8-16-1996

Management Strategies for Operating Critical Transaction Processing Systems

D. Harrison McKnight
Carlson School of Management, University of Minnesota, hmcknight@csom.umn.edu

Management Strategies for Operating Critical Transaction Processing Systems

D. Harrison McKnight (hmcknight@csom.umn.edu)
University of Minnesota--Carlson School of Management
395 HHH, 271-19th Avenue South, Minneapolis, MN 55455

Introduction

What happens when a major on-line computer system goes down? Some transaction processing systems (TPS) simultaneously service tens of thousands of dependent users. "A transaction processing system is a computerized system that performs and records the daily routine transactions necessary to conduct the business...In the business environment of the 1990s, TPS failure for a few hours can spell the demise of a firm and perhaps other firms linked to it." (Laudon and Laudon, 1995: 37)

This research addresses the question, "What strategies do managers employ to operate critical transaction processing systems (TPS) at high levels of reliability?" Systems managers try to keep these systems operating at levels of reliability well above 99%. How do they do it? The study develops models about the effects of two specific strategies. A strategy is a means towards a goal.

To our knowledge, no research has been done on this question, in spite of an early warning that system reliability is important (Lucas, 1975). In fact, few have studied the more general topic of system operations (Ives, Hamilton and Davis, 1980). Lyytinen and Hirschheim's (1987) topical review of "information system failures," however, briefly discusses operational reliability. Furthermore, information Systems (IS) textbooks are beginning to discuss reliability issues (e.g., Laudon and Laudon, 1995).

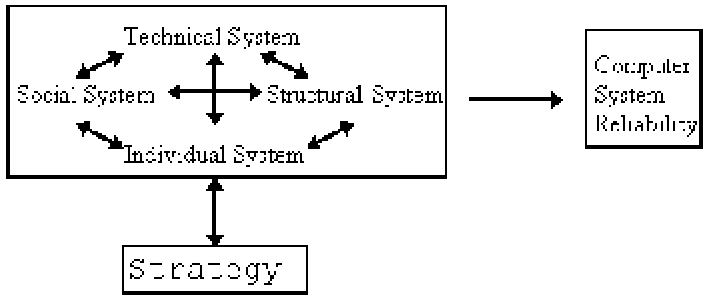
To initiate research on this topic, we focused on the strategic level. We hope to benefit IS managers through strategic-level research. We describe complex issues surrounding two strategies (implementation testing controls and "lights dim") that an IS organization uses to manage its highly critical TPS. Paradoxically, the two strategies designed to improve TPS reliability also hold significant potential to decrease reliability. We chose to study one large, critical TPS at XYZCo, an organization in the travel/hospitality industry. XYZCo operates its TPS at over 99.8% reliability.

Research Framework

Lyytinen and Hirschheim (1987) recommended that system failures should be researched via a systems approach. This approach assumes that failure causes are complex and interactive. Others agree, both in IS research (Lucas, 1975) and in the industrial danger reference discipline (Hale and Glendon, 1987).

Figure 1 displays our research framework. This framework's large box synthesizes the frameworks of Bostrom and Heinen (1977) and Orlikowski (1992). The framework's research approach allows us to understand the interactive effects of management strategies upon these systems. As described below, strategies affect reliability through the interactive super-system constituted by these four systems. These systems also impact strategies. The Individual System focuses on the perceptions, traits, knowledge, and capabilities of people. The Technical System encompasses the computer system, its physical environment, and operator tools. The Structural System refers to the formal aspects of organization (e.g., official positions and roles, procedures, and official measurement/incentive systems). The Social System involves the informal interaction roles and relationships that exist among workers.

Figure 1 Research Framework



Methodology

This research is part of a larger grounded theory research study examining what contributes to TPS reliability. Since it builds and tests theoretical models directly from qualitative data, grounded theory is best suited for studying new or complicated phenomena (as in our case). Our data so far consist of taped interviews of twenty managers and technicians who operate XYZCo's TPS. We analyzed the data through grounded theory's open- and axial coding methods (Strauss and Corbin, 1990), in order to induce and relate theoretical concepts. We iterated between data gathering, analysis and model building. To assure reliability and construct validity, we: a) used the constant comparative method to be sure each data item properly supports a unique concept or relationship between concepts (cf. Orlikowski, 1993); b) documented, through cross-referencing software, how each segment of data is transformed into conceptual form; c) retraced the linkages between data and corresponding concepts and relationship; d) searched the data again to try to find counter-evidence to our models.

Current Status

A portion of the twenty interviews have been analyzed. Findings reported here are primarily descriptive. These descriptions contribute by identifying two difficult systems operations issues that merit further research. From the open and axial coding, we are developing a detailed theoretical model of what leads to TPS reliability at XYZCo.

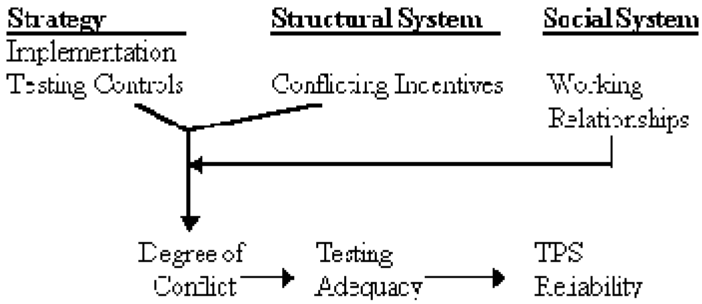
Findings to Date

I. Implementation Testing Controls and Change

Management employs a strategy of protecting the TPS against application complexity. XYZCo's TPS consists of about 35,000 interacting segments of real time application code. New code enters the system weekly, and over 30,000 segments are changed each year. Thompson (1967) predicted that the Structural System will deal with complexity and uncertainty by protecting the Technical system from environmental threats. We found that management has placed tight implementation controls around the TPS. Before a new or modified application goes on-line, it must pass a series of rigorous tests and must gain applications manager approvals.

However, these controls and a recent change in the Structural System produce potentially system-harmful conflict. In 1993, management structurally separated the operations function from the applications function. The two organizations now have different incentive systems (Figure 2). While the operations group is strongly incented to keep system reliability high, the applications group is incented to move code into production quickly. Contrary to what one might expect, however, this has only produced minor conflicts between the two groups. Since individuals from the two groups have worked together for many years, cooperation is still the norm. Hence, the Social System moderates the conflict produced by the Structural System. However, if this buffer's strength decreases, incentive-driven conflict may lead to the implementation of application segments that are not fully tested. This would decrease TPS reliability (Figure 2). So paradoxically, the combination of the incentive system change and the system protection strategy may produce results contrary to management objectives.

Figure 2 Structural System Impacts on Reliability



II. Towards "lights dim:" A Balancing Act

Management has adopted a strategy to move toward a "lights dim" environment, which means almost total automation of on-site operator functions. Management's motivation is two-fold: a) greater TPS reliability, by preventing the twenty-five or thirty operator errors still made each year; b) reduced costs through fewer personnel. Of "those things that have caused the availability to miss...100%, at least fifty percent of the time, you're going to find a human." A number of automation efforts have already yielded good results at XYZco. Management has formed a task force to design additional steps towards "lights dim."

As discussed below, going to "lights dim" is not merely a Technical System exercise. Management must grapple with three Individual System issues: complacency, incomprehensibility, and demotivation. To effectively pursue lights dim, management must balance people issues with technology issues.

A. Complacency

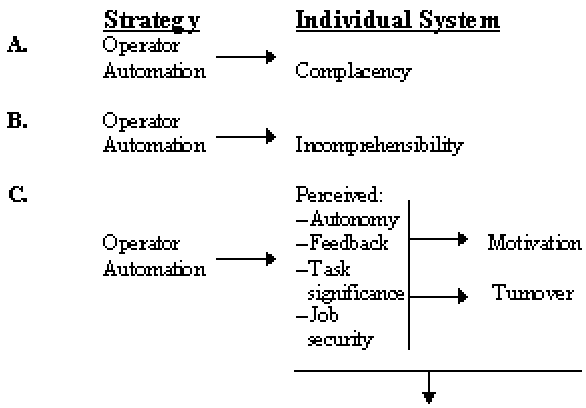
We found that operators need to be alert (attentive) to early warning signals in order to quickly solve system problems. Automation of operator functions may negatively affect alertness (Figure 3-A). Through case studies, Lee (1991) found that industrial operators can become complacent as their function becomes more computerized. Complacency means operators come to rely almost completely on automation. Hence, they become less alert to problem signals. When operations automation goes wrong, the operator may doubt there is a problem (Lee, 1991), and thus may react too slowly, extending the outage.

B. Incomprehensibility

(Lyytinen and Hirschheim, 1987)

Currently, the system is complex enough that no one person understands all of its inner workings. When asked who was responsible for solving one major outage, respondents could only identify the team, not the individual. Automation of operations adds another layer of system incomprehensibility (Figure 3-B). The term system comprehensibility means the extent to which it is possible to understand how a system works. Zuboff (1984), Perrow (1984) and Lee (1991) found that when systems run systems, the added complexity increases incomprehensibility. Hence, their diagnoses and system interventions are as likely to make things worse as to fix the problem (Perrow, 1984).

Figure 3



TPS Reliability

C. Demotivation

Currently, the organization relies heavily on its people (a) to guard the system from problems, and (b) to fix the system quickly when it fails. Operations people pride themselves on their ability to diagnose failures and bring the complicated system back on-line in very few minutes. One manager said, "Pride is what's got [us] where [we] are, and pride is what's going to continue to get [us] the goals [we] have established." Operators enjoy their jobs, and feel excited by the challenge of keeping the system running. However, the "lights dim" strategy may alter operator motivation (Figure 3-C). First, decreased human intervention and control tends to decrease the autonomy, feedback and task significance that lead to motivational work outcomes (Hackman and Oldham, 1980). Second, as one XYZCo manager pointed out, the possibility of losing one's job to a machine is a very demotivating prospect (Lyytinen and Hirschheim, 1987).

These three potential negative effects must be considered within the context of how the system is kept running today. When asked who is essential to keeping the system running, respondents answered with long lists of people and functions. Diagnosing and fixing the system requires a large virtual network of specialists. The specific system problem determines whose expertise is required. A wide variety of problems arise--seemingly at random, making it difficult to remove a specialist from an operator's list of those to call when the system encounters problems.

This means that management is completely dependent on the cooperation of numerous expert employees to keep the system running. Realizing this, a manager responded to the question of how do you keep the TPS running: "First, there's lots of teamwork." In the past, employees have taken significant pride in their jobs and in the organization. However, the "lights dim" strategy could lower morale and cause turnover in key positions. Such Individual System outcomes may reduce TPS reliability--the opposite of what management's "lights dim" strategy intends.

Contribution/Future Research Directions

This study reports an interesting paradox: two strategies management employs to increase system reliability may have the unintended effect of reducing reliability. Management must carefully manage the related people issues to avoid these pitfalls. The completion of this study will yield a set of models that explain key issues and processes related to TPS reliability.

Selected References

Ives, B., Hamilton, S. and Davis, G. B. "A Framework for Research in Computer-Based Management Information Systems." Management Science, 1980, Volume 26, Number 9, pp. 910-934.

Lee, L. The Day the Phones Stopped. New York: Donald I. Fine, 1991.

Lucas, H. C. Why Information Systems Fail. New York: Columbia University Press, 1975.

Lyytinen, K. and Hirschheim, R. "Information Systems Failures--A Survey and Classification of the Empirical Literature." Oxford Surveys in Information Technology, Oxford University Press, 1987, Volume 4, pp. 257-309.

Orlikowski, W. J. "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development." MIS Quarterly, 1993, Volume 17, pp. 309-340.

Strauss, A. and Corbin, J. Basics of Qualitative Research. Newbury Park, CA: Sage, 1990.