

Exploring the Influence of New Technology Planning and Implementation on the Perceptions of New Technology Effectiveness

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Abstract

This study explored influences that perceptions of new technology implementation and planning processes, and dimensions of organizational climate have on perceptions of new technology deployment effectiveness. It also examined the extent to which dimensions of organizational climate moderates the relationships among new technology implementation, planning, and new technology deployment effectiveness.

Data for this study was collected from 100 employees within 6 different types of organizations that had recently installed new technology. The results of the study indicate that these factors do indeed influence new technology deployment effectiveness. Organizational climate was not shown to have a moderator affect.

Introduction

The rapid speed of technological development and its effect on organizational strategy, structure, and processes has created a critical need for a systematic approach to managing technology. Technology Management "...links engineering, science, and management disciplines to address the planning, development, and implementations of technological capabilities to shape and accomplish the strategic and operational objectives of an organization" (Manufacturing Studies Board 1986). Technology management has its roots in strategic management, engineering management, innovation management and R & D management, all dating back to the 1970's (Ulhoi, 1996). Technology management during the past two decades has emerged as a viable framework within corporate strategy making (Burgelman, Madique, & Wheelwright, 1995; Collier, 1985; Porter, 1985) and is considered to be an independent sub-discipline of organizational management. Its interdisciplinary framework focuses upon understanding the peculiar integration between information history and radically new modes of production that is rarely understood within the industrial technology paradigm of current management thought (Bellamy, Becker, Kuwik, 2001). For the conceptual purposes of this paper, technology is defined as the ideas, tools, and knowledge that are utilized for

developing, transforming, or modifying a product, service, and skills. This definition acknowledges the nonmaterial aspects of technology as well as tools and equipment. Technology management refers to the management strategies and processes that are utilized in the effective deployment and maintenance of technology. Strategies and processes consist of such things as the assessment and requisite changes of the organizational structures, work processes, modes of integration, communication networks, and human resources that are needed to effectively bring about an isomorphic relationship between technology and the accomplishment of organizational objectives.

This exploratory study examined the extent to which perceptions concerning technology planning, implementation, and organizational climate influence perceptions of the effectiveness of new technology. The study is further concerned with exploring the extent to which organizational climate moderates the relationships among technology planning, technology implementation, and technology effectiveness. Previous and existing literature has tended to focus more on the macro level aspects of technology management and strategy (such as environmental monitoring of technology, product development and innovation,) and technology leadership (Barclay, 2002; Barclay, 1990; Cooper and Kleinschmidt, 1995; Clarke and Thomas, 1990). The emphasis placed upon these broader aspects of technology management is understandable given the implications that technology has for improving an organization's competitive position. However, specific organizational processes such as the way in which organizations go about planning and implementing technology are equally salient to the management of technology. The influence that these processes have on technology management, has for the most part, been ignored within the empirical literature. What does exist within the literature are theoretical statements regarding the importance of implementation and planning processes. However, there is a critical need to empirically investigate the impact that these processes have on technology outcomes.

Technology is believed to have more effective outcomes when it is integrated systematically within an organization's strategy process (Steele 1989; Uhoi, 1996). The micro processes of planning and implementation relate to an organization's strategic behavior toward technology management. Conducting empirical research on how these factors influence the deployment of technology will provide deeper insights into the processes needed for developing an effective technology management strategy.

Factors Examined in Study

Planning and Implementation Factors

The way in which internal planning and implementation processes are managed could greatly influence the fecundity of new technology. Analyses of how these processes are managed could be seen as an indicator of the extent to which organizations strategically approach the deployment of new technologies (Hong & Kyung-Kwon, 2002). Technology implementation and planning refers to the extent in which the organization has strategically approached the deployment of new technologies and the manner in which it has prepared for the execution of the technologies prior to their implementation. The processes incorporated within this design have been cited to influence the overall effectiveness of both the deployment and utilization of technology (Bancroft, 1992; Haddad, 2002).

The implementation factors examined within this study consisted of perceptions relevant to the structure of the implementation process (cross-functional teams), and the extent to which pre-assessment of such things as training needs, required organizational changes, and the capabilities of the new technology was conducted prior to the deployment of new technology.

The study approached the planning process by examining the extent to which the organization devoted time to technology planning, the level of clarity within the planning process, and the extent to which a strategic plan was utilized.

Although the implementation and planning factors incorporated within this study do not exhaust all of the possible factors related to the deployment of technology, it does include a representative cadre of constructs that has been identified within the conceptual literature as being relevant and significant to the implementation of technology (Cleland & Bursic, 1992; Haddad, 2002; Preece, 1995; Steele, 1989).

Criterion Factors

Three types of factors were examined to determine the impact that the technology implementation and planning factors and organizational climate have on new technology outcomes. They are perceived unanticipated outcomes, perceptions of whether the technology accomplished what it was intended to achieve (Overall Perceptions), and perceptions related to its impact on production issues (Production Outcomes).

Organizational Climate

When exploring the ways in which management practices are related to technology implementation outcomes, it is important to realize that these relationships occur within the context of organizational characteristics, such as its climate (Barley, 1990).

Organizational climate refers to:

“a relatively enduring quality of the internal environment of an organization that is (a) experienced by its members, (b) influences their behavior, and (c) can be described in terms of a particular set of characteristics or attributes of the organization” (Tagiuri, 1968, p 35).

This definition conceptualizes climate as a construct that is linked to perceived qualities of the organization such as leadership, organization design, decision-making processes, and organizational policies and procedures (Guion, 1973). Perceptions of these organizational traits can influence individual behavior in relation to organizational effectiveness (deWitte and de Cock, 1988). More specifically, organizational climate appears to influence the manner in which an organization conducts its planning for new technology. For example, an organization that is characterized by its members as being rigid and unwilling to change would probably approach new technology planning and implementation differently than an organization described as open and that does not resist change. There may also be parallel differences in the effectiveness in which new technology is deployed (Sparrow & Gaston, 1996). The perceived climate of the organization may mediate the relationship among technology, the planning processes, and the perceived effectiveness of the deployment of technology.

There is a lexicon of studies and writings that point to the usefulness of the climate

variable in conducting organizational analyses (Sparrow & Gaston, 1996). It has been linked to motivation and job satisfaction (Reichers & Schnieder, 1990). It has also been shown to mediate the relationship between job satisfaction and performance (deWitte and de Cock, 1988). Although recent attention has been focused on examining the influence that climate has on innovation and organizational learning (Agrell & Gustafson, 1994; Anderson & West, 1994) very little empirical attention has been directed to describing its role in technology management issues.

This study examined the following four dimensions of culture extrapolated from the Business Organization Climate Index (BOCI) (Payne & Mansfield, 1978): (a) questioning authority, (b) administrative efficiency, (c) open-mindedness, and (d) innovation. These four factors were chosen from among 17 factors within BOCI because they appeared to be the most relevant toward the subject of implementing and planning for new technology.

Research Questions

This study explored the following research questions:

1. What is the nature and strength of the relationship among technology assessment, technology planning factors, and perceived technology effectiveness outcomes?
2. What is the impact of organizational climate on technology assessment,

technology planning, and perceived technology effectiveness outcomes?

3. In what way does organizational climate moderate the relationships among technology assessment, technology planning, and perceived technology effectiveness?

Methodology

Sample

Data for this study was collected from 101 employees who had direct experience with selecting and implementing new technologies within their work units. These respondents were selected from six departments within six different organizations located in Southwestern Michigan. Access to each of these departments was attained through 6 graduate students who were enrolled in a technology management class during the Winter 2 semester of 2002. These students were employed in these departments. Figure 1 presents an overview of the sampling demographics of these departments. Participants within each organization specified within the chart, represent the number of people within a particular work unit who were directly involved with the planning and implementation processes of their new technologies.

Measurement.

All of the departments with the exception of one were involved in the implementation of new information technology (non-mechanical). Examples of the technologies include CAD/CAM software, group decision-making software, and accounting management software.

Figure 1. Demographics of sample

Type of Organization	Size of Work Department	Occupation of Respondents	Number of Respondents
Health Care Insurer	150	Managers and Supervisors	20
Military Logistics	90	Information Systems Admin.	16
Police Agency	108	Managers	10
Manufacturing	30	Managers and Supervisors	9
Engineering* Design	77	Engineers	12
Engineering* Design	52	Engineers	17
University	71	Academic Administration	17
*Indicates two departments from same organization.			

One department (manufacturing) had recently installed new numerically controlled machinery. Each respondent completed a questionnaire and was informed to respond to technology implementation, planning, and outcome items as these pertained to the most recent new technology within their departments. For each of the items within the questionnaire, respondents were asked to circle the response value that most indicated their opinion concerning the statement within the item.

Planning

A technology planning scale was developed by combining each of the first five items listed within Figure 2. A five point scale and five anchor response format was utilized for each item in which respondents were asked to describe the extent to which each item was used during the technology planning process. Anchors ranged from "Strongly Agree" to "Strongly Disagree" with corresponding scores of 1 through 5. A value of five was assigned to a "Strongly Agree" response whereas a value of 1 was assigned to a "Strongly Disagree" response. Scores for this scale ranged from 8 to 25, with a median of 17. The alpha reliability for this five-item scale is .86. These items are representative of the domain of ideas pertaining to technology planning delineated within the technology management literature. As such, the items appear to have high content validity. The high alpha reliability for the scale lends further support to the scale having good content validity.

Item 6, the use of a strategic plan for the new technology, was used as a separate one item scale. Factor analyses revealed that it is a separate factor from the created implementation scale. Higher scores on each of the scales indicate a higher orientation toward new technology planning.

Implementation factors

Eight items pertaining to technology implementation were included within the questionnaire (Figure 3). Each item utilized a seven point scale and three anchor response format in which respondents were instructed to rate the extent to which each item was utilized during the most recent technology implementation within their department. Anchors ranged from "Strongly Agree" to "Strongly Disagree" with corresponding scores of 1 through 7. A value of seven was assigned to a "Strongly Agree" response while a value of 1 was assigned to a "Strongly Disagree" response.

Items 1 through 6 were combined to form one implementation scale. Scores ranged from 9 to 41, with a median of 27. The alpha reliability for this scale is .87. Figure 3 illustrates each of the implementation items. These items are representative of the domain of ideas pertaining to technology implementation delineated within the management of technology literature. As such, the items appear to have high content validity. The high alpha reliability for the scale lends further support to the scale having good content validity.

Figure 2. Planning Factors

1. The extent that management had a clear understanding of the objectives of the new technology.
2. The amount of time devoted to planning for the new technology
3. The extent to which there was a clear plan for implementing the new technology.
4. The extent to which there was appropriate planning for costs associated with upgrades for the new technology.
5. The extent to which workers were informed of the new technology before it was implemented
6. The use of a strategic plan for the new technology.

Figure 3. Implementation Factors

1. The extent to which training needs related to the new technology were assessed.
2. Assessment of the new technology's impact on existing personnel functions.
3. Assessment of the organizational changes needed to fully support the new technology.
4. Assessment of the capabilities of the new technology.
5. Assessment of the financial feasibility of the new technology.
6. Assessment of how the new technology would affect job responsibilities.
7. The extent to which there was top management involvement during the implementation process.
8. The use of cross-functional planning and implementation teams.

Items 7 and 8, top-management involvement and the use of cross-functional teams were used as separate one-item scales. A factor analysis revealed that they are separate factors from the created implementation scale. Higher scores on each of the scales indicate a higher orientation toward new technology assessment.

Organizational Climate

This variable was measured by utilizing four dimensions of the Business Organization Climate Index (Payne & Mansfield, 1978), which contains 17 climate dimensions. These four dimensions were selected because they appear to be relevant to the technology implementation concepts of this particular study. Participants were asked to describe the extent to which each of the climate items were indicative of their work department. A four-point scale and four-anchor scale format was utilized with responses ranging from "Definitely True" to a "Definitely False". A score of 4 was attached to a "Definitely True" response and 1 to a "Definitely False" answer. Each dimension consists of eight items. The four dimensions along with their alpha reliabilities, range of scores, and median values are as follows:

Questioning Authority: alpha = .77; range of scores = 10-26; median = 21.00

Administrative Efficiency: alpha = .81; range of scores = 7-26; median = 19.00

Open-mindedness: alpha = .89; range of scores = 15-30; median = 21.00

Innovation: alpha = .82; range of scores = 15-27; median = 20.50

Higher scores on each of the dimensions indicate a higher orientation towards that aspect of organizational climate. A copy of the items contained within each of these climate dimensions is provided within Appendix A.

Technology Outcomes

Eight items were used to measure perceptions of new technology outcomes. These eight items were used to create three separate technology outcome variables: perceptions of unanticipated new technology outcomes, (3 items) perceptions of improved performance and morale (4 items), and overall perception of whether the new technology accomplished its intended objectives (one item). The scale and response format for the first and third outcome variables are the same for the planning factors. The items along with the alpha reliabilities for the unanticipated technology outcome and accomplish intended objectives variables are as follows:

Unanticipated Technology Outcomes Scale.

Scores for this scale ranged from 3 to 15, with a median of 9. The alpha reliability for this scale is .83. The high alpha reliability gives evidence to this scale having high content validity.

1. The new technology had an unanticipated impact on employee's job responsibilities.
2. The new technology had an unanticipated impact on employee work stress.
3. The new technology had an unanticipated impact on work processes.

Perceived Performance and Morale Scale (Overall Perceptions).

The performance and morale variable used an eight point scale response structure ranging from 0 to 7 with four anchors. A zero response indicates a very low level of the item, whereas a response of 7 indicates a high level for a specific item. Scores for this scale ranged from 0 to 27, with a median of 14. The alpha reliability for this scale is .88. The high alpha reliability gives evidence to this scale having high content validity. Performance and morale scale consisted

Table 1. The Effect of Perceptions of Technology Assessment and Planning Factors, Organizational Climate Dimensions, on Perceptions of Technology Outcomes

N = 100

	Assessment	Planning	Questioning Authority	Innovation	Open Mindedness	Admin Efficiency	Top Mgt Involvement	Strategic Plan	Cross Functional Teams
Unanticipated Outcomes	-.170*	-.204*	-.210*	.151*	-.251**	-.173*	-.195*	-.142*	.022
Productivity Outcomes	.523**	.480**	.113	.039	.045	-.029	.237**	.402**	.417**
Overall Perception	.347*	.316**	.013	-.115	.044	— .091	.125	.167*	.100

$P \leq .05$ ** $p \leq .00$

of the extent that the following things occurred as a result of the most recent new technology.

1. Improved productivity
2. Improved product or service quality
3. Enhanced the competitiveness of the organization
4. Improved employee morale

Results

Research Question One:

“What is the nature and strength of the relationship among technology assessment, technology planning factors, and perceived technology effectiveness outcomes?” As revealed in Table 1, the new technology assessment and planning factors are significantly correlated with each of the technology outcome variables. The negative correlations between these factors and unanticipated outcomes indicate that increases in planning and assessment activities decreases the instances of unintentional outcomes that could negatively affect the effectiveness of the new technology. The positive correlations between

the implementation and planning factors and the productivity and overall perception variables, shows that engaging in technology planning and assessment processes improves perceptions of its effectiveness.

The study also reveals statistically significant correlations between top-management involvement during the implementation and planning processes and the unanticipated outcomes and productivity criterion factors. This factor, however, is not correlated with employee's overall perceptions of the new technology accomplishing what it was intended to accomplish.

Table 1 shows that the use of cross-functional teams during the planning and implementation processes is significantly correlated only with the productivity outcome variable. An interesting finding shown in Table 1 is that the four climate dimensions are only significantly correlated with the unanticipated outcome variable. No statistically significant correlations are shown with the other two outcome factors.

Table 2. Effect of Organizational Climate Factors on Perceptions of Technology Assessment and Planning Factors, Management Involvement, The Use of Cross Functional Team, and The Use of a Technology Strategic Plan

N = 100

	Questioning Authority	Innovation	Open Mindedness	Admin Efficiency
Assessment	-.001	.160*	.089.	.001
Planning	-.001	-.026	.017	-.133
Top Mgt Involvement	.235**	-.037	.111	.037
Cross Functional Teams	-.033	.151*	.097	.040
Strategic Plan	.165*	-.179*	.108	.698**

* $p < .05$ ** $p < .00$

Table 3. Correlations Between Technology Assessment and Planning Factors, Controlling for Dimensions of Organizational Climate

N = 100

Control Factors

	Questioning Authority		Innovation		Open Mindedness		Admin. Efficiency	
	Assessment	Planning	Assessment	Planning	Assessment	Planning	Assessment	Planning
Unanticipated Consequences	-.17	-.20*	-.19*	-.20*	-.17	-.21*	-.17	-.23*
Productivity Outcomes	.53**	.48**	.52**	.45**	.52**	.47**	.52**	.48**

* $p < .05$ ** $p < .00$

Research Question Two

“What is the impact of organizational climate on technology assessment, technology planning, and perceived technology effectiveness outcomes?”

Table 2 reveals that relatively few statistically significant correlations between the organizational climate dimensions and the assessment and planning factors are found within this study. However, the data does indicate that each dimension has a different influence on these factors. The questioning authority and administrative efficiency dimensions reveal two relatively strong and statistically significant correlations. The questioning authority dimension is positively related with the amount of top-management involvement. This finding seems to imply that top-management involvement with the implementation and planning processes influences a climate where employees are encouraged to challenge issues surrounding new technology. The strongest correlation is shown between the administrative efficiency and the strategic plan variables. This finding alludes to the idea that departments that are highly structured in terms of having such things as well organized work processes, that sufficiently disseminates information to employees, and that are concerned about work quality, are more oriented toward developing strategies for technology deployment. A related finding is that all but one (open-mindedness) of the organizational climate dimensions correlates with the strategic plan variable.

Table 2 reveals statistically significant correlations between the innovation climate dimension and the technology assessment, the use of cross-functional teams, and strategic plan factors. In short, based upon having the greatest number of statistically significant correlations, one can partially assume that an innovative climate is the most significant factor of the organizational climate dimensions examined within this study. In comparison, a climate of open-mindedness appears to be the least significant.

Research Question Three

“In what ways do organizational climate moderate the relationships among technology assessment, technology planning, and perceived technology effectiveness?”

The results presented within Table 3 indicate that none of the organizational climate factors moderate the relationships between the technolo-

gy implementation and planning factors and the technology outcome variables.

Discussion

Practical Implications of Study for The Management of Technology

The results of this exploratory study provide confirmation to the somewhat ubiquitous conceptual proposition that the structure of the implementation process and the nature of the planning process influence the effectiveness of the deployment of new technology. Both the assessment and planning factors were shown to be correlated with each of the criterion factors. The practical implication of this finding is that it informs managers that engaging in specific assessment and planning processes of new technology *prior* to its deployment may lead to better technological outcomes. Managers oftentimes approach performance issues within their company through the use of technology. The data from this study strongly alludes to the idea that the “manner” in which new technologies are deployed have a high if not equal degree of saliency than the new technology itself. Particular attention should be focused on the relationship between employee’s perceptions of the assessment/planning process and the unanticipated outcomes variable. Unanticipated technological outcomes are very commonplace in most organizations. They also carry a heavy financial and performance cost. To the extent that these perceptions of employees can be translated into valid unanticipated outcomes, the results of this study suggest the following things to management regarding how unanticipated outcomes of new technologies can be reduced:

1. Develop an assessment plan that analyzes such things as the technology’s impact on employee training, work processes, and job responsibilities.
2. Develop a technology management strategy that includes not only the technical and financial aspects of the new technology, but also a robust planning process that examines such things as the clarity of the implementation plan, and the extent to which management has a clear understanding of the objectives of the new technology.
3. Make use of cross-functional teams in developing and implementing the technology strategy.

4. Conduct a comprehensive study of the climate of the organization.

These suggested steps should be conducted prior to the deployment of new technologies.

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Appendix A

Questioning Authority

1. ___ Criticism of policies and practices are encouraged.
2. ___ When people disagree with a decision, they work to get it changed.
3. ___ People here are not likely to accept managerial ineptitude without complaint or protest.
4. ___ When people dislike policy they let it be known in no uncertain terms.
5. ___ People avoid direct clashes with senior personnel at all costs. (R)
6. ___ Many people will not hesitate to give strong support to a project that senior management is opposed to.
7. ___ People who get pushed around here are expected to fight back.
8. ___ People delight in challenging official policies.

Open Mindedness

1. ___ Errors and failures are talked about freely so that others may learn from them.
2. ___ No one needs to be afraid of expressing extreme or unpopular viewpoints here.
3. ___ The expression of strong personal belief is pretty rare here. (R)
4. ___ One of the values most stressed here is open-mindedness.
5. ___ People here tend to be cautious and restrained. (R)
6. ___ People here speak out openly.
7. ___ Criticism is taken as a personal affront in this organization. (R)
8. ___ People here feel free to express themselves impulsively

Innovation

1. ___ Policy changes occur slowly here and only after considerable deliberation.
2. ___ Quick decisions and actions are not characteristic of this place. (R)
3. ___ Thinking of alternative ways in which problems might be solved or things done differently is encouraged here.
4. ___ New ideas are always being tried out here.
5. ___ The latest scientific discoveries make a few changes in the way this place is run.
6. ___ Unusual or exciting plans are encouraged here.
7. ___ There are conventional ways of doing things here which are rarely changed. (R)
8. ___ Programmes here are quickly changed to meet new conditions.

Administrative Efficiency

1. ___ Work is well organized and progresses systematically from week to week.
 2. ___ Most activities here are planned carefully.
 3. ___ People get sufficient notice of policy decisions to be able to plan their own work accordingly.
 4. ___ Work is checked to see if it is done properly and on time.
 5. ___ The flow of information downward is smooth and efficient.
 6. ___ There is no wasted time here; everything has been planned right to the minute.
 7. ___ There is a specific place for everything and everyone here.
 8. ___ The quality of work is rated or evaluated frequently.
- (R) Denotes that score was reversed.