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INTERNAL AUDITING AND EXPERT SYSTEMS:
Technology Adoption of An Audit Judgment Tool*

Introduction

This chapter is concerned with the analysis of those variables related to the adoption of a technology designed to support accounting and audit judgment. In particular, the purpose of this chapter is to investigate the diffusion of expert systems (ES)/ artificial intelligence (AI) technology, among internal auditors.

ECONOMICS OF DIFFUSION

Researchers in the economics of diffusion generally regard "diffusion" as the "spread" of a technology [Rosegger, 1980]. In some cases "technology transfer" is used to capture the notion of diffusion. From the view of the user, we can talk about adoption of the technology as the ultimate manifestation of that diffusion.

The economics of diffusion has studied such far ranging technologies as strip mining and blast furnaces [Rosegger, 1980]. It is an empirical issue as to whether ES diffuse in a manner similar to such other technologies. The economics of diffusion are discussed further below in the context of ES adoption.

IMPORTANCE OF THE PROBLEM

Determination of the variables that relate to the adoption of audit

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expert systems is a critical issue for a number of reasons. First, understanding the adoption of ES by internal auditors can be useful as a comparison with the adoption by other users throughout the firm. This would facilitate an understanding of the importance of the functional area.

Second, much of the previous research on technology diffusion and innovation is resident in the economics literature. Thus, one approach to integrating economic-based arguments into expert systems research is to focus on technology diffusion issues. To date there has been little research integrating economics and ES.

Third, if the variables affecting adoption of an internal audit judgment tool are known, then that can facilitate the determination of whether ES are appropriate for a given internal auditor environment. Focusing on those variables that facilitate the introduction of ES allows us to better understand the process of choosing and introducing ES into accounting and auditing.

Fourth, understanding the adoption of ES by internal auditors may facilitate the understanding of the adoption of ES by other accountants and auditors. For example, factors that affect internal auditor adoption of audit judgment technology may be useful in studying public accounting auditors. Many of the issues faced by internal and external auditors are the same and often external auditors use the judgments of internal auditors, although external auditors are in a different corporate environment.

CHAPTER OUTLINE

This chapter proceeds as follows. The next section provides a brief summary of some definitions and of the history of ES use in auditing and internal auditing. The following section investigates the relevant economics research in the area of technology diffusion and summarizes the resulting hypotheses. Then the next section discusses the survey instrument and some measurement issues. The subsequent section summarizes the findings. The final section summarizes the chapter, discusses some contributions and elicits some extensions of the research.

Expert Systems and Internal Auditing

The use of ES in internal auditing was one of the first applications of ES in accounting, auditing or tax. In a sequence of papers, the feasibility of the use of ES in the determination of reasonableness of prices paid for goods in a military purchase system was suggested in

1983 [Dillard et al. 1983]. Flesher and Martin [1987] published the first paper in the general internal auditor literature surveying the use of ES. A recent survey suggests that there were few other applications in the internal auditing literature through 1989 [Brown and Phillips 1991].

INSTITUTIONAL SPONSORED EXPERT SYSTEMS

Although internal auditors may receive information on technologies from a number of different organizations, the Institute of Internal Auditors (IIA) provides information directly to member internal auditors. The IIA has roughly 15,000 members to whom they provide software and publications on different technologies. Prior to this study, the IIA provided at least two sources of information related to ES. The IIA issued software for support of the internal audit process [Boritz 1986]. In addition, a primer on ES was issued by the IIA [Moeller 1987]. Other organizations include the EDP Auditors' Association (EDPAA).

Economic Theory of Diffusion and Innovation

The economic theory of technology diffusion and innovation [e.g., Gold, 1977 and Rosegger 1980] has led to the development of the recognition of a number of factors relating to the ultimate adoption of a technology. Rosegger [1980] summarized those theoretical factors as originating from at least three basic categories: environment, organization and the specific innovation. In this section, that theory is related to each hypothesis i (Hi). The corresponding questions (Qi), used on the survey are listed in Appendix A.

ENVIRONMENT

The environment in which the firm functions can play a critical part in influencing adoption of different technologies. Two variables that have been used to characterize the environment are the type of industry in which the firm is located and the actions of different relevant agencies that directly influence the flows of information regarding innovations to those in a given industry.

Industry. The industry may be helpful in explaining the adoption of ES technology to support internal auditing judgment. For example, certain types of industries, such as insurance, have extensive data processing capabilities. The corresponding staff, equipment and software could facilitate ES adoption, compared to an industry with fewer capabilities. Thus, the hypothesis is that industry impacts the adoption of ES.

Hypothesis 1 (H1) (Q2). The adoption of expert systems technology is related to industry.

Impact of Agencies such as IIA. Adoption of technology requires more than just information about that technology. Carlson [1967] noted that the mere verbal transmission of technical information, which is not used, is not diffusion of technology. Rosegger [1980] found that although transmission or acquisition of information is essential to diffusion, it is not sufficient. Further, in the analysis of one industry [1970], typically "huge" amounts of information in the form of technical papers, exchanges and visits by experts, precede actual increases in diffusion rates.

This finding is critical to organizations and agencies whose aims include the diffusion of information. Although little is known about organizations that support technological diffusion [Gold, 1977] simply providing the opportunity to have information about an innovation does not ensure the adoption. In addition, by ignoring a technology, such agencies may be viewed as providing a negative signal about the technology.

Since large quantities of information have been found as positively related to technology adoption, we would expect that the perceived flow of information from agencies such as the IIA would be positively related to the adoption of the technology.

Hypotheses 2 (H2) (Q14g). The adoption of expert systems is positively related to the perceived information flow received from the IIA.

ORGANIZATIONAL FACTORS

Organization factors can take a number of different forms. The economics of diffusion and innovation point to size variables, opportunity to adopt, pressures to adopt and budget to adopt.

Size. The size of the organization may partially account for the adoption of expert systems technology [Rosegger, 1980]. There are a number of explanations for this, including scale effects, likelihood of having the necessary knowledge to adopt the technology to the specific firm, etc. In internal auditing departments, the size of the department is characterized by the number of internal auditors and the number of internal auditors specializing in EDP applications. Thus, we would

expect the adoption of the technology to be positively related to the number of internal auditors or the number of internal EDP auditors or both.

Hypothesis 3 (H3) (Q3a). The adoption of expert systems technology is positively related to the number of internal auditors.

Hypothesis 4 (H4) (Q3b). The adoption of expert systems technology is positively related to the number of internal EDP auditors.

Opportunity and Pressure to Adopt. Kennedy and Thirlwall [1972] differentiate between the opportunity and the pressure to innovate. Opportunity to adopt is a necessary condition for adoption, while pressure to adopt can force the use of a specific technology. The opportunity to adopt expert systems technology in internal auditing could be facilitated if there were general organizational support for ES technology throughout the organization. Such support may include training programs or access to experts in ES (e.g., knowledge engineers). Thus, we would expect a positive relationship between such support and adoption.

Hypotheses 5 (H5) (Q14b). The adoption of expert systems is positively related to the ES support available in the organization.

Pressure to adopt technology can come from within the organization in the form of a corporate strategy or other vehicles. For example, at the time of the study, DuPont made it well known both within the organization and in the press, that corporate plans included the development of a large number of expert systems (2000 systems by 1990, Williamson [1990]). Thus, some of the internal audit departments may have received pressure to adopt ES. As a result, it is assumed that corporate pressure to adopt ES is positively related to the adoption of the technology.

Hypothesis 6 (H6) (Q13). The adoption of expert systems is positively related to firm-wide pressure to adopt the use of expert systems.

Budgetary Pressures. Gold [1964] found that the existence of innovations did not depend so much on the existence of an "innovative" entrepreneur, but instead on the availability of financial and physical resources and on the technical setting of the firm. If there are no resources to spend on the technology, it is unlikely that it will be adopted. Thus, we would expect the existence of budgetary pressures would be negatively related to the adoption of ES—those with no money to invest in the technology are not likely to adopt it.

Hypotheses 7 (H7) (Q14a). The adoption of expert systems technology is negatively related to budgetary pressures

NATURE OF THE INNOVATION

ES and other innovations each have different characteristics that might lead to adoption of the technology. Those characteristics include the economic advantage of adoption, uncertainties associated with use of the innovation, the potential for disruption resulting from adoption of the innovation, and the commitment required for use of ES.

Economic Advantage. Mansfield [1968] indicated that the extent of economic advantage of the innovation over the older methods had a positive impact on the rate of adoption. Thus, if ES can favorably affect the costs of the use of the technology (for example, reduce manpower needs) then the use of expert system could be positively related to economic advantage. Since ES are an "automation of human expertise" we would expect the extent to which there is perceived potential for reduction in manpower to be positively related to adoption of ES in internal auditing.

Hypotheses 8 (H8) (Q14c). The adoption of expert systems is positively related to the perception of the ability of expert systems to reduce manpower needs over manual systems.

Uncertainty. Mansfield [1968] also indicated that two types of uncertainty could influence adoption of technology: the extent of uncertainty associated with the innovation when it first appears and the rate of reduction of the initial uncertainty regarding the innovation's performance.

These two different types of uncertainty translate into two different questions regarding expert systems and internal auditors. First, if internal auditors perceived that there was uncertainty of expert systems to improve the audit process then we would expect there to be a negative impact on adoption. Second, if internal auditors perceived that the uses of expert systems by others were successful, that could reduce the uncertainty of adopting the technology, creating a positive impact on adoption. These are not the same. Improvement of the process does not ultimately result in a successful application, although it might be anticipated that improvement in the process is a necessary condition for a successful application. This results in the following two hypotheses.

Hypothesis 9 (H9) (Q14d). The adoption of ES is positively related to the perception of the certainty of ES to improve the audit process.

Hypothesis 10 (H10) (Q14e). The adoption of ES is positively related to the perception of the success of ES applications.

Disruption Due to Adoption. Simon [1973] indicated that the opportunity costs of failure include not just the cost of the innovation, but the potential consequences of adopting the innovation and then disrupting the entire system or organization. Thus, we would expect that the perceived potential of ES to disrupt operations would be negatively related to the adoption of ES.

Hypothesis 11 (H11) (Q14f). The adoption of ES is negatively related to the perceived ability to disrupt operations beyond the department.

Commitment. Mansfield [1968] found that the extent of commitment required to try out the innovation was an important determinant of the rate of diffusion. An important aspect of commitment is the out-of-pocket costs of such a commitment. At the time of this study, the commitment required to try out ES was quite low. Depending on the awareness of the internal auditors,

inexpensive and easy-to-use ES shells provided the ability to try the technology and develop prototype ES in a personal computer environment. Thus, we would expect adopters to be more aware of the ability to try the technology with minimal commitment.

Hypotheses 12 (H12) (Q14h). The adoption of ES is positively related to the perceived ability to build ES in an inexpensive manner.

Testing the Hypotheses

Only a portion of the survey was devoted to the diffusion of ES technology in internal auditing. Those questions that relate to the diffusion of ES are listed here. They were coded (-1 not true, 0, +1 true). Average response and standard deviation are included in parentheses, as is the outcome of a t-test of the mean, for information purposes. This information is provided for descriptive purposes. Statistical analysis for this and other questions, is discussed further below. All, except Q14c, were significant at the .01 level or better.

Q13 There is firmwide "pressure" to adopt the use of expert systems technologies into departments within your firm, including internal auditing (-.7/.49). (t-test for different than "0" was -28.57)

Q14a Budgetary pressures make it impossible to spend any resources on expert systems in internal auditing (-.22/.69). (t-test for different than "0" was -6.42)

Q14b There is substantial support available internally for the development of expert systems (-.54/.61). (t-test for different than "0" was -17.83)

Q14c Expert systems offer advantages in terms of reducing manpower needs over current manual methods (-.02/.61). (t-test for different than "0" was -.655)

Q14d There is substantial uncertainty that expert systems can improve the audit process (-.15/.7). (t-test for different than "0" was -4.28)

Q14e Expert Systems developed to date have had very good success (-.12/.54). (t-test for different than "0" was -4.44)

Q14f Internal audit expert systems have substantial opportunity to disrupt the operations of the firm beyond the scope of the internal audit department (-.58/.6). (t-test for different than "0" was -19.33)

Q14g There has been substantial flow of information from organizations, such as the IIA and the EDPAA regarding the use of expert systems in accounting and auditing (-.48/.63). (t-test for different than "0" was -15.23)

Q14h Suitable expert systems can be built for use in internal auditing using inexpensive (e.g., $300) expert system shells (-.067/.63). (t-test for different than "0" was -2.09, while t-test for different than "1" was -33.6)

MEASURING "ADOPTION"

Probably the best measure of "adoption" is whether or not the particular firm adopted ES into the audit process. In order to capture that information, subjects were asked the question 5 "To what extent are you employing ES technology as part of the internal audit function? (0 None, 1 Low, 2 Moderate, 3 High). (.4/.66)." The t-statistic for the mean being different than 0 is 18.3 (.01).

The sample of 406 ("familiar") responses was divided into two samples, based on their answer to that question. Those that answered "none," (68.51%) were treated as a group and those that answered either "low," (24.18%) "moderate,"(6.30%) or "high," (1.01%) were treated as a second group. All the adopters were placed in one group since in each case they had adopted the technology into the audit process. The total populations for each of those two groups were, 278, and 128 respectively.

LOG LINEAR ANALYSIS OF DATA

A log linear model was used to investigate the resulting frequency tables using BMDP [Dixon et al. 1981]. The frequency tables, by percentage in groups, are summarized in the appendix.

The log linear model fits categorical variables by representing cell frequencies as a combination of interactions and main effects. In a two-way analysis of sets A and B, the expected value of a cell (i,j) is represented as $\ln F_{i,j} = t + w_{A_i} + w_{B_j} + w_{AB_{ij}}$, where the w parameters sum to zero over their indices and t is the mean-effect. The log linear process chooses the parameters to solve those equations. The concern in this chapter is with the model AB, the interaction effect of adoption and other variables, in a pairwise analysis, as described in the hypotheses.

The quality of the log linear models (AB) is measured using the Pearson chi-square test. Similarly, the Pearson correlation coefficient, between the observed frequencies and fitted frequencies, is used for determination of direction. The corresponding t-value is used to measure correlation significance.

Survey Findings

These results are summarized in table 6-1. The results indicate that the models for all but the industry hypothesis, number of auditors, number of EDP auditors, and potential for disruption, were significant at the .01 level. The hypothesis for potential of disruption was significant at the .1 level. Each correlation value, for all but industry and number of internal auditors, was significant at the .1 level or better. Correlation coefficients are used to indicate the direction of the relationships being tested. The hypothesized directions also are summarized in table 6-1.

ENVIRONMENT HYPOTHESES

Industry. In the case of the industry variable, the largest number of adopters were in the finance, insurance, utilities, and manufacturing industries. The highest percentage of adopters in different industries included food, agricultural and retail industries. However, there was no general industry effect.

Agencies. Alternatively, the other environment hypothesis, H2, the impact of agencies was significant at the .001 level. It appears that the flow of information is one of the critical factors separating adopters and nonadopters.

Table 6-1

SUMMARY OF RESULTS&

Question	Correlation (t-value)	Prob of Pearson Chi-Square (Probability)	Sign on Hypothesis
H1 (Industry)	–0.018 (-0.368)	0.3539	+/–
H2 (Information Flow)	0.185 (3.583)***	0.0011	+
H3 (No. of Internal Auditors)	0.042 (0.787)	0.6178	+
H4 (No. of EDP Auditors)	0.012 (1.421)*	0.2101	+
H5 (Development Support)	0.241 (4.682)***	0.0000	+
H6 (Firm-wide Pressure)	0.282 (5.152)***	0.0000	+
H7 (Budgetary Pressures)	–0.145 (-3.057)***	0.0072	–
H8 (Reduction in Manpower)	0.184 (3.580)***	0.0002	+
H9 (Uncertainty in Improvement)	–0.148 (-3.058)***	0.0105	–
H10 (ES have been Successful)	0.213 (4.069)***	0.0000	+
H11 (Potential for Disruption)	–0.073 (-1.485)*	0.1004	–
H12 (Inexpensive Shells)	0.130 (2.529)**	0.0086	+

& Results using subjects' responses coded with 0 = not adopted in audit processes, 1=low adoption, medium adoption and high adoption into audit process.

* *Significant at the .1 level*
** *Significant at the .01 level*
*** *Significant at the .001 level*

ORGANIZATIONAL HYPOTHESES

Size. The model associated with the number of internal auditors (H3) was not significant. However, there seems to be a unique relationship between number of internal auditors and adoption of ES. The standardized deviates, summarized in table 6-2, indicate that the relationship between size and adoption of the technology seems to change when the number of auditors exceeds 100.

It is possible that the number of auditors was not significant because another phenomenon was involved. It is likely that, although there may be economies of scales as firms become larger, at a certain point, the number of auditors appears to inhibit the potential for change. Apparently, when internal auditor organizations (and possibly public auditor organizations) reach a certain size, then their ability or willingness to consider new innovations may decrease. A similar finding occurs for the relationship between adoption and number of EDP auditors (H4). This finding deserves further investigation.

Opportunity and Pressure. The hypotheses for opportunity and pressure yielded the strongest statistical results. H5, the existence of support, was the second most significant of all the questions. Thus, it appears that one of the critical variables in the adoption process is the availability of support to help potential adopters to develop the sys-

Table 6-2

NUMBER OF INTERNAL AUDITORS AND ADOPTION OF EXPERT SYSTEMS*

Number of Int. Auditors	Nonadopters	Adopters	Total
Under 25	0.1	–0.2	–0.0
25 to 50	0.1	–0.1	–0.0
50 to 100	0.3	–0.4	–0.1
Over 100	–0.7	1.0	0.3
Total	–0.2	0.4	0.1

**Standard Deviates. Standardized deviates are computed as (observed-expected) / squareroot of (expected).*

tems for their department.

H6, the existence of firmwide pressure, yielded the strongest statistical result. Firmwide pressure appears to provide substantial incentive for technology adoption.

Budgetary Pressures. The lack of budgetary pressures (H7) was found to be positively and statistically significantly related to the adoption of ES. If the department does not have the resources then apparently that interferes with technology adoption.

NATURE OF THE INNOVATION

The analysis of the data indicates that each of the four characteristics tested in this research was found to be statistically significant at the .1 level or better.

Economic Advantage. The ability of ES to provide economic advantage, in particular, reduce manpower, was expected to be positively related to the adoption of ES. The results in table 1 indicate H8 significant at the .0002 level.

Uncertainty. If there is uncertainty about the ability of the technology to improve the process then that would be negatively related to adoption. The results indicate that H9 is significant at the .01 level.

Success. If the ES adoption is uncertain to lead to a successful implementation, then we would anticipate that to be negatively related to the adoption of ES. H10 was found to be significant at the .0000 level.

Disruption. If the adoption of ES were expected to be disruptive of other departments, then we would anticipate that would inhibit the adoption of ES. H11 was found to be significant at the .1 level.

Required Commitment. H12, suggested that if the perceived required commitment of ES is relatively minor then the technology will be adopted. H12 was found to be significant at the .01 level.

Summary, Contributions and Extensions

This section briefly summarizes the chapter, elicits some of the contributions of the chapter and discusses some extensions of the research in this chapter.

SUMMARY OF FINDINGS

The results in this chapter were consistent with the theory elicited from the economics of diffusion and innovation. The results indicate that adoption of the expert systems technology among internal auditors is positively related to the number of EDP auditors, firmwide pressure to adopt expert systems, the existence of support for expert systems development, the perceived potential for reducing manpower, the perception of the success of expert systems, and the existence of tools that require only minor commitment to try out the technology. It is also positively related to the flow of information from the IIA. The existence of budgetary pressures, the uncertainty of the technology to improve the audit process and the potential for disruption of other activities in the firm are negatively correlated with adopters.

The number of auditors was found to have an interesting relationship with adoption of expert systems technology. Once internal audit departments begin to get large (measured here as greater than 100 internal auditors), the adoption of technology seems to be inhibited.

CONTRIBUTIONS

This chapter has a number of implications for future research.

First, this is the first large-scale study of the factors relating to expert systems adoption in a discipline requiring substantial judgment. Accordingly, this study can guide future studies of expert system and other technology adoption. Second, the data analysis employs a log linear model. That approach is useful here, since it captures the differences associated with the levels in the variables that are measured. This same approach can be used in the analysis of similar data. Third, this study is one of the few large scale studies of accountant technology adoption. Future research could focus on other types of technology used in accounting. The study of a portfolio of technologies could provide additional insight into adoption of technologies. Fourth, the research findings here are consistent with previous diffusion research. As a result, this research substantiates previous work and the use of the economics of diffusion in the analysis of ES diffusion. Fifth, each study necessarily concentrates on a selected set of issues, e.g., disruption of other departments. Additional research could focus on other aspects, such as investment variables.

This chapter is the first to investigate the diffusion of a technology in accounting and audit judgment. Thus, the results presented here form a basis for the study of the diffusion of other accounting and audit judgment support tools.

The research employed the previous literature of expert systems in auditing and the economics of diffusion and innovation to develop a survey instrument that was sent to over 3,000 internal auditor department heads. The respondents were placed into one of three categories: not familiar with expert systems; familiar with expert systems, but did not adopt in their audit process; and familiar with expert systems, and adopt in their audit process. The focus of this chapter was on the differences between the last two categories (nonadopters and adopters).

EXTENSIONS

The results of this chapter can be extended in a number of different ways. First, the study could be extended to other time periods, to determine if there were any differences in the adoption of ES technology. Such a study could focus on changing patterns of factors. Second, the adoption of alternative forms of AI activity, such as case-based reasoning, not present in audit applications during the period investigated, could be analyzed. Third, the study could be extended to other audit judgment support tools and technologies, such as CD/ROM. Comparisons could then be made between the patterns of factors associated with technology adoption. Fourth, alternative types of auditing environments, such as public accounting, could be investigated for adoption factors. It is likely that many of the same factors influencing internal auditor decisions on adopting audit judgment support, also influence external auditors. Fifth, an understanding of adoption of ES may be used to study diffusion of general judgment support.

LIMITATIONS

As noted in Kerlinger [1973, p. 414], "survey research has contributed much to the methodology of the social sciences." However, the primary limitations of this study derive from the methodology being a survey. For example, throughout we are measuring perceptions of internal auditors, not actual actions. We never actually "see" the adoption of a technology. It is assumed that if the survey respondent tells us they have adopted the technology, then they are treated as an adopter. Although there are a number of well-known limitations, surveys still provide an important method for accessing large populations of professionals.

Frequency Table Percentages

This appendix presents the frequency tables in percentage form.

H1. Industry (not presented ... 22 different industries were in the set of respondents)

H2. Information Flow from IIA (Percentages)

Scale	Nonadopters	Adopters	Total
–1	42.1	13.8	55.9
0	22.7	14.3	36.9
+1	3.4	3.7	7.1
Total	68.2	31.8	100.0

H3. Number of Auditors (Percentages)

Scale	Nonadopters	Adopters	Total
Under 25	52.0	23.6	75.6
25 to 50	8.4	3.7	12.1
50 to 100	3.9	1.5	5.4
Over 100	3.9	3.0	6.9
Total	68.2	31.8	100.0

H4. Number of EDP Auditors (Percentages)

Scale	Nonadopters	Adopters	Total
Under 10	61.3	27.3	88.7
10 to 25	5.2	2.5	7.6
Over 25	1.7	2.0	3.7
Total	68.2	31.8	100.0

H5. Support (Percentages)

Scale	Nonadopters	Adopters	Total
–1	47.0	13.5	60.6
0	18.0	15.0	33.0
+1	3.2	3.2	6.4
Total	68.2	31.8	100.0

H6. Organizational Pressure (Percentages)

Scale	Nonadopters	Adopters	Total
–1	53.9	17.0	70.9
0	14.3	13.5	27.8
+1	0.0	1.2	1.2
Total	68.2	31.8	100.0

H7. Budgetary Pressures (Percentages)

Scale	Nonadopters	Adopters	Total
–1	23.2	14.3	37.4
0	32.8	15.0	47.8
+1	12.3	2.5	14.8
Total	68.2	31.8	100.0

H8. Manpower (Percentages)

Scale	Nonadopters	Adopters	Total
–1	14.8	4.7	19.5
0	45.1	17.7	62.8
+1	8.4	9.4	17.7
Total	68.2	31.8	100.0

H9. Improve Audit Process (Percentages)

Scale	Nonadopters	Adopters	Total
–1	20.0	13.3	33.3
0	33.7	14.8	48.5
+1	14.5	3.7	18.2
Total	68.2	31.8	100.0

H10. Successful Expert Systems (Percentages)

Scale	Nonadopters	Adopters	Total
–1	16.7	4.9	21.7
0	48.5	20.4	69.0
+1	3.0	6.4	9.4
Total	68.2	31.8	100.0

H11. Disrupt the Organization (Percentages)

Scale	Nonadopters	Adopters	Total
–1	41.4	22.4	63.8
0	22.9	14.8	30.3
+1	3.9	2.0	5.9
Total	68.2	31.8	100.0

H12. Inexpensive Shells (Percentages)

Scale	Nonadopters	Adopters	Total
–1	17.2	6.4	23.6
0	42.1	17.2	59.2
+1	8.9	8.1	17.0
Total	68.2	31.8	100.0

References

Boritz, J., "CAPS: The Comprehensive Audit Planning System," Paper presented at the University of Southern California Symposium on Audit Judgment, 1983.

———, "Audit MASTERPLAN," Audit Planning Software Published by the Institute of Internal Auditors, 1986.

Brown, C. and Phillips, M., "Expert Systems for Internal Auditing," *Internal Auditor,* August 1991, pp. 23-28.

Burton, C., "Experts Say AI Freeze is Beginning to Thaw," *Computerworld,* July 29, 1991, p. 66.

Carlson, J., "Aspects of the Diffusion of Technology in the United States," Paper presented at the fifth meeting of the Senior Economic Advisors, United Nations, Economics Commission for Europe, Geneva, October 2, 1967.

Dixon, W., Brown, M., Engelman, L., Frane, J., Hill, M., Jennrich, R., Toporek, J., *BMDP Statistical Software Manual,* University of California Press, Berkley, Ca. 1988.

Flesher, D. and Martin, C., "Artificial Intelligence," *The Internal Auditor,* February, 1987, pp. 32-36.

Gold, B., "Industrial Growth Patterns: Theory and Empirical Findings," *Journal of Industrial Economics,* Volume 12, November 1964.

———, Peirce, W., and Rosegger, G., "Diffusion of Major Technological Innovations in U.S. Iron and Steel Manufacturing," *Journal of Industrial Economics,* Volume 18, July 1970.

———, "Diffusion of Technology in Industry," in *Research, Technological Change and Economic Analysis,* edited by B. Gold, Lexington, MA, D.C.Heath, Lexington Books, 1977.

Kennedy, C. and Thirlwall, A., "Surveys in Applied Economics: Technical Progress," *Economic Journal,* Volume 82, March 1972.

Kerlinger, F., *Foundations of Behavioral Research,* Holt, Rinehart, and Wilson, New York, 1983.

Lecot K., "An Expert System Approach to Fraud Prevention and Detection," *Expert Systems Review,* Volume 1, Number 3, 1988.

Mansfield, E., *Industrial Research and Technological Innovation,* New York, 1968.

Moeller, R., *Artificial Intelligence—A Primer,* Institute of Internal Auditors Monograph Series, 1987.

Ramakrishna, K., Dillard, J., Harrison, T., and Chandrasekaran, B., "An Intelligent Manual for Price Analysis," *Federal Acquisition Research Symposium,* U.S., Air Force, Willamsburg, Virgina, December 1983.

Rosegger, G., *The Economics of Production and Innovation,* Pergamon Press, Oxford, 1980.

Simon, H., "Technology and Environment," *Management Science,* Volume 19, June 1973.

Tener, W., "Expert Systems for Computer Security," *Expert Systems Review,* Volume 1, Number 2, March 1988.

Turban, E. and Watkins, P., "Integrating Expert Systems and Decision Support Systems," *Management Information Systems Quarterly,* June 1986, pp. 121-138.

Vasarhelyi, M., Halper, F., and Fritz, R., "The Continuous Audit of On-line Systems," Paper presented at the University of Southern California Audit Judgment Conference, 1988.

Williamson, M., "Knowledge-based Systems," *PC Week,* July 1990.