Managerial Influences on Intraorganizational Information Technology Use: A Principal-Agent Model

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ABSTRACT

Our current understanding of information technology (IT) usage does not explain why and how managers can influence organizational members to use a new IT. Drawing on principal-agent research, this paper develops and tests a model of intraorganizational IT usage that addresses this important issue. Managerial incentives and control are examined as important components of managerial influences, which are linked to IT usage via a principal-agent model (PAM). Seven research hypotheses are generated from this model and empirically tested using a laboratory experiment. Results of the study indicate that managers can promote IT usage within organizations by designing appropriate incentives and control structures such as monitoring and multiple-period contracts. However, the effectiveness of these structures will depend on potential users' ability to distinguish between various forms of incentives and control.

Subject Areas: Agency Theory, End-User Computing, Incentives, IS Implementation, and IS Use.

INTRODUCTION

Investments in information technology (IT) represent over 50% of capital budget expenditures in United States' organizations today (Rockart, Earl, & Ross, 1996). It is a common belief that IT must be appropriately utilized by individual users within these organizations in order to achieve increased worker productivity, better decision making, or other expected benefits (Srinivasan, 1985). However, availability of IT does not automatically guarantee its utilization by organizational members (Howard & Mendelow, 1991). In fact, the term "shelfware syndrome" has been coined to describe software productivity packages sitting idle on bookshelves without being used by the persons for whom they are intended (Bowen, 1986). Motivating users to utilize IT remains a significant problem for organizational managers.

   The problem of intraorganizational IT usage falls broadly within the general area of IT implementation research. Intraorganizational IT use, in this context, refers to individual use of IT within organizational settings. Two key aspects of

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this definition are: (1) IT is used at an individual level, as opposed to a departmental or group level; and (2) IT is used within organizational contexts, as opposed to personal-use contexts such as computer use at home. A review of IT implementation research indicates that organizational users' utilization of IT depends not only on their beliefs, attitudes, and intentions, but also on managements' strategies, policies, and actions (Lucas, 1978; Ginzberg, 1981; Ives & Olsen, 1984; Leonard-Barton & Deschamps, 1988). Though many studies have examined the effects of micro-level individual variables (e.g., beliefs, attitudes) and macro-level managerial variables (e.g., management support), very little attention has been devoted to the interaction between these variables. Since organizational introduction of an IT is neither strictly macro nor micro in nature (DeSanctis, 1984), a complete understanding of IT implementation requires an integration of both perspectives within a common framework.

Current models of IT usage, such as the technology acceptance model, TAM (Davis, Bagozzi, & Warshaw, 1989), and the theory of planned behavior, TPB (Ajzen, 1991), explain usage in terms of individual attitudes and intentions, but do not address how managers can proactively influence users' attitudes and actions toward desired organizational goals. Derived from the social psychology literature, the technology acceptance model holds that an individual's IT usage behavior is governed by his or her behavioral intentions to use the IT, which in turn, are based on his or her attitude toward IT usage. Attitude is viewed as a function of potential users' perceptual beliefs regarding usefulness and ease of use of the IT. The theory of planned behavior, a generalization of the technology acceptance model, defines intention and usage in terms of three determinants: attitude, subjective norm, and behavioral control. These, in turn, are respectively determined by three sets of behavioral beliefs: behavioral beliefs (the individual's personal beliefs regarding the intended behavior), normative beliefs (referent others' opinion about that behavior), and control beliefs (availability of skills and resources constraining that behavior). Though TPB does not specify the exact set of beliefs operative for a particular behavior, it goes beyond the behavioral beliefs of TAM (i.e., usefulness and ease of use) to incorporate other usage barriers such as social inertia (a normative belief) and access to IT resources (a control belief) (Mathieson, 1991; Taylor & Todd, 1995).

Though TAM and TPB provide reasonable predictions of IT usage in personal-use settings, their usefulness in explaining implementation within organizational settings has been questioned because of their inability to incorporate the role of managerial influences on intraorganizational IT usage (e.g., Fichman, 1992). The current study addresses this limitation by developing a theory-based model of IT usage based on an integration of individual and managerial variables within a common framework, and then testing research hypotheses generated from this model using data collected from a laboratory experiment.

The specific managerial influences examined in this study are incentives and control structures, which are often considered powerful motivators of human behavior within organizations (Eisenhardt, 1989; Nilakant & Rao, 1994). Drawing on agency theory from the microeconomics literature (Arrow, 1985; Sappington, 1991), a principal-agent model (PAM) of intraorganizational IT usage is developed, which explains how managerial incentives and control can motivate organizational

members' IT usage toward goals desired by the management. Three research questions are addressed by this study: (1) What incentives can managers employ to influence organizational members' use of IT? (2) What potential problems can arise in implementing these incentives? and (3) How can such problems be mitigated?

The paper proceeds as follows. The second section describes the major elements of principal-agent theory, links them to the current problem of intraorganizational IT usage, and derives seven research hypotheses. The third section discusses methodological issues relating to the empirical validation of these hypotheses, including research strategy, operationalization of variables, and instrument validation. This is followed by a description of empirical results obtained from this study. The fifth section discusses the implications of these results for MIS research and practice. The final section outlines the study's limitations and provides directions for future research.

RESEARCH MODEL AND HYPOTHESES

Agency theory in the microeconomics literature forms the underlying theoretical basis for the intraorganizational IT usage model proposed in this paper. This theory views organizations as "legal fictions which serve as a nexus for a set of contracting relationships among individuals" (Jensen & Meckling, 1976, p. 310). Examining organizational behavior using a contractual framework, agency theory argues that cooperative effort within organizations is often plagued by opportunistic behavior on the part of organizational members, and that incentive systems and control structures can help mitigate problems associated with such behavior. Agency theory assumes that human beings are boundedly rational, risk averse, and motivated by self-interest, and that organizations are characterized by goal incongruence, information asymmetry, and efficiency norms (i.e., more effort leads to better outcomes) (Eisenhardt, 1989).

Principal-agent model (PAM) describes the behavior of two parties involved in a business relationship in which the payoffs of one party (the principal) depend on the actions of the other (the agent). The principal owns the means of production but does not possess the time or ability to produce the desired output, and therefore hires an outside agent to perform the task on his or her behalf. However, the agent may act in a manner that is inconsistent with the principal's interests, resulting in an agency problem. PAM attributes this agency problem to three reasons: (1) goal incongruence: the agent's goals may differ from that of the principal, (2) information asymmetry: the principal cannot accurately observe the agent's behavior or private information utilized in such behavior, and (3) differential risk preferences: the principal and agent may have different attitudes toward risky behavior. PAM attempts to resolve the agency problem by proposing appropriate incentive schemes (or "contracts") and control mechanisms.

The different components of PAM are illustrated in Figure 1. The principal designs a contract, specifying incentives that the agent will receive for different possible outcomes. The agent decides whether to accept or reject this contract, and in case the contract is rejected, the relationship is terminated. If the contract is accepted, the agent observes a "state of nature" (i.e., one or more exogenous variables, such

Figure 1: Principal-agent theory.
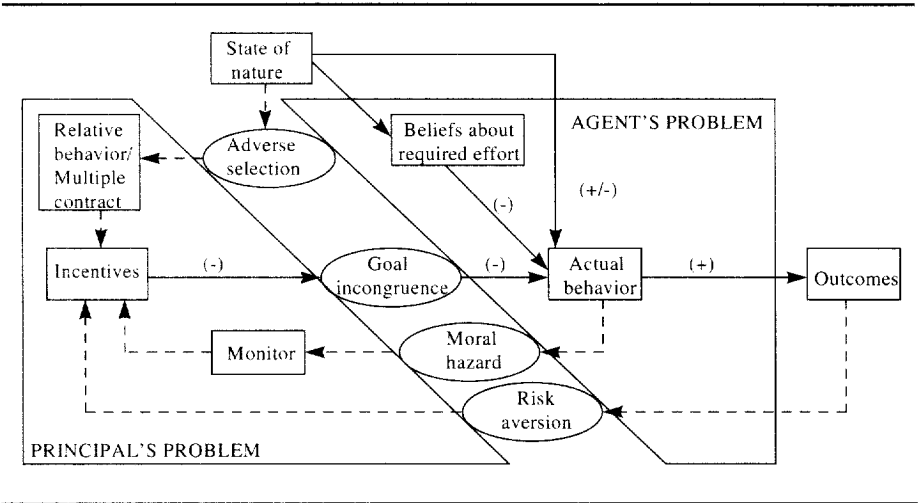
as task-related information, that are unpredictable and outside the control of either party) and decides how much effort to put forth. The agent's payoffs depend on three variables: (1) the amount and type of incentives offered by the principal (which provide utility to the agent), (2) the effort required to perform the behavior (which provides disutility), and (3) the agent's observation of the state of nature (which moderates the effect of effort expended on intended outcomes). Based on these variables, the rational agent selects an effort level that maximizes his or her utility. The principal cannot see the actual effort expended by the agent but observes the realized outcomes, based on which the agent is rewarded as promised in the contract. As such, PAM equates the design of contracts to reconciling the agent's utility maximization problem and the principal's cost minimization problem (i.e., designing ex ante incentives that would minimize the costs of motivating, monitoring, and ensuring the agent's commitment).

Intraorganizational IT usage can be modeled in the form of a principal-agent relationship by viewing the management as principal and individual users as agents. Managers typically acquire IT to achieve organizational benefits (e.g., productivity gains, increased profits) and want users to use these IT appropriately so that the intended benefits are realized (Leonard-Barton & Deschamps, 1988). But users value individual benefits (e.g., career advancement, leisure) over management goals (Francik, Rudman, Cooper, & Levine, 1991), hence the conflict of interests. IT usage typically requires users to expend effort in overcoming usage barriers such as learning curves (Attewell, 1992) and social inertia (Keen, 1981), and may therefore be resisted by users. To overcome this resistance, managers must provide potential users either with incentives (e.g., commissions, recognition, praise) for IT use or penalties (e.g., threats, demotion) for nonuse.

Figure 2 depicts the research model employed in this study, formed by applying the generic principal-agent model to the specific context of intraorganizational IT usage. At the core of the principal-agent problem lies goal incongruence, which

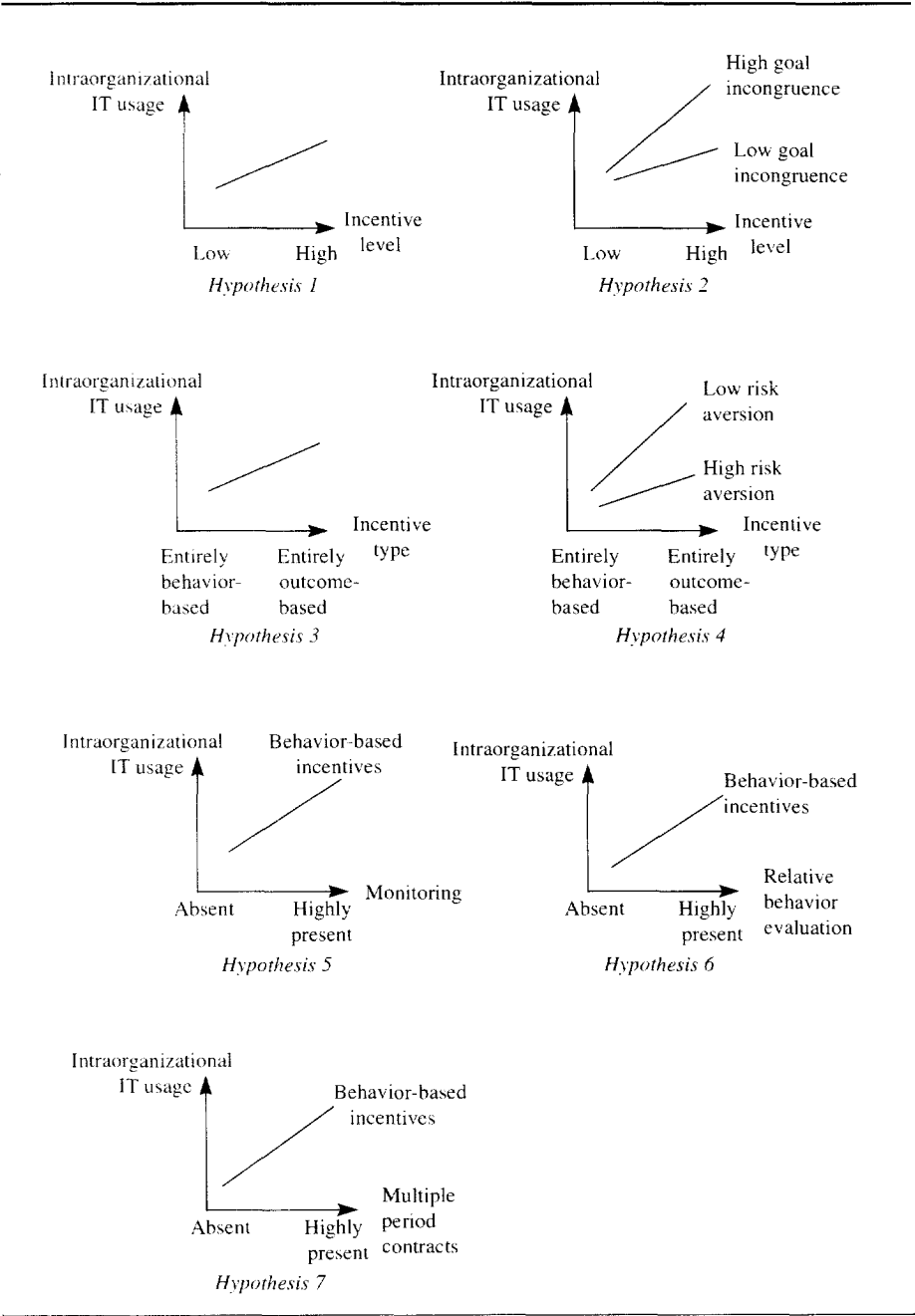**Figure 2:** Principal-agent model of intraorganizational IT usage.
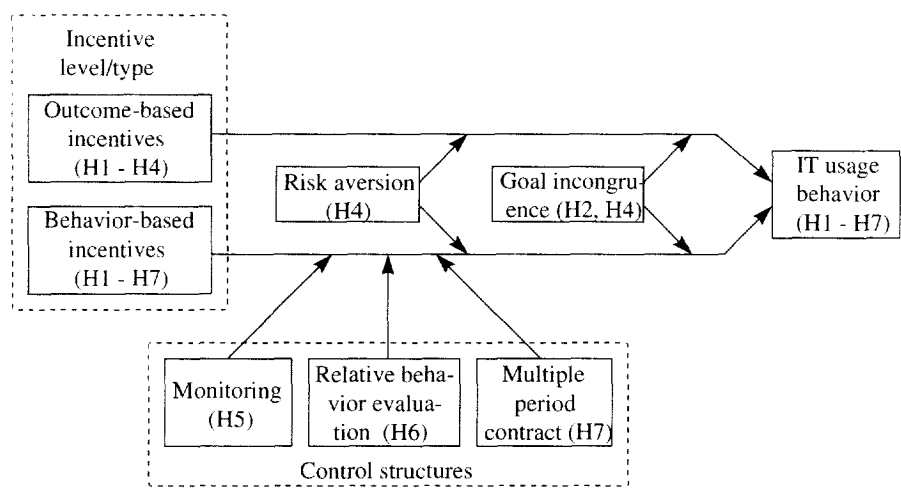
Note: Hn indicate research hypotheses related to the associated construct.

may induce users to behave against management's interests. The notions of goal incongruence and opportunistic behavior are supported by the political conflict stream of MIS research (e.g., Kling & Iacono, 1984; Markus, 1983), which views organizations as comprised of stakeholders with diverse, conflicting interests and often indulging in subversive political actions to further their personal goals. While political conflict theory attempts to resolve this goal incongruence via bargaining, negotiations, and coalitions—the power mechanisms of political science, PAM resolves goal incongruence via the use of incentives and control structures.

Incentives offered by management may be categorized based on level (high versus low) and type (behavior-based versus outcome-based) (Ouchi, 1979; Nilakant & Rao, 1994). High incentive levels will motivate users to utilize the IT appropriately by coaligning management and user goals. Prior research on IT implementation supports this hypothesis. Using a survey of 422 business school faculty members, Howard and Mendelow (1991) demonstrated that availability of incentives was one of seven factors that discriminated between zero, minimal, and high levels of computer use. Currid (1995) stated that such incentives need not be financial; innovative, nonmonetary incentives such as yielding control over employees' working agenda, providing public recognition, and changing of titles can prove equally effective over the long run as salary raises or bonuses. Hence, as illustrated graphically in Figure 3, incentive level is hypothesized to have a direct positive effect on intraorganizational IT usage.

H1: The level of incentives for IT usage is positively related to the extent of intraorganizational IT usage.

Figure 3: Graphical representation of propositions.

Intraorganizational IT usage

Incentive level

Low High

Hypothesis 1

Intraorganizational IT usage

High goal incongruence

Low goal incongruence

Incentive level

Low High

Hypothesis 2

Intraorganizational IT usage

Incentive type

Entirely behavior-based

Entirely outcome-based

Hypothesis 3

Intraorganizational IT usage

Low risk aversion

High risk aversion

Incentive type

Entirely behavior-based

Entirely outcome-based

Hypothesis 4

Intraorganizational IT usage

Behavior-based incentives

Monitoring

Absent

Highly present

Hypothesis 5

Intraorganizational IT usage

Behavior-based incentives

Relative behavior evaluation

Absent

Highly present

Hypothesis 6

Intraorganizational IT usage

Behavior-based incentives

Multiple period contracts

Absent

Highly present

Hypothesis 7

Since incentives are directed at reducing goal incongruence between management and users, the marginal effect of incentives will depend on the extent of goal incongruence between the two parties. As demonstrated by Davis, Bagozzi, and Warshaw (1992), if potential users perceive IT usage as intrinsically increasing

their utilities (e.g., if such usage provides them enjoyment or social status among their peers), they will be motivated to use it appropriately even with fewer incentives from management. The greater the goal incongruence, the greater the expected marginal effect of incentives on user behavior. In other words, goal incongruence between management and users moderates the effect of incentive level on intraorganizational IT usage (see Figure 3).

> H2: The marginal effect of incentive level on intraorganizational IT usage is positively related to the extent of goal incongruence between management and users regarding IT usage.

Incentives for IT usage may be based on users' behavior (e.g., hourly wage) or on the outcomes of such behavior (e.g., commissions based on sales). From management's perspective, outcome-based incentives are the safest way of ensuring the fidelity of users because such incentives transfer the risks of inappropriate behavior to users, making them accountable for the realized outcomes (Sappington, 1991). On the other hand, behavior-based incentives insure users from unfavorable outcomes due to nonuse of IT, and thereby may induce them to shirk from IT usage. In a survey study of salespersons in 54 retail stores, Eisenhardt (1985) found that commissions (outcome-based incentives) were more effective in motivating salesperson behavior than salaries (behavior-based incentives). Hence, as shown in Figure 3, *incentive type* is hypothesized to have a direct effect on intraorganizational IT usage.

> H3: Outcome-based incentives have greater effects on intraorganizational IT usage compared to behavior-based incentives.

Note that incentive type, though described above as a dichotomy, is actually a continuum ranging from purely behavior-based to purely outcome-based incentives. Organizations may employ a combination of behavior-based and outcome-based incentives to motivate user behavior, as opposed to the polar ends. However, incentive type is empirically operationalized here as a dichotomous variable for simplicity of analysis.

Though outcome-based incentives are generally more effective compared to behavior-based incentives in motivating user behavior, the differential effect of the two incentive types depends on risk aversion on the part of potential users. PAM assumes users to be risk averse and principals to be risk neutral. However, risk aversion is a general attitudinal trait that typically varies from one user to another. More risk-averse users are generally less motivated to use IT under outcome-based incentives (compared to behavior-based incentives), because of the risks imposed by such incentives. On the other hand, less risk-averse users are less affected by the choice of incentive type, and are therefore expected to exhibit less differential effect of incentive type on IT usage. Hence, users' extent of risk aversion moderates the effect of incentive type on IT usage (see Figure 3).

> H4: The differential effect of outcome-based incentives over behavior-based incentives on intraorganizational IT usage is greater for more risk-averse users than for less risk-averse users.

The design of behavior-based incentives is also complicated by information asymmetries in principal-agent relationships. For instance, management may know how much time a user is logged onto a computer or how many times he or she has accessed a particular database, but will still be unsure whether the IT was appropriately utilized. Two information asymmetry problems discussed in the literature are that of moral hazard and adverse selection, also called the problems of hidden action and hidden information (Arrow, 1985). In the *moral hazard* problem, opportunistic users may take advantage of management's inability to accurately infer their behavior and set their effort at lower levels. In the *adverse selection* problem, management's ignorance of users' private information (state of nature) affecting their usage may lead to the design of ineffective incentives.

PAM suggests that the moral hazard problem can be remedied in part by using monitoring mechanisms such as computer logs, time sheets, and spot checks by supervisors (Sappington, 1991). Though monitors do not provide perfect information about user behavior, they are still effective in curbing user opportunism, because monitors are perceived by users as revealing their behavior to management. This induces users not to "cheat" management with the promised effort level. This effect was confirmed by Eisenhardt (1985) in an empirical study of salesperson behavior. Therefore, as shown in Figure 3, monitoring has a direct positive effect on IT usage under conditions of behavior-based incentives.

> H5:   For behavior-based incentives, presence of monitoring is positively related to intraorganizational IT usage.

The adverse selection problem can be mitigated in part in multiple-agent settings by comparing a user's behavior with that of his or her peers, or in multiple-period settings by linking the user's behavior to his or her behavior in prior or future periods. Strictly speaking, managers can never decipher private information possessed by users (e.g., access to a useful IT resource outside the organization), unless users themselves volunteer this information. However, the presence of multiple users may help reduce user opportunism by controlling for the effects of a state of nature that is common to all users although unobservable to management. Since any additional information is available to all users and is utilized in their rational behavioral choice, incentives based on a *relative behavior evaluation* can control for the effects of private information employed by users in setting their effort level. One example of such evaluation is a simple "tournament" (e.g., promotion) in which a single user, from a group of users, is rewarded based on ordinal ranking of user behaviors (Sappington, 1991). Tournaments can be particularly valuable incentive devices, especially when management has very limited resources to commit, because they help reduce users' opportunistic behavior without imposing any additional costs on management (note that tournaments assume no collusion or strategic cooperation among agents). Hence, as illustrated in Figure 3, relative behavior evaluation has a direct effect on IT usage in the presence of behavior-based incentives.

> H6:   For behavior-based incentives, relative evaluation of user behavior has greater effects on intraorganizational IT usage compared to absolute behavior evaluation.

Multiple-period contracts provide new opportunities for designing incentives in cases in which users' private information or behavior cannot be assessed by management. In such settings, if a user's incentive in a future period is linked to his or her behavior in the current period, the user will be motivated to utilize the IT appropriately in order to improve the chances of obtaining better incentives in the future period (Eisenhardt, 1989). Also, as managers and users engage in long-term relationships, managers may learn more about the users and be able to assess their behavior more accurately. This was confirmed in a laboratory experiment by Parks and Conlon (1995), in which multiple-period contracts had significantly greater effects on subjects' behavior than single-period contracts. Therefore, under behavior-based incentives, multiple-period contracts can be hypothesized to have a direct positive effect on intraorganizational IT usage (see Figure 3).

H7: For behavior-based incentives, presence of multiple-period contracts has greater effects on intraorganizational IT usage compared to single-period contracts.

Note that control structures such as monitoring, relative behavior evaluation, and multiple-period contracts, are of interest only under conditions of behavior-based incentives, because outcome-based incentives, by their very nature, reduce information asymmetry problems by coaligning users' goals with that of management.

Empirical testing of the effects of incentives and control on IT usage has been very limited, though similar studies are gaining interest in marketing and management literature (e.g., Eisenhardt, 1985; Mento, Steel, & Karren, 1987). This lack of attention can be attributed to the novelty associated with such compensation schemes and operational difficulties associated with controlling incentives in field settings. The remainder of this paper addresses these empirical shortcomings using a suitably designed laboratory experiment.

RESEARCH METHODOLOGY

This section describes methodological issues concerning the empirical testing of the seven research hypotheses presented earlier. This section is organized into three parts: the first part describes the research setting (e.g., subjects, tasks), the second part addresses operationalization and measurement issues, and the final part describes psychometric validation of the research instrument used in this study.

Research Strategy

A laboratory experiment was employed in this study to empirically test the proposed model of IT usage. Selection of this approach was motivated by two reasons. First, given that empirical research related to incentives and control is still formative, internal validity (causality among variables) was considered more important than external validity (generalizability to other contexts). Laboratory experiments can provide high levels of internal validity, by employing rigorous controls on the variables of interest. Second, inadequate treatment manipulation has been cited as one of the major reasons for the lack of significant results in this area (Eisenhardt,

1989). Difficulty in manipulating treatment variables related to incentives and control in field settings motivated the use of a laboratory approach.

Students from a sophomore-level business applications class at a large southwestern university served as subjects for this study. The intraorganizational context was simulated by artificially introducing incentives and control structures typical of organizational settings. Subjects received bonus points toward their class grade for participating in an optional, extra-credit assignment involving the potential use of a new software tool. Prior to the experimental treatment, subjects were introduced to the IT and similar tasks via an in-class demonstration and a written tutorial. They were also shown how to perform such tasks using other IT and non-IT means (e.g., calculator, spreadsheets).

On the scheduled date, subjects were randomly allocated among six treatment groups (described in the next section) and asked to complete a pretreatment questionnaire intended to elicit their perceptions of model variables. They were then given the experimental task and asked to complete it using any IT or non-IT of their choice. Subjects were asked to save their work on diskettes so that it could be evaluated at a later time. Upon task completion, subjects were administered a posttreatment questionnaire to assess their perceptions of IT usage.

The task selected for this study was a managerial budget allocation problem (see Appendix) that could be facilitated by the use of IT. Subjects were asked to assume the role of a marketing manager of an appliance store and determine the exact number of refrigerators, stoves, and microwave ovens to buy, subject to budgetary, warehouse, and back order constraints, in order to take advantage of a promotional dealer pricing for these products. Such tasks are fairly typical of those faced by marketing managers (i.e., IT users) in organizational settings (McIntyre, 1982). A pilot study confirmed the reasonableness of this task for the subject sample.

The IT recommended for performing the assigned task was Microsoft Excel's SOLVER, a tool for solving linear and integer programming problems. Subjects were told that SOLVER was particularly suited for complex tasks of this type because it reduced the time required and potential errors in performing such tasks. However, subjects were free to use any other IT or non-IT of their choice. This degree of freedom was necessary to ensure that subjects' use of IT was voluntary. Note that Excel was taught as part of this class; however, SOLVER was not part of the curriculum and was not covered in class. A pilot study revealed that over 98% of the students in this class had no prior exposure to SOLVER, and therefore, it was considered acceptable for examining subjects' IT usage behavior.

Operationalization of Variables

Five independent research variables (i.e., incentive level, incentive type, monitoring, relative behavior evaluation, and multiple-period contract) and two moderating variables (i.e., goal incongruence and risk aversion) were measured in this study, whereas IT usage was a multidimensional dependent variable. Given the lack of prior empirical work to guide operationalization of PAM's incentive and control variables, these variables were manipulated dichotomously (i.e., low versus high, present versus absent) as treatment variables. The experimental

design employed was a randomized blocks design with six treatment groups (Huck, Cormier, & Bounds, 1974), in which each group represented a unique combination of the five treatment variables. The purpose of this design was to incorporate adequate experimental control so that each hypothesized main or interaction effect could be isolated, while controlling for possible confounding effects of other treatments. It was expected that purposive manipulation of treatment variables would induce variance in these variables so that their effects could be easily detected. Treatment manipulation across the six treatment groups is illustrated in Table 1, and treatment operationalization and measurement are summarized in Table 2.

Incentive level was manipulated as low versus high depending on whether subjects received two or seven points toward their grade for using SOLVER in the experimental task. The specific point allocation was determined from an initial pilot study in which subjects were asked to suggest reasonable incentives for this task, and 90% of subjects agreed that four or five points should be adequate. Incentive type was manipulated by dividing the high incentive group into two subgroups: subjects in the first subgroup (behavior-based incentives) were rewarded based on their extent of SOLVER usage irrespective of their solving or not solving the problem, whereas those in the second subgroup (outcome-based incentives) had incentives specifically linked to their solving the assigned task irrespective of SOLVER use or nonuse.

Monitoring was manipulated by informing a section of the behavior-based incentives group that their use or nonuse of SOLVER was being monitored continuously by a network monitoring software, whereas the other section was told that they were not being monitored. To manipulate relative behavior evaluation, a portion of the behavior-based incentive group was informed that their SOLVER utilization would be evaluated relative to that of other subjects in the same group, whereas the remaining subjects were evaluated on an absolute scale (i.e., irrespective of others' behavior). Multiple-period (repeated) contract was manipulated by informing a subgroup of the low-incentive behavior-based group that they could get an additional five points for performing a second (similar) task if they utilized SOLVER appropriately in the current task, whereas others did not have any such opportunity. For purposes of equalizing the total reward that subjects could receive from this project, the high-incentive group was not exposed to multiple-period contracts, whereas the section of the low-incentive group without a multiple-period contract was later given an opportunity to earn an extra five points by completing a different assignment unrelated to the experimental task. To cross-check whether the manipulated treatments had the intended effects on subjects, subjects' perceptions of all five treatment variables were elicited using a pretreatment questionnaire.

The final two independent variables (i.e., goal incongruence and risk aversion) were measured using prevalidated multiple-item Likert scales. Goal incongruence was measured using Moore and Benbasat's (1991) behavioral intention scale. Because management's goal is to have users utilize the IT, goal incongruence in this study referred to subjects' lack of intention to use IT, and was hence the inverse of the behavioral intention construct. Risk aversion was measured using Jackson Personality Inventory (Jackson, Houdnay, & Vidmar, 1972), which

Table 1: Manipulation of treatments across treatment groups.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Incentive level	Low	Low	High	High	High	High
Incentive type	Behavior based	Behavior based	Outcome based	Behavior based	Behavior based	Behavior based
Monitoring	Absent	Absent	Absent	Absent	Absent	Present
Relative behavioral evaluation	Absent	Absent	Absent	Present	Absent	Absent
Multiple-period contract	Absent	Present	Absent	Absent	Absent	Absent

assesses individual risk attitude toward risky situations using four modes of measurement: self-rating, situational dilemmas, vocational choice, and personality inventory.

Intraorganizational IT usage, the dependent variable in this study, was operationalized as a combination of acceptance (users' decision to use or not use IT) and infusion (the extent to which IT is used) (Cooper & Zmud, 1990), each measured using objective and perceptual scales. This multidimensional characterization of IT usage captured both the breadth (acceptance) and depth (infusion) of use. Acceptance was operationalized as a binary variable, measured objectively using a network auditing software called SofTrack and perceptually using a Likert-scaled measure on the posttreatment questionnaire. Infusion was operationalized as the number of correct functionalities within SOLVER employed by subjects while performing their task, as identified from guidelines in the users' manual on how to solve integer programming problems using SOLVER. Infusion was measured objectively in this study by examining the diskette turned in by subjects and perceptually by using a multiple-item Likert scale. An additional check-in item was used for measuring self-reported infusion, in which the subjects were provided with a list of SOLVER functionalities and asked to check those that they used in the task. Several spurious functionalities were included in this list to guard against possible random checking by subjects. Simultaneous measurement of usage variables using objective and perceptual means was intended to cross-validate usage data in addition to examining the fit between these measures, because one recent study (i.e., Straub, Limayem, & Karhanna-Evaristo, 1995) provided evidence to the contrary.

Instrument Validation

An initial version of the research instrument was constructed by randomly ordering items from different scales into a common pool. As recommended by Moore and Benbasat (1991), all scale items were worded to relate specifically to SOLVER

Table 2: Operationalization and measurement of variables.

Variable	Operational Measure	Mode of Measurement	Scale	Source
Incentive level*	Whether incentive provided to subject was high or low	Treatment manipulation Perceptual measure	Binary Interval	None —
Incentive type*	Whether incentive provided was behavior based or outcome based	Treatment manipulation Perceptual measure	Binary Interval	None —
Monitoring*	Whether subject's use of SOLVER was being monitored	Treatment manipulation Perceptual measure	Binary Interval	None —
Relative behavior evaluation*	Whether subject's incentive was based on relative or absolute behavior evaluation	Treatment manipulation Perceptual measure	Binary Interval	None —
Multiple-period contract*	Whether subject's incentive was based on their SOLVER usage in multiple periods	Treatment manipulation Perceptual measure	Binary Interval	None —
Risk aversion	Subjects' overall predisposition to risky situations	Four-item Prevalidated measure	Interval	Jackson et al. (1972)
Goal incongruence	Degree to which subject intended utilizing SOLVER for the task (behavioral intention)	Three-item Perceptual measure	Interval	Mathieson (1991)
IT acceptance	Whether SOLVER was used (and not subsequently rejected) during the task	Auditing software Perceptual measure	Binary Interval	Davis et al. (1989)
IT infusion	Number of functionalities within SOLVER used by subject	Diskette examinination Perceptual measure	Ratio Interval	None

*Variables manipulated via dichotomous treatments.

usage rather than to IT usage in general. This instrument was then subjected to a pilot test sample of 71 student subjects. Respondents were asked to complete each questionnaire and comment on its length, wording, and instructions. This helped identify unclear or ambiguous items, which were then either reworded or eliminated. The final scales, consisting of three to four items per construct, were

psychometrically evaluated for their reliabilities and construct validities using 132 subjects in the subsequent experimental study (22 subjects per treatment group).

Scale reliabilities were calculated from the matrix of interitem correlations using PROC CORR in SAS (SAS Institute Inc., 1990) with the ALPHA option. The means, standard deviations, and Cronbach's alpha (internal consistencies) for each scale are reported in Table 3. Six of the nine perceptual scales (seven independent variables and two dependent variables) had Cronbach's alpha greater than .80. The remaining three scales, incentive type ($\alpha = .784$), relative behavior evaluation ($\alpha = .775$), and risk aversion ($\alpha = .698$), had reliabilities fairly close to the target figure. Overall, the research instrument was thus considered reliable.

Factor analysis was employed to examine the construct validity of each scale. The 28 items in the nine perceptual scales were pooled together and factor analyzed using PROC FACTOR in SAS. A correlation matrix was constructed, which was then used to extract the common factor model using principal component analysis. Adequacy of factor extraction was checked in two ways: by visually inspecting scree plots of extracted factors (ignoring factors lying below the elbow region of the plot), and by eliminating factors having eigenvalues less than 1.0. Both criteria were met by identified factors, with the exception of risk aversion. The initial factor model was then subjected to an oblique rotation technique called PROMAX to identify an unambiguous factor structure. Oblique rotation was preferred over the more commonly used orthogonal rotation, because it is a more conservative technique and does not arbitrarily impose the restriction that factors be uncorrelated (in fact, some of the factors examined in this study, such as behavior-based and outcome-based incentives, perceived and actual infusion, were expected to be correlated). Factor loadings for each item, along with the eigenvalues for each factor, are summarized in Table 3.

A simple factor structure emerged from the above analysis. One rule of thumb for assessing construct validity is that each item should have a factor loading exceeding .6 on its hypothesized construct (for convergent validity), while having less than .3 loading on all other constructs (for discriminant validity) (SAS Institute Inc., 1990). The convergent validity criterion was met for 24 of 28 items, whereas the discriminant validity criterion was satisfied for 343 of 377 cross-factor loadings. Factor loadings ranged from .41 to .94, with several loadings exceeding .80. Furthermore, after rotation, no item loaded highly on more than one factor, further attesting to the discriminant validity of the scales. Factor analysis results, therefore, provided overall support for the construct validity of the research instrument.

As a final stage in instrument validation, chi-square tests were conducted to assess the goodness of fit between actual treatment manipulations and perceptual measures (averaged) of these manipulations. Three of the five treatments (i.e., incentive level, monitoring, and multiple-period contract) had chi-square values significant at .05 level, whereas the other two treatments (i.e., incentive type and relative behavior evaluation) were significant at .10 level (see Table 4), indicating that overall, the treatments were perceived by subjects as intended. The somewhat less significant fit for the latter two variables might have resulted from scaling differences between the two modes of measurement (i.e., binary for actual treatments

Table 3: Scale reliabilities and validities.

Scale	Number of Items	Mean	Standard Deviation (pooled)	Cronbach's Alpha	Factor Loadings	Eigenvalues
Incentive level	3	4.580	2.061	.906	.903, .936, .870	2.899
Incentive type	3	3.611	2.205	.784	.849, .409, .827	1.308
Monitoring	3	4.134	2.119	.864	.855, .908, .858	2.464
Relative behavior evaluation	3	3.596	2.138	.775	.839, .625, .820	1.439
Multiperiod contract	3	2.843	2.177	.867	.889, .913, .942	2.190
Risk aversion	4	5.273	2.269	.698	.624, .552, .874, .344	0.557
Goal incongruence	3	5.328	1.683	.893	.907, .936, .870	2.899
Perceived acceptance	3	0.621	0.635	.831	.783, .721, .549	1.036
Perceived infusion	3	4.982	2.146	.796	.912, .913, .880	6.070

and interval scale for perceived treatments), and does not necessarily invalidate manipulation of these treatments.

RESULTS OF THE STUDY

The seven research hypotheses stated earlier were tested using a series of multivariate analysis of variance (MANOVA) tests. MANOVA, an extension of the univariate analysis of variance approach to the case of multiple correlated dependent variables, is a simple yet powerful test for examining differences in group means, in which each group is characterized by simple, two-condition treatments, though it can be extended to cases involving multiple independent variables.

MANOVA makes two assumptions about the populations from which sample observations (dependent variables) are drawn: (1) normality: normal distribution of observations, and (2) homoskedasticity: equality of residual variances across treatment groups. Though MANOVA is fairly robust to the violation of these assumptions, especially for sample sizes greater than 20 (Kotz & Johnson, 1982), these assumptions were nevertheless checked for purposes of rigor. Normality was assessed for perceived and actual infusion within each treatment group using Shapiro-Wilk's test, whereas homoskedasticity was evaluated using

Table 4: Validation of manipulated treatment effects.

Treatment Variable	Pearson's Chi-square	p-value (Goodness of Fit)
Incentive level	35.224*	.006
Incentive type	19.294†	.074
Behavioral evaluation	24.803†	.090
Multiple-period contract	44.322*	.001
Monitoring	18.713*	.040

Chi-squares significant at .05 and .10 levels are denoted by * and †, respectively.

Bartlett's test. Shapiro-Wilk's W statistic and Bartlett's L statistic were both significant for these variables at .05 level, attesting to the normality and homoskedasticity of the underlying population distribution. Low values of skewness and kurtosis (−2 to +2) for most observations provided additional evidence of normality. Perceived and actual acceptance were not examined for normality because they were defined in binary terms, that is, they followed binomial distributions.

According to the norms of classical inference testing, all hypotheses were stated in alternative form, so that the corresponding null hypotheses were expected to be rejected. For each hypothesis, MANOVA was accomplished by first extracting a small subset of data from the original data set, in which all treatment variables other than those being examined were controlled. This subset was subjected to PROC GLM in SAS by partitioning the dichotomous treatment levels using the CLASS option. For each hypothesis, an approximate F-statistic derived from Wilks' lambda was used to test the significance of the overall MANOVA (all four dependent variables grouped together). If the MANOVA result was significant, follow-up ANOVAs were conducted to identify which of the four dependent variables (i.e., actual acceptance, perceived acceptance, actual infusion, and perceived infusion) experienced significant effects due to the hypothesized cause. The means and standard deviations of each treatment group are listed in Table 5, whereas results of the MANOVA and follow-up ANOVA analyses are provided in Table 6.

H1 examined the main effect of incentive level (low versus high) on IT usage, whereas H2 was concerned with the interaction effect between incentive level and goal incongruence on IT usage. Data from treatment groups 1 and 5 were employed for testing both hypotheses. Subjects in these groups received two and seven points (representing low and high incentive levels), respectively, for using SOLVER in the assigned task; all other incentive and control variables were the same across the two groups (i.e., both groups had behavior-based incentives, no monitoring, no relative behavioral evaluation, and no multiple-period contracts). Exclusion of other groups helped control for potential confounding effects of other treatment variables and ensured that the observed effect was purely due to differences in incentive level (see Table 1). Goal incongruence was not manipulated but instead was measured using a multiple-item, perceptual, Likert scale; the median value was used to classify these subjects into high and low goal incongruence groups. Though converting from interval scale to a dichotomous scale resulted in

Table 5: Group means and standard deviations

Group Number	Sample Size	AC_a: Mean (SD)	AC_p: Mean (SD)	IN_a: Mean (SD)	IN_p: Mean (SD)
1	22	0.182 (0.395)	0.400 (1.400)	1.500 (0.964)	3.300 (2.000)
2	22	0.727 (0.456)	1.600 (0.234)	4.636 (2.517)	4.600 (2.038)
3	22	1.000 (0.000)	1.500 (0.420)	6.409 (0.796)	5.800 (0.733)
4	22	0.909 (0.294)	1.600 (0.298)	5.909 (2.091)	5.800 (1.022)
5	22	0.500 (0.512)	1.500 (2.265)	2.227 (1.771)	4.000 (1.857)
6	22	0.909 (0.294)	1.600 (0.117)	5.864 (1.754)	5.400 (1.444)

Note: AC_a = Actual acceptance, AC_p = Perceived acceptance, IN_a = Actual infusion, IN_p = Perceived infusion.

loss of data quality for this variable, it was necessary given that MANOVA cannot handle continuous or interval-scaled treatment variables. For both H1 and H2, the overall F-statistics obtained from MANOVA (i.e., 17.184 and 3.990) were significant at .05 level (see Table 6). Follow-up ANOVAs for all four dependent variables were also significant, providing support for PAM's contention that incentive level is significantly related to IT usage and that the effect of incentive level on usage is moderated by users' extent of goal incongruence.

H3 tested for the main effect of incentive type (behavior based versus outcome based) on IT usage, whereas H4 examined the interaction effect between incentive type and risk aversion on the dependent variable. Groups 3 and 5 were used for this purpose. Subjects in both groups received seven points for performing the task, but their incentives were specifically linked to outcomes obtained and effort expended, respectively. Risk aversion was measured using Jackson Personality Inventory (Jackson et al., 1972) on a perceptual scale, based on which subjects were grouped into high and low risk aversion categories via a median split. For both the main and interaction effects, the overall MANOVA F-statistics were significant at .10 level, but not at .05 level (see Table 6). Follow-up ANOVAs revealed that the hypothesized effects were significant for actual and perceived infusion, but not for actual or perceived acceptance. Partial support for these linkages may be attributed to at least three reasons. First, the risk aversion scale employed in this study measured subjects' overall risk attitude, instead of risk attitude specific to the behavior under consideration (i.e., SOLVER usage). Cognitive psychology research indicates that overall attitude scales tend to account for less proportion of variance in individual behavior compared to domain-specific scales (Fishbein & Ajzen, 1975). Second, the relatively low goodness of fit between actual and perceived measures of incentive type suggests that manipulation of this variable might have been inadequate and the effect size too small to be detected. Third, as revealed in subsequent discussions with a few subjects, even though some subjects perceived behavior-based incentives and outcome-based incentives to be different, this difference did not cause any differential impact on their behavior (SOLVER usage) in the experimental setting. Many subjects felt that, irrespective of group assignments, they had to utilize SOLVER appropriately and complete the assigned task in order to receive the most reward (i.e., seven points). Partial

Table 6: Results of MANOVA analysis.

Hypotheses	Treatment Groups	Overall F (p-value)	AC_a	AC_p	IN_a	IN_p	Overall Results
			F-statistic (p-value)				
H1: IL	1 and 5	17.184* (.0001)	6.35* (.0160)	10.64* (.0023)	58.23* (.0001)	21.60* (.0001)	Supported
H2: IL*GI	1 and 5	3.990* (.0046)	4.07* (.0486)	7.21* (.0006)	19.13* (.0001)	20.88* (.0001)	Supported
H3: IT	3 and 5	1.856† (.0998)	1.94 (.1403)	2.73 (.1179)	4.803* (.0348)	4.68* (.0396)	Partially supported
H4: IT*RA	3 and 5	1.169† (.1003)	2.30 (.1243)	2.53 (.1079)	5.11* (.0297)	10.17* (.0031)	Partially supported
H5: MN	5 and 6	8.384* (.0001)	5.19* (.0192)	4.46* (.0419)	38.06* (.0001)	14.01* (.0001)	Supported
H6: RB	4 and 5	0.816 (.5254)	1.13 (.1121)	1.79 (.1738)	2.12† (.0781)	0.94 (.2910)	Not supported
H7: MC	1 and 2	7.833* (.0002)	4.97* (.0319)	9.10* (.0044)	26.74* (.0001)	7.23* (.0109)	Supported

Note: F-statistic significant at .05 and .10 levels are denoted by * and †, respectively.
Legend: IL: incentive level, GI: goal incongruence, IT: incentive type,
    RA: risk aversion, MN: monitoring, RB: relative behavior evaluation,
    MC: multiple-period contract, AC_a: actual acceptance, AC_p: perceived acceptance,
    IN_a: actual infusion, IN_p: perceived infusion.

support does not negate H3 and H4, but merely indicates the lack of adequate evidence to prove them.

H5, H6, and H7 examined the main effects of three control structures (i.e., monitoring, relative behavior evaluation, and multiple-period contracts) on intraorganizational IT usage, under conditions of behavior-based incentives. Subjects from groups 5 and 6 were used to test for monitoring, groups 4 and 5 for relative behavior evaluation, and groups 1 and 2 for multiple-period contracts. Consistent with theoretical expectations, the F-statistic for the overall MANOVA and subsequent ANOVAs for each dependent variable were significant for monitoring and multiple-period contracts (see Table 6), confirming the effect of these control structures on IT usage. However, the hypothesized effect of relative behavior evaluation was not supported (except for a weak support for actual infusion). This unexpected lack of support may be attributed to subjects' inability to perceive differences between relative and absolute evaluation of behavior, as indicated by the low goodness of fit between actual and perceived measures of this variable.

A secondary goal of this study was to examine the goodness of fit between actual and perceived measures of usage. In the current experimental setting, actual usage measures were expected to be different from perceived measures because some subjects were likely to overstate their usage levels due to reward structures (i.e., bonus points received from the task) associated with such usage. Chi-square

tests indicated a significant difference between perceived and actual measures of acceptance at .05 level (chi-square = 7.683), although no such difference was found between perceived and actual infusion (chi-square = 2.115 for 132 subjects). This mixed finding is consistent with a prior study by Straub et al. (1995), and indicates that perceived usage should not be universally treated as a surrogate for actual usage. However, the greater fit between perceived and actual infusion suggests that perceived infusion may be employed as a reasonable surrogate of actual infusion when actual usage measures are not available.

In summary, of the seven sets of hypotheses representing main and interaction effects of PAM's incentive and control variables on IT usage, four hypotheses sets were supported using the experimental data, two sets were partially supported (i.e., infusion variables were supported but acceptance variables were not), and one set was not supported. Implications of these results are discussed in the next section.

IMPLICATIONS OF THE STUDY

The purpose of this paper was to develop a theoretical model that can explain how managerial influences affect intraorganizational IT usage. Such a model can advance not only our state of knowledge in IT implementation, but can also provide normative guidelines for IT managers interested in designing strategies for effective IT implementation. Implications of this study for MIS practitioners and researchers are described next.

Implications for Practitioners

As a normative model, one of the strengths of the proposed model (PAM) is its ability to prescribe guidelines that can be used by managers to enhance IT diffusion/implementation within their organizations. Results of the study indicate that managers can proactively motivate users' behavior within organizations by designing appropriate incentives and control structures tailored to IT usage. This runs counter to most organizational incentive systems characterized by compensation largely independent of performance, overwhelming use of promotion-based incentives, and absence of effective bonding contracts (Baker, Jensen, & Murphy, 1988). It is only recently that companies like Microsoft and The Washington Post have started using stock options (an outcome-based incentive) to motivate user behavior within their organizations (Sloan, 1996).

This study also indicates that users' inability to perceive differences between different forms of incentives and control will constrain their effects on user behavior. Though outcome-based incentives are generally more effective compared to behavior-based incentives, the expected benefits of such incentives may not be realized if users perceive little or no difference between these incentive types. The same applies for relative versus absolute behavior evaluation. In addition to employing novel organizational incentives, managers should therefore strive to inform organizational users of the exact nature of these incentive schemes in order to ensure their effectiveness.

Behavior-based incentives may lead to opportunistic behavior on the part of users, and control structures such as monitoring (e.g., computer usage logs) and

multiple-period contracts (in which incentives are linked to user behavior in mul-
tiple time periods) should be employed to curb user opportunism and positively
affect their behavior. However, PAM offers no recommendations regarding the rel-
ative usefulness of the different control structures. Hence, management's choice of
control structures would depend on organizational considerations outside the
scope of the current model, such as costs of creating and enforcing control struc-
tures, political climate within the organization, and so forth.

Implications for Researchers

The most important contribution of this study to MIS research is that it develops
and validates a theoretical model linking managerial influence with intraorganiza-
tional IT usage. Though prior empirical research has demonstrated managerial
influence to be an important determinant of user behavior (e.g., Leonard-Barton &
Deschamps, 1988; Fichman, 1992), the reason behind this association was not
clearly understood. The proposed model (PAM) postulates incentives and control
as important components of managerial influence, which impact individual IT
usage behavior by coaligning users' goals with that of management.

Prior implementation research has advocated the need to integrate micro-
level individual and macro-level managerial factors within a common framework
in order to provide a better and more comprehensive understanding of IT usage
(DeSanctis, 1984). Although prior usage models such as TAM and TPB were pri-
marily concerned with individual-level factors, PAM provides a framework to link
these factors with managerial factors, and thereby extend current models of IT
usage to organizational contexts.

In attempting to explain self-interested albeit utility-maximizing individual
behavior within organizations characterized by goal incongruence and opportunis-
tic behavior, PAM provides a bridge between the traditionally segregated eco-
nomic and political schools of thought in MIS research. PAM provides an
economic lens to interpret politically motivated behavior within organizations. As
observed by Jensen and Meckling (1976), agency theory, underling the proposed
model, may serve as "the foundations for a powerful theory of organizations . . . a
major advance beyond the usual sociological methods of organizational analysis"
(p. 324).

LIMITATIONS AND FUTURE RESEARCH

Being one of the earliest studies in the area of managerial incentives and control,
the current study suffers from several theoretical and methodological limitations.
First, laboratory experiments, by their very nature, tend to limit the external valid-
ity (generalizability) of their results. Chapnis (1983) noted that such experiments
can examine only a small number of variables, develop models that are at best
rough and approximate models of reality, and produce results that may not be ade-
quately generalizable to other populations, settings, and treatments. Given this
study's emphasis on causality, a laboratory experiment was considered justified.
Future research may attempt to improve the generalizability of the laboratory find-
ings by replicating this study in field settings. Such replication may also take into

account the effect of negative incentives (e.g., threats, disincentives) that were not examined in this study.

Second, most applications of principal-agent research to the study of organizations have been restricted to theoretical exposition of propositions (e.g., Eisenhardt, 1989; Gurbaxani & Kemerer, 1990), rather than empirical testing of these propositions. Testing of these propositions may have suffered due to difficulties in operationalizing economic constructs such as risk aversion and information asymmetry. Inaccurate instrumentation may be partially responsible for some of the nonsignificant results reported in this study. Future studies may focus on developing more appropriate instruments for measuring these constructs.

Finally, the principal-agent model is a generic economic tool that can be applied potentially to a large number of MIS management problems characterized by goal incongruence, risk aversion, and information asymmetry (Gurbaxani & Kemerer, 1990). Future research efforts may be directed at identifying research areas in MIS that can potentially benefit from the use of this model. [Received: January 8, 1996. Accepted: May 6, 1997.]

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APPENDIX: EXPERIMENTAL TASK

Appliance Mart Superstore, headquartered in Boulder, Colorado, specializes in retailing household electrical appliances such as refrigerators, stoves, and washers. Most of their appliances are bought at wholesale prices from local manufacturers such as Goldstar Corp. Mike Jordan, the general manager of Appliance Mart, has hired you as his marketing manager for the Boulder outlet.

Mike has just received information from Goldstar about special dealer pricing on selected models of Goldstar refrigerators, stoves, and microwave ovens.

Refrigerator Model 5601, which usually costs $935 wholesale, is now available at $850. The Gourmet Model S1200 stove, which usually costs $450 wholesale, is currently $420. And the popular Model 660 microwave oven, which usually costs $220 wholesale, is currently $195. This looks like a great opportunity to stock up on these fast moving merchandise and to increase profits.

Mike wants you to find the most profitable mix of refrigerators, stoves, and microwaves that should be ordered to take advantage of the special Goldstar pricing. He tells you that you have a total budget of $50,000 for the order.

You figure that you need profit margins on each of these three items since you are maximizing total profits for the entire order. You check with the sales manager John Smith, and he tells you retail selling prices for refrigerators, stoves, and microwaves are $1250, $595, and $250, respectively. You also learn that Appliance Mart has outstanding customer orders (back orders) for six refrigerators, 14 stoves, and 19 microwaves that are currently unavailable from their inventory, but must be delivered in a few days. The order that you recommend should meet these back orders.

Next, you call the warehouse manager and learn that the warehouse can accomodate 1,300 cubic feet of storage space for the entire order. Each refrigerator, stove, and microwave require 25, 18, and 3 cubic feet of storage space, respectively.

Taking the above data into account, please provide your recommendations on the quantities of refrigerators, stoves, and microwave ovens to order, and the total profit expected out of this order. You are free to use or not use any computer hardware/software for performing this task. You can do any of the following (or any other method of your choice): (1) perform the calculations using a hand calculator and write down your recommendations on a piece of paper that you turn in, (2) use trial-and-error in Microsoft Excel, or (3) use the SOLVER tool in Excel. The use of SOLVER is suggested as one of the quickest, error-proof, and most productive ways of solving complex business problems of this type.

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