely to influence adoption behavior are ignored. These include technology factors, the characteristics of the adopters, and the characteristics of the development team or the group. We intend to examine these in our study.

In terms of the impact of the organization, Agarwal *et al.* [1] examined specific strategies that can create organizational climates conducive to innovation. Their findings suggest that the variables such as characteristics of the technology, the adopters, and the nature of the innovation moderate the effects of three generic strategies, which include support, advocacy, and total commitment. However, the authors used their model to only qualitatively analyze a representative case. They suggest that further research should involve the use of a quantitative approach. Thus, we employ a quantitative approach in this study.

The above discussion indicates that to encompass all pertinent elements in technology adoption within organizations, we need to focus on four themes. They are: 1) the characteristics of the individual involved in the adoption; 2) the individual's perception of characteristics of the group; 3) their perception of company characteristics; and 4) their perceptions of technology. Within each of these four groupings in the literature, several variables have been suggested that impact adoption. From these we have selected those variables that are considered important within the software industry. These variables are described below. The hypotheses that are being examined in this study that relate to these variables are also described.

A. *The Characteristics of the Individual*

The first set of variables found in the literature deals with the characteristics of the individual. Variables considered in our study and discussed in the literature include an individual's own experience and how the values of the firm met the individual's own values (firm's values perception abbreviated as firm's values).

1) Experience: We define experience as encounters that one undergoes or lives through. The experience of organization members may influence adoption decision making. Barclay [9] found that those department members who, on an average, have more education and more work and life experience are better prepared to cope with interdepartmental conflict. Bandura [7], [8], Hill *et al.* [48], and Perkins and Rao [84] found that more experience would enable individuals to contribute to innovation decisions. In their findings, experienced individuals had encountered more decisions and perceived an increase in their ability to make innovation decisions. Thus experience of individuals should have a positive impact on adoption of new technologies. Hence, we propose the first hypothesis as below.

H1—Experience: The greater the work experience of an individual, the more likely they are to adopt. Experience will be higher for adopters.

2) Firm's Values: West [109] describes vision as an idea of a valued outcome that represents a higher order goal and motivating force at work. He also suggests that it is important for vision to be shared. Peters and Waterman [85] argue strongly for the importance of the firm's value since it determines the firm's excellence. They report that "virtually all the better performing companies had a well-defined set of guiding beliefs" and when the employees found the beliefs are valuable and cause worthy, they are more likely to follow the direction of the company, including technology direction. Thus, the more the individual finds values of the firm as rewarding, the more likely is the individual to be innovative.

In this study, we define congruence with firm value as a state in which individuals are in harmony and agreement with the firm's values. The impact of this factor on adoption has been examined by O'Reilly and Chatman [81], Janis [49], Parmeter and Gaber [82], Corfman and Lehmann [24], and Corfman *et al.* [25]. They suggest when individuals share the same values and beliefs they form a psychological bond as a group. If these values are shared with the firm, it is found that individuals are more congruent to the organization. West [109], Peters and Waterman [85], and Mitchell *et al.* [68] emphasize that when organizations and individuals share the same beliefs and values, the effort of adopting new technologies are concerted. The extent of the bonding and harmony within a group, or a firm, leads to sharing of ideas and commitment to innovate within a group. Thus a positive relationship between this factor and adoption is proposed in this study, forming our second hypothesis.

H2—Firm's values: The more congruent and rewarding the individual perceives the firm's values, the more positive is the influence on adoption of innovations. Adopters are more likely to consider firm's values to be congruent and rewarding.

B. *Group Factors*

The second set of variables encountered in the literature deals with the individual's perception of characteristics of the group that is involved in the adoption process. Variables examined in the literature include such factors as teamwork, opinion leadership, communication, and response to risk.

1) Teamwork: Teamwork is when several individuals perform work that subordinates personal prominence to the efficiency of the whole. Janis [49], Parmeter and Gaber [82], Barclay [9], and Coopey [23] have examined the significance of teamwork and cooperation in an organization. They found that when there is less conflict among individuals within a group, it leads to more cooperation and teamwork. Walton *et al.* [106] established that the most important issue in adopting a new technology, company wide, is achieving an unusual degree of company and group unity. Such unity is attributed to a spirit of teamwork and cooperation. Therefore, in this study we propose that teamwork increases the likelihood of adoption of new technologies within the firm as described in H3.

H3—Teamwork: More teamwork among group members will positively drive technology adoption. Adopters will be in group that show higher teamwork than nonadopters will.

2) Opinion Leadership: According to Rogers [95], opinion leadership is the degree to which an individual is able to influence other individuals' attitude informally, in a desired way, with relative frequency. The role of opinion leadership in adoption has been well documented in the literature. Katz and Lazarsfeld [54], Rogers [93], [95], Geschka [39], Nemeth and Wachtler [74], and Maass and Clark [64] concluded that opinion leaders have greater exposure to the relevant technology. The literature suggests that opinion leaders can aid in dissemination of innovation. Therefore, opinion leadership is hypothesized to have a positive relationship to adoption of new technologies. Our fourth hypotheses is the following.

H4—Opinion leadership: The greater the opinion leadership among group members the greater is the likelihood of technology adoption. Opinion leadership will be higher for adopters.

3) Communication: Myers [72] defined communication as a process by which individuals exchange information through a common system of behavior. Communication between group members is also viewed as an influence on adoption. Rogers [93] suggests that communication with opinion leaders will influence potential adopters. Myers [72], Rogers and Svenning [92], Rogers [94], Nilakanta and Scamell [75], Schramm [96], Katz [53], Friestad and Wright [37], and Kotler and Roberto [59] have examined the effect of communication on adoption. The literature suggests that increased communication between members of an adopting unit promotes adoption and communication network links are crucial for technology adoption. Thus, this variable is hypothesized to have a positive relation to technology adoption and our fifth hypothesis is the following.

H5—Communication: Communication among individuals within the group is positively related to adoption of new technology. Communication will be higher for adopters.

4) Response to Risk: Response to risk is defined as the reaction of individuals within the group or firm toward the possibility of loss. Since adoption decisions usually involve an element of risk, response to risk and attitude toward risk will influence adoption. West [109], Myers [72], Popielarz [87], and Arndt [5] agree that willingness to take risk tends to lead to more innovativeness. They concurred that differing attitudes toward perceived risk appears to be the most significant feature in distinguishing adopters from nonadopters. Therefore, willingness to take risks is hypothesized as being positively related to technology adoption. We focus in this study on risk related to technology. Our sixth hypothesis is as follows.

H6—Response to risk: The higher the willingness of a group to take technological risk, the more likely is the adoption of new technology. Adopters will be in group that are less risk averse.

C. Company Factors

The third set of variables encountered in the literature centers on the individual's perception of company factors in terms of its overall culture, structure, and its management support system.

1) Company Culture: We interpret company culture as an integration of human behavior that includes thought, speech, and action of an organization. Researchers identified company culture as an important antecedent of innovation. Fischer and Farr [36], Kanter [51], Kao [52], King and Anderson [58] Rogers [91], Taylor [99], [100], and O'Reilly [80] conclude that promoting creativity within firms will lead to innovations. Hemphill [47] associates higher level of *esprit de corps* with a positive atmosphere for innovation. Kanter [51], Peters and Waterman [85], Nystrom [77], and Coopey [23] support that leadership with participative and collaborative style will promote and facilitate innovation. West [109], and Wall and Lischeron [104] concur that more participation in decision making is associated with less resistance to change and more likelihood for adoption of new technology. Lai and Guynes [61] assert that organizational openness will influence adoption positively. Thus the literature suggests that a favorable supportive company culture and climate is one of the most important resources and that such a culture promotes adoption of new technologies. This leads to H7.

H7—Company culture: A supportive company culture is positively related to adoption of innovations. Adopting individuals will be in firms with a supportive company culture.

2) Company Structure: We consider company structure as an arrangement and interrelation of members to each other within an organization. It can take on many different forms. The organization can be centralized or decentralized, formalized or integrated. In this study, we focus on three aspects of company structure: centralization; formalization; and integration. According to West [109], centralization refers to the extent to which authority and decision making are concentrated at the top of the organizational hierarchy; formalization is the degree of emphasis placed on following rules and procedures in role performance. Integration can be defined as an act in which processes are incorporated into a whole.

Previous studies demonstrate that the structure of a company impacts technology adoption. Hage [43], [44], Moch and Morse [69], Kimberly and Evanisko [56], Nystrom [77], and Coopey [23] found that there is a negative correlation between centralization and adoption. In terms of formalization of an organization's structure, Hage [42], [45], Zaltman *et al.* [110], Pierce and Delberg [86], Zmud [111], and Kanter [51] agree that there is a negative association between formalization and adoption of a new innovation. However, Lai and Guynes [61] found in their study of ISDN adoption that formalization and centralization of organization have no significant impact on adoption. Coopey [23], Farris [35], West and Wallace [108], Glassman [40], Jones [50], Amabile [2], [3], and Lovelace [63] agree that integration or joint interaction and sharing between individuals and groups is positively related to innovation.

In most of these studies, the results show that organizations that allow more participative decision making or are less centralized and less formalized in sharing of ideas and information across functional work groups would be more innovative. Individuals within such organizations would therefore be more likely to adopt new technologies. We thus propose three hypotheses related to company structure—H8, H9, and H10—as follows.

H8—Company structure—Centralization: Centralization is negatively related to adoption. Adopters will be found in firms that are less centralized.

H9—Company structure—Formalization: Formalization is negatively related to adoption. Adopters will be found in firms that are less formalized.

H10—Company structure—Integration: Integration is positively related to adoption. Adopters will be found in firms that are more integrated.

3) Technology Policy: By technology policy, we mean a company's internal procedures related to technology selection and adoption. Grover [41] emphasized that aggressive technology policy is reflective of the firm's willingness to keep ahead of competitors. While most firms do have a technology policy, it may be unknown to the individual employees who are not at top management level. Filtering down the policy can help the adoption process at the individual level.

In this context, the role of technology policy within firms has been examined. Organizational knowledge captured in a technology policy within a firm is conducive to adoption. Mezias and Glynn [67], Pennings and Harianto [83], O'Reilly [80], and Ettlie [31] affirm that a technology policy must exist in order to promote new adoption. Lai and Guynes [61] postulate that having organizational strategies for diffusion of technology relates positively to adoption. The conclusion is that having more champions will support new technology adoption. These studies have posited a strong relationship between organizational knowledge and innovativeness. This knowledge is powerful and leads to assertiveness in the implementation of the firm's technological policy. Thus we propose that the existence of a technology policy in a firm positively impact technology adoption. We therefore propose H11.

H11—Technology policy: The existence of a technology policy is expected to be positively related to technology adoption. Adopters will be in firms that are more likely to have a technology policy.

4) Competitive Strategies: We define competitive strategies as a company's long term plans to respond to competition. Similar to technology policy, the rank and file in a company typically are not aware of these strategies. The communication of such strategies throughout the firm is essential in directing employees toward a common goal such as adopting a new technology.

Competition can stimulate innovation and technology adoption. Researchers have found that the nature of competition influences innovation adoption. Brown [15] and Dutton and Duncan [30] suggest that organizations that are more prepared for competition are more willing to make innovative changes. Rogers [93] and Moore [70] assert that the more established the network of alliances in a firm is, the faster is the rate of innovation adoption. From the literature review, we find that firms that strive to be innovative typically would have an established competitive strategy and the strategy is well publicized throughout the organization. Thus the existence of competitive strategies is hypothesized as being positively related to technology adoption. We propose H12 as follows.

H12—Competitive strategies: Having a competitive orientation in an organization is expected to be positively related to technology adoption. Adopters will be in firms that have greater competitive orientation.

5) Management Risk Perception: West [109] considers management risk perception to be the propensity of top management toward risk taking. According to Grover [41], organizations that are more likely to adopt innovations typically have management that is willing to take financial and organizational risk.

Risk attitudes of top management are found as an influence to innovation adoption. West [109]; Farr and Cameron [34]; Cash and Konsynski [18]; Clemons and McFarlan [21]; O'Loughlin [79]; and Dewar and Dutton [28] suggest that firms that have top management who encourage risk-taking and change are more inclined to be innovative. Grover [41] affirms that when top management is receptive toward taking risk, it has a positive effect on innovation. These studies indicate that being less averse to risk provides a positive environment for innovation. Therefore, in this study, management risk perception is hypothesized to be an important factor. Positive risk attitudes on the part of top management will lead to a positive impact on adoption decisions as stated in hypothesis thirteen.

H13—Management risk perception: The less risk averse top management is toward technological changes, the more likely there will be adoption. Adopters will be in firms that have top management that is less risk averse than nonadopters' firms.

6) Top Management Support: Top management support is the continual active and enthusiastic approval of senior executives for a proposed innovation. Such support must be transmitted throughout all levels of the organization. Management commitment provides a positive environment for innovation.

Some researchers have concluded that top management support is important in adoption of innovation. Dewar and Dutton [28] and Grover [41] find that organizations in which management is more supportive of updating technological infrastructure are more ready for innovation. McGinnis and Ackelsberg [66], Quinn [88], West [109], Farr and Cameron [34], Baldridge and Burnham [6], Ettlie [32], Case [17], Nelson and White [73], Mahmood and Soon [65], and Zmud [111] agree that vision, or an idea of high goals, when shared within the organization and continually communicated and supported by senior management, will lead to clear common objectives toward technological advances. West and Farr [107] and West [109] have shown that penalizing employees for mistakes does not encourage innovativeness. O'Connor *et al.* [78] assert that promoting quality and organizational support will propel innovations. These studies confirm the necessity of top management support for a proposed innovation and suggest that without top management support, an innovation is less likely to be adopted. Thus, management support is hypothesized to be critical for nurturing the adoption of new technologies. H14 is as follows:

H14—Top management support: Top management support is positively related to adoption. Adopters will have a higher degree of top management support.

D. Individual's Perception of the Technology

The fourth set of variables pertains to the individual's perception of technology characteristics. Diffusion of innovation theory suggests that perceptions of technology characteristics, such as its relative advantage, compatibility, complexity, trialability, and observability, impact adoption [93]. Tornatzky and Klein [103] found that the first three attributes have consistently predicted adoption. These variables have been examined in studies of adoption of innovations in organizations as in Grover's study [41]. Therefore, in this study we focus on these three characteristics of technology, its relative advantage, its compatibility, and its complexity.

1) Relative Advantage: Rogers [95] defines relative advantage as the degree to which an innovation is perceived as better than the idea it supersedes. The degree of advantage can be measured in different terms such as economic, social, convenience, and satisfaction. In the case of OT adoption, the relative advantage can be measured in terms of technical advantage.

Rogers [93], Kimberly *et al.* [57], Kimberly [55], and Tornatzky and Klein [103] hypothesized that the perceived relative advantage of an innovation is positively related to adoption since the individual will not adopt the new technology if they find that there is no advantage to making the change. Therefore we propose H15 as follows.

H15—Relative advantage: The higher the perceived relative advantage, the greater is the chance of adoption. Adopters will perceive higher relative advantage in the new technology.

2) Compatibility: Rogers [95] defines compatibility as the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. In this study, if OT is viewed as incompatible with the prevalent values of the individual, the individual will not adopt it.

Compatibility has been proposed to be positively related to adoption. Rogers [93], Tornatzky and Klein [103], Bedell *et al.* [11], Ettlie and Vellenga [33], and Grover [41] confirm that when a technology is consistent with the existing values of the firms, is aligned with past experience, and matches the needs of adopters, it is positively related to adoption. Therefore, we propose H16 as follows.

H16—Compatibility: The higher the compatibility, the greater is the likelihood of adoption. Adopters will perceive higher compatibility in the new technology.

3) Complexity: Rogers [95] defines complexity as the degree to which an innovation is perceived as difficult to use. If OT is viewed as a difficult technology, the individual will not adopt such a technology.

Complexity has been proposed to be negatively related to adoption. Rogers [93], Kwon and Zmud [60], Cooper and Zmud [22], Tornatzky and Klein [103], and Grover [41] agree that more complex technologies have greater negative impact on technology adoption. We propose H17 as follows.

H17—Complexity: The complexity of a technology is negatively related to adoption. Adopters will perceive less complexity in a new technology than nonadopters will.

Thus, we consider four sets of variables affecting new technology adoption in organizations: 1) characteristics of the individual; 2) individual's perception of group factors; 3) individual's perception of company factors; and 4) perceptions of technology factors. These form the conceptual framework for the model in this study.

Variables to be considered in this study have been selected based on the existing literature and industry discussions. We propose that for the first set of variables, the characteristics of the individual, variables to include are experience and individual's perception of firm's values. For the second set of variables dealing with group factors, we include teamwork, opinion leadership, communication, and response to risk. For the third set of variables, company factors, we include company culture, company structure (centralization, formalization, and integration), technology policy, competitive strategies, management risk perception, and top management support. For the fourth set of variables, perceptions of technology, we include relative advantage, compatibility, and complexity of the new technology. In Section III we propose a model of adoption that incorporates these variables. We use this model to examine the above hypotheses.

III. Research Methodology

1) Conceptual Framework: To enhance the study by Lai and Guynes [61], whose focus was mainly on organizational characteristics, this study focuses not only on organizational variables but also on those variables related to individual adopters, the group, and technology. Fig. 1 shows the model and the variables comprising the constructs of the conceptual framework. These independent variables are expected to enable the differentiation of adopters from nonadopters of a new technology.

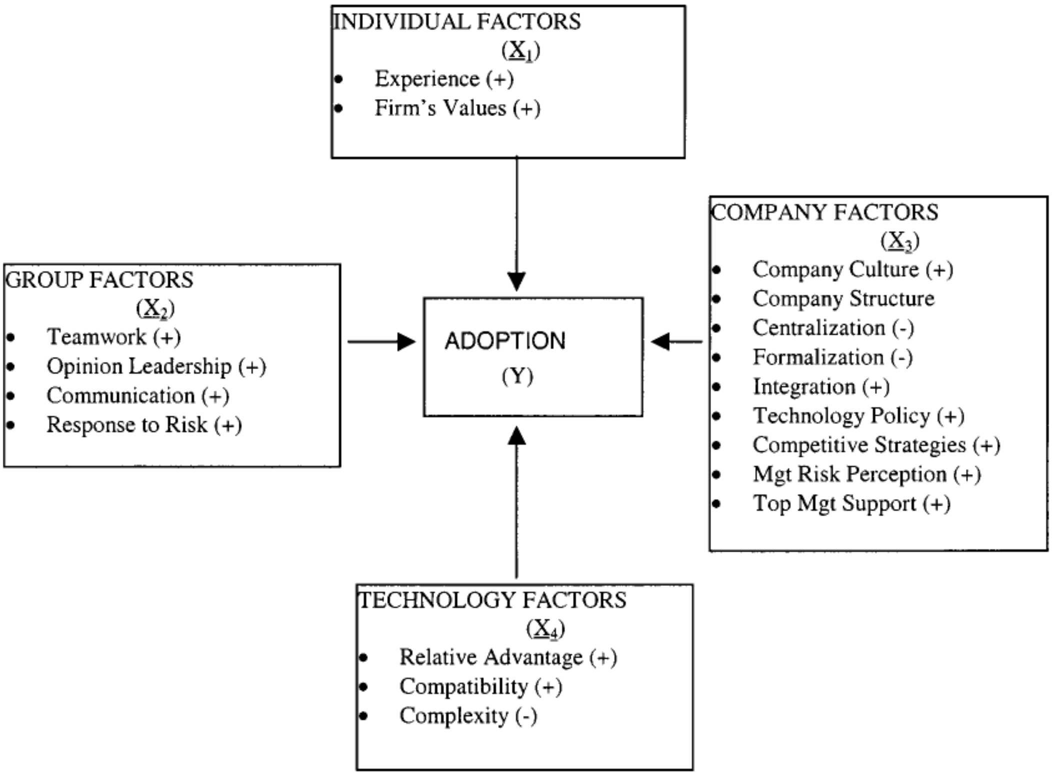
As shown in Fig. 1, the conceptual framework for this study indicates the variables which are hypothesized to have an influence in adoption of a new technology by organizations and the proposed directionality of these relationships.

This framework will be used to differentiate adopters from nonadopters of technology in firms. The dependent variable in this study (Y) will be adoption of a new technology *viz* OT by individuals within an organization. This will be related to the independent variables included in the four sets of variables discussed in the previous section and shown in Fig. 1: (X_1) individual factors; (X_2) group factors; (X_3) company factors; and (X_4) technology factors.

IV. Operationalization of Variables

Operationalization of variables was done based on discussions with managers in the software industry.

1) Dependent Variable: Adoption of technology is the dependent variable in our model. Typically in a firm, individuals are unlikely to make independent decisions toward a



(Note: Hypothesized relationships are shown in parentheses)

$Y = f(\underline{X}_1, \underline{X}_2, \underline{X}_3, \underline{X}_4)$

Where Y = 1 if the individual within an organization is an adopter of new technology

And Y = 0 if the individual within an organization is a non-adopter of the new technology

Fig. 1. Conceptual framework.

change such as adoption of a new technology. As such, an individual is considered to have adopted the innovation if the response is positive to the question whether the functional group they belong to is currently using OT. In this case the dependent variable $Y = 1$ shown in Fig. 1. This is because once a functional group in a firm adopts OT, all members of the group adopt if they wish to remain in the group. If they choose not to, they usually leave the group or rarely may leave the firm. This study noted that in software companies, the environment is such that individuals, such as software engineers, are not forced to adopt a certain technology if they feel that the technology is not their personal preference. If they feel it is not aligned with their ideal technological framework, they may seek a transfer within the firm or, in some extreme cases, seek opportunities in other firms. Therefore, an individual is considered not to have adopted OT when the response to the same question is negative and $Y = 0$ for this case. Thus the dependent variable, which reflects adoption of OT by an individual, is measured by whether the functional group they choose to belong to has adopted OT.

2) Independent Variables: All the independent variables described in the conceptual framework are measured on a seven-point Likert-type scale, where 1 is strongly disagree and 7 is strongly agree. Appendix I provides a description of the operationalization of each variable.

In order to test these hypotheses, two sets of analyzes were conducted. First, a t-test methodology was used to examine the differences in the key variables for adopters and nonadopters of the new technology. A comparison was made of the difference in the means of the independent variables. Second, discriminant analysis was used to analyze the conceptual framework shown in Fig. 1 in two ways, first by examining each factor individually in a discriminant analysis, and then in a composite model to determine the degree of accuracy in predicting the classification of adopters and nonadopters.

A. *The Study*

The respondents selected for this study differ from those in other recent studies on organizational adoption. These differences include: 1) the level of the respondent within the organization and 2) the functional affiliation of the respondent.

1) Level of Respondent: In Grover's [41] study close to 84% of the 214 respondents were at the director level or above. Over 40% were at the VP or CIO levels. Since the factors studied were primarily at the strategic and management level, Grover claimed that the seniority of these respondents enhanced the quality of collected data. However, these responses were the opinions of executives and senior managers whose views could be different from those who actually use the new technology. In the Lai and Guynes study [61], out of 161 respondents, 130 were top-level managers such as VP of MIS, CIO, and MIS directors. The rest were middle managers. In the Chau and Tam study [19], the 89 respondents included 11 directors/vice presidents, 64 IS managers/section heads, and 14 managers of other areas. Similar to the two studies cited above, all of the respondents in their study were in the managerial level. Our position in this research is that in order to study adoption in organizations, it is more relevant to study the adopting individuals themselves, so in the case of OT adoption, it is more relevant to examine those individuals who would actually adopt, i.e., use this technology. Our sample selection reflects this stance.

2) Respondents' Functional Group Affiliation: Grover [41] suggests using multiple participants within each organization. Lai and Guynes [61] recognized in their study that the profile of the respondents at the IS management level may not be representative of the organization. A multiple-respondent data collection approach should be followed. Chau and Tam [19] also suggested future research should obtain multiple sources within the organizations. In this study we incorporated these suggestions by looking at respondents from a variety of functional areas.

3) Data Collection: First, a pilot study was conducted using a convenience sample of 30 respondents from IA Corporation, a software product company in Emeryville, CA. The pilot study led to a revision of the wording of the questionnaire for eliciting reasonable responses from intended respondents. The questionnaire required about 20 min to complete. Phone interviews were also conducted after the questionnaire administration to confirm and clarify responses.

We identified a total of 49 U.S. software companies from those that advertise in *Career Expo Magazine* and *PC World*. These companies were likely to have various degrees of exposure to OT. Letters were sent to these companies to solicit anonymous participation in the study. Of the 13 companies that responded, 11 companies were willing to answer the survey representing a rate of approximately 20% of companies. These companies develop large and powerful software applications. For such companies, OT is more likely to be adopted due to its proclaimed benefits.

The study uses responses from members of various functional groups within the selected firms. These members include managers, software engineers, and technical support engineers. This sample selection is well represented throughout the organization, with both managers and technical personnel included in the study. To reemphasize, we are assuming in this study, based on discussions with software firms, that when a group is using OT, the individual respondents have adopted the technology, otherwise they will not remain as part of the group.

A senior member of each organization was assigned as a liaison to facilitate the identification of employees for distribution of the questionnaires. This senior management support was essential for ensuring that relative accurate responses are presented by these identified individuals. Since the questionnaire is quite extensive, it was imperative that those who answer it be knowledgeable enough to answer the questions. Although we recognize that this selection process could possibly introduce some bias, our view is that this was necessary to insure data integrity. The administrative assistant of the senior manager collected the completed questionnaires. Of the 390 questionnaires that were sent out, 261 were returned from 11 firms. Of these, 231 were usable for analysis, representing a response rate of 59.23%.

After the data collection, we also conducted a series of phone interviews to examine expectations of respondents for future trends and expectations of the usefulness of OT. Data obtained from the discussions were used to validate findings derived from the results of the statistical analysis of the responses.

B. Analysis

1) Profile of Sample Firms: The geographic location of these respondents, the size, and annual revenue of their companies are fairly evenly distributed within the continental United States, indicating randomness of the sample chosen. Out of the 11 companies that responded, three companies are located in the Eastern United States, three in the Central United States, and the remaining five companies are located on the West Coast.

2) Profile of Respondents: Appendix II shows the functional groups and the positions of the respondents. It indicates that a variety of functional groups are represented in this sample. It shows that 61% were software engineers, 18% were system engineers, 2% were managers from IS, 10% from other management, and 9% were from systems support. Thus the respondents are not only at the strategic or top management level in their firms.

3) Reliability of Scale Items: As proposed by Churchill [20] and Nunnally [76], for reliability, Cronbach's alpha was used. As can be seen in Table I, all reliability coefficients are above 0.65, thus adequately meeting the standards for such research [76].

4) Test of Propositions: To test the propositions, two separate analyzes were conducted using the average values of the independent variables for individual characteristics, group factors, company factors, and technology factors. First, a t-test methodology was used for testing the responses of the two groups represented in the sample: adopters and nonadopters. A comparison was made of the difference in means of the independent variables by doing pair wise comparisons for the 17 independent variables categorized under the four sets of constructs (X_1, X_2, X_3, X_4) and included in the conceptual framework shown in Fig. 1. Next, discriminant analysis was used individually for each independent variable to identify heavier weighted discriminant coefficients as better predictors of the dependent variable [62]. This discriminant analysis indicates which of the 17 independent variables does better in classifying adopters and nonadopters of OT.

5) Difference in Means t-Tests: Results of the difference in means t-tests are shown in Table II. It shows the variables

TABLE I
MEASURES OF HYPOTHESIZED DETERMINANTS OF OT ADOPTION

NO.	MEASURES	NUMBER OF QUESTIONS	CRONBACH'S ALPHA
H1	Experience	3	0.84
H2	Firm's Values	2	0.81
H3	Teamwork	2	0.80
H4	Opinion Leadership	2	0.80
H5	Communication	2	0.80
H6	Response to Risk	3	0.82
H7	Company Culture	2	0.80
H8	Company Structure: Centralization	3	0.89
H9	Company Structure: Formalization	2	0.89
H10	Company Structure: Integration	3	0.80
H11	Technology Policy	4	0.80
H12	Competitive Strategies	4	0.80
H13	Mgt Risk Perception	2	0.80
H14	Top Mgt Support	2	0.80
H15	Relative Advantage	5	0.82
H16	Compatibility	4	0.82
H17	Complexity	4	0.86

that are significant for distinguishing between adopters and nonadopters. Of the 17 variables, 13 are significantly different in pairwise comparisons between the two groups. For the first set of variables related to individual characteristics, significant differences exist between adopters and nonadopters for firm's values but not for the experience variable. The result supports H2 but not H1. Adopters find that the firm's values are rewarding and their values tend to be more congruent with those of the firm.

For the second set of variables related to individual's perception of group characteristics, there is also a significant difference between the two groups. Adopters are more inclined to

TABLE II
DIFFERENCE BETWEEN ADOPTERS/NONADOPTERS

FACTORS	VARIABLES	N_1=123ADOPTERS AVE. VALUES	N_2=108N-ADOPTERS AVE. VALUES	t-VALUE (Difference in Means)
Individual	Experience	2.787	2.657	1.533
	Firm's Values	5.142	4.153	5.161*
Group	Teamwork	5.382	4.380	5.142*
	Opinion Leadership	5.199	4.060	5.538*
	Communication	5.585	4.419	5.858*
	Response to Risk	5.846	5.565	2.169*
Company	Company Culture	5.537	4.130	6.956*
	Company Structure: Centralization	2.618	4.187	-6.846*
	Company Structure: Formalization	2.634	4.037	-6.442*
	Company Structure: Integration	5.423	3.750	7.233*
	Technology Policy	5.350	3.981	7.194*
	Competitive Strategies	5.365	4.009	6.993*
	Mgt Risk Perception	6.000	4.222	9.547*
	Top Mgt Support	5.683	3.907	8.612*
Technology	Relative Advantage	5.344	5.093	1.549
	Compatibility	4.951	4.824	0.751
	Complexity	2.820	3.083	-1.629

* Significant t-Value @ α = .01

perceive teamwork and stronger opinion leadership within the group. In addition, there is more communication and they are more willing to take risk in technological changes within the group. We find that H3–H6 are supported.

For the third set of variables, representing the individual's perception of company factors, we find that the study supports H7–H14. Adopting individuals perceive that the company has a nurturing culture and their organizations are less centralized and formalized, but more integrated. Adopters are in firms that have an established technology policy and competitive strategies. Top management of such organizations responds positively to risk and generally is supportive toward technology adoption.

For the fourth sets of variables related to technology, we find results that do not support our propositions and contradict findings in previous studies. The t-test results show that the individual's perception of the technology is insignificant in distinguishing between adopters and nonadopters within firms. Whereas these factors may be important in individual adoption, for individuals within organizations, company and group

TABLE III
DISCRIMINANT ANALYSIS—INDIVIDUAL VARIABLE

FACTORS	VARIABLES	ADOPTER PREDICTION PERCENT	NON-ADOPTERS PREDICTION PERCENT	Discriminant Power	Strength of Discriminant Power
Individual	Experience	71.31	39.81	.042	No
	Firm's Values	82.11	50.93	.467*	Strong
Group	Teamwork	82.93	51.85	.464*	Strong
	Opinion Leadership	84.55	55.56	.538*	Strong
	Communication	84.55	52.78	.602*	Strong
	Response to Risk	76.42	39.81	.083	No
Company	Company Culture	81.30	53.70	.849*	Strong
	Co. Structure : Centralization	81.30	58.88	.826*	Strong
	Co. Structure : Formalization	80.49	56.48	.728*	Strong
	Co. Structure : Integration	81.30	54.63	.918*	Strong
	Technology Policy	85.37	55.14	.912*	Strong
	Competitive Strategies	83.74	54.63	.858*	Strong
	Mgt Risk Perception	97.56	53.70	1.599*	Strong
	Top Mgt Support	85.37	54.63	1.301*	Strong
Technology	Relative Advantage	76.23	26.85	.042	No
	Compatibility	95.12	22.22	.010	No
	Complexity	83.61	32.41	.047	No

*Significant discriminant power = approximately .500 or greater

factors, as well as individual characteristics, appear to be more important than technology factors. H15–H17 are not supported.

One explanation for this outcome could be attributable to the prominence of OT. Since most of the respondents are in the software industry, both adopters and nonadopters are fully aware of the claimed benefits of the technology. They may differ in their decision in adopting it because of other factors mentioned above rather than their view of the technology. Thus, our t-test shows that 13 of the 17 proposed hypotheses are confirmed.

6) Discriminant Analysis: To confirm the findings from the means t-test, the conceptual framework was also analyzed using discriminant analysis to identify those variables that help the most in classifying adopters from nonadopters. Each factor was individually tested in a discriminant analysis. Results of this analysis, shown in Table III, confirm the proposed directionality of the variables and are consistent with the results from the previous analysis. Based on Morrison's [71] criterion of 50.7% prediction rate, all variables are strong predictors of adoption. However, in terms of discriminant power in distinguishing between the two groups, adopters and nonadopters, 12 of the 17 variables have strong discriminant power.

Discriminant power is derived from the Mahalanobis distances between the group's centroids. Based on the manual for the statistical software STATISTICA, the larger the distance, the more discriminant power the variable possesses. For measuring the strength of the discriminant power of each variable, we

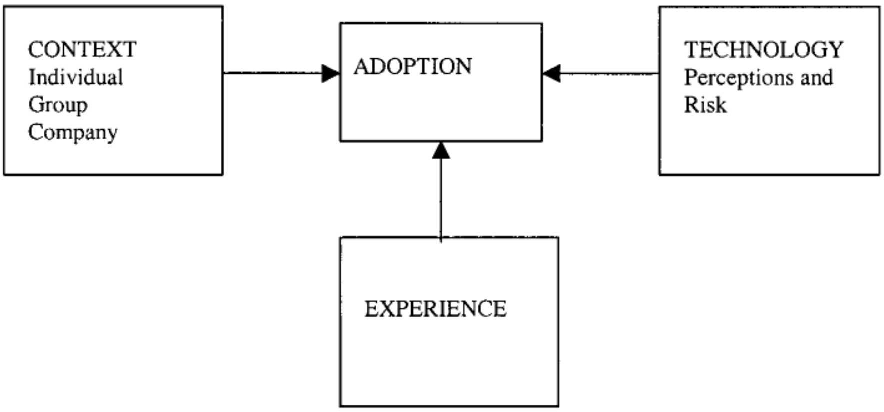


Fig. 2. A parsimonious composite model.

adopted a cutoff of 0.500 as being a strong predictor of adoption. Table III shows that the discriminant power of variables related to individual characteristics, individual's perception of the group characteristics, and company characteristics is high for distinguishing adopters from nonadopters with a couple of exceptions: experience and response to risk. Other notable exceptions are variables that pertain to technology perceptions that do not help distinguish adopters from nonadopters. Among individual characteristics, the variable firm's values have strong discriminant power while experience has no discriminant power. Among group characteristics, communication has the highest discriminant power followed by opinion leadership and teamwork. Response to risk has weak discriminant power. In terms of company characteristics, all items have strong discriminant power with highest impact from the variable management risk perception and top management support. They are strong predictors with strong positive impact on adoption. This is followed by integration, technology policy, and competitive strategies and company culture. Centralization and formalization also are strong predictors of adoption.

The results of this individual variable discriminant analysis are generally consistent with the results from the pairwise means t-test. We see that the technology variables such as relative advantage, compatibility, and complexity and the individual characteristic of experience are weak predictors of adoption of OT. In addition, the group's response to risk is not significant when the variable is examined individually in a discriminant analysis, even though in pairwise tests there are significant differences in the mean values of this variable for the adopters and nonadopters.

7) A Parsimonious Composite Model: In order to understand the collective impact of the variables proposed in conceptual framework in Fig. 1, we propose a composite model of adoption. However, due to multicollinearity between the 17 independent variables in the model, we decided first to construct a parsimonious composite model by conducting a factor analysis of all the variables, as done by Grover [41]. Once the parsimonious model is constructed as shown in Fig. 2, the resulting factor scores are used as independent variables in an overall composite discriminant analysis. The overall composite discriminant analysis indicates which factors separate adopters from nonadopters.

8) Factor Analysis: The factor analysis results used to examine the 17 variables are shown in Table IV. A three-factor solution is found. Factor 1 dominates the solution with 65.6% of the variance. The results show that the principal component of these three factors represents 82.6% of the cumulative variance.

The first factor can be named "context," as it relates to the group and company context as well as individual characteristics that manifest within a firm. An individual context variable that loads heavily on this factor is the variable firm's values. Group context includes teamwork, opinion leadership, and communication. Company context variables include company culture, company structure (centralization, formalization, integration), technology policy, competitive strategies, management risk perception, and top management support.

The second factor can be called "technology"; this includes technology perceptions as well as group technology risk perceptions. The variables that load on this second factor include technology perceptions of the adopting individual in terms of relative advantage, compatibility and complexity, as well as group risk perceptions. This second factor adds only 10.6% to the total variance.

For the third factor, the individual's experience is the only variable that loads on this factor. We can therefore label this as "experience." This factor accounts for only 6.4% of the total variance.

9) Discriminant Analysis of the Parsimonious Composite Model: Discriminant analysis was used to determine adoption prediction capability of the parsimonious composite model based on the three factors from the factor analysis. A discriminant analysis was run using the three factors collectively. The results are shown in Table V. It indicates that factor 1, representing context variables, individual, group and company, is significant with a standardized coefficient of 0.995 and p value of 0.000. However, factors 2 and 3 are not significant. The significance of the context factor supports the results of the t-test and the individual level discriminant test that individual, group, and company characteristics are important in technology adoption, while perceptions of technology, technology risk factors at the group level, as well as individual experience are not significant in predicting adoption of a new technology.

TABLE IV
VARIMAX FACTOR ANALYSIS

FACTORS	VARIABLES	FACTOR 1	FACTOR 2	FACTOR 3
Individual	Experience	0.070	0.017	-0.970*
	Firm's Values	0.716*	0.228	0.223
Group	Teamwork	0.858*	0.347	-0.080
	Opinion Leadership	0.894*	0.276	-0.024
	Communication	0.798*	0.399	-0.148
	Response to Risk	0.242	0.757*	0.080
Company	Company Culture	0.890*	0.280	0.040
	Co. Structure: Centralization	-0.844*	-0.272	0.127
	Co. Structure: Formalization	-0.838*	-0.283	0.172
	Co. Structure: Integration	0.893*	0.266	-0.060
	Technology Policy	0.934*	0.219	-0.068
	Competitive Strategies	0.911*	0.249	-0.034
	Mgt Risk Perception	0.913*	0.160	0.015
	Top Mgt Support	0.885*	0.278	0.032
Technology	Relative Advantage	0.337	0.863*	0.074
	Compatibility	0.294	0.808*	-0.122
	Complexity	-0.216	-0.855*	0.070

*Significant Value >.500

FACTORS	EIGENVAL	% TOTALVARIANCE	Cumul.Eigenval	Cumul.%
1	11.144	65.555	11.144	66.555
2	1.807	10.627	12.951	76.182
3	1.086	6.389	14.037	82.571

Classification results based on the discriminant analysis using the parsimonious composite model are shown in Table VI. It displays the following items: 1) the percentage of adopters and nonadopters that are correctly classified and 2) the overall percentage correctly classified. Adopters are predicted with 86% accuracy. Collectively the three factors of the parsimonious composite model, the individual, group and company context factor, technology perceptions and risk factor, as well as the experience factor, predict adoption of OT with a prediction rate of 71.37%.

Thus this discriminant analysis reveals that adopters of technology could be predicted with an accuracy of 86% using the factors in the parsimonious composite model shown in Fig. 2. Our overall prediction rate is 71%. We therefore conclude that the factors in the parsimonious composite model help classify adopters and nonadopters of technology such as OT. The most significant predictors of adoption relate to an individual, group, and company context, while technology perceptions and risk, and individual experience, do not seem to be as significant in distinguishing between adopters and nonadopters.

V. Findings and Implications

A. Findings

This study examined factors that influence the adoption of new technology by organizations. The difference in means t-test results (shown in Table II) indicates that 13 of the 17 variables (76%) of the model are confirmed to be relevant for distinguishing adopters and nonadopters. As shown in Table III, an individual variable discriminant analysis shows similar results. We find that 12 of the 17 proposed variables (71%) are strong predictors of adoption. By comparison, in Grover's [41] study only 11 out of the 25 variables (44%) were strong predictors of adoption, in the Lai and Guynes [61] paper only five out of nine (56%) were strong predictors and in Chau and Tam's [19] exploratory research, only three out of seven variables (43%) in the model showed a positive relationship to adoption.

Thus we find strong empirical support for the conceptual framework proposed in the study. Both tests, the difference in means test and the individual variable discriminant analysis, provide consistent results. They confirm that individual characteristics and group and company factors are significant for predicting adoption of OT while technology factors are less significant in predicting adoption. Additionally, the individual discriminant analysis provides the strength of the discriminant power of each variable and indicates how good a job each variable does in separating adopters from nonadopters.

In order to present a parsimonious model of adoption shown in Fig. 2, a factor analysis of the 17 variables of model was conducted. The factor analysis in Table IV indicates the variables that load on to each of the three factors that we named context, technology, and experience.

A discriminant analysis based on the parsimonious composite model indicates results that are consistent with the previous two tests (the difference in means t-test and the individual discriminant). As shown in Table VI, the predictive power of this parsimonious composite model, based on the three factors collectively, is strong. It classifies adopters and nonadopters with 85.95% and 54.72% accuracy, respectively. The average hit ratio is 71.37%. The high hit rate substantiates the usefulness of this parsimonious composite model for identifying adopters of a new technology such as OT.

TABLE V
Discriminant Analysis of Three Factors

Factor	Variable	Standard Coefficient	p-level
1	CONTEXT Individual, Group and Company	0.995	.000
2	TECHNOLOGY Perceptions and Risk	0.052	.710
3	EXPERIENCE	-0.119	.391

TABLE VI
Classification Summary of Discriminant Factors

OT ADOPTION	ADOPTERS	NON-ADOPTERS	TOTAL
Adopters	104 85.95	17 14.05	121 100.00
Non-Adopters	48 45.28	58 54.72	106 100.00
Total Percent	152 71.37	75 28.63	227 100.00
Priors	0.5000	0.5000	
ERROR RATE/HIT RATE ESTIMATE FOR OT ADOPTION:	**ADOPTERS**	**NON-ADOPTERS**	**AVERAGE**
Error Rate	14.05	45.28	28.63
Hit Ratio	85.95	54.72	71.37

(* Note: missing data = 4 cases are deleted)

1) Differences from Previous Findings: The results of this research are in general agreement with other studies in the literature. However, unlike the findings of two recent studies on technology adoption conducted by Grover [41] on customer-based organizational systems (CIOS) and Lai and Guynes [61] on ISDN, this study found that factors related to organizational structure do have high predictive power. Therefore, it confirms that factors such as centralization and formalization within the firm inhibit adoption while integration encourages adoption.

A surprising finding in this study is that individuals' perception of the new technology does not impact adoption by individuals within firms. The result of this study differs from that of Grover's on CIOS [41]. One explanation is that most of the respondents are very familiar with OT. Another explanation is that Grover [41] focuses on manager's response; therefore, the adoption decision is examined on the strategic level. This study focuses on the responses of individuals not at top management level but at the middle manager or technical level who are typically more familiar with the technical aspects of the new technology.

This study shows that in technology adoption, a technical person's individual perceptions of relative advantage, and other technology-related factors, such as compatibility and complexity, becomes secondary to other factors such as individual, group, and company factors. This may be because when the company context is supportive, the employees are freer to be innovative in trying new technologies without concerns about the technological characteristics of OT. Whether OT has perceived relative advantage, whether OT is compatible with the existing technology, or whether it is more or less complex to use by an individual, is not as essential as the context in which the innovation is taking place.

We confirmed in this study that adoption of new technology is affected by many variables. A combination of shared values and a persistent climate of group cohesiveness and a supportive firm environment is necessary for adoption of new technology. This study therefore provides a framework of pertinent variables that helps in predicting adoption of new technologies.

B. Discussion

We consider that the model presented in this study is a valuable conceptualization of technology adoption by individuals within firms. It explicitly distinguishes four major sets of variables that influence adoption. This research uses the model to analyze the adoption of OT quantitatively. The major finding in this study, that context variables are significant predictors of technology adoption, emphasizes the importance of an environment that facilitates such adoption. The parsimonious composite model of adoption indicates that context variables such as individual, group, and company-related variables are important influences on technology adoption. This suggests several implications.

First, individual context variables were shown to be important in technology adoption. This study shows those individuals whose values are congruent with the firm's values and who perceive the values of the firm to be rewarding have a tendency to adopt new technology.

Second, when the group has the characteristics of teamwork, leadership, communication, and positive response to risk, individuals have a higher tendency to adopt new technology than when the group does not possess these characteristics. We find that individuals who are in groups that have a team approach and those groups that have opinion leaders influence individual adoption positively. In terms of communication characteristics, we find that groups in which employees exchange ideas and have both formal and informal communication with others positively impact individual adoption. In addition, groups that are willing to take risk in terms of technology encourage individual adoption.

Third, in terms of company context variables, this study finds that all the company variables considered here have a significant impact on adoption. In particular, both company culture and structure influence adoption.

In terms of company culture, our measurement of culture in an organization indicates that a company culture that allows for participation in decision making yet holds employees accountable has a positive influence on adoption.

In terms of company structure, we find that organizations with less centralization, less formalization, and more integration promote innovations. Therefore, top management needs to promote continually and support a company structure which is less centralized, less formalized, and more integrated.

In terms of company policies, we find in this study that the existence of a company technology policy and competitive strategy also influences adoption positively.

In terms of top management attitudes, this study finds that top management risk attitudes and support can greatly influence technology adoption. As such, management's risk attitude in terms of encouraging changes in the organization should be clearly communicated to the employees.

Based on the findings of this study, we can conclude that individuals and top management must maintain open communication lines between adopting individuals and top managers. Such relationships will ultimately help to build a supportive base for technology adoption within the organization.

In terms of technology, a surprising finding in this study is that technology perceptions and technology risk, are not significant in terms of new technology adoption, what is more important is the context in which the adoption is taking place, in terms of individual, group, and company variables.

The results of this study provide empirical evidence of this context-based model. Since the adoption process of organizations is generalizable, the model presented in this study can be applicable to industries other than software companies with different cultural and economic contexts.

C. Managerial Implications

The model suggested in this study provides top management an understanding of how adoption of technology by individuals takes place in an organization. The variables studied help in differentiating adopters versus nonadopters. The individuals most likely to adopt OT are not necessarily those who have a lot of experience, rather they are those who work in a cohesive group that promotes teamwork and communication. We find that technology adopters are identified in supportive organizations. Adopters are more likely to be present in organizations that are not highly structured and are decentralized. Such an environment is more conducive to adopting new technologies.

A major practical implication is that managers must be supportive and should try to create an organization that is less structured and less centralized if they want to encourage technology adoptions.

Another implication is that managers must recognize that communication is important for a positive company culture. Management must continually inform their employees of management-support systems. Managers must recognize the significance of well-defined and articulated strategies and policies. An exchange of information will create an environment that is conducive to innovativeness. This may require frequent and candid discussions with employees. This helps in creating a culture that fosters innovation. The more importance managers attach to maintaining a positive company culture, the more likely individuals in the firm will be to adopt innovations easily. Although culture is hard to measure and manage, it affects what transpires in an organization.

Managers must recognize the importance of human resources to technology adoption. Our study suggests that hiring those individuals who share the same values and philosophy as the organization will facilitate new technology adoption, while ignoring such factors when hiring personnel will inhibit adoption and stymie the adoption process.

From this study, managers can gather a fundamental understanding of adoption of innovations. Such an understanding can allow them to keep up with competition. This study indicates that to encourage innovation, firms need to have clear competitive strategies. They need to hire creative people who have broad interests that match firm's values. A context must be created where free exchange of ideas can take place and a culture must be maintained where people feel rewarded and valued.

Thus to encourage new technology adoption, managers need to put in practice the elements that influence adoption in terms of

TABLE VII
OPERATIONALIZATION OF VARIABLES

VARIABLES	STATEMENTS	OPERATIONALIZATION
Individual Factors		
Experience	Years on the job Years of knowledge of OT Years with the company	Mean of three items
Firm Values	Are values of firm rewarding to self Are values of firm congruent with self	Mean of two items
Group Factors		
Teamwork	Does teamwork in group/firm exist Is teamwork preferred within group	Mean of two items
Opinion Leadership	Are there technology experts in groups Are there experts in R&D department that determine technology	Mean of two items
Communication	Do employees exchange ideas Are there formal and informal communication	Mean of two items
Response to Risk	Are technological changes welcome Are employees generally comfortable with technological changes Do employees perceive technological change as a challenge	Mean of three items.

the company structure, culture, policy, and strategies. Managers must effect these changes in the organization before technology adoption can take place. This, we consider as a major hurdle that managers may face. Changing an environment can be drastic since it may be reversing the trends of many years. In dealing with this challenge, managers must solicit support from senior managers who must: 1) recognize the need for a change; 2) plan the change; and 3) implement the change. The change process is usually a difficult one since support must permeate throughout the entire organization. While top management needs to provide continual support in all three phases, staff members must also provide cooperation. Our research shows that such structural changes leading to more supportive, less centralized, less formalized structures are needed to enhance technology adoption.

Most adopters and nonadopters recognize that OT can provide many technology benefits when used in large software applications. The insignificance of the technology characteristics in differentiating adopters and nonadopters in this study is an interesting finding. However, managers should not overlook these factors in examining technology adoption. In this study we found other variables such as company, group, and individual variables to be more significant than technology variables. Despite these findings, the impact of technology characteristics such as relative advantage, compatibility, and complexity cannot be ignored. It is clear that if a new technology is more complex, incompatible, and has less advantage than existing technology, it will be unlikely to spark any interest in adoption by individuals within organizations. Thus these technology characteristics still need to be understood by managers.

D. Limitations and Recommendations for Future Research

This study focuses on the adoption of one technology. Although it can provide insights for adoption of any new technology, the generalizability of these findings needs to be examined with additional studies of other innovations besides OT and in other industries besides the software industry.

In future studies, the number of variables examined should be reduced to avoid multicollinearity between the independent variables. The variables could be operationalized more uniquely. A more refined operationalization could result in a clearer interpretation of the factors obtained in the factor analysis.

Future studies should include a larger number of firms to be researched. Although the sample size of 231 individuals used in this research is acceptable, the number of companies 11 should be increased. Also, a multiple respondent approach should be employed.

The selection method of individual respondents could be improved to avoid biases. For example, randomness can be introduced if someone other than the senior manager makes the selection of the respondent. However, this must be traded off against the knowledge that the respondent has about technology adoption factors that are to be measured.

Despite these limitations, we feel that this study makes an important contribution to the understanding of technology adoption by individuals within firms.

APPENDIX I

See Table VII.

TABLE VII (*Continued.*)
OPERATIONALIZATION OF VARIABLES

VARIABLES	STATEMENTS	OPERATIONALIZATION
Company Factors		
Company Culture	Are employees allowed in participation in decision making Is there team accountability	Mean of two items
Company Structure: Centralization	Is approval required at all times Are the employees encouraged to participate in decision making Do employees make independent decisions	Mean of three items
Company Structure: Formalization	Are employees allowed to be flexible Are employees' work subject to be reviewed	Mean of two items
Company Structure: Integration	Are joint projects with other groups encouraged Are groups encouraged to share resources Do employees participate in technical decisions	Mean of three items.
Technology Policy	Do employees participate in trade shows Are employees allowed to subscribe to tech journals Is the firm first to try new technology Does the firm recruit best software engineers	Mean of four items
Competitive Strategies	Is being competitive important to firm Does the firm have a focus and direction Does the firm stress quality control Is the firm first to use new technology	Mean of four items
Management Risk Perception	Is top management willing to adopt technological changes Is top management interested in adopting OT	Mean of two items
Top Management Support	Is top management willing to make changes Does top management support OT adoption	Mean of two items
Technology Factors		
Relative Advantage	Does OT enable quick access Does OT enable faster implementation Does OT facilitate client server Does OT provide distributed application Does OT take fewer steps	Mean of five items
Compatibility	Can OT be used in different operating systems Does OT integrate easily When OT is used, does it impede the integration to mainframe Does OT enable the use of common GUI	Mean of four items
Complexity	Does OT handle complex data easily Does OT allow reuse Is OT uncomplicated Does OT facilitate customization	Mean of four items

TABLE VIII
RESPONDENTS' PROFILE ($n = 231$)

FUNCTIONAL GROUPS	PERCENT of sample (%)	TITLE	PERCENT of sample (%)
Engineering	43	SW Engineers	61
Tech Support	13	Systems Sup Eng.	9
Operations	8	Systems Engineers	18
MIS	10	IS Management	2
Marketing/Sales	10	Other Management	10
R&D	16		
TOTAL	100	TOTAL	100

APPENDIX II

See Table VIII.

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