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Information Leverage Theory: A Process Level Approach to Understanding the IT-Performance Linkage

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ABSTRACT

This paper proposes a theory of information leverage to explain the enabling role of IT in enhancing process performance within the information processing paradigm. The basic contention is that a measure of IT value can best be ascertained at the site of its application — the organizational process. A set of eight propositions provides the theoretical framework within which the design and use of IT and its impact on performance may be studied.

The central construct of the theory is information use rather than technology use. Information may be leveraged in feedback and feedforward modes and the specific information leverage pattern in the process is contingent on the level of state and motivational uncertainties faced by the process. The paper views IT as a lever of information and the extent of its impact on performance is the extent of the fit between the design/use of IT and the information leverage needs. The bottom line is that the appropriateness of the design and use of IT determines process performance which in turn may affect organizational performance.

1. INTRODUCTION

This paper finds its purpose in the confluence of a number of issues of concern in MIS. First, although the increasing use of information technology (IT) has been justified on the grounds of increased organizational effectiveness, empirical evidence for this has been hard to come by (Brynjolfsson 1992; Loveman 1988). A few have found some significant relationship (Weill 1992) but the findings remain weak. This paper proposes that IT affects organizational performance indirectly through process performance (Barua, Kriebel and Mukhopadhyay 1994). Furthermore, the paper presents a theory of information leverage to overcome the paucity of a comprehensive theoretical framework to study the performance effects of IT.

Second, recent interest in the process revolution has refocused the attention of management thought on organizational processes and the enabling role of IT (Davenport 1993; Hammer and Champy 1993). Though information technology is the central construct of MIS research, it has been studied mostly at the macro, organizational level (Porter and Millar 1985; Ives and Learmonth 1984; King 1978). Its use and application in organizational processes has received limited attention (Earl 1987). This paper will propose a theory to study the role of IT at the process level.

Third, MIS literature has treated the information resource as being made up of two components: information and information technology (Sabherwal and King 1991). This paper sets for itself the task of putting this conceptual distinction to practice. Furthermore, not all of the information used in controlling business activities is acquired through information technology. Hence, one of the basic objectives of this paper is to propose a theory of information use rather than technology use.

Finally, in the face of widespread environmental turbulence, existing control systems need to be reconceptualized and repositioned. Developments in control theory and cybernetics will be used to guide such an effort (Strank 1983; Merchant and Simons 1984). Although control is recognized as a basic activity by MIS literature, it has been primarily treated as a *post hoc* adjunct to planning, its main purpose being to ensure a smooth implementation of plans through feedback. An alternative form of control, better suited to the needs of a dynamic environment, is often used by managers: feedforward (Ishikawa and Smith 1972; Veliyath 1985; Harrison 1991; Michael 1980). Feed-

forward is used to anticipate possible deviations in planned performance by questioning the assumptions of the plan itself. In this sense, feedforward renders the "primacy of planning" untenable (Tadepalli 1992).

It is argued that management of processes may require the use of both feedback and feedforward information and the improper use of one to the exclusion of the other may lead to poor process performance.

Based on the above discussion, the following objectives are laid down:

(a) Introduce the construct of information leverage and the two modes of leverage: feedback and feedforward.

(b) Explain the implications of information leverage for an MIS.

(c) Explain the cause of specific information leverage patterns in a process.

(d) Explain the relationship between information leverage and the information lever (information technology).

(e) Explain how all of the above influence the impact of information technology on performance.

In the first section, I will lay out the basic assumptions and understandings of the various constructs (information, processes, information technology) involved in the proposed theory. Section 3 will then introduce the definition of information leverage and explain the two modes of information leverage, feedback and feedforward, and their implications for the nature of an MIS. In section 4, the various propositions will be laid out so as to place the new construct in a nomological chain of antecedents and consequences. Finally a brief discussion of the implications of this theory will be conducted before concluding.

2. INFORMATION IN PROCESSES

The above heading involves the two central constructs of this thesis: information and processes. The understandings and assumptions about information, processes and the role of information within these processes are laid down here.

2.1 What are Processes?

A process is defined as an open information processing system with a specific ordering of activities across time and place and clearly identified inputs, outputs and structure for action (Davenport 1993). In this paper, the term process will be used to refer to only those sets of activities which are instrumental in achieving or setting the formal goals. The above definition is independent of the scope or granularity of activities. Although valid for processes at any level in the organizational hierarchy, the following discussion is made with a specific interest in operational processes.

It should be noted that process modes of thinking differ from functional views of the organization in that a process is not necessarily restricted to functional or organizational boundaries. This means that the inputs and outputs of a process are defined by needs and expectations of the process customer, rather than the function(s) within which they reside.

A process is just another lens for analyzing organizational subunits and represents one of the many subsystems that are interacting within the organizational super system. It is composed of sets of tasks or subunits that are interdependent on each other to varying degrees (Katz and Kahn 1966). Organizational processes are open information processing systems that process information to cope with uncertainty (Tushman and Nadler 1978).

Varying sources of uncertainty require varying control mechanisms which in turn characterize the process employing them (Burchell et al. 1980). For example, consider two contrasting organizational processes in the same organization: a routine, bureaucratic procurement process for a large university versus a large software development University research project for the creation of a futuristic software in artificial intelligence. As will be elaborated through the rest of this paper, the two present a contrasting set of control requirements.

2.2 Information and Process Uncertainty

The role of information in organizations has been studied from a number of perspectives. For example, as a signal and a symbol (Feldman and March 1981), as a resolver of equivocality (Daft and Weick 1984), as power (Pfeffer 1981; Pettigrew 1972) and as an economic commodity (Glazer 1991; Porter and Millar 1985). For the purpose of this paper, the information processing view of Galbraith (1973) will be adopted.

According to Galbraith, the primary role of information is to reduce uncertainty. Uncertainty is defined as the difference between information possessed and information required to complete the tasks involved in the process (Galbraith 1973). However, while Galbraith primarily

focused on the *amount* of information processed, this paper also takes into consideration the *nature* of the information (feedback/feedforward) processed. It is proposed that the nature of information processing depends on the sources of uncertainty which can be divided into two main categories: *state* and *motivational* uncertainty. State uncertainty arises due to the perceived nature of the environment and/or task being performed while motivational uncertainty arises due to the perceived nature of the people performing the task.

For example, in the case of the university, the bureaucratized procurement process using full-time employees would typically exhibit a much higher conflict between the management and workers (and therefore higher motivational uncertainty) than the software development process which survives on the voluntary participation of interested students. On the other hand, the procurement process would have much lower state uncertainty than the software development process. The former would typically be a fairly routinized process exhibiting lower task uncertainty than the latter given the fact the software is a front-line, state of art package with no precedent. Furthermore, while the services provided (acquisition of commodities for University use) and the customers supported (university employees) by the procurement process is fairly well-defined, the final product and the ultimate use of the software project is quite ambiguous. Similarly, the procurement process which has a relatively assured flow of capital and human resource through the university is much better protected from the vagaries of the environment than the latter which depends heavily on the competitive acquisition of funds through research grants and sustained interest of the scientific community in the research. Thus the two processes present contrasting pictures. The procurement process is high on motivational but low on state uncertainty while the software development process is high on state but low on motivational uncertainty.

A number of frameworks in control theory support a distinction of control activities along the task/environment versus people dichotomy (Burchell et al. 1980; Birnberg, Turopolec and Young 1983; Thompson and Tuden 1959). In fact, such a distinction forms the basis of principal agency theory in which the design of contracts involves ensuring appropriation of belief revision and performance evaluation information to cope with state and motivational uncertainty respectively (Baiman 1982).

Processes, in coping with different sources of uncertainty, appropriate information differently and in that process employ different forms of control. By this logic, the procurement process would tend to employ different modes of control than the software development process. As discussed earlier, this paper proposes a typology of control based on the cybernetic principle: feedback versus feedforward control. A number of researchers have attempted an activity-based approach to differentiate between feedback and feedforward control (Veliyath 1985; Michael and Carter 1991; Harrison 1991). This paper proposes an information-based approach.

3. THE CONSTRUCT OF INFORMATION LEVERAGE

The stage is now set for discussing the nature of information use in organizational processes. This section will provide the conceptual operationalization of information leverage. Information leverage can be defined as the *derived* and *intended use of information* in *attaining or setting formal goals* of the process. The italics highlight the salient features of the definition:

- *Derived:* This indicates the existence of antecedents to the construct of information leverage. In this sense, the use of information is contingent on the context (Baiman 1982). For example, given their particular contexts, the procurement process would emphasize performance evaluation while the software development process would pay relatively greater attention to the external environment (funding institutions, other research institutions, new technologies, etc.)

- *Intended:* Given bounded rationality, managers cannot anticipate all consequences of their decisions. However, as Perrow (1972) points out, managers are intendedly rational and the definition of information leverage refers to this intendedly rational use of information.

- *Use of information:* The acquisition of control information by itself does not cause a change in performance. A change occurs only when managers use this information to take relevant actions (Anthony and Reece 1975). Hence the focus is on the use of information.

- *Attaining and setting formal goals:* Information may be put to a number of irrational uses (e.g., Feldman and March 1981). However, this paper only considers the instrumental use of information in setting and achieving goals. Hence the use of a special term *leverage* rather than the more general *use*.

Information may be leveraged in two modes: feedback and feedforward (Figure 1). Feedback is the most commonly identified form of system intelligence and there is considerable consensus regarding its definition and application. *Feedback is information about output or performance*

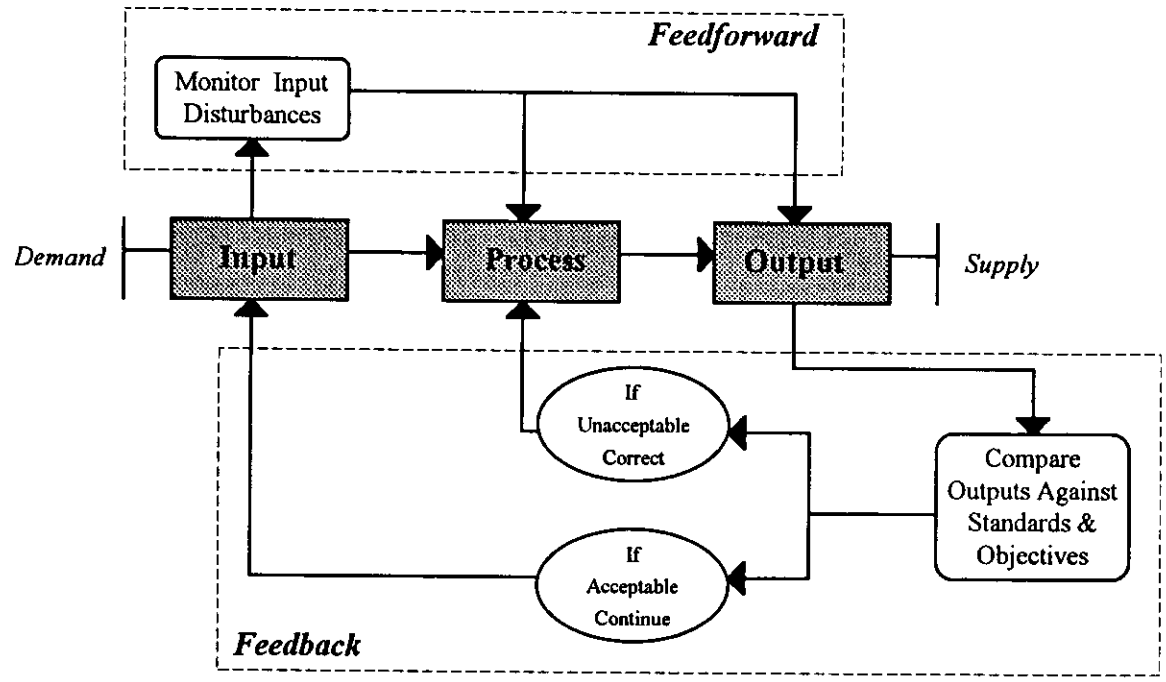

Figure 1. Diagrammatic Comparsion between Feedback and Feedforward
(Adapted from Michael 1980)

deviation from standards which is used to correct these deviations (Bogart 1980). Feedforward is an alternative and contrasting form of system intelligence which, although introduced to management literature many years ago (Koontz and Bradespies 1972; Ishikawa and Smith 1972), has not found explicit recognition in the MIS community. Specifically, *feedforward is defined as information about the input or disposition of the environment relative to input which is used to anticipate future problems and take preventive action* (Bogart 1980). While feedback leverage assumes the standards set by the plan as a given, feedforward leverage involves continuous evaluation of planned objectives and is largely focused on addressing the dynamic nature of the business environment. The value of the feedback/feedforward couplet describes the information leverage pattern of a process.

On the basis of Figure 1 and Table 1 (#1 to #7), each mode of leverage will be explained in greater detail by describing the nature of an MIS employing them.

While Figure 1 presents a diagrammatic distinction, Table 1 describes the sharply contrasting natures of feedback and feedforward in tabular format. For reasons of brevity, a list of references is included in Table 1 to refer the reader to the justifications for these distinctions.

The notion of feedforward is not new to management thought. Systems supporting feedforward leverage have been referred to as semi-confusing systems (Hedberg and Jonsson 1978), double loop learning systems (Argyris 1977) or technologies of foolishness (March 1971).

IT forms an integral part of a modern MIS by leveraging information in three capacities: database management, computing and communication. Hence, the following discussion will characterize such an MIS for feedback and feedforward modes along three areas of distinction: *information base, information processing* and *communication.*

3.1 Information Base

The information stored and captured by an MIS will be different for feedback and feedforward in terms of its *source, variety,* and *time span.*

Table 1. Feedback versus Feedforward

#	*Dimensions of Distinction*	*Feedback*	*Feedforward*
A	**Information Leverage**		
1	***Nature of information*** (Brown and Duguid 1991; Boland 1987)	Commodity (data)	Concept (knowledge)
2	***Nature of use*** (Michael 1980; Ishikawa and Smith 1972; Veliyath 1985)	Remedial Routinized	Preventive Innovative
3	***Objective of use*** (Veliyath 1985; Michael 1980; Camillus 1980)	Motivational uncertainty reduction Monitoring output variables for performance evaluation.	State uncertainty reduction Monitoring key input variables for disturbances
4	***Basis of use*** (Ishikawa and Smith 1972; Veliyath 1985)	Predominantly past events	Predominantly future events
5	***Trigger for use*** (Veliyath 1985; Hedberg and Jonsson 1978; Newman 1975)	End of pre-determined planning period Deviations from expected outcomes	Changes in assumptions Deviations from expected external events
6	***Type of learning supported*** (Argyris 1977)	Single loop learning	Double loop learning
7	***Decisions supported*** (Ishikawa and Smith 1972; Veliyath 1985)	Regarding action on past events	Regarding action in future scenarios
B	**Information Lever (MIS)**		
8	***Complexity*** (Tadepalli 1992)	Low	High
9	***Flexibility*** (Hedberg and Jonsson 1978)	Low	High
10	***Operative Purpose*** (Veliyath 1985)	Efficiency	Effectiveness
11	***Time span of consideration*** (Assad 1981)	Short	Long
12	***Assumed Risk*** (Baiman 1982)	Risk of opportunism	Risk of prediction

- *Source:* As shown in Figure 1, feedback leverage captures deviations in the output while feedforward monitors disturbances in the input. Hence an information base for feedback leverage would primarily contain performance/output figures and that supporting feedforward would primarily contain contextual/input variables. For example, the management of the bureaucratized procurement process would be more concerned with the monitoring of employee performance (feedback leverage) while the management of

the software development process would be more concerned with monitoring external agencies such as funding institutions, the research community, etc. (feedforward leverage).

- *Variety:* Tadepalli identifies two characteristics of feedforward: requisite variety in sources of feedforward and identification of key variables. One of the primary objectives of feedforward is reduction of state uncertainty due to high heterogeneity in the task or environment (Table 1, #3). Variety in captured data helps cope with heterogeneity. However, this could potentially result in an information overload and this is why identification of key variables becomes important (Ackoff 1967). An MIS supporting feedforward would therefore show more variety (complexity) in its information sources than feedback. Therefore, the software development process facing greater state uncertainty would show greater variety in sources of information than the procurement process.

- *Time span:* The time span of consideration while designing the feedforward information base is much more than that for feedback. Assad (1981) postulates that data captured by the MIS for feedback would tend to be more recent than that for feedforward. Due to the *post hoc* nature of feedback there is always a time lag between the detection of the error and the corrective action (Wiener 1948). Hence, recency of data becomes an important criterion for feedback. Furthermore, since the objective is to reduce the current output deviation, the information base would be oriented toward capturing the most recent deviation (Table 1, #4). Thus the focus of use of the information base in feedback is restricted to the recent past or the present. A bureaucratic procurement process would therefore be primarily controlled through exception reports, variance analysis, or performance evaluation which typically carry relatively recent information.

  On the other hand, feedforward involves making decisions in future scenarios (Table 1, #7). Thus the need for prediction in feedforward is higher than in feedback. For example, the management of the software development process would be primarily concerned with anticipating the future not only in terms of their research findings but also the support necessary to sustain the research. Predictive information may range from simple extrapolative models (time-trends) to moderately complex decision-calculus models to very complex axiomatic models (Tadepalli 1992). In order to improve prediction of future scenarios, the feedforward information base would make greater use of historical data. In our example, the management would conduct extensive and on-going literature scanning to anticipate any pitfalls.

3.2 Information Processing

Information technology also provides the processing power to make the captured data useful to managers. The processing needs of feedback are quite different from that of feedforward and can be distinguished in terms of the processing structure.

MIS supporting feedforward would tend toward distributed processing while that for feedback would tend toward centralized processing. Distributed processing provides greater support to the gatekeeping roles of the organization and thus stimulates the innovativeness, responsiveness and flexibility required in situations of high state uncertainty. Centralized processing, on the other hand, is better suited in the more routinized and repetitive situations that feedback leverage addresses (Hedberg and Jonsson 1978; Table 1, #2). For example, the stability-oriented procurement process would tend to show more centralized computing than the software development process where innovativeness and flexibility of communication will be valued.

3.3 Communication

Communication opportunities provided by an MIS can be distinguished by the *reporting format* and *direction.*

- *Reporting format:* Feedforward reports would show less standardization (Table 1, #2), more forecasts (Table 1, #4) and greater frequency (Assad 1981). While feedback reports would contain primarily performance data, feedforward reports would contain primarily contextual data to help the managers cope with dynamism (Sengupta and Abdel-Hamid 1993). Last, the event which triggers the generation of a feedback report (deviation from output or end of pre-determined planning period) is different from that for a feedforward report (change in assumptions or deviations from expected external events) (Table 1, #5). Given a fairly stable environment, the management of the procurement process would typically resort to standardized reports and formal modes of communication in contrast to the management of the software development process which would adopt a more cooperative, interactive and informal mode of communication with the co-workers in response to their high levels of task and environmental uncertainty.

- *Direction:* Doll and Torkzadeh (1994) report two possible directions of IT-supported communication: vertical and horizontal. Vertical communication involves reporting of performance up and down the hierarchy. Such communication primarily serves to institute a performance appraisal system (as in the procurement process): a feedback objective (Table 1,

#3). On the other hand IT for horizontal communication supports cooperative effort (e.g., GDSS, E-Mail, etc.) which is essential for finding solutions to new problems (as in the software development process): a feedforward objective (Table 1, #1 and #2).

Part B of Table 1 (i.e., #8 through #12) describes, in a nutshell, the characterization of MIS in the above discussion and serves as the basis for the propositions in the following section.

4. THE THEORY OF INFORMATION LEVERAGE

This section will introduce the antecedents and consequences of information leverage. As shown in Figure 2, the antecedents make up the sources of uncertainty that determine the type of information leverage pattern. The consequences are broadly divided into two categories: information lever (information technology) and performance.

4.1 The Antecedents

As explained earlier, information leverage is based on the assumption that the demand for information is *derived* from the uncertainties faced by the process. Sources of uncertainty were divided into two types: motivational and state uncertainties.

There are two sources of motivational uncertainty: self interested behavior and risk averseness of process participants (Baiman 1982). Bensaou (1992) suggests that motivational uncertainty can be measured in terms of level of goal incongruence (Birnberg, Turopolec and Young 1983) and lack of trust (Ouchi 1980).

In the face of high motivational uncertainty, the function of control is to provide the appropriate incentives and sanctions to motivate the process workers to perform toward attaining the set goals. Veliyath (1985) in fact identifies performance evaluation as a feature of feedback which distinguishes it from feedforward. Merchant (1982) argues how feedback control can serve as a performance appraisal system. Tadepalli also points out the motivating influence of feedback. Information leveraged to enforce this form of control has been defined as feedback information (Bogart 1980).

Proposition 1: *Processes exhibiting higher motivational uncertainty will show greater feedback leverage.*

Proposition 1a: *Processes exhibiting higher goal incongruence will show greater feedback leverage.*

Proposition 1b: *Processes exhibiting lower levels of trust will show greater feedback leverage.*

There are three sources of state uncertainty: task characteristics, task environment and task interdependence (Thompson 1967). State uncertainty can be measured along the dimensions of: *heterogeneity-homogeneity* (degree of similarity of the elements of population) and *stability-dynamism* (degree to which contingencies or causal relationships remain the same over time) (Duncan 1972).

As described earlier, feedforward information is used to overcome the problems of time lag which could prove to be expensive in case of a feedback for a highly dynamic system (Koontz and Bradespies 1972). Hence we can argue that the need for feedforward is affected by the level of state dynamism. Similarly, the heterogeneity or complexity of the task or environment increases the need for feedforward by increasing the number of input variables that need to be monitored. Although partially manageable by identifying key early warning indicators, the need for feedforward increases nonetheless (Tadepalli 1992). This problem could become all the more acute when coupled with dynamism when the search for early warning indicators themselves is increased. Furthermore, Veliyath (1985) found significant association between uncertainty due to dynamism and heterogeneity and feedforward process traits.

Proposition 2: *Processes exhibiting higher state uncertainty will show greater feedforward leverage.*

Proposition 2a: *Processes exhibiting higher state dynamism will show greater feedforward leverage.*

Proposition 2b: *Processes exhibiting higher state heterogeneity will show greater feedforward leverage.*

4.2 The Consequences

The information leverage pattern influences the performance and the choice of the information lever: information technology.

4.2.1 Performance

The measure of process performance is specific to the objective of the process. For example, on-time payment and credit intensity for order-processing (Pokorney, Kekre and Mukhopadhyay 1992), inventory level for inventory control and number of defects for a quality control (Kekre and Mukhopadhyay 1991), or commissions and new policies for evaluating delivery processes in the insurance industry (Venkataraman and Zaheer 1990). In the following discussion we shall assume that performance is process specific.

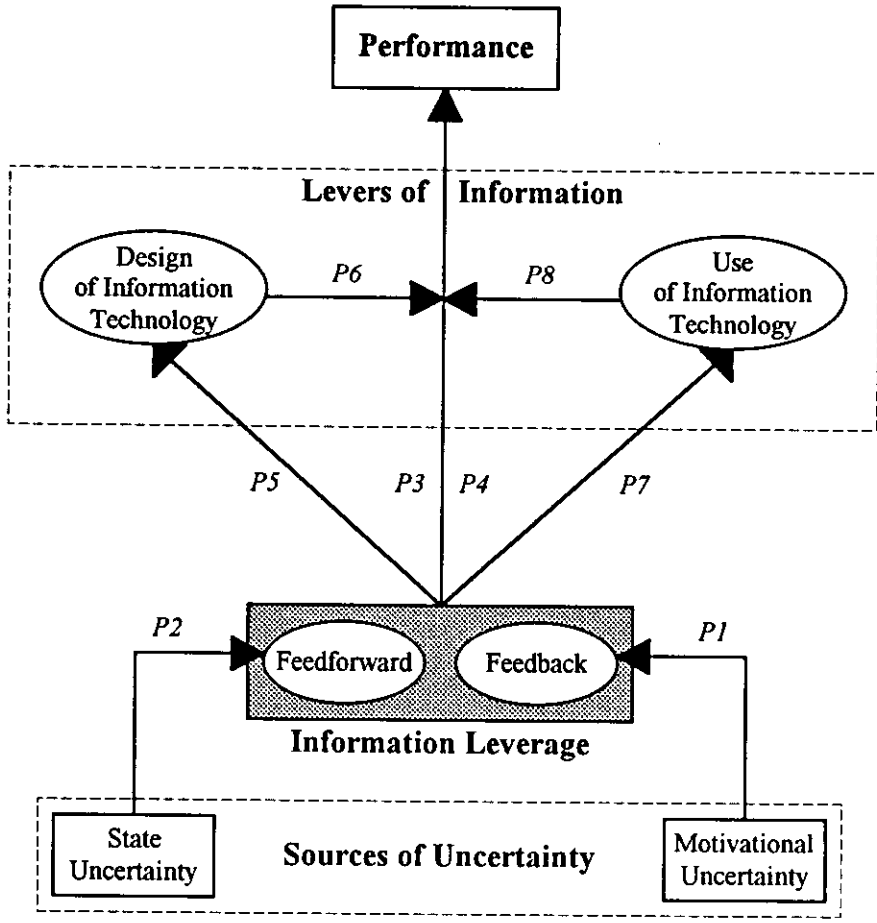

Figure 2. The Information Leverage Theory: A Conceptual Model

Although the exact relationships proposed below have never been tested before, there is ample evidence in organizational contingency theory suggesting that a match between environmental uncertainties and organizational units is associated with higher performance (Tushman and Nadler 1978). The utility of outcome feedback for performance appraisal has been proposed (Merchant 1982) and successfully validated in the past (Henderson and Lee 1992). More recently, Glazer and Weiss (1993) also propose that successful performance depends on the congruence between the level of turbulence and the information-processing style adopted. Furthermore, Sengupta and Abdel-Hamid (1993) experimentally validated the utility of feedforward over feedback in situations of high state uncertainty.

Proposition 3: *In the presence of high motivational uncertainty, higher process performance would be strongly associated with feedback leverage.*

Proposition 4: *In the presence of high state uncertainty, higher process performance would be strongly associated with feedforward leverage.*

4.2.2 The Design and Use of IT for Leveraging Information

The two primary areas of concern to MIS researchers are the design and use of information technology. For the most part, the two have been studied separately. This paper proposes an approach to reconciling these two apparently distinct aspects of the leveraging role of information technology in organizations. The argument proposed here is that the propensity to leverage information in a certain way decides the design of the information technology as well as its use. As shown in Figure 2, the design and use of IT in turn influence process performance.

Table 2. The Prospector versus Defender Designs of IT

Design Attributes	*Defender*	*Prospector*
The Designed Product Features (Information Technology)		
Automation: *Level* of Computerization. (Stinchcombe 1990)	High	Low
Connectivity: Level of Centralization. (Apte and Vepsalainen 1993)	Centralized	Decentralized
The Design Process Features (Systems Development)		
Source of technology: Origin of developmental expertise. (Das, Zahra and Warkentin 1991)	Internal	External
Contribution: Level of user involvement. (Ives and Olson 1984)	High MIS developer contribution	High process user contribution
Medium: Formality of medium adopted for communication. (Kendall and Kendall 1988)	Formal, hierarchical	Informal, cross-functional teams

Design refers to the various generic features that characterize the IT and developmental process. In other words, the design features should refer to both the process and the product of IT design. Table 2 presents the five dimensions along which the design features of information technology in organizational processes can be characterized. Two of these are product attributes (automation and connectivity) and three are process attributes (source, contribution and medium). For conciseness, each of these dimensions is presented and described in tabular format.

The list of items in Table 2 are closely adapted from a list of MIS features developed by Das, Zahra and Warkentin (1991) to describe the strategic role of IT. They proposed that their list of MIS features can be clustered along the Miles and Snow (1978) defender-prospector typology. The application of the typology to study the role of IT has been supported conceptually (Camillus and Lederer 1985) and empirically (Simons 1987; Tavakolian 1989).

Although the above discussion pertained to the strategic level, the dimensions in Table 2 could be used to study IT design at a more micro, process level. Earl, in fact, gives a call for greater micro level research of the role of IT by applying such macro frameworks at lower levels. Runge (1985) provides one of the few examples of such an approach when he used the Consumer Resource Life Cycle model to study micro level phenomenon.

The five design features of IT in processes can be clustered along the Miles and Snow typology as shown in Table 2 (for detailed explanation, refer to Das, Zahra and Warkentin 1991). Veliyath successfully used the Miles and Snow typology to study the relationship between strategic posture (prospector/defender) and process traits (feedback/feedforward). This line of argument seems reasonable, since both feedforward and the prospecting role are proactive and externally-focused in nature and seem to be oriented toward a dynamic environment, while both feedback and the defending role seem to be reactive and internally focused in nature and oriented toward a stable environment. Hedberg and Jonsson propose that most existing MIS foster stability through routinization, a feedback characteristic, and propose that semi-confusing systems are better suited to meet the needs of an environment with high state uncertainty — the objective of feedforward leverage (Table 1, #9). Hence,

> ***Proposition 5:*** *The type of information leverage pattern determines the type of IT design features.*
>
> ***Proposition 5a:*** *A process employing higher levels of feedback leverage will be strongly associated with a defending design of information technology.*
>
> ***Proposition 5b:*** *A process employing higher levels of feedforward leverage will be strongly associated with a prospecting design of information technology.*

Table 3. Dimensions of Usage of IT and Their Classification Type

Dimensions of IT Usage	*Purpose of Usage (Doll and Torkzadeh 1994)*	*Type*	*Justification*
Problem Solving	Problem identification Data Analysis Finding optimum solution	FB	A problem cannot be solved till an error is detected. Hence, problem solving is oriented towardsexplaining or correcting the problem post-facto (Strank 1983)
Vertical Integration	Report performance to superiors and subordinates Communicate plans and schedules	FB	Reporting performance institutes the performance appraisal system. Plans and schedules also serve to provide a basis for feedback on performance (Merchant 1982)
Decision Explanation	To clarify, justify, rationalize decisions	FB	It is ex-post to the problem detection and solution. It's purpose is to justify the decision so as to affect one's performance appraisal (Demski 1967)
Improving Decision Process	To control or shape decision process To improve its effectiveness and efficiency	FF	It is ex-ante to the problem detection. It's purpose is to evaluate existing objectives and assumptions (Demski 1967; Ishikawa and Smith 1972)
Horizontal Integration	Communicate and coordinate laterally	FF	Improves the effectiveness of communication to support cooperative work (Tadepalli 1992)
Customer Service	Serve customer better Know his needs and expectations	FF	Monitors the demand or input side of process control (Michael 1980; please refer figure 1).

FB = Feedback, FF = Feedforward

Hedberg and Jonsson argue that semi-confusing systems can stimulate the organization's capacity to innovate and thus help it cope with variety and dynamism in the environment. Bensaou proposes a similar fit between technological features and information requirements. The prospector design type (which is not unlike semi-confusing systems) is better suited to feed information forward while the defending design is better suited to feed information back. Das, Zahra and Warkentin used the prospector-defender typology as the basis for proposing a fit between strategy (information processing requirements) and strategic role of IT (information lever). Applying the same argument at the process level,

Proposition 6: *The process performance is determined by the degree of fit between the information leveraging pattern in the process and the design of the information technology used to leverage.*

Proposition 6a: *A process employing a high degree of feedback would show a better performance with a defending design for IT than the prospecting design*

Proposition 6b: *A process employing a high degree of feedforward would show a better performance with a prospecting design for IT than the defending design.*

The type of information leveraging pattern not only determines the type of design features incorporated but also the type of use of the information technology. The "system use" construct, typically used as an indicator of system acceptance, can also be used to anchor MIS research in information processing theory. Doll and Torkzadeh developed a multidimensional instrument to measure the context specific usage of information technology. The instrument measures how well IT is used in an organizational context to perform the five functions of problem solving, customer service, horizontal integration, vertical integration and

decision rationalization. Decision rationalization includes two underlying dimensions: decision explanation and improving decision process and so in effect there are six dimensions of usage.

Problem solving, decision explanation and vertical integration were classified as feedback activities while the rest were classified as feedforward. Table 3 provides the rationale for this classification.

Hedberg and Jonsson (1978) and March (1971), in describing the activities supported by MIS, seem to support the above arguments. Hence it is proposed that

> ***Proposition 7:*** *The type of information leverage determines the pattern of usage of information technology.*
>
> ***Proposition 7a:*** *Processes employing high levels of feedback leverage will show a high usage of information technology for problem solving, vertical integration and explaining decisions.*
>
> ***Proposition 7b:*** *Processes employing high levels of feedforward leverage will show a high usage of information technology for customer service, horizontal integration and improving decision processes.*

The above propositions imply the notion of a fit between the information usage of the process and the technology usage in the process. El Louadi (1992) proposed a fit between these two on the basis of information processing theory with organizational performance as a surrogate for fit. However, there are a number of intervening variables between the site of usage of IT and the organizational performance and this could perhaps explain his inability to get significant findings. This paper proposes to study the effectiveness of fit at the process level of performance.

> ***Proposition 8:*** *The process performance is determined by the degree of fit between the information leveraging pattern in the process and the usage of the information technology.*
>
> ***Proposition 8a:*** *A process employing high feedback leverage will show a better performance with a usage of IT for problem solving, decision rationalization and vertical integration.*
>
> ***Proposition 8b:*** *A process employing high feedforward leverage would show a better performance with a usage of IT for customer service and horizontal integration.*

5. DISCUSSION

The previous section was devoted to developing falsifiable propositions for the theory and suggesting dimensions along which each of the constructs could be measured. This section will discuss the utility of the theory by enumerating two of its implications.

5.1 The Enabling Role of IT

Lately, there has been much talk about the enabling role of information technology in organizational processes (Davenport 1993; Hammer and Champy 1993). However, there is no existing theoretical basis to explain the notion of an enabling role. The information leverage theory provides an insight into the enabling role of IT in two ways.

First, the enabling role of IT can be defined in terms of the leveraging role it plays. According to information leverage theory, IT may enable a process in two ways (feedback and feedforward) and the appropriateness of the specific role is determined by the sources of uncertainties (state and motivational). The construct of information leverage thus provides the basis for a conceptual and researchable operationalization for the amount and nature of the enabling role played by information technology. Second, since information leverage also describes the process, one can analyze the enabling role of IT in terms of the change in the information leverage pattern in the process.

5.2 The Value of IT

An information leverage approach to assessing the value of IT to the firm would suggest that IT will impact organizational performance indirectly through the process. Information leverage theory maintains that the direct effects of IT are at the site of application of IT — the process. This approach seems to be better suited to measuring the value of IT in the light of the fact that a number of past studies have come up with no insignificant impacts of IT on firm performance. The process performance may in turn influence organizational performance and this may provide us with the organizational value of IT to a firm (Barua, Kriebel and Mukhopadhyay 1994).

Information leverage theory explains the relationship between IT and process through their interaction with information. One of the common reasons cited for lack of an IT-performance linkage is that processes are not designed to fit IT (Kekre and Mukhopadhyay 1991). Information leverage theory can provide an insight into how processes may be designed to fit information technology.

Furthermore, the theory also provides a comprehensive framework within which to explain the performance effects of IT. The implication of the theory is that the value of IT to a firm is not just a function of the investment in IT but the appropriateness of its design and use.

6. CONCLUSION

The construct of information leverage was used as an integrating tool to bring together a number of related concepts in MIS literature. The proposed theory can be empirically tested in two stages. In the first stage, a qualitative comparative study of two processes which present contrasting scenarios in the theory could be conducted. The comparison of the procurement process versus the software development process serves as an excellent example of the nature of the processes to be selected for comparison. The objective of this study will be to distinguish between feedback and feedforward modes of leverage and to provide preliminary support for the hypotheses. The information from the case study coupled with relevant literature can be used to design a questionnaire to measure information leverage. This would provide a basis for conducting a mail questionnaire survey to address the issues of generalizability of the proposed theory.

The paper provided a conceptual operationalization of the use of information in organizational processes through the construct of information leverage. There are two modes of leveraging information: feedback and feedforward. It should be noted that, although only one information lever (IT) was considered, this does not preclude the identification of other relevant mechanisms such as structures of control, channels of communication, authority, incentive systems, etc., for further exploration.

The notions of feedback and feedforward leverage provide an interesting perspective into MIS research. The proposed theory fills in the gap in MIS research at the process level by building upon well established theories in management and thus is in keeping with a cumulative scientific tradition. Finally, the theory provides a framework for understanding how information technology may be of value to organizations.

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