Expert Systems Implementation and Impacts: A Managerial Perspective

CRAIG K. TYRAN
WASHINGTON STATE UNIVERSITY

AND

JOEY F. GEORGE
FLORIDA STATE UNIVERSITY

ABSTRACT

This paper introduces several issues pertinent to the implementation and impacts of expert systems (ES) and presents the results of a descriptive mail survey study which investigated managerial perceptions related to these issues. The survey findings are based on responses associated with 45 successful ES implementations. Most of the ES represented in the study were medium-sized ES running on a personal computer or workstation. With respect to ES implementation issues, the results of this study generally support the claims made by authors of ES case studies. As several of the issues considered to be important by the respondents had a strong user orientation, and it may behoove ES implementors to actively integrate the user in the ES implementation process. The study also provides insight into the social and operational impacts of ES. Based on this study, ES was perceived to have a beneficial impact on job content and user job satisfaction. Generally, there was no change in employment levels associated with ES implementation. With respect to operational impacts, the value-added benefits of ES (e.g., improvements in consistency and quality) were rated more highly than the productivity-related impacts (e.g., time needed to perform a task).

INTRODUCTION

Expert systems (ES) technology has started to make its long-awaited migration from the research laboratory to the work place, as evidenced by reports of successful implementations [3,6,10,11,14,18,22] and the upward trends in ES utilization [13]. As ES are introduced into the work environment, end-user management will be confronted with the challenge of implementing the new technology and dealing with its impacts. In order to exploit the benefits of ES — and avoid its pitfalls — end-user managers will need to learn more about the managerial implications of ES.

To date, much of the literature on ES has focussed on technical theory and the task of building an ES. Relatively little attention has been paid to managerial issues such as implementation and the organizational impacts of the technology. Most of the articles and books that explicitly address aspects related to the management of ES are based on case studies of commercial ES [3,5,6,10,14,23,29]. These accounts have provided valuable information regarding the real-world application of ES technology, yet are rather limited in generalizability as they are typically based on single organizations. To determine whether the findings from the case studies can be generalized to broader contexts, a study involving a larger sample of ES implementations is needed.

The objective of this article is to introduce several issues pertinent to the management of ES and to present the results of a descriptive study which investigated managerial perceptions related to these issues. The study was undertaken to extend the line of research on the managerial aspects of ES technology and entailed a cross-sectional mail survey of end-user managers. The findings from the study are descriptive in nature and focus on responses associated with 45 successful ES implementations. Successful implementations are emphasized since our aim is to learn from the experiences of those managers who have demonstrated an ability to effectively introduce an ES into the work place and who are familiar with the organizational consequences of utilizing ES technology.

The article has five major sections. In the first two sections, we review a number of issues identified in the

literature which are relevant to the implementation and organizational impacts of ES. In the third section we briefly describe the survey and the respondents. Fourth, we present the results of the survey and discuss the potential implications for the management of ES. We conclude with a summary section.

IMPLEMENTATION ISSUES

Implementation is the process of developing and introducing a system into the working environment of an organization. As defined here, implementation is viewed as a long-term process that encompasses a wide range of activity: it starts with the first notion of the ES and is not over until the ES is successfully institutionalized or the ES project is abandoned in failure [20]. In many cases, ES implementation is problematic: it has been estimated that only 10% of medium and large ES implementations are successful [16].

To facilitate the introduction of ES technology, managers can benefit from an implementation strategy that takes into account factors that may influence implementation success [9,20]. Several factors that may be relevant to ES implementation have been identified through the ES literature, as well as research involving conventional management information systems (e.g., management information systems (MIS) and decision support systems (DSS)). Based on a review and synthesis of existing literature, this study focussed on the following implementation factors: 1) assessment of user needs; 2) organizational climate; 3) personnel considerations; 4) educational activities; and 5) technical expertise.

Assessment of User Needs

The acceptance of an innovation often hinges on the extent to which the innovation meets a felt need [27]. The assessment of user needs has been empirically identified as a key implementation factor for MIS [12] and DSS [21,26]. Needs assessment is typically performed by the system development staff. Close interaction between systems personnel and the user group is required to formulate a comprehensive understanding of the specific user needs and the problem domain. This is not a trivial activity, since it demands personnel who have strong interpersonal skills, as well as a basic understanding of system and business operations. Needs assessment does not end with the early stages of system development; rather, this task needs to be redone periodically to ensure that the system continues to meet the changing needs of the users.

Organizational Climate

Studies examining the implementation of conventional MIS suggest that successful implementation is associated with an organizational climate that accommodates and supports innovation [12,31]. One way to establish a favorable organizational climate for the implementation of a new innovation is to enlist the support of top management [15]. Top management support is defined as managerial behavior which promotes the implementation of an innovation. Champions from the higher levels of management may influence system implementation success by providing the resources necessary for development (e.g., funds for equipment and labor) and by advocating the adoption of the system [1]. Recently, several authors have indicated that top management support may be a contributor to ES implementation success [6,10,16,17,23].

Personnel Considerations

High-level managers are not the only individuals that may have an impact on ES implementation success. Other key players in the implementation process may include the human expert, the users, and the ES "sponsor."

The Expert: At least one human expert is required to provide the knowledge that will be coded into an ES. Important qualities for the expert include a thorough knowledge about the application domain, ability to articulate expert reasoning, accessibility, and commitment to the ES project [3,5]. The commitment of the expert has been singled out by several authors as an especially vital quality, since the development of an ES requires much input and patience on the part of the human expert [5,6,8,10,14,16].

The Users: Since a new system has the potential to change a user's work life, the users are key stakeholders in the implementation process. If system users do not have a positive attitude toward a new system, then they are not likely to accept the system and the implementation will fail. User participation (i.e., the inclusion of the user in the system development process) has been suggested as a tactic that may increase the chances for user acceptance of a system [20]. ES case studies indicate that user participation can promote the acceptance of an ES through increased user ownership and through the development of a system that better addresses the needs of the users [10,14,16].

ES Sponsor: An ES "sponsor" is defined to be an individual from the end-user organization who serves as a committed system advocate and acts to stimulate interest and support for the ES project. The sponsor may come from the staff ranks (e.g., an expert or user) or may be a manager. As described in ES case studies, the sponsor role is not generally assigned, but rather is naturally assumed by one or more persons who have a personal interest and commitment to an ES project [6,10,23]. Case studies of successful ES projects report that ES implementation may be nurtured through the efforts of an ES sponsor within the end-user work group [3,6,8,10].

Educational Activities

Educational activities deal with the task of educating the

organizational community about the new system and include such activities as demonstration of the system features and capabilities, user training, and general orientation of system concepts. These activities may be appropriate for both user and management personnel [10]. The purpose of these activities is to promote system acceptance and usage by helping the user and management personnel in the end-user work group become familiar and comfortable with the system before deployment [7,28]. Educational activities may be especially important for ES since the technology is relatively new and personnel may harbor fears or unrealistic expectations regarding the impacts of the technology [4,10]

ES Technical Expertise

ES technical expertise refers to technically oriented activities such as knowledge acquisition and representation, system construction, and system testing. Technical competence is generally considered to be a prerequisite for implementation success [4,7]. In the event that ES success hinges on technical expertise, it will be necessary for ES implementors to focus on the attainment of technical proficiency as one of their top priorities (either internally developed or acquired from an external consultant).

ORGANIZATIONAL IMPACTS

As discussed above, there are a number of factors that an end-user manager may need to consider to successfully steward the process of ES implementation. In addition to these factors, a manager also needs to gain an appreciation for the impacts of ES on the organization. While most ES are introduced with the expectation that the system will have a positive impact on operations (e.g., productivity), it is possible that the ES may also have undesirable effects on the work environment (e.g., the ES may make jobs more routine and less intellectually stimulating). By becoming familiar with the different types of ES impacts, the implementor may be better prepared to anticipate and evaluate the consequences of ES implementation. In this section we discuss the operational and social impacts of ES.

Operational Impacts

Operational impacts are defined to be the effects which are directly associated with the business operations (e.g., quality, cost). The operational impacts of ES can be broken into two categories: "value-added" impacts and productivity impacts. The value-added impacts include quality of work, consistency of work, relationships with customers and development of user job skills. These types of impacts can be subjective in nature and can often be hard to measure and quantify. Productivity impacts refer to the more tangible effects that can be quantified, such as the cost and time needed to perform a task.

Social Impacts

Social impacts are defined to be those effects that a system has on individuals and the organization. Since most implementors of ES place a high priority on realizing benefits to their operations, they may not recognize that the adoption of ES can also have social repercussions. For instance, an ES may change the quality of work life for those who use the system or it may have an impact on employment. Managers need to be sympathetic to the social impacts of ES and provide input to ES development so that the technology may be designed in a way that will be socially beneficial and acceptable [24,29]. Three socially-oriented aspects of the work place that may be affected by ES are user job content, user job satisfaction, and employment.

Job Content of the User: Researchers disagree about the effects of information technology on the user's job content [2]. Some investigators claim that automation eliminates the intellectual challenge of a job and makes work more routine. However, other researchers contend that information technology can have a positive effect on job content by absorbing the routine aspects of the job and allowing workers to focus on the more enriching elements of their work tasks. With regard to ES, there is anecdotal evidence that suggests that the impact of ES on job content can be either beneficial or negative, depending on the application context [29].

User Job Satisfaction: Job satisfaction refers to the degree to which employees have a positive affective orientation toward employment by the organization [19]. Specific facets of work life which may impact job satisfaction include job content, relationships with co-workers, and autonomy. Since an ES has the potential to modify these aspects of the job [21,29], overall job satisfaction for the ES user may be affected.

Employment: ES technology may impact employment as a consequence of productivity improvements [25]. However, the nature of the impact of ES on employment is not yet known. While some speculate that ES could reduce employment [4,30], it is also possible that new jobs will be created by the advent of ES. The latter scenario was reported in one case study that found that the net effect of ES deployment on staffing levels was an increase in jobs, as new technical ES staff positions more than offset the drop in employment within the user group [29].

DESCRIPTION OF THE STUDY AND THE RESPONDENTS

Study Method

A mail survey was conducted to gain a managerial perspective on issues relating to the implementation and impacts of ES technology. The survey was aimed at individuals who were responsible for the supervision of a work group using an operational ES (i.e., not a prototype). Potential respondents for the survey were identified by contacting organizations that were known to have experience with using ES in the work place. The prospective respondents were then contacted personally by phone to solicit their participation in the study and to confirm that their work group was using ES technology. (For the purposes of this study, an ES was defined to be "a computer program that mimics the behavior of an human expert." Other types of systems, such as conventional DSS did not qualify as an ES.) Survey questionnaires were sent to 70 managers from 50 different organizations across the United States during the winter of 1990. Each potential survey respondent represented a distinct ES implementation and a distinct organizational site.

Respondents

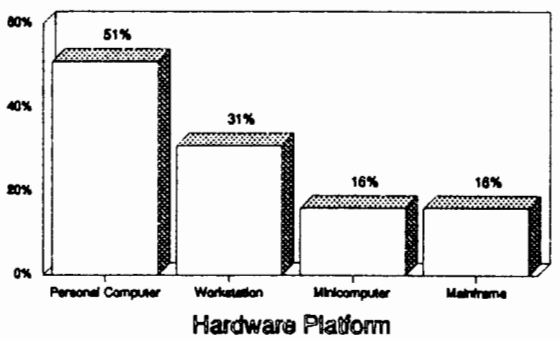
The overall survey response rate was 79%. The response rate was relatively high and is attributed to three factors: 1) the personal contact that had been made with the prospective respondents over the telephone prior to the mailing of the questionnaires, 2) the respondents' interest in the study (which was expressed over the telephone), and 3) a questionnaire process that minimized the inconvenience for the respondents (e.g., the questionnaire was easy to read and follow, a self-addressed stamped return envelope was included with each questionnaire).

The survey findings discussed here are based on the responses from those managers (N=45) who indicated that their ES was a success (i.e., they reported that their ES was a "good" or "very good" business investment). These survey responses represented 45 implementations from 31 different organizations. A large majority of the respondents were managers from Fortune 500 firms or large government agencies. The typical respondent was a manager with an average of 14 years of work experience. Over half of the respondents directly supervised work groups of at least 15 people. The respondents were generally well acquainted with the ES that served as the focus of their questionnaire responses, as 87% of them had been associated with the ES for two years or more in the role of manager. Most respondents also had hands-on experience with their ES: 68% of them reported that they used the ES frequently or occasionally.

ES Implementations

Most of the ES represented in the survey were characterized as "medium-sized" [10] (i.e., a rule base of 200 to 3000 rules). As indicated in Figure 1, most ES ran on a personal computer (51%) or a workstation (31%). Minicomputers (16%) and mainframe computers (16%) were also used as hardware platforms. (In some cases an ES operated on more than one type of hardware platform.) Almost two-thirds (64%) of the respondents reported that an ES shell (e.g., ESE, Level5, Personal Consultant) was used to develop their ES.

Figure 1
ES Hardware Platforms



Note: Some respondents reported multiple ES platforms. N=45 respondents.

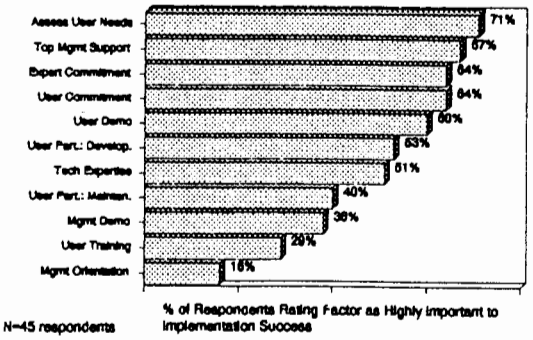
The typical ES had been in use for one to three years. The types of generic tasks supported by the ES represented in the study included: diagnosis (e.g., equipment diagnosis and repair), planning (e.g., manufacturing work instructions), configuration (e.g., computer order configuration), and selection (e.g., selection of an appropriate tax planning strategy). The ES typically were used to support users at the operational level of an organization, rather than the executive level. For example, the ES represented in the study were used to support personnel such as equipment repairmen, manufacturing plant operators, computer salespeople, and accountants. Virtually all of the ES were used by multiple users, with a majority (52%) of the ES being used by more than five people in the immediate work group. Most of the ES (59%) were also being used by other work groups in the organization.

RESULTS AND DISCUSSION

Managers in the survey assessed the importance of a number of specific implementation factors on a discrete five-point scale ranging from 1 ("low" importance) to 5 ("high"

importance). A rating of "high" importance was interpreted to mean that the respondent considered the factor to be particularly vital to ES success. Ratings below "high" importance were interpreted to mean that the respondent considered the factor to be a relatively less critical success factor. As illustrated in Figure 2, the study generally confirmed the importance of the factors identified earlier. The survey results are discussed below along with implications for managerial practice.

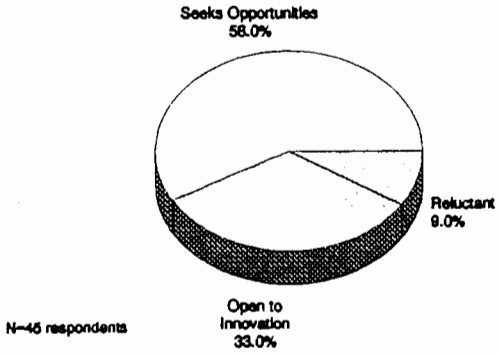
Figure 2
Perceptions of Implementation Factors



Assessment of User Needs: As indicated in Figure 2, this factor was ranked highest in our survey, as 71% of the managers regarded it to be of high importance. This finding indicates that needs assessment is a task of high priority that demands the support of end-user management. Although the activities associated with this task may cause slight disruptions within the end-user work group (e.g., interviews with workers to elicit needs will take people away from their work), it is important for the end-user manager to encourage and support such efforts to help promote the development and maintenance of a successful ES.

Organizational Climate: The ES represented in the study were typically implemented within organizations that were considered to be receptive toward innovation: 58% of the managers felt that their organization "aggressively seeks opportunities to innovate" and 33% were considered to be "open to new innovation opportunities." Only 9% of the sample thought that their organizations were "reluctant to innovate" (see Figure 3). With regard to top management support — a factor which may influence the organizational climate for system implementation — two-thirds (67%) of the respondents in our study reported that it was of high importance to the implementation effort. It thus appears that end-user managers interested in undertaking an ES project should make strong efforts to enlist and nurture the backing of upper management. One way to generate top management interest and support for an ES project may be to educate management about ES through a demonstration of a simple ES prototype [10].

Figure 3
Perceptions of Organizational Climate: Receptivity to Innovation



Personnel Considerations: The survey findings confirm the importance of personnel considerations (i.e., the expert, the users, and the ES sponsor) to the management of ES implementation.

The Expert: Most of the managers in the survey (64%) considered the expert's commitment to the ES project to be highly important to ES success. To encourage expert commitment for an ES project, a pro-active approach may be required. For example, experts should be recognized and compensated for their contributions to the ES project. To ensure that the expert has enough time to devote to the ES project, managers may need to adjust the expert's workload during ES development. In some cases, an expert may resist participation in an ES project due to a reluctance to share expertise or a fear of being replaced by a machine [10]. Managers need to be prepared for this type of behavior and make efforts to address the concerns that experts may have.

The Users: Sixty-four percent of the respondents considered user commitment to be highly important to ES success. One way to promote a favorable user attitude toward the system may be through user participation in ES development and maintenance. Fifty-three percent of the managers indicated that they considered user participation during development to be critical. User participation during ES maintenance was not considered to be as critical to the implementation process, as only 40% of the managers rated this factor

to be highly important. One reason that participation during ES maintenance is rated lower may be that user input during the formative stages of ES development has a greater impact on determining the ES characteristics and hence has a greater influence onimplementation success. Also, for the work groups studied, the ES may not be mature enough to require substantial maintenance, making this activity seem less important than the development phase. Although the survey data suggest that user participation during development is more important than during maintenance, it is apparent that many of the managers surveyed consider user input to be a vital consideration throughout the entire life cycle of the ES.

ES sponsor: A large majority (82%) of the respondents reported that there was at least one individual in their work group who "served as a strong advocate or sponsor of the ES and thereby played a key role in its development." Since an ES sponsor often appears to be associated with successful implementations, managers may wish to actively support the efforts of those who assume the role of sponsor within their work group. In some situations, the end-user manager may serve as the ES sponsor [10]. However, to gain a broader base of support for the ES, it may behoove end-user managers to consciously seek out and encourage other individuals who are willing to fill this important organizational role.

Educational Activities: Managers evaluated the importance of four educational activities to ES success: demonstration of ES to users, demonstration of ES to management, user training, and orientation for management. Demonstration of the ES to the user community was rated as the most important educational activity, with 60% of the respondents considering this task to be critical to success. This was the only one of the four educational activities regarded as vital by a majority of the respondents. Given the relatively small expense associated with preparing an ES demonstration and its perceived importance, an ES demonstration may be a cost effective way to promote ES implementation success. The other educational activities included in the survey were rated as follows: demonstration of the ES to management (considered highly important by 38% of the respondents); ES training for users (29%); and general ES orientation for managers (16%). It was surprising to find that user training was not typically considered to be a critical activity. One explanation for this finding may be that the ES represented in the survey were generally easy to use, making training a less important issue. The relatively low ratings for ES demonstration and orientation for management personnel suggests that demonstration activities directed at users should take priority over those aimed at managers.

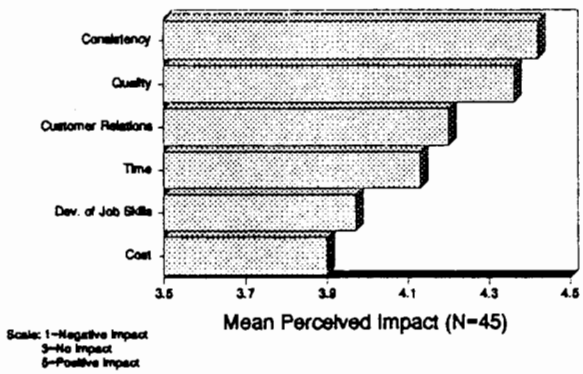
ES Technical Expertise: A slight majority (51%) of the managers considered ES technical expertise to be highly important. While this finding indicates that organizations wishing to implement ES should be technically competent, the fact that almost half of the sample failed to rate technical expertise as a critical factor suggests that expertise with ES may not always be a vital prerequisite for success. The experiences of the respondents supports this notion: a sizable portion (44%) of the respondents reported that their organizations had not had any experience with ES technology prior to the successful introduction of the ES in their work groups. This finding should offer encouragement to managers who have been reluctant to pursue the development of ES due to a relative unfamiliarity with the technology. However, we note that the importance of technical expertise is likely to depend on the complexity of the ES being developed. These survey results reflect perceptions relating to medium-sized ES implementations which were typically developed using an ES shell using a personal computer or workstation. Also, as the respondents were end-user managers, they may have had a relatively low appreciation for the technical aspects of ES and thus discounted the importance of technical expertise.

Organizational Impacts

Operational Impacts: Managers were asked to rate six aspects of their operations that had been impacted by their ES using a scale of 1 ("negative" impact) to 5 ("positive" impact), with a score of 3 corresponding to "no impact." Figure 4 summarizes the findings. On an aggregate level, the ES were found to have a favorable impact on all of the listed aspects of operations. According to the respondents, ES technology had the most positive impact with respect to: consistency of work output, quality of work output, and relationships with customers. Each of these top three ranked impacts of ES technology reflect the value-added aspects of operations. The productivity-related impacts of ES — time and cost — were ranked lower (fourth and sixth, respectively).

Although the aggregated findings indicate that the ES

Figure 4
Perceptions of ES Operational Impacts



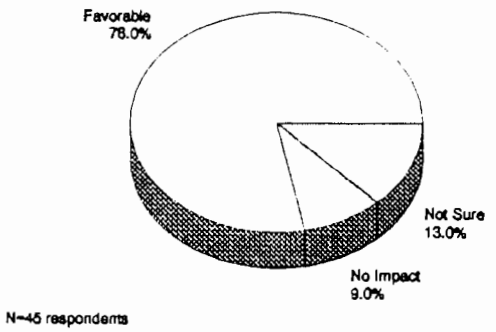
were perceived to have a positive impact with respect to all operational impact items, a review of the individual survey responses shows that a few of the 45 managers in the study reported some type of negative impact due to ES. Aspects of operations for which managers reported negative impacts (i.e., a score of "1" or "2") included: time needed to perform task (14% of managers reported a negative impact), cost of performing task (12%), and development of user job skills 7%). There were no reports of negative impacts with regard to the value-added benefits of quality, consistency, or relationships with customers. Thus, even though all of the ES represented in this article were rated as successful by the managers, one out of seven managers felt that their ES had a negative impact on task time, and one out of eight felt that the ES had a negative impact on cost. A review of individual questionnaires suggests that for these cases, any negative productivity-related operational impacts were offset by the strong value-added gains of improved quality and consistency.

The relative importance of ES operational impacts will depend on the particular application task. However, the relatively high ranking of the value-added impacts in this study highlights the positive effects that ES can have on the intangible aspects of operations. Hence, when planning for and evaluating ES implementations, managers need to look beyond the "bottom-line" and take into account a number of ES operational benefits that may be difficult to measure and quantify.

Social Impacts: The impact of ES on user job content and satisfaction was assessed by the respondents. Although this assessment was subjective, we believe that the respondents provided an accurate appraisal of user impacts as most (68%) of them had gained a user's perspective through their personal use of their work group's ES. Also, since ES users were directly supervised by the respondents, we expect that the respondents had a good sense of user impacts based on observations and feedback from subordinates.

Job Content of the User: The survey offers support for the notion that ES technology can enhance the intellectual content of the ES user's job (see Figure 5). A large majority of the managers (78%) believed that "the ES has allowed the user to concentrate on the more intellectually challenging aspects of the job, since the ES frees the user from performing routine tasks." Nine percent of the sample group reported no impact, while 13% were "not sure" of the impact. None of the respondents felt that the ES had reduced the intellectual challenge of the user's job. One explanation for the positive impact of ES technology on job content is that most of the ES represented in this study were explicitly developed to support users rather than to strip their jobs of the conceptual components: 60% were designed as "a tool for workers needing access to expert knowledge" and 29% were designed

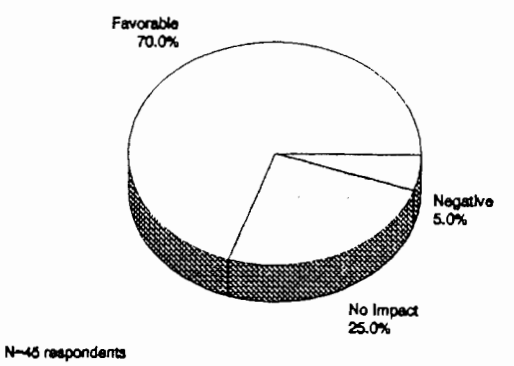
Figure 5
Perceptions of ES Imopact on User Job Content



to be "an expert's assistant tool that was built and used by a human expert to help automate the expert's routine task."

User Job Satisfaction: Seventy percent of the respondents perceived that the ES had resulted in a "positive" or "somewhat positive" impact on the job satisfaction of the users. Twenty-five percent felt that there had been no impact on satisfaction, while 5% thought that their ES had made a negative impact (see Figure 6). When coupled with the results related to job content, these findings indicate that ES technology can have favorable social impacts on users.

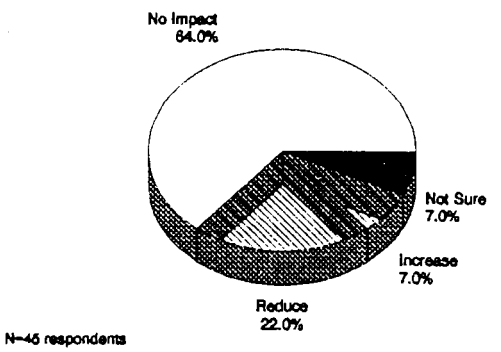
Figure 6
Perceptions of ES Impact on User Job Satisfaction



Employment: With respect to those jobs that could be supported by the ES, the ES represented in the study appeared to have little effect on employment for a majority of the work groups surveyed (see Figure 7). In 64% of the

cases, the ES had no impact on the number of jobs. Employment was reduced in 22% of the work groups, while 7% reported an employment increase (7% were "not sure"). We attribute the overall lack of significant impact of ES on employment to the fact that only one of the ES represented in the survey was designed as a "replacement for the worker." Also, our earlier finding that ES have value-added benefits raises the possibility that many of the work groups are utilizing ES to work more effectively while maintaining the same level of employment, rather than to decrease employment through improved productivity.

Figure 7
ES Impact on Employment



CONCLUSIONS

This study builds on the existing body of empirical work relating to ES management by extending the findings from case studies to a wider variety of ES applications and organizational settings. The perceptions and experiences of end-user managers formed the basis for the study. Based on the empirical findings, implications regarding ES management practices were suggested.

With respect to ES implementation issues, the results of this survey study generally support the claims made by the authors of the ES case studies. It is of interest to note that several of the implementation issues considered to be particularly important by the survey respondents had a strong user orientation: assessment of user needs, user commitment, ES demonstration to users, and user participation in ES development. Based on these findings, ES implementors may be wise to actively integrate the user into the ES implementation process. Other organizational members who appear to play a critical role in the implementation process are top management, the expert, and the ES sponsor.

The survey of implementation issues did produce two unexpected results. First, ES user training and management educational activities were not generally considered to be critical. This finding was surprising since these activities are typically cited as an important component of the system implementation process [7,10,28]. The second unexpected finding was the relatively low rating for ES technical expertise. As noted earlier, this result may indicate that established technical competence is not always necessary for developing successful ES projects of the type generally represented in the survey (i.e., medium-sized ES developed on a personal computer or workstation platform).

The study also provides insight into an area which has not received much attention from empirical researchers: the impacts of ES. The findings related to the social impacts of ES were especially interesting. Although some authors have suggested that ES may have an unfavorable impact on the social aspects of the work place [24,29,30], the results of this study indicate otherwise. In a majority of the cases, the ES was perceived to have a beneficial impact on job content and user job satisfaction. Generally there was no change in employment levels associated with ES implementation.

The investigation into operational impacts also yielded some interesting results. While ES were considered to have a positive effect on a variety of operational aspects, the value-added benefits of ES (e.g., improvements in consistency and quality) were rated more highly than the productivity-related impacts (e.g., time needed to perform task). In some cases, the value-added benefits of ES appeared to compensate for perceived negative impacts related to productivity. These results underscore the relative importance of ES operational impacts which are intangible in nature.

The descriptive study reported in this article has provided insight into the management of ES. However, there are limitations to a study of this type. For example, the emphasis on successful ES implementations makes it difficult to isolate the determinants for ES implementation success. Also, the survey methodology does not allow for an evaluation of the dynamics of the implementation process. Additionally, the study generally focussed on medium-sized ES used at the operational level of an organization. The findings from this study may or may not generalize to different types of ES projects. Although there is much to learn about the management of ES, we expect that there will be more opportunities for researchers to explore this area as ES technology continues to migrate into the work place.

REFERENCES

[1] Alter, S., *Decision Support Systems: Current Practices and Continuing Challenges,* Addison-Wesley, Reading, MA, 1980.

[2] Attewell, P. and Rule, J., "Computing in Organizations: What We Know and What We Don't Know," *Communications of ACM,* Volume 27, Number 12, 1984, pp.

1184-1192.

[3] Barker, V. and O'Conner, D., "Expert Systems for Configuration at Digital," *Communications of the ACM,* Volume 32, Number 3, 1989, pp. 298-317.

[4] Barrett, M. and Beerel, A., *Expert Systems in Business,* John Wiley and Sons, New York, N.Y., 1988.

[5] Bobrow, D., et al., "Expert Systems: Perils and Promise," *Communications of the ACM,* Volume 29, Number 9, 1986, pp. 880-894.

[6] Braden, B., et al., "Developing an Expert Systems Strategy," *MIS Quarterly,* Volume 13, Number 4, 1989, pp. 459-468.

[7] Bryant, N., *Managing Expert Systems,* John Wiley and Sons, New York, N.Y., 1988.

[8] Cupello, J. and Mishelevich, D., "Managing Prototype Knowledge/Expert Systems Projects," *Communications of the ACM,* Volume 31, Number 5, 1988, pp. 534-541.

[9] Eason, K.D., "New Systems Implementation," in *Evaluation of Human Work,* J.R. Wilson and E.N. Corlett (Eds.), Taylor Francis, London, 1990.

[10] Feigenbaum, E., et al., *The Rise of the Expert Company,* Random House, New York, N.Y., 1988.

[11] Fox, M., "AI and Expert System Myths, Legends, and Facts," *IEEE Expert,* February 1990, pp. 8-20.

[12] Ginzberg, M.J., "Key Recurrent Issues in the MIS Implementation Process," *MIS Quarterly,* Volume 5, Number 7, 1981, pp. 47-59.

[13] Harmon, P. and Sawyer, B., *Creating Expert Systems for Business and Industry,* John Wiley and Sons, New York, N.Y., 1990.

[14] Irgon, A., et al., "Expert System Development: A Retrospective View of Five Systems," *IEEE Expert,* June 1990, pp. 25-35.

[15] Kanter, R.M., *The Change Masters: Innovation for Productivity in the American Corporation,* Simon and Shuster, New York, N.Y., 1983.

[16] Keyes, J., "Why Expert Systems Fail," *AI Expert,* November 1989, pp. 50-53.

[17] Leonard-Barton, D. and Deschamps, I., "Managerial Influence in the Implementation of New Technology," *Management Science,* Volume 34, Number 10, 1988, pp. 1252-1265.

[18] Leonard-Barton, D. and Sviokla, J., "Putting Expert Systems to Work," *Harvard Business Review,* March-April 1988, pp. 91-98.

[19] Locke, E.A., "The Nature and Causes of Job Satisfaction," in *Handbook of Industrial and Organizational Psychology,* M.D. Dunnette (Ed.), Rand McNally, Chicago, 1976.

[20] Lucas, H., *The Analysis, Design, and Implementation of Information Systems,* McGraw-Hill, New York, N.Y., 1985.

[21] Meador, C.L., et al., "Setting Priorities for DSS Development," *MIS Quarterly,* Volume 8, Number 2, 1984, pp. 117-129.

[22] Meyer, M. and Curley, K., "Expert System Success Models," *Datamation,* September 1, 1989, pp. 35-38.

[23] Mumford, E. and Macdonald, W., *XSEL's Progress: The Continuing Journey of an Expert System,* John Wiley and Sons, New York, N.Y., 1989.

[24] Mumford, E., "Managerial Expert Systems and Organizational Change: Some Critical Research Issues," in *Critical Issues in Information Systems Research,* R.J. Boland, Jr. and R.A. Hirschheim (Eds.), John Wiley and Sons, New York, N.Y., 1987, pp. 135-155.

[25] Nilsson, N.J., "Artificial Intelligence, Employment and Income," *AI Magazine,* Summer 1984.

[26] Ramon, K.S. and Phoon, C.K., "Decision Support Systems in Singapore: Issues in their Management and their Beneficial Contributions," *Information and Management,* Volume 18, 1990, pp. 153-165.

[27] Rogers, E.M., *Diffusion of Innovations,* Free Press, New York, N.Y., 1982.

[28] Sprague, R.H. and McNurlin, B.C., *Information Systems Management in Practice,* Prentice Hall, Englewood Cliffs, N.J., 1993.

[29] Sviokla, J., "An Examination of the Impact of Expert Systems on the Firm: The Case of XCON," *MIS Quarterly,* Volume 14, Number 2, 1990, pp. 127-140.

[30] Trappl, R., "Impacts of Artificial Intelligence: An Overview," in *Impacts of Artificial Intelligence,* R. Trappl (Ed.), Elsevier Science Publishers B.V., Amsterdam, Netherlands, 1985.

[31] Zmud, R.W., "An Examination of 'Push-Pull' Theory Applied to Process Innovation in Knowledge Work," *Management Science,* Volume 30, Number 6, 1984, pp. 727-738.

ABOUT THE AUTHORS

Craig K. Tyran *is an Assistant Professor in the Department of Management and Systems at Washington State University. Dr. Tyran received his B.S. and M.S. degrees in engineering from Stanford University, his M.B.A. from UCLA, and his Ph.D. in MIS from the University of Arizona. He has worked in industry as an engineer for Exxon Corporation. His current research interests include information systems development, the management of information systems, and group support systems. Dr. Tyran's research has appeared in several outlets including* MIS Quarterly, Database, *and the* Proceedings of the ICIS.

Joey F. George *is an Associate Professor in the Department of Information and Management Sciences at Florida*

State University. Dr. George received his bachelors degree from Stanford University in 1979 and his doctorate from the University of California at Irvine in 1986. His current research interests include computer-based monitoring in the work place, group support systems, and the information systems development process. Dr. George's research has appeared in several journals including the Communications of the ACM, Communication Research, *and Information Systems Research.*