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Authors

Pinsonneault, Alain
Kraemer, Kenneth L.

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THE IMPACT OF INFORMATION TECHNOLOGY
ON MIDDLE MANAGERS*

Alain Pinsonneault

École des Hautes Commerciales

5255 Decelles

Montréal, Québec

CANADA, H3T 1V6

and

Kenneth L. Kraemer

Graduate School of Management

University of California, Irvine

Irvine, California   92717

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ABSTRACT

This article reviews studies that examine the impact of information technology (IT) on the number of middle managers in organizations. We find contradictory evidence suggesting, paradoxically, that IT both increases and decreases the number of the middle managers. We resolve this "empirical paradox", by looking at the effects of IT on middle managers as contingent upon the degree of centralization of computing decisions, and of organizational decisions more broadly. When both computing decisions and organizational decisions are centralized top managers tend to use IT to reduce the number of middle managers. When these decisions are decentralized, middle managers use IT to increase their numbers. A recent case study provides preliminary support for this perspective by showing an interesting case of reduction in middle managers.

KEYWORDS

Information technology	Technological determinism
Impact on middle managers	Managerial actionalism
Direct impacts	Structurational perspective
Indirect impacts	Empirical paradox
Increase/decrease in middle managers	Centralization of decision authority
Centralization of IT	Information roles
Decision roles	Communication roles
Capital-labor substitution	Environmental forces

ACM CATEGORIES

J.1, K.4, K.6

THE IMPACT OF INFORMATION TECHNOLOGY
ON MIDDLE MANAGERS*

INTRODUCTION

Production technologies have profoundly affected organizations in general and blue collar workers in particular. It is commonly argued that information technology (IT) will have similar profound effects on white collar workers, and on middle managers in particular (Drucker, 1988; Leavitt and Whisler, 1958). It has been estimated that IT has eliminated almost a third of the U.S.A. middle management jobs or about two million managers (Byrne, 1988). A reduction of over 60% of the middle management workforce has been forecasted for the next decade in the U.S. (Drucker, 1988). In the United Kingdom, recent lay-offs--11,000 at Nat West, 6,000 at Lloyds, 5,000 at British Telecom, 4,500 at Philips, 4,300 at Barclays, and 1,000 at British Petroleum--are attributed mainly to IT (Syedain, 1991).

But some researchers believe that, rather than depressing middle management employment, IT increases it substantially (Gillman, 1966; Pfeffer and Leblebici, 1977). They propose that present decreases in the number of middle managers are not caused by IT, but by other factors. One is the transformation of modern organizations from multi-layered, hierarchical, fat ones to networked, flat, thin ones. Another is greater horizontal centralization (bringing business units together) and vertical centralization (bringing decision authority to the top of the hierarchy), taking place in organizations. Still another is organizational downsizing to reduce operating costs and organizational re-engineering to decrease the time between strategy formation and implementation. Both are aimed at helping organizations to face adverse environmental conditions such as economic recession, foreign competition, or industry regulation. In the process of making these transformations, organizations tend to reduce the managerial workforce,

particularly middle managers. While not caused by IT, such changes are likely to be facilitated by IT.

In this article we examine the empirical studies addressing the impact of IT on the number of middle managers. IT might decrease or increase the number of middle managers. Empirical studies show that it does both, presenting an empirical paradox wherein the net effect of IT on middle managers is difficult to determine. In an effort to transform this paradox into a solvable puzzle, we explore the theory underlying predictions about IT's impact on middle mangers and identify two dimensions that might help explain the differential impacts found in empirical studies: the degree of centralization of computing decision authority, and the degree of centralization of organizational decisions. We present a conceptual framework that integrates these two dimensions, derives four contingent situations that explain differential impacts, and illustrates how the results of empirical studies fit with these contingencies A case study provides preliminary support for the framework.

INFORMATION TECHNOLOGY AND THE NUMBER OF MIDDLE MANAGERS

The following review of empirical studies examines what we know about the impact of IT on the middle management workforce, and how well we know it. It looks first at studies which show that IT decreases the number of middle managers, and then at studies which show that IT increases their numbers.

IT Decreases the Number of Middle Managers

Many writers have predicted that IT will decrease the number of middle managers (Child, 1984; Drucker, 1988; Leavitt and Whisler, 1958; Malone, Yates and Benjamin, 1987; Whisler, 1965). The rationale for this prediction is that middle managers have mostly provided an informational

link between top managers and operations managers and that IT will now perform these functions. IT will permit top managers to bypass middle managers in both upward and downward communication. IT also will centralize organization structures: horizontally by bringing business units together, and vertically by bringing decision authority to the top of the hierarchy. The overall effect is a drastic reduction in the number of middle managers. The remaining middle managers are expected to shift in two directions. The majority will see their jobs become more structured and routine and sink into the operational level of organizations. A smaller portion will be promoted to top level jobs requiring more creativity and control over a broader range of decisions. Such an organizational structure will resemble an hourglass: the top half contains some high level managers and very few middle managers, and the bottom half contains many clerical workers and first line supervisors and a few middle managers.

Studies showing that IT decreases the number of middle managers are described in Table 1 and reviewed next. The empirical studies that support this position do so either *directly* by focusing on decreases in the number of middle managers, or *indirectly* by examining changes in the concentration of authority or in the job and role of middle managers, both of which imply decreases in their numbers. The review is followed by a summary of the commonalities in the findings and by a discussion of their strengths and weaknesses.

Insert Table 1 about here

Direct Impact of IT On Number of Middle Managers

Four studies have directly analyzed the impact of IT on middle managers (Table 1A). Two of these focus on operations level IT (Hoos, 1960; Whisler, 1970), one on computer conferencing

(Crowston, Malone and Lin, 1986), and one on economy-wide investments in IT (Brynjolfsson, Malone and Gurbaxani, 1988).

In the first operations level study, interviews were carried out with a wide range of office workers from top managers to keypunch operators and union representatives. IT was reported to centralize decision authority by integrating functions and by grouping business units. IT was also found to combine middle managers' jobs and to reduce their number substantially (Hoos, 1960).. In the second study, interviews in 19 insurance companies found that computerization reduced the number of levels of managers and centralized decision authority (Whisler, 1970).

In the third study, the merger of two divisions responsible for compensations and benefits provided an opportunity to explore the effects of computer conferencing on middle managers (Crowston, Malone, and Lin, 1986). Interviews, observations, and examination of messages indicated that computer conferencing centralized decision authority, reduced the number of line middle managers, and increased staff specialists higher up in the hierarchy. However, computer conferencing did not affect the total number of people in the organization.

The impact of IT on coordination mechanisms used in the U.S. economy was explored in the fourth study (Brynjolfsson, Malone, and Gurbaxani, 1988). Analyses of data on employment categories, firm size, and IT investment between 1975 and 1985 in the U.S.A., indicate that IT leads to a shift away from hierarchies toward market coordination. Increases in IT investments in an industry are correlated with decreases in the number of managers employed and with increases in the number of sales workers. The study also observed a significant learning curve in the utilization of IT leading to delays of up to five years before the effects are fully felt.

Indirect Impacts Which Imply Decrease in Numbers of Middle Managers

The impact of IT on the number of middle managers can also be understood indirectly--by studying related phenomena, such as the impact of IT on centralization of decision making authority or on the job and roles of middle managers. Three such studies are particularly relevant (Table 1B). The first explored the implementation of a customer account system in a power company (Mann and Williams, 1960). Unstructured interviews conducted with managers at all levels indicated that computerization centralized decision authority and formalized the structure of the organization. In particular, computerization of customer accounts eliminated several more routine and tedious jobs and some higher level jobs involving minor decisions. However, the overall job grade levels within the organization were not affected.

In the second study, anagement support systems were not found to be associated with any changes in the formal structure in the majority of eight organizations studied in five countries (Robey, 1981). Rather, these systems were found to reinforce the existing distribution of authority. However, when computerization was associated with organizational changes, it tended to centralize control.

Finally, an integrated management information system at General Motors permitted top managers to bypass hierarchical communication channels and to obtain direct access to information otherwise controlled by middle managers (Foster and Flynn, 1984). The information system was also found to facilitate lateral networking that tied together individuals from different parts of the organization. Although the resulting IT impact at General Motors was not explored, the authors speculated that IT created slack resources which <u>could</u> result in the consolidation and reduction of jobs at managerial and professional levels.

Assessment of the findings

Together, these studies indicate that IT centralizes decision authority and hierarchical structures. IT reduces the number of organizational layers, particularly at the middle management level. It also fosters horizontal consolidation by integrating functions and business units. The result is a shorter, narrower hierarchy requiring far fewer middle managers. How IT affects the roles of the middle managers who remain is not clear. In one instance IT routinized the roles of middle managers (Whisler, 1970), while in another the jobs that remained were more varied that those eliminated (Mann and Williams, 1960).

The finding that IT decreases the number of middle managers is supported by three strengths of these studies.[1] They were conducted over almost thirty years, thus reducing the possibility that a temporary environmental factor caused the decrease in middle managers. The finding is valid for an array of IT: operational systems, communication systems, and management systems. And, the finding extends across several industries and functional areas, and at both the firm and the industry levels.

However, these studies also suffer from two important weaknesses. "IT" and "middle management" are not always defined and operationalized clearly. For example, "middle management" is defined in only one study (Hoos, 1960). However, hierarchical organizations are continuous and fluid and middle managers do not form a well defined homogeneous group that can be differentiated easily from top managers and from operations managers. Roles are not very different between managers with a small hierarchical gap. Also, middle managers cover a broad spectrum in the studies. It is doubtful that a first level supervisor who directly manages operations plays a role similar to that of a manager just below the junior executive level. These weaknesses in defining "middle management" and "IT" hinder our ability comparison across studies.

The focus of the studies is another weakness. Three studies include organizations from different industries (Brynjolfsson et al., 1988; Hoos, 1960; Robey, 1981). This has the advantage of ruling out inter-industry differences in explaining computer impacts. However, two of those studies do not analyze enough organizations to be representative. Also, because organizations are so varied and because our correct understanding of the organizational impact of IT is so limited, we face complexity that can defy insightful analyses. The remaining studies were more narrowly focused, looking at a single industry (Whistler, 1970), or a single firm (Crowston et al., 1986; Mann and Williams, 1960; Foster and Flynn, 1984). An accumulation of sector-specific research could provide findings that permit the comparison of results across industries and enable the determination of whether or not industry helps explain IT effects. Such findings could then be developed into a general theory. Presently, the number of studies and the knowledge derived from them is too limited to permit such integration.

In summary, these studies provide consistent findings that IT reduces middle management, but methodological problems limit our confidence in their findings. These problems neither discredit nor invalidate the findings. But they do suggest that further support is required before we can accept the contention that IT decreases the number of middle managers.

IT Increases the Number of Middle Managers

Another group of researchers take a completely opposite position. They propose that IT increases the number of middle managers and decentralizes decision authority. This is expected to result in organization structures that resemble a bulging pyramid rather than an hourglass.

Middle managers, according to this view, are more than just information transmitters. They also perform interpersonal and decisional roles. They use processes and rely on information not

amenable to computerization. Furthermore, IT, by its very existence overwhelms organizations with information that needs further processing by middle managers to become endowed with relevance and purpose. This richness of information allows middle managers to uncover detail that were not previously known but that are relevant to management decisions. Middle managers thus make more decisions and analyze more alternatives in greater depth than before (Ellis, 1984; Guthrie, 1974; Wildavsky, 1983; Wynne and Otway, 1983). Furthermore, the globalization of the economy renders the environment of organizations more complex and increases the need for scanning, analyzing, and understanding of emerging competitive forces and events occurring outside the organization. Thus, more middle managers are needed to complement top managers' efforts.

Generally, these researchers believe that IT decreases the need for only a small portion of the informational roles of middle managers--the communication portion--rather than their jobs as a whole. Moreover, the slack resources created by a decrease in the communication role is quickly filled by other roles (e.g. decisional roles). Thus, rather than decreasing the roles of middle managers, IT enlarges and enriches middle managers' jobs by: (a) requiring them to use more knowledge, judgment, and experience, (b) adding to their present activities or replacing some informational roles with interpersonal and decisional ones, and (c) increasing the importance of other informational roles such as filtering, organizing, interpreting, and evaluating information.

A number of empirical studies support this position (Table 2). Here again studies are grouped by whether they *directly* analyze the impact of IT on the number of middle managers or whether they do so *indirectly*--by examining the impact of IT on other aspects of middle managers' work which are related to changes in the number of middle managers. Each study is reviewed next, and the body of research then summarized and evaluated.

Insert Table 2 about here

Direct Impact of IT on Number of Middle Managers

Four studies analyzed the direct impact of IT on the middle management workforce (Table 2A). Three of these focused on operation level IT (Lee, 1964; Meyer, 1968; Blau et al., 1976) and one on organizational level IT. The effects of computerized merchandising and production planning systems on the data processing, product planning and specification, and merchandise departments of a shoe manufacturer were examined in the first study (Lee, 1964).   Based on personal interviews and comparative analyses of working forces before and after introduction, computerized information systems were found to decrease clerical manpower by 17% and increase managerial manpower by more than 22%.

Automated operations information systems were found to increase the number of hierarchical levels, especially among middle managers, in a second study of 254 city, county, and state governments (Meyer, 1968). The systems were also found to widen the span of control of first-line supervisors.   These structural changes appeared to promote greater decentralization of decision authority.

Automation of various administrative functions was found to increase the division of labor and to decrease the span of managerial control in a third study of 110 New Jersey manufacturing companies (Blau et al., 1976). IT was also found to increase the number of hierarchical levels and the number of managers. Moreover, the location of computer facilities appeared to govern the locus of decision authority: on-site computers (in divisions or plants) fostered decentralization, while off-site computers (generally in head offices) fostered centralization.

 Computerization was related to an increase in the number of hierarchical levels and in the number of departments in 38 small manufacturing organizations in a fourth study (Pfeffer and

Leblebici, 1977).   Computerization also appeared to favor the decentralization of decision authority. The study did not specify the IT analyzed but appears to be considering IT at the level of the organization as a whole.

Indirect Impacts Which Imply Increases in Number of Middle Managers

Five studies analyzed the impact of IT on aspects indirectly related to changes in the number of middle managers (Table 2B). Four of these studies focused on operations level IT (Shaul, 1964; Klatzky, 1970; Björn-Andersen and Pedersen, 1980; George, 1986).

IT was found to extend the scope of middle managers' jobs, make their jobs more complex, and raise their status in the first study, which examined eight companies from eight different industries--aircraft, petroleum, electronics, radio and TV, banking, life insurance, finance, and telephone (Shaul, 1964). IT also led to more planning, staffing, and directing activities for middle managers, while reducing the time they spent controlling. Overall, there was no change in the occupational profile of middle managers. However, the number of middle managers might be expected to increase because the computer makes it possible for them to devote more time to functions previously neglected, while making their job more complex and broader in scope.

Case analysis was used to explore automation impacts in 53 U.S. state employment agencies in the second study. Here, the extent of automation appeared to lead to greater decentralization of decision through what was called the "cascade effect" in which higher level manages "push down" more and more of their tasks as automation of routine tasks frees the time of lower level managers (Klatzky, 1970). Automation frees lower level managers from the more routine tasks. As the superiors recognize the slack resources thus created, they delegate some of their own responsibilities down, which in turn frees the higher level managers. This downward delegation,

or "cascade", repeats itself up to the highest level of management. The net effect is an increase in the roles and responsibilities of middle managers if not an increase in their numbers.

The computerization of production and scheduling systems in a radio and television manufacturing company was explored in a third study (Björn-Andersen and Pedersen, 1980). Computerization was found to increase the influence of the gatekeepers of IT (middle managers who were direct users) and limit the discretion of both direct and indirect users (also middle managers).

The impact of automation on the concentration of authority in 224 city governments was examined in a fourth study. The degree of sophistication of computerized information systems was positively correlated with greater decentralization of decision authority (George, 1986). Based on questionnaires completed by the manager of each data processing installation and the city manager, IT was found to free the lowest level managers from more routine tasks. The researcher believed that decision authority was not pushed down by higher level managers (Klatzky's cascade effect), but rather "pulled down" by lower level managers seeking to increase their authority (gravity effect). The implication, as in Klatsky's study, was an increase in the roles and responsibilities of middle managers.

The impact of office automation on middle managers work was analyzed in a fifth study. A survey of 75 middle managers from 14 organizations indicated that IT resulted in favorable changes in middle managers' jobs and work (Millman and Hartwick, 1987). Middle managers felt that automation made their work more demanding, interesting, and important. They believed they had more freedom in how they performed their jobs and greater responsibility for the results.

Assessment of the findings

Overall, these results indicate that IT increases the number of hierarchical levels in organizations, increases the number of departments, and decentralizes more authority to the middle management level. Information technology therefore increases the number of middle managers directly, and indirectly as their jobs become more complex and broader in scope.

This finding is supported by three strengths of these studies. The studies were conducted over a period of more than twenty years, thus reducing the probability that the findings result from a temporary environmental factor. In addition, the findings are based on both in-depth case study and surveys of very large samples. Finally, this finding was obtained in diverse industry sectors and in diverse functional areas. Most studies are sector-specific, but as a group, they cover a wide array of industries.

However, these studies suffer from two weaknesses. Most studies focus on operations level information systems which might limit the generality of the finding. And, here again the concept of "middle management" is weakly defined.

Together, these sixteen empirical studies indicate that IT both increases and decreases the number of middle managers in organizations. The second set of studies provides stronger empirical evidence than the first. There are more studies in the set; it covers a wider range of sectors and functional areas; and most studies in the set were conducted in a more systematic fashion. This suggests that IT probably increases the number of middle managers rather than decreases them. However, we are reluctant to draw a firm conclusion one way or the other because of limitations in all of the studies. Perhaps the strongest finding from this assessment is that the studies present an "empirical paradox", a paradox which is not resolvable by simply adding up the findings for one side or the other.

RESOLVING THE EMPIRICAL PARADOX

Poole and Van de Ven (1989) describe four modes of working with paradoxes.[2] While each is valid, the fourth mode, "Introduce new terms to resolve the paradox" seems particularly relevant to our situation. This avenue implies clarifying the opposing positions and their relationships by bringing to bear complementary perspectives. This avenue, we think, might transform the paradoxical findings about IT impacts on the number of middle managers into a solvable problem. We use three perspectives: technological, managerial, and structurational (Table 3).

Insert Table 3 about here

The Technological Perspective

The technological perspective (or technological determinism in some literature) conceptualizes organizations as a set of precise procedures that control the mobility and coordinate the efforts of several individuals or groups toward the attainment of common organizational objectives (Astley and Van de Ven, 1983). Organizations are influenced, and their internal structures mainly determined by external forces which are only partially controllable by managers (Astley and Van de Ven, 1983). Managers are basically reactive, adapting organizations to the forces that confront them. The focus of managerial actions therefore is on gathering correct information about relevant contingent factors, interpreting it, and evaluating the consequences of responses to different external demands for organizational success (Astley and Van de Ven, 1983). Middle managers are viewed as the communication links between top management and operations

management. They transmit and "translate" decisions made at the top downward, and they report exceptions upward.

As Table 3 indicates, the technological perspective considers IT as a fundamental factor affecting organizations. IT is not customized to the requirements of specific organizations. Instead, new technology emerges and is applied because of its superiority in resolving organizational problems; and, organization structures are adapted to the technology. New IT that alters information access and control might modify the distribution of power among various organization members and create new dependencies while also dissolving old ones; hence it would induce structural changes (Attewell and Rule, 1984; Bartley, 1986; Markus, 1984; Markus and Pfeffer, 1983).

This perspective focuses attention on the substitutability of IT for middle managers, as both are means to perform functions required at the middle level of the hierarchy. IT impacts can be explained therefore in terms of capital-labor substitution. By analyzing what middle managers do and what IT can do and by comparing these alternatives in terms of costs and benefits, it should become clear whether IT (capital) is a cost-effective substitute for middle management (labor).

The technological perspective can be summed up as follows. Middle managers continue to perform tasks in which they have comparative advantage, and relinquish tasks where the computer has a comparative advantage. Hence, IT takes over most informational and structured decisional activities but few (if any) interpersonal and unstructured decisional activities. Decreases in the number of middle managers thus will occur in organizations where middle managers primarily process information and make structured decisions; these tend to be in centralized organizations, where decision authority is concentrated at the top of the hierarchy. On the other hand, increases in the number of middle managers will occur in organizations where

the emphasis of middle management is on unstructured decisions. IT will take over only a very small portion of their jobs, leaving middle managers with more time to perform other managerial tasks.

Pfeffer and Leblebici's (1977) analysis illustrates this perspective. They argue that "IT substantially alters the mechanisms and the nature of organizational coordination and control, and therefore, has direct causal effect on the structure of the organization" (p. 247). Two such effects are greater managerial capacity for information processing, and more rapid, comprehensive feedback to managers regarding performance. Changes in organization structures are thus fundamentally determined by the technical capabilities of IT, which facilitate the delegation of decision authority, favor greater decentralization of decision authority, and increase the number of departments and hierarchical levels. Who controls and chooses IT, and whose interests are being served by IT (the managerial perspective) are given limited attention in their analysis.

The Managerial Perspective

According to the managerial perspective (or managerial actionalism in some literature), what really determines IT impacts is who controls computing and has the ability to use IT to achieve their interests--whether personal, professional, or organizational. The impetus for IT innovation is the perception of those in control that there is an opportunity to promote their interests and enhance their position through the technology (Kraemer and Dutton, 1979; Kraemer et al., 1989). The managerial perspective draws attention to individuals, their interactions, and their mix of interests. Consequently, research efforts using this model of change are directed away from the technology per se, toward managerial decision making processes (Astley and Van de Ven, 1983).

In this perspective, organizations are conceptualized as a group of individuals with unequal power, authority, and influence, and with divergent interests. Joint action depends on negotiation (Weick, 1976), and while choice is available in the design of organizational structures, they are fashioned more in accordance with political considerations (subunit bargaining, personal needs, self-interested behavior) than with technical ones. Organization structures are assumed to be largely under the control of managers and shaped by their decisions and actions (Astley and Van de Ven, 1983). Middle managers are seen as political agents who use and manipulate information to promote their personal interests and assure their growth while also pursuing broader organizational interests.[3]

The managerial perspective also assumes that IT does not determine or shape organization structures in any significant manner. Instead, it is the person or group which controls computing that determines the structural changes when using IT to achieve various goals. Information technology is therefore an adjunct to managerial decision that is mostly fashioned in accordance with who controls computing decisions.

These arguments can be summed as follows. On the one hand, the number of middle managers decreases in those organizations where top managers control computing because they tend to substitute IT for middle managers. They do so for organizational and personal reasons. They seek to achieve the organizational objective of efficient functioning by substituting capital for labor (England, 1967; Long, 1960; Mintzberg, 1983).[4] Hence executives will substitute IT for middle managers for those functions IT performs best (Buddle et al., 1982; Child, 1984a). But they also achieve personal objectives by doing so. Middle managers are a source of uncertainty for top managers because they control information, and they can withhold, bias or alter the information they transmit upward.[5] Top managers reduce their uncertainty by using IT to gain greater control over information through the elimination of middle managers.

On the other hand, the managerial perspective suggests that the number of middle managers will increase in organizations where middle managers control computing. Middle managers will pursue growth through automation because their prestige, status, power, and salary basically depends on the size of the unit they manage (Dalton, 1959; Mintzberg, 1983; Stewart, 1987).[6] Automation projects provide an opportunity to garner new or additional technical staff and equipment, to gain control over information and expertise, and to circumvent organizational control systems. Consequently, in organizations that have decentralized computing authority, IT is likely to increase the number of middle managers, and their roles and responsibilities.

The analysis by Blau and colleagues' (1976) illustrates the managerial perspective. They found that increased decentralization of decision authority and increased number of hierarchical levels depended upon where control over IT was located. When division managers controlled IT (in divisions or plants), IT decentralized decision authority. When top managers controlled IT (in headquarters), it centralized decision authority. Thus, the impact of IT appears essentially determined by who controls major computing decisions.

Our foregoing analysis of these two perspectives (technological and managerial) indicates that two fundamental dimensions shape the impact of IT on the number of middle managers. The first is the roles middle managers play in organizations and the degree to which these roles are structured, standardized, and routine (these roles in turn are a reflection of the broader organization structure). The second is who controls the choice and usage of IT and has the ability to achieve various interests through its use.

The Structurational Perspective

While useful in providing different explanations for IT impacts, the technological and managerial perspectives do not provide a comprehensive explanation. The structurational perspective

provides such an explanation by integrating the two.[7]   The structurational perspective conceptualizes organizations as both a mechanical device and a group of individuals with divergent interests and unequal power. Organizational structures are determined by external factors that are mediated by internal organizational factors like managerial actions, strategic choices, and political plays. IT is an external force that triggers organizational changes, and managerial actions are the internal force that materializes these changes. IT impact occurs as it is internalized by the organization as it seeks to maximize return on IT investment.

Both the industrial and IT revolutions illustrate the structurational perspective. The industrial revolution was initiated by the development and perfection of machine technology. However, machinery alone was insufficient to revolutionize the organization of production (Landes, 1969; Peitchinis, 1983). Rather, the steam engine and later the electric dynamo had to be "managed" into integrated production and distribution systems. And it was managers who decided how that would be done, first designing highly centralized systems in an effort to establish control, and later evolving to more decentralized ones as they decided to push control downward.

The IT revolution provides a similar catalyst for organizational change. And like the steam engine, IT is only an instrument. It is not by itself, sufficient to alter organizations significantly. Understanding IT, or even its usage by independent actors, and understanding managerial action and personal interests are not sufficient by themselves to explain IT-induced organizational changes.   Information technology is the necessary instrument that permits organizational changes, but management action is needed to integrate and internalize IT into organizations. Hence, both the technological and managerial perspectives are necessary, but neither one alone is sufficient to provide significant understanding of how and why IT changes organizations.

The structurational perspective helps us understand the organizational impacts of IT by integrating the two key dimensions used to explain IT impact in the technological and managerial

perspectives; these are the centralization of computing decisions and the centralization of organizational decisions, the latter which is indicative of the roles middle managers play. These two factors form the basis for a framework that enables us to resolve the empirical paradox with respect to IT's impact on middle managers. The framework is presented in Table 4, and elaborated next.

Insert Table 4 about here

The first dimension in the framework, the centralization of computing decisions, refers to whether control over computing resources is centralized in top management or decentralized to middle managers. The managerial perspective predicts that IT will result in a decrease in the number of middle managers when control of computing decisions is centralized ("high" centralization of computing decisions in Table 4) and increase their number when control is decentralized ("low" centralization of computing decisions).[8]

However, the IT impact on middle managers also depends on the roles middle managers play and on their degree of structure, both of which may facilitate or counter management's use of IT to change the number of middle managers.[9] The second dimension in the framework, the structure of organizational decisions   (excluding computing decisions), refers to whether control of decision making is more centralized or decentralized. When organizational decision making is centralized, the role profile of middle managers is more routine, structured, and informational in nature. When decision making is decentralized, the role profile is more unstructured, and decisional in nature. In this context, the technological perspective predicts that IT decreases the number of middle managers when their roles are routine, structured and informational ("high" centralization of organizational decision making in Table 4) and increases their number when

their roles are unstructured and decisional ("low" centralization of organizational decision making). As can be seen in Table 4, these two dimensions create four quadrants, each representing a different contingent outcome with respect to the impact of IT on middle managers.

The Four Contingent Situations

The impact of IT is expect to be most pronounced and significant in the two quadrants where both structures of decision converge and reinforce each other's influence. We refer to these as "extensive" because <u>both</u> computing decisions and organizational decisions are either centralized or decentralized. We refer to the other two quadrants as "partial" because the two structures of decision <u>counter each other</u> and decrease the IT impact.

In extensively centralized organizations (cell 2), the two structures of decision are centralized. Top managers control computing decisions. The main roles of middle managers are informational, and their decisional roles are structured and routine. Consequently, top managers will be able to initiate the use of IT so that the greater part of middle managers' jobs will be taken over by IT. We anticipate then that middle management jobs will be consolidated and reduced.

Conversely, in extensively decentralized organizations (cell 3), the two structures of decision are decentralized. Middle managers control computing, and their main roles are mostly unstructured and decisional in nature. Consequently, they will be able to choose and use IT so it takes over some of the more routine decisions and some informational roles. Middle managers will then be able to give greater attention to their unstructured decisions and increase their number and importance in the organization.

The impact of IT is much less pronounced in the partial situations than in the extensive situations because the two structures of decision counter each other, thus limiting the effects of IT on

middle managers. However, because the degree of centralization of computing decisions has been found to have a more pronounced impact than the degree of centralization of organizational decision in general, small IT impacts are still expected (Kraemer and Dutton, 1979).

In the partial centralization situation (cell 1), computing authority is centralized, but the structure of organizational decision is decentralized. The roles of middle managers are not easy to computerize, but top managers control computing and try to reduce middle management by capitalizing on the portion of the roles that can be automated. Organizations with such a structure can expect a small decrease in the number of middle managers. This might be a proportionate decrease rather than an absolute one. That is, middle managers might be kept stable while the rest of the organization grows.

In the partial decentralization situation (cell 4), middle managers control computing, but their roles are easy to automate. To protect their interests, middle managers use the IT that reinforces and creates greater demands for their unstructured roles. This increases their importance and makes them more essential to the organization. However, because middle managers are in organizations where decision authority other than computing is centralized, they perform only few unstructured roles and therefore the increase in their number can only be small. Table 5 summarizes the key features of each cell in the framework.

Insert Table 5 about here

THE CASE STUDY

As a preliminary test of the framework and an exploration of the influence of contextual factors, we conducted a detailed case study of Energy Inc. We sought an organization that was highly centralized because this is where the impact of IT is expected to be the strongest. Interviews with the VP of operations and with the MIS department head at Energy Inc. indicated that authority about organizational and computing decisions were indeed highly centralized. All major decisions needed to be approved by an appropriate Vice-President. Moreover, until 1986, the gas industry was highly regulated by a government agency which required top management to be actively involved and to control major organizational decisions (see the description of the industry below).

We alsosought an organization that had applied computing extensively so there would be greater chance for IT to have a noticeable impact. Energy Inc. had over 500 microcomputers installed and was acquiring 100 micro-computers per year. These microcomputers and about 50 mainframe applications were distributed widely in the organization.

Fifteen semi-structured interviews were conducted in Energy, Inc.: two with vice-presidents of operations and human resources to gather information on the organization and its environment; six with department heads (finance, personnel, MIS, engineering, production, sales and services) to obtain detailed information on each department; and seven with middle managers (division heads and section heads) throughout the organization. Numerous documents (annual reports, MIS budgets, detailed organizational charts, and newspaper clippings) covering the 1984-1991 period were also used to validate and triangulate information gathered in interviews.

Energy Inc. distributes natural gas. It also sells and services natural gas heating and cooking appliances. It employs more than 1,400 individuals distributed on seven hierarchical levels:

president, vice-president, department heads, division heads, section heads, first-level supervisors, and operational employees. Table 6, which presents revenues, expenses, and profits from 1984 to 1990, reflects a dramatic change in the environment of Energy Inc. that occurred in 1986. Before 1986, the industry was highly regulated and Energy Inc. was a quasi-monopoly. Energy Inc. benefited from this situation, owning more than 95% of the natural gas sales and distribution market. In 1986, the industry was deregulated and major competing companies entered the market. The environment suddenly changed from very stable and monopolistic to very dynamic and oligopolistic and this had severe impact on Energy Inc's incomes. Before 1986, profits increased rapidly and steadily, but when deregulation occurred, profits decreased substantially until 1990. This created great pressures on the organization to become as efficient as possible.

Insert Table 6 about here

Concepts Used To Examine The Case

Information technology can be conceptualized in a variety of ways. It can be looked at in terms of (a) the nature of the technology, including considerations such as power, capacity, sophistication; (b) the extent of application of the technology within the organization, including, for example, the number of computer applications in operation; and (c) the actual use of the technology by individuals within the organization (George, 1986; Pinsonneault, 1990). While each is an appropriate measure, it is the extent of automation that is most directly relevant to this analysis. Computer power or technological sophistication and computer use by individuals might be great but narrowly applied and concentrated, and consequently its impact on the number of

middle managers would be light. The extent of automation is an appropriate concept because it measures the degree to which automation has penetrated the organization broadly, across functions horizontally and across roles or levels of the organization hierarchy vertically. The more pervasive the technology's application, the greater the likelihood that its impact will be sufficient to affect the middle management workforce. For example, the greater the penetration, the greater the likelihood that computing will allow top managers to bypass middle management and to operate without them.

Middle managers are conceptualized in the literature in a number of different ways, but these conceptualizations revolve around one key element. In essence, middle managers are neither at the top of the hierarchy--where policies and procedures are defined--nor directly supervising operations--where the policies and procedures are executed. They are in the middle, linking the two groups by interpreting and operationalizing policies and procedures, and monitoring implementation. Therefore, we set the lower boundary of middle management above first-level supervisors because managers from this level down directly supervise operations and are responsible for executing policies and procedures. The upper boundary is set below the department head because managers from this level up are usually responsible for designing policies and procedures and for introducing changes in the organizations. In Energy, Inc., middle management includes division heads and section heads.

The Impact Of IT On The Middle Management Workforce

Insert Table 7 and Table 8 about here

Table 7 presents the evolution of the number of major computing applications and personal computers attached to the mainframe computer. Table 8 presents the evolution of the number of middle managers and the number of employees of Energy Inc., from 1986 to 1991. Energy Inc. had about 50 major mainframe applications in operation in 1990 that employees accessed through 500 microcomputers which were essentially used as terminals. The sales and market development department had seven applications, all related to managing construction projects and monitoring sales of different commodities and appliances. The operations and engineering department used eight applications related to managing the production process of the appliances and inventories. The finance and administration department used 26 applications related to accounting and managing human resources. Table 7 indicates that the extent of automation has progressed steadily from 1984 to 1990. Computing efforts were not affected negatively by deregulation and decreasing profits from 1987 to 1990. Rather, Energy, Inc. increased its computerization effort: between 1987 and 1990, the number of microcomputers increased by 75% and the number of applications increased by 32%.

Interviews with the two vice-presidents and with the MIS department head clearly indicate that Energy Inc. decided to invest in IT to be in a better position to face deregulation and increased competition. Managers felt that the major way to do so was to increase the span of control of department heads and simultaneously, to provide them with computer applications that give them information to deal with this increased control. For example, Energy, Inc. installed an on-line information system that provided direct access to data on the manufacturing of gas appliances to the head of the operations department which was originally managed by the middle managers of the "appliances" section. Two years after the implementation of the information system, the middle managers of the appliance section were laid off. Table 8 illustrates this phenomenon quite clearly. Between 1988 and 1991, the number of middle managers decreased from 173 to 155 (-10%) while the total number of employees in Energy, Inc. rose from 1318 to 1397 (7%).

Thus, the case study provides partial support for the framework presented in this article. Information technology clearly was used by top managers of Energy, Inc. to reduce the number of middle managers. However, the case study also indicates the importance of environmental pressures on the manager's actions. Although IT capabilities were present before deregulation, their potential for decreasing the middle management workforce was not exercised at Energy, Inc. Most of the computer applications later used to facilitate middle management reductions were operational before deregulation of the industry. Top managers simply did not use them to decrease the number of middle mangers until environmental pressures for greater efficiency triggered the rationalization process.

CONCLUSION

This article examined whether IT decreases or increases the number of middle managers in organizations. The empirical studies suggested that IT both increases and decreases the number of middle managers. To resolve this "empirical paradox", we presented a new framework (Table 4) in which the effects of IT on middle management staffing are viewed as contingent upon the degree of centralization of decision making in the organization as a whole and in computing matters in particular.

This framework permits us to reconcile the conflicting findings about IT impacts on middle management staffing. For example, when there is extensive centralization of decision making, IT will tend to be used by higher level managers to reduce the size of the middle management workforce; when there is extensive decentralization, IT will tend to be used by middle managers to increase their importance and number.

The case study provides preliminary support for the framework by showing reduction in the middle management workforce under "extensive centralization." The case study also demonstrated that environmental pressures play an important role. That role is to trigger the rationalization processes of organizations (at least those fitting the extensive centralization cell of the framework). The change from a monopolistic to an oligopolistic environment increased the external pressure on Energy, Inc. to become more efficient. And the managers of Energy, Inc. chose to become more efficient through automation aimed at reducing the number of middle managers and providing greater informational and computing support to remaining staff.

The literature assessment and this case study suggest that managers should be aware of six characteristics of IT impacts in organizations. *First, the effects of IT on the number of middle managers are both direct and indirect, but their net effects are not straightforward. Rather, they are contingent.* IT impacts mostly depend on who controls computing decisions and who is able to systematically use IT to pursue their personal, professional and organizational interests. It is managerial action that mainly determines whether IT will increase or decrease the middle management workforce. When middle managers are given control over computing decisions, they tend to use IT to increase their number. *Therefore, in order to obtain the desired IT impacts, it is essential that top managers become clear about the values they seek, that they convey these values tin making major computing investments , and that they look to see whether these values are achieved.*

Second, IT impacts are moderated by the roles middle managers play in the organization. Structured and standardized roles facilitate top managers' efforts to substitute IT for middle managers, whereas unstructured and unstandardized roles facilitate middle managers' usage of IT to enlarge their ranks.

Third, the effects of IT are stronger in situations where centralization or decentralization are "extensive" rather than "partial" (Table 4). In the extensive situations, managerial action is particularly important and likely to result in more profound staffing changes, whereas in the partial situations, managerial actions are likely to result in modest staffing changes.

Fourth, top managers appear not to routinely use IT to reduce the number of middle managers even though they could. Such a use has to be triggered by environmental, competitive, cost or similar pressures.

Fifth, wholesale reduction of middle management ranks can be a self-destructive strategy because IT is less substitutable for unstructured roles than for structured ones. Top managers must therefore be sensitive to these subtleties when making reductions. Moreover, reductions might not always be the right course. In situations of increased environmental complexity and dynamism, top managers frequently need to broaden and intensify their capacity for scanning the environment. Middle managers can help do so. Therefore, although IT might take over some middle managers' roles and create slack resources, greater organizational payoffs might come from reinvesting this time savings and using the flexibility generated from IT to help the organization adapt to a dynamic environment.

Finally, there is strong support for the notion that IT <u>currently</u> might be reducing the number of middle managers. The explanation for the current reductions is as follows: downsizing is stimulated by managers' need to reduce personnel in order to face the continuing economic recession and growing international competition; the current high level of IT diffusion in organizations is an <u>enabler</u> of such downsizing; some top managers have seen this linkage and acted on it. This explanation is consistent with the empirical studies, our case study, and anecdotal evidence. The empirical studies show that top managers tend to use IT to reduce the number of middle managers in highly centralized organizations; and it is the large, vertically

integrated organizations that are most experiencing downsizing today. The case study showed

such an organization (Energy, Inc.) which reduced its middle managers in response to cost

pressures from competition after its industry was deregulated. The relatively high level of

automation enabled the reduction. Finally, the business press repeatedly links the decline in

middle managers to economic conditions and IT (Byrne, 1988; Syedain, 1991; Tremblay, 1991).

This analysis and triangulation of evidence suggests that the high level of IT in some

organizations probably is an enabler of organizational downsizing.

This line of reasoning also explains why we have not seen profound IT impacts in other

economic downturns. Previously IT was not sufficiently diffused in organizations to facilitate its

substitution for labor. However, the decade of the eighties saw continuing, extensive diffusion of

IT throughout organizations such that many information and communication functions of middle

managers were no longer be required. In addition, IT added to the capacities of staff enabling all

levels to do more. These dual effects created slack resources which were either absorbed by

corporate growth, or lay fallow. The slack was not excised previously because there was no need

to do so. When environmental conditions changed, top managers exercised their option. Such an

overall conclusion is consistent with the theoretical analysis in this article, but clearly further

study is warranted.

We encourage further testing and validation of the framework presented in this article to

determine the importance of environmental context and other factors in explaining IT's impact on

middle managers. Moreover, the framework used to assess the research findings and the

limitations of current studies have several implications for future research. A greater number of

studies need to be conducted to provide a more substantial body of evidence. Studies need to

define better the middle managers and IT being studied. It would be highly desirable to have

multiple studies use precisely the same definitions. Studies need to focus on homogeneous

samples of organizations (e.g., by industry sector) in order to better understand the influence of

environmental and organizational variables. Then findings from different industry or organizational sectors could be integrated to develop a general theory of IT impacts on middle managers and organizations. Finally, studies need to examine organizational contingencies which moderate IT impacts, such as structures of control and interests served. This current research has shown the importance of understanding IT capabilities and the roles of middle managers on the one hand, and who controls major computing decisions, and the nature of political mobilization around these decisions, on the other.

FOOTNOTES

1.   The validity of the findings of a set of studies does not depend only on the quality of any one particular study but also on the heterogeneity and diversity of the research designs and contexts, which provide an indication of the general concurrence of the findings common to a particular set of studies (Salipante, Notz, and Bigelow, 1982).

2.   These four different modes are as follows: (1) accept the paradox, (2) clarify levels of analysis, (3) temporally separate the levels of analysis, and (4) introduce new terms (concepts, perspectives) to resolve the paradox. While each mode is valid, the last seems particularly useful with regard to the present paradox. Accepting the paradox in this case does not add to the understanding as is apparent from the analysis above. Clarifying levels of analysis and temporally separating levels of analysis are not applicable avenues because there are an insufficient number of studies at all three levels (firm, industry, cross-industry) in the body of research.

3.   This utilitarian behavior has been stressed by several researchers from different disciplines (Kraemer and Dutton, 1979; Olson, 1966; Porter and Lawler, 1968).

4.   This is often posited by researchers on the effects of technology on unemployment (Chern, 1980; Guiliano, 1982; Hines and Searle, 1979; Jenkins and Sherman, 1979; Sleigh, et. al., 1979).

5.   Messages transmitted from one person to another are rapidly altered, often after only a few transmissions (Campbell, 1958).

6.   An excellent illustration of such self-interested behavior of middle managers is Dalton's (1959) study of managerial behavior which shows how middle managers used deception to protect themselves from the head office.

7.   Structuration theory was developed in recent work on social theory by Giddens (1979, 1984) and elaborated in IT research by Markus and Robey (1988), Orlikowski (1991), and Orlikowski and Robey (1990).

8.   Research shows that major computing decisions are controlled by top managers or middle managers. When they are made at lower levels, they often need to be approved by higher-level managers, or to comply with standards established by such managers (Hoos, 1960; Whisler, 1970). There are three reasons for this control by top and middle managers. First, IT is a critical resource in most organizations. It is a functional necessity as well as a strategic one without which most organizations can no longer compete and survive. Second, very large budgets are allocated to IT (annual budgets in the tens of millions of dollars are common). Third, the control of IT is one of the main intra- and inter-organization communication devices and the source of important power and authority (Pettigrew, 1973; Pfeffer, 1978).

9.   We use the structure of organizational decision making authority to depict the role profile of managers in organizations as in Pugh, Hickson, Hinnings and Turner (1968).

10.   The name of the company is disguised.

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ABOUT THE AUTHORS

Alain Pinsonneault is Assistant Professor in Ecole des Hautes Etudes Commerciales.

Kenneth L. Kraemer is Professor in the Graduate School of Management and Director of the Center for Research on Information Technology and Organizations (CRITO) at the University of California, Irvine. He is co-author of seven books on information systems, and his most recent book, *Managing Information Systems*, was published by Jossey-Bass in 1989. Articles have appeared in *Public Administration Review*, *Communications of the ACM*, *Computing Surveys*, *Policy Analysis*, *Telecommunications Policy* , and *Social Science Computer Review* among other journals. He is currently conducting research on IS performance measurment, on government policy and the diffusion of information technology in Asia-Pacific countries, and on advanced integrated manufacturing environments in U.S. companies.