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Perceived Impact and Diffusion of Expert Systems in Banking: An Exploratory Investigation

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The impact of information technology (IT) on organizations has long been an important issue from the application perspective and research perspective. There are many studies on expert systems (ES), specifically on IT, that focus mainly on system development. However, there has not been much research on ES impacts. Based on a study of expert systems in 20 British banking organizations, this paper analyzes and reports a major part of its findings: expert systems' impact and diffusion into those organizations. The research finds that there is a general tendency that ES benefits are perceived in process-related organizational aspects of IT management. However, the perceived ES impact is not found associated with ES adoption in banking organization. © 1998 Elsevier Science Ltd. All rights reserved

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Introduction

From both the application perspective and the research perspective, the impact of information technology (IT) on organizations is obviously an important issue. As a result, a considerable amount of research can be found in both academic and practitioners' journals about the impact that IT presumably has on the performance of organizations[1] although there has not been a conclusive resolution of the 'IT investment paradox'. On the other hand, research on the adoption of IT innovations[2] points to significant relationships between beliefs and adoption intention.

Within the general trend of increased IT utilization, companies started developing expert systems (ES) to be used to simplify product maintenance or support training of customers. Expert systems, a specific type of information technology, are defined in this paper as computer programmes that recommend specific actions by applying decision rules that replicate the way human experts make decisions. Since 1980s, expert systems have been applied as a specific type of IT by many organizations including banking institutions.[3–8] However, the use of ES applications experienced a situation similar to IT in that the justification of their benefits is an unresolved issue, hence the need for continuing effort in search of better ways to adopt and manage ES applications. These issues are important in that specific impacts of ES can be identified which will be useful for evaluating ES. In addition, it is critical to reveal whether it is useful to rely on IT management's perception for adoption.

[1]Soh C. and Markus, M. L., How IT creates business value: a process theory synthesis. *The Sixteenth International Conference on Information Systems*, Amsterdam, Dec. 10–14, 1995, pp. 29–40.
[2]Davis, F. D., Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 1989, **13**(3), 319–340.
[3]Brown, C. E., Expert systems—one set of views of the state of the art. *Expert Systems With Applications*, 1995, **9**(4), 433–439.
[4]Gill, T. G., Early expert systems: where are they now? *MIS Quarterly*, 1995, March, 51–81.

Continued on page 140

Continued from page 139

[5]Hartvigsen, G., Limitations of knowledge-based systems for financial analysis in banking. *Expert Systems with Applications*, 1992, **4**(1), 19–32.
[6]O'Leary, D. E. and Turban, E., The organizational impact of expert systems. *Human Systems Management*, 1987, **7**(1), 11–19.
[7]Sangster, A., The Bank of Scotland's COMPASS: the future of bank lending? *Expert Systems with Applications*, 1995, **9**(4), 457–468.
[8]Shao, Y. P., Wilson, A. and Oppenheim, C., Knowledge-based systems in retail banking: a survey of current practice. *International Journal of Intelligent Systems in Accounting, Finance and Management*, 1997, **6**(1), 73–81.
[9]*Op. cit*., Ref. 8.
[10]Metheny, B., Relying solely on productivity to measure the impact of information technology is misleading. *Journal of Systems Management*, 1994, **45**(3), 24–26.
[11]Clements, E. K., 1991, Evaluation of strategic investments in information technology. *Communications of the ACM*, **34**(1), 22–36.
[12]Fletcher, K. and Wright, G., The strategic context for information systems use: an empirical study of the financial services industry. *International Journal of Information Management*, 1996, **16**(2), 119–131.
[13]McFarlan, F. W., Information technology changes the way you compete. *Harvard Business Review*, 1984, **62**(3), 98–103.
[14]Entwisle, P. and Williams, R., Applications of information technology in banking. *Information Technology Public Policy* (UK), 1993, **11**(2), 114–23.
[15]*Op. cit*., Ref. 7.
[16]Weill, P., The relationship between investment in information technology and firm performance: a study of the value manufacturing sector. *Information Systems Review*. 1992, **3**(4), 307–333.
[17]Grabowski, M. and Lee, S., Linking information systems application portfolios and organizational strategy. In *Strategic Information Technology Management*: *Perspectives on Organizational Growth and Competiive Advantage*, R. D. Banker, R. J. Kauffmann and M. A. Mahmood, Eds., pp. 33–54, Harrisburg, PA, Idea Group Publishing. 1993.
[18]Markus, M. L. and Soh, C., Banking on information technology: converting IT spending into firm performance. In: *Strategic Information Technology Management*: *Perspectives on Organizational Growth and Competiive Advantage*, R. D. Banker, R. J. Kauffmann and M. A. Mahmood, Eds., pp. 375–403, Harrisburg, PA, Idea Group Publishing. 1993.
[19]Svikola, J. J., An examination of the impact of expert systems on the firm: the case of XCON. *MIS Quarterly*, 1990, **14**(2), 127–140.
[20]*Op. cit*., Ref. 4.
[21]*Op. cit*., Ref. 5.
[22]*Op. cit*., Ref. 7.

The purpose of this paper is to report findings of the perceived impact on IT management and its association with ES diffusion from a study conducted in the British banking sector.[9] The paper is organized as follows. First, a literature review in the research area will highlight the issues and problems of concern. Second, design and methodology of the research project will be described. Third, results of the work will be reported. Finally, the paper concludes with suggestions for future research.

Value of IT, expert systems and technology adoption in organizations

Value of IT in organizations

There have been constant efforts trying to resolve the 'IT investment paradox'. Most have realized that relying solely on productivity to measure the impact of IT will be misleading.[10] Investments in IT *per se* do not always imply higher organizational performance: different types of technology, IT applications in different industries and different management style of IT may also contribute to the complexity of this relationship.

The move to find competitive or strategic contribution of IT to organizations is one of the ways to study IT and organizations. The focus of this effort has been on IT applications that leverage the firms to obtain differential sources of competitive advantage in the market place.[11–13] There is now a realization that IT has strategic importance – quality of service, profitability and new products are all dependent on it.[14] As such, competitive advantage is frequently cited by organizations as a reason for deploying information technology.

Another type of effort towards resolving the productivity paradox is business value oriented research.[15] The concept of 'IT conversion effectiveness' was introduced to account for the failure of some IT investments to reach the firm's bottom line.[16] Many researchers have followed and proposed theoretical models that trace the path investment inputs and lead the way to becoming the outputs of 'productivity increase', 'realized business value', 'organizational performance improvements'.[17,18]

This process-oriented angle of studying IT value is very promising. The linkages of IT and business processes are close. It may be more appropriate to measure process performance than organizational performance. This orientation also keeps away some external effects on organizational performance such as the overall economic situation.

Expert systems in organizations

Expert systems have been used by many organizations. Some well-known systems, e.g. Digital's *XCON*, American Express' *Authorizer's Assistant*, have amply demonstrated the technology's capability both to generate huge financial returns and to contribute to the strategic goals of the firm.[19] A number of major companies were reported in actively developing and maintaining expert systems and some even asserted that their key businesses were strategically dependent on these systems and were likely to remain so in the future.[20]

Literature on business and information systems contains many ES cases in the banking and financial sector.[21,22] Expert system technology is proving to be an indispensable aid to commercial lending, by improving

a bank's efficiency, consistency and quality of their lending decisions and ultimately, their competitive edge.

Although some banks deployed expert systems, the adoption of this technology had been slow and bankers seemed to be reluctant to embrace it fully.[23] This is true considering a survey finding on industry participants of a major AI conference in 1993 that 60% of the participants predicted that the AI industry would either remain flat or decline between 1993 and 1999.[24]

As a result, a study on the diffusion of ES, its effects and management in the banking sector would contribute to the understanding and future adoption of ES technology and to IT applications as well.

Organizational decision making

The impact of information technology and expert systems on decision making has been considered as critical.[25–27] Three dimensions of concern can be found in the literature.

The concertina effect. Research has shown that managers and employees find that the way they make decisions is being changed by the information technology they use.[28] It requires considerably less time to make a decision than in the old manual system. This, however, may not always result in superior outcomes. The effect appears to be similar to a concertina, the compressing of an original decision making process into a much smaller temporal space.

The positioning effect. 'Positioning' means the location of a decision or its elements within the interactional flow in an organization. In decision support systems, people other than the employees contribute to an organization's decision processes, and are more likely not competent to do so. Organizations may make decisions predetermined by outward criteria and ground rules. Failing to keep a man in the decision making process is where many applications have gone wrong.[29]

Structure of decision making. Even though organizational design is decentralized, an information system can be used to establish strong central controls. Leavitt and Whisler[30] reasoned that computers would cause centralization as accurate information would become readily available to higher levels. Thus, greater decentralization has been predicted as computers are used in this manner.

Expert systems have been used in decision making processes and their impact on decision making is both interesting and intriguing to investigate. There are possibilities for increased control by ES applications.[31] However, a study also concludes that the quality of an organizational decision is largely a consequence of the quality of the organizational intelligence and the quality of the decision making process.[32] Another study also finds that the implementation of expert systems would lead to less complex and political decision processes.[33]

Technology adoption in organizations

The technology acceptance model (TAM)[34] offers both a strong theoretical foundation and standardized belief and attitude measures. TAM posits that beliefs about IT are important predictors of its adoption intention, which in turn is an important predictor of adoption behavior.

What remains unresolved is empirical research that demonstrates the feasibility and applicability of these changes of orientation: competition,

[23]McGinn, C., Computer mentors give loan officers a hand. *ABA Banking Journal*, 1990, **82**(11), 45–53.
[24]Coleman, K., The AI marketplace in the year 2000. *AI Expert*, 1993, **8**(1), 34–38.
[25]Lawler, J. J. and Elliot, R., Artificial intelligence in HRM: an experimental study of an expert system. *Journal of Management*, 1996, **22**(1), 85–111.
[26]Lawrence, T., Impacts of artificial intelligence on organisational decision making. *Journal of Behavioral Decision Making*, 1991, **4**(3), 195–214.
[27]Molloy, S. and Schwenk, C. R., The effects of information technology on strategic decision making. *Journal of Management Studies*, 1995, **32**(3), 283–311.
[28]Harrington, J., *Organizational Structure and Information Technology*. Prentice-Hall, London, 1991.
[29]Steinborn, D., The man in the loop. *Bank Systems and Technology*, 1992, 36–40.
[30]Leavitt, H. J. and Whistler, T. L., Managment in the 1980s. *Harvard Business Review*, 1958, **36**(6), 41–48.
[31]O'Keefe, R. M. and Rebne, D., Understanding the applicability of expert systems. *International Journal of the Applied Expert Systems*, 1993, **1**(1), 3–24.
[32]Huber, G. P., Theory of the effects of advanced information technologies on organisational design, intelligence and decision making. *Academy of Management Review*, 1990, **15**(1), pp. 47–71.
[33]*Op. cit*., Ref. 26.
[34]*Op. cit*., Ref. 2.

business processes. Another related issue is the difficulty relating to how, why and what technology provides value to organizations. How do organizations adopt and diffuse IT to provide business value to business processes?

Research design and methodology

The research objective was to ascertain the extent of ES diffusion into banking processes in retail banks, and the corresponding perceived process impacts. All the 13 UK high street banks and the top 13 building societies [those with over £3000 million assets and over 1000 employees] were selected for inclusion in the study. Postal questionnaires, telephone interviews and field visits were used to collect data. Twenty of the 26 banks that were contacted agreed to participate in the study, though not all to the same degree. Some only completed a questionnaire, whilst others provided extensive in-depth interviews. The institutions that took part in the study had average assets of £28,965 million, an average of 22,376 employees and an average of 822 branches. These values are higher than the population averages.

A key part of the research strategy was the identification of potential expert witnesses, people with responsibility for either ES development or general IT operations, in their banks. Seventeen IT directors or heads of knowledge system groups were contacted and interviewed by phone. Telephone interviews were conducted with the expert witnesses in the banks in November and December 1993. Telephone interviews varied in length from 25 to 45 min. Five face-to-face interviews were also conducted after the telephone interviews. The face-to-face interviews with the witnesses were conducted in March 1994 and, on average, 40 min were spent for each interview. One lasted for 90 min. Annual financial reports of various banking organizations were used to collect financial information. Information was also obtained from the *Bankers Almanac*[35] and *Yearbook of Building Societies*[36] for statistics on the number of retail branches, the number of employees, etc.

The methods employed to analyse the research data are largely qualitative rather than quantitative. A relatively small amount of data on management perceptions was collected through postal questionnaires and the analyses are indicative as the statistical analysis may not provide strong statistical significance. For the purpose of easy reading, sections containing a large amount of qualitative data analysis are arranged in the order of statistical analysis of the questionnaires first and qualitative replies of questionnaire returns and interview analysis second.

Research findings

Specifically, this section will first address perceived ES benefits' diffusion in banking business processes. They are analyzed in terms of different banking processes and organizational aspects. The section will then report the relationships between perceived benefits and ES diffusion in those banking organizations.

Perceived process impact

Some impact of expert systems on organizations were identified and perceived as having ES impacts.[37,38] These process indicators (transported

[35]Reed Information Services, *The Banker's Almanac*, West Sussex, 1993.
[36]Building Societies Association, *The Yearbook of Building Societies*, London, 1993.
[37]Martin, B., Subramanian, G. H. and Yaverbaum, G. J., Benefits from Expert Systems: An Exploratory Investigation. *Expert Systems with Applications*, 1996, **11**(1), 53–58.
[38]*Op. cit.*, Ref. 6.

into banking organizations) are banking (process) efficiency, communications, productivity (staff), risk management, expertise distribution, data utilization, management control, management time, exploration of alternatives, and decision making process.

Table A.1 in the Appendix lists various aspects of ES impacts of which the management were asked to give their perceptions. The respondents were asked to choose among 'strongly disagree' [score 1 was assigned], 'disagree', 'neither agree nor disagree', 'agree' and 'strongly agree' with various statements on the benefits of expert systems on banking organizations (for the last 12 statements, the respondents were asked to choose from 'not at all', 'little', 'don't know', 'some', and 'lot'. In order to find a central tendency, means and standard deviations were adopted and the values are computed and shown in *Table A.1*.

Banking efficiency. From *Table A.1*, the mean of the 'ES can improve banking efficiency' is 3.58 with a standard deviation of 0.61. Overall, 63% of the respondents agreed to the statement. This indicates that most of the respondents perceived ES to be improving banking efficiency.

The interviews support this conclusion. For example, a senior manager in one bank, which has been using credit evaluation system, commented during the field interview that:

> Improved efficiency in the process has to be one (of the effects), and benefits have been seen.

However, this efficiency improvement has to be considered in specific areas in the banking business, not the overall bank efficiency, although it may have an accumulation effect. One senior manager stated:

> Improve product, serve quality and improve productivity, is what we're trying to do. These two things ended in improving our efficiency.

In commenting on ES impact, another manager put it like this:

> If you equate efficiency and effectiveness, then that is more important, followed closely by profitability.

In summary, most of the respondents from the banking organizations perceived expert systems to improve banking efficiency. However, further analysis of interviews does not provide plausible consensus on ES's impact on banking efficiency. Even though there are positive perceptions on this, one still has to examine the issue in specific areas, perhaps in a quantitative way.

Operational savings. The amount of management time used[39,40] to complete business processes is critical. Its reduction would benefit banking institutions. Time saving has been regarded to provide advantages to the bank such as getting more transactions done and gaining competitive advantages over its rivals. Costs on staff are also a major consideration in the banking business. Savings from staff costs can be a significant benefit.

Firstly, the mean of the 'expert systems can provide significant clerical time and labor savings' is 3.95 with a standard deviation of 0.97. Overall, 79% of the respondents agreed and strongly agreed with the statement. This indicates that most of the respondents perceived ES providing significant clerical time and labor savings.

Secondly, the mean of the 'improvement in the utilization of management time' is 3.58 with a standard deviation of 0.69. Overall, 58% of the respondents strongly agreed with the statement. This indicates that over

[39]Davenport, T. H., *Process Innovation: Re-engineering Work through Information Technology*. Harvard Business School Press, Boston, 1993.
[40]*Op. cit.* Ref. 6.

half of the respondents perceived ES as improving utilization of management time.

However, the difference between these two percentages shows more people perceiving benefits towards clerical and labor savings than the utilization of management time. Generally, interviews have given strong support to this aspect. Time saving is the dominant effect that expert systems have brought into banking business. These aspects were confirmed by several senior IT managers.

In one bank, the senior manager in the particular business area reported that:

> When we brought in this expert system it was to reduce the clerical work. So basically it is to reduce the number of staff, to reduce the manual tasks which could be processed by machine.

He continued:

> When the system was installed, we managed to release four staff into other work. So basically, it was a labor saving device.

In another bank, the senior manager elaborated on this:

> "What we have been able to do in some areas is to reduce head-count and save staff resources. That has been the biggest impact. Allied to that is significant savings in managerial time where there have been a lot of manual processes to bring in information and then make the decision … there have been some head-count savings with significant managerial time savings."

An interviewee from another bank also reported that:

> In terms of the way we went, certainly, clerical time and labor savings, and customer satisfaction are the major benefits, they virtually went hand in hand.

Thirdly, staff productivity is one of the major desired effects of information technology applications. When asked this question, a mean of 3.37 was obtained with a standard deviation of 1.01. Overall, 74% of the respondents perceived that expert systems increase staff productivity.

The technological head of a bank stressed that:

> Productivity is the main thing. As I said this is about cutting the time down, which I guess is product and service quality as well, improving productivity, and service quality, which is what we were trying to do.

In interviews with two other senior managers, they both ranked staff productivity improvement as the second most significant effect just after efficiency or product and service quality, respectively. Clearly, within those banking organizations researched, expert systems are perceived to have positively affected staff productivity.

In summary, for the respondents from those British banking organizations, expert systems were perceived to have led to operational savings. However, the benefits have to be evaluated with the particular systems the organizations used. Like many other technologies, ES has long been regarded as a tool to facilitate specific banking processes and those perceived benefits within operations may be some dominant factors in considering ES adoption.

Risk management. When asked about the extent to which expert systems have affected on the provision of better risk management, 84% of the postal questionnaire respondents believed that ES had given some or a lot of help. The mean for the statement is 4.11 with a standard deviation of 0.81. This indicates a strong central tendency towards the positive perceptions of ES providing benefits to risk management processes.

Successful risk management is probably vital in banking. The analysis of interviews indicates that 9 out of 14 telephone interviews with ES adopters and all five field interviews revealed significant benefits perceived by the respondent organizations in risk management processes.

A senior member from a major bank said that:

> It is clear that intelligent systems have a major role, … can have a significant contribution into anything to do with risk. It has got a lot to offer in this area.

The following quotation was obtained from a senior staff of another bank. He confirmed that:

> … the two most important (benefits) are better risk management and the time saving element, or the efficiency element if you like. Certainly, in the consumer market, we have not got the number of managers to cater on a one-to-one basis with the volume of customers that we have got and we have proved that, by using these systems on a portfolio basis the decision process is more efficient than myself, or some of my colleagues in analyzing a set of propositions in this environment. And the efficiency is far greater. So, I think that we have seen the risk management improvements have significantly improved. That is the overall risk management, the on-going risk in decision process.

He further stated:

> We have in fact just implemented a system which uses these to suppress low risk customers if they go above their credit limit or go overdrawn without a limit. If they are of low risk we don't report them to the manager to have a look at, we only report medium to high risk customers. So we are starting to use these expert systems in a very proactive way at the moment.

Another bank's experience in business loan application also confirmed that:

> In terms of this application, better risk management was one of the most important (benefits) because they were trying to control risk situation. Those three (savings, customer satisfaction and risk management) cover 90% of the reasons we did the job (of applying ES).

A senior manager from a major building society then gave a further comment on risk management.

> I would argue, probably if I apportion the weighting, I would say 60% on the process, 40% on the risk management.

Risk management is a challenge in the banking business. Risk judging is not a task that every bank employee can do well, which calls for bank policy, professional knowledge, industry specific experience and many years of on-the-job training. These requirements suit features of expert systems. To summarize, both the questionnaire responses and the interviews support the proposition that better risk management has been perceived within most of the banking organizations.

Management control. Questionnaire responses show that there is no central tendency towards expert systems' positive perceptions on top management control. The mean of 'ES can improve top management control' is 3.21 with a standard deviation of 0.98. The overall percentage of respondents who agreed and strongly agreed to the statement is only 42. This clearly indicates that expert systems are not perceived to provide leverage on top management control.

In telephone interviews, one senior manager ranked top management control as the least significant effect of expert systems, while another one gave it the ninth place in importance before communication between managers and wider and deeper exploration of alternatives.

Management control is a broad area and ES are generally not seen as a tool to facilitate this. The respondents' experience was not related to

management control, what they were familiar with was the specific business areas like fraud detection and the help desk. Those areas are not specifically called for management control. This implies that ES may be most suitable for business areas. In summary, there is no consensus perceptions among respondents on the issue of improvement of top management control.

Expertise distribution. Like any other business, the banking business also relies on expertise drawn from many years of learning and practice. When asked about the extent of expert systems' contribution to the broader distribution of expertise throughout the organization, less than 63% of the respondents perceived that ES provided 'some' and a 'lot' of assistance towards this. The mean is 3.37 with a standard deviation of 1.01. This is clearly indicated as a contradictory finding with conventional perceptions on expert systems.

Interviews revealed some disagreements with postal responses on this particular point. One bank's experience confirmed that:

> We tend to view it as a way of providing easy access to less skilled staff. For example, in the bank, you cannot have an expert at every branch, what you can have is an expert system, something that can give you 90% of the expertise. That is the perception here at this end.

Another also confirmed that:

> What they [expert systems] can do is to make the expertise in the form that makes them more widely available.

A senior banking manager perceived this aspect as the third important effect just after customer satisfaction, clerical time/labor savings. Clearly, there are differences between results from the questionnaire and interviews.

Exploration of alternatives. The mean of the 'ES can assist staff to make deeper and wider exploration of alternatives' is 3.47 with a standard deviation of 0.70. Overall, only 47% of the respondents agreed and strongly agreed with the statement. This indicates that most of the respondents perceived ES as not assisting the exploration of alternatives.

In telephone interviews, one senior manager from a bank stated that it was the second least important aspect just before 'communication between managers'. To conclude, there is no central consensus towards ES effects on exploration of alternatives.

The analysis of the findings on various banking operational factors has given some evidence on expert systems' effects on banking organizations. In particular, expert systems are perceived to have positively affected banking efficiency, operational costs and risk management.

Organizational aspects

This part of the analysis on organizational aspects will focus on the broader areas of ES impacts such as bank profitability, market share of business, banking products, the number of bank customers and customer satisfaction.

Bank profitability. The mean of the 'ES can significantly increase bank profitability' is 3.63 with a standard deviation of 1.01. Overall, 63% of the respondents agreed and strongly agreed with the statement. This

indicates that over half of the respondents perceived ES as significantly increasing bank profitability.

The senior staff in a bank stressed that the use of ES was:

> To improve the profitability, improve the bottom line cash profit, and reduce cost. Primarily, using the systems is to reduce cost.

Although increasing bank profit may be an important effect, it was only regarded by the above manager as the fifth most important one after product/service quality, productivity, bank customers and efficiency.

This understanding has been reflected in interviews as one measure to reduce cost. Information technology, expert systems in particular, has been used primarily to reduce cost of operations. Therefore, it is reasonable to conclude that expert systems are perceived to have delivered improvements in bank profitability, perhaps in an induced way.

Market share of the business. Market share of any business is important in the evaluation of any business' performance. Expert systems' effect on this side of the business performance is interesting to study. The mean of the 'ES increase the market share' is 2.84 with a standard deviation of 1.17. Overall, only less than 32% of the respondents perceived that ES has some or a lot of effect on market share. This indicates that most of the respondents perceived ES as not providing much help towards market share.

Interview analysis suggests an induced market share benefits from adopting expert systems. For instance, a senior manager from a bank stressed that:

> It increases market share, certainly. Initially it reduces costs. Hence increasing market share is further down the line.

However, another respondent objected and explained that:

> "I would not really want to make a case about market share in terms of improvement from expert systems."

Another senior staff members from a different bank ranked the market share benefit as only the seventh important effect of organizational performance after product/service quality, staff productivity, bank customers, efficiency, profitability, and new banking products. One senior staff member from a building society regarded it as the fifth important effect after efficiency, productivity, bank customers, and profitability.

However, market share would be increased indirectly by using expert systems or neural networks as one of the respondents confirmed:

> Quality of service is certainly the important aspect. One of the important things we do is quality of service. If we do not supply quality service, we lose our customers. Neural networks or expert systems are very much in the area to increase quality of service. Market share is a different thing. Market share is important, we do not use it specifically. We use neural nets obviously to help … then adopt a strategy to increase market share with certain products. At the moment, what we are doing is to improve quality and reduce cost, quality is essential.

Market share is an important business concept and of practical significance. It is an aggregate effect that draws many efforts from business activities. If ES has any effect on it, expert systems may be only a contributing factor in this long process.

As a result, it is difficult to conclude that expert systems are perceived to have provided direct contribution toward the increase of market share of the banking business, although in-depth interviews showed a tendency that ES usage was leading to the increase of market share.

Banking products. There are two aspects relevant to this particular item of impacts. The first is about the quality of banking products; the second is the number of new banking products introduced.

First, the mean of the 'ES improve product/service quality' is 3.26 with a standard deviation of 0.93. Overall, 79% of the respondents perceived that ES provided some effects on product and service quality. This indicates that most of the respondents perceived ES as improving product and service quality.

The various interviews with adopter organizations gave support for the assertion that expert systems provide quality improvements in product and services. For instance, one of respondents gave the top rank to product and service quality well ahead of other performance-specific indicators.

In assessing their benefits, another senior manager suggested that:

> The quality of services and consistent application of the service—your company policy, that's where expert systems have provided the most applications.

I conclude that expert systems are perceived to have positively affected the quality of banking product and services. However, there is no evidence that they provided direct help towards developing new banking products.

Bank customers. Two aspects seem to be particularly important: the number of bank customers; and customer satisfaction.

Number of bank customers. The mean of the 'ES increase the number of bank customers' is 2.37 with a standard deviation of 1.21. Overall, only 16% of the respondents perceived that ES provided some and a lot of effects on the number of bank customers. This indicates that the majority of the respondents perceived ES as not providing much help towards increasing the number of bank customers.

This suggests that there is no consensus on the perception that expert systems had a direct effect on the number of bank customers, although there was a comment that 'It was acquiring new customers for the bank', from one bank manager. However, this point may have some connection with the competitive advantage which the banks gained through the use of expert systems.

Customer satisfaction. The mean of the 'ES increase customer satisfaction' is 3.26 with a standard deviation of 0.81. Overall, only 37% of the respondents perceived that ES provided some and a lot of effects on customer satisfaction. This indicates that most of the respondents perceived ES as not providing much help towards customer satisfaction.

However, in-depth interviews seem to provide an opposite tendency towards ES effect on customer satisfaction. For instance, one senior staff member stated:

> There are areas where, first of all, you increase customer satisfaction by making information easily available to people, secondly, you can allow people to experiment without fully exposed. Say, for example, somebody could use expert systems to find out how much different loans would cost, whether or not they would like to get a loan, and this makes them more confident by doing that, without actually exposed themselves to a person. So, there is that level that you are using expert systems to facilitate that. That will clearly lead to customer satisfaction.

Another bank's technological head added that:

> In terms of the way we went, [clerical time] and customer satisfaction are the most significant effects, they virtually went hand in hand.

The interviews with another two banks confirmed that customer satisfaction is among the most significant improvements effected by expert systems.

One of the above two further elaborated in the face-to-face interview that:

> Customer satisfaction is, there is no doubt, the prime mover.

What seems certain from those interviews is the agreement that ES has been perceived to provide better customer services. It is therefore valid to conclude that expert systems are perceived to improve customer satisfaction and that ES are perceived to have no direct contribution towards the number of banking customers.

Summary. As a summary for this section and the earlier one, it is necessary to analyze an interesting aspect. The respondents were asked in the postal questionnaire to give their views on the statement 'There is no managerial/organizational benefits' with reference to their perceptions. The mean is 2.11 with a standard deviation of 0.94. Overall, only 26% of the respondents agreed with the statement. This clearly indicates that there is a central perception tendency that expert systems are not perceived as providing no managerial or organizational benefits.

Expert systems are perceived to have positively affected some parts of organizational performance. Specifically, it has affected bank profitability, quality of banking products and services, customer satisfaction and staff productivity. However, it seems that there is not much direct impact on their market share, number of new banking products and number of bank customers, and it appears that there are indirect links between market share, number of bank customers and the use of appropriate ES applications.

Decision making

Two main points will be discussed on the aspects of decision making. These are the structure of decision making and the performance of decision making. Further to that, within the performance part are the quality of decision making, consistency of decision making.

The structure of decision making. First of all, there is an issue of centralization of decision making. The mean of 'Expert systems can be used to centralize decision making' is 3.42 with a standard deviation of 0.96. Overall, 58% of the respondents agreed and strongly agreed with the statement. Thus, a small majority of the respondents perceived that expert systems can be used to centralize decision making.

Secondly, concerning the statement that expert systems can devolve decision making to lower management/clerical levels, the mean of this variable is 3.84 with a standard deviation of 0.90. Overall, 74% of the respondents agreed and strongly agreed with the statement. Thus, the majority of the respondents perceived that expert systems can be used to devolve decision making to lower management levels.

Thirdly, concerning the statement whether expert systems can promote decentralized decision making, a mean of 3.68 was obtained with a

standard deviation of 0.48. Overall, 68% of the respondents agreed with the statement. Clearly, the majority of the respondents perceived that expert systems promote decentralized decision making.

Thus, questionnaire responses suggest that expert systems were used to both centralize and decentralize decision making. This result clearly requires further research.

Interviews show that both centralization and decentralization were supported by using expert systems. However, it is interesting to note that the decisive effect or structure of decision making is not determined by the use of ES, but by a combined mix of technological features and the business organizations.

In summary, expert systems have been used in both ways, i.e. centralized structure and distributed (de-centralized) manner. Evidence seems to support this conclusion and how it is to be used depends on the business structure and needs.

Performance of decision making. Major indicators of decision making performance studied in this research include the quality, the consistency and the capability of decision making.

Quality of decision making. Within the questionnaire responses, when asked about the extent expert systems had helped in the improvement of the quality of decision making, 74% of the respondents perceived that ES provide some and a lot in improving decision making quality. The mean is 3.84 with a standard deviation of 0.90. Thus, the majority perceived that expert systems helped towards improving the quality of decision making.

One interview respondent emphasized that:

> Quality of decision making was certainly and dramatically improved, very dramatically in some areas.

Clearly, interview results support the improvement of decision quality and this should be confined within specific successful systems developed and used by banking organizations. In summary, the quality of decision making is perceived to have been improved with the use of expert systems by most of the respondents.

Consistency of decision making. Consistency of decision making implies that if there are identical decision conditions, there should be a very similar or identical decision result. For example, if a bank customer is looking for a loan, he should be treated in the same way in several banking outlets of the same bank, then we can say that the banking organization has got very good levels of decision making consistency. This consistency has been revealed through most of the telephone interviews to be critical in banking business.

The mean for 'ES improve the consistency of decision making' is 4.21 with a standard deviation of 0.79. Overall, 89% of the respondents perceived that ES provided some and lot in improving decision making consistency.

On the improvement towards the consistency, one senior manager replied:

> Absolutely. One of the prime reasons for using something like this could be that Mr A working in any outlet of the bank would give the same advice. If somebody could prove that they get better advice at this branch than that one, there would be a disaster. The consistency of advice, it may be consistently

> wrong, but has to be consistent. We put our hands on our arms and say that we are giving the best advice we can everywhere. This is why we would want to use such things.

These interviews clearly suggest that ES are perceived to provide remarkable consistency towards decision making activities and it is a dominant benefit ES have on banking organizations.

Expert systems have affected positively on the quality and consistency of decision making in most of the banking institutions. However, there is no agreement to the claims that expert systems tend to centralize decision making or decentralize decision making in banking institutions.

Competitive advantages

Within the questionnaire responses, when asked their perceptions on ES' effect on increasing competitive advantages, 63% of the respondents provided that ES increased competitive advantages. The mean is 3.58 with a standard deviation of 0.90. Thus, over half of the respondents perceived that expert systems helped towards increasing bank's competitive advantages.

However, when asked differently, the questionnaire responses revealed that 42% of the same respondents perceived that expert systems contributed some or a lot to increasing competitive advantages. The mean is 2.11 with a standard deviation of 1.10. These two indications are somewhat contradictory.

Analysis of the interview transcripts revealed some significant insights. There are several channels through which expert systems deliver competitive advantages to banks and building societies. Some of the channels are identified by this research: improving competitive positioning; enhancing productivity and improving performance.

When discussing this, a senior manager from a major bank reported:

> Mainly competitive advantage. If you let somebody know that you are looking at X, then they know it's worth looking at and will look as well. It's like credit scoring, if you get an advantage by passing all the bad debts to your competitors or bad risk to your competitors, then you have got two benefits. In one sense, you get good customers, likely, they are getting the bad ones. So as soon as somebody knows you have done credit scoring exercises, the chances are that they will build one themselves, so your competitive advantage disappears. If you keep still, it will become easier.

In conclusion, expert systems have been perceived as positively affecting competitive advantage in most of the banking organizations researched even though the questionnaire responses are somewhat contradictory. Interviews specifically support this assertion in terms of application processes. To conclude this section, it is supportive to use the following comments from a major bank:

> Fraud system does give us competitive advantages, but not many management teams can build one. One thing with fraud problem is that they will try somewhere else. You can't actually stop it overall. But you can, by having a good fraud prevention system (the detection system), make them try somewhere else. So, it has a double benefit to us. It makes us better, makes others worse. So, in that sense, it has a competitive advantage.

ES adoptions and perceived ES impacts

This section of the paper reports the analysis of the relationship between ES impact perceptions and ES diffusion. A variable of ES diffusion (the number of ES applications used by each responding banking organization

at the time of postal questionnaire) was added to *Table A.1* and further analysis by using correlation analysis was performed. The Kendall correlation coefficients are given in *Table A.2* of the Appendix together with the number of cases and two-tailed significance.

From *Table A.2*, there is only one positive correlation between ES diffusion and benefit perception on increasing customer satisfaction. The Kendall's coefficient is 0.45 with significance at 0.023 level. The rest of the supposed relationship does not exist or exists with very low correlation and at significant levels statistically. Thus, a conclusion can be made that the adoption for expert systems does not correlate with IT management's' perceptions on ES benefits.

Conclusions and future research

There is a general tendency among IT management that there are perceived ES impacts on process-related organizational aspects. ES were perceived to provide benefits to a range of banking processes. A striking reoccurring characteristic is process-related benefits. Almost all process-related ES applications such as in the risk management and decision making quality are perceived to benefit from employing expert systems. Not surprisingly, organizational level aspects such as bank profitability and competitive advantages are mostly unconfirmed. This appears to suggest that process-oriented value analysis may be more appropriate in evaluating IT impact than adopting organizational level measures.

The finding of knowledge or expertise content in ES-applied banking business processes is not surprising since it confirms the traditional understanding of ES features to those processes. This finding thus supports the general view that there is a certain match between an innovation and its application areas.

The findings on issues of decision making structure and competitive advantages are intriguing. ES are found to neither support decentralization nor promote centralization of decision making. This clearly fits the social-technical model of information technology research in that social systems adapt the technology in a way that interactions occur. The management may be in a better position to promote one or the other.

The issue of competitive advantage has long been of practical and research concerns. This particular study has found no sufficient evidence that ES improved organizational competitive advantages in general and this also coincides with the issue of market share improvements. This, however, does not rule out the fact that some organizations obtained competitive advantages by using ES technology. Thus, the issue of competitive advantages may be better tackled and evaluated in specific business areas.

However, the current literature suggests that perceived benefits on an innovation promote the adoption of that particular technology.[41] Perceived ES impacts are not related to ES adoption. This issue is interesting to discuss further. To illustrate this contradiction to most of the current literature, an extract from an overview of this study is indicative:

> The reason why we decided to use ES was because we saw some benefits from their use. We believed those companies (that used ES) and when evaluating expert systems, we found that there could be common approaches to a problem. There will be a consistency of the solution and that was the reason we did it. Business needs, probably. Certainly it wasn't IT push, and it wasn't from the

[41] *Op. cit.* Ref. 2.

business, either, but we felt, we could gain value from using expert systems for business people.

Two explanations may be useful to note. First, IT management's perceptions may be different from that of those in a higher position in the business, and IT management's perceptions may be important and help the decision of the top management, but may not be final or decisive in adopting ES. This may suggest that perceptions of an innovation from higher business main stream positions may constitute somewhat different and more appropriate indicators for technological diffusion. Second, technology managers may tend to rank technological benefits more favorably by their potential to appreciate emerging technologies than those having less knowledge on technologies.

Future research

The method to study ES diffusion is both quantitative and qualitative. However, there are other methods which can be used to conduct this type of research. In addition, some related issues need further research.

Case studies

A study of the domain experts, developers and the end users would be useful. Such studies would no doubt provide a fruitful understanding of the projects, their success/failure, and the key factors within the process of development and usage. In addition, case studies may study ES diffusion with other factors such as organizational culture, organizational management style and its competitive environment.

Research can be undertaken to examine both successful and less successful ES cases. Organizations which do not use ES or neural networks may have experienced failures of development. Studies of those ES projects are as important as the studies on successful ES. They would apparently contribute to the understanding and development of ES systems.

Longitudinal studies

A fruitful area of research would be to participate fully in the adoption and diffusion of ES applications in banking organizations, and to observe what is going to happen if it is a successful implementation. A longitudinal study is recommended for such a research on the impact of information technology on organizations. Longitudinal analysis is an effective means to determine the effect over time of the firm's performance using measures such as actual economic and financial indicators of performance and related activities.

Impact of information technology is time dependent, i.e. IT impacts can be assessed more appropriately after a certain amount of time has elapsed since its implementation. Investigators should make a 'before' and 'after' analysis. This implies that a longitudinal study will be appropriate and valuable in order to derive a more profound conclusion in situations where ES may not necessarily result in immediate benefits.

However, before such research can be undertaken, gaining access to the organizations is critical. The organizations must allow the researcher to be with the development team and be involved in other follow-ups, and allow him access data needed after ensuring the necessary confidentiality. In this

way, the researcher can then study the impacts of the technology over time.

Smaller retail banking organizations

This current research only studied the large British retail banking organizations. Further research into the rest of the retail banking organizations would be appropriate to discover the extent of ES usage among those of the smaller scale banking organizations, and would also fill the gap this research did not attempt. Smaller organizations may have a different orientation towards things like ES investment, ES usage and impacts on organizational activities. Such research would provide more insights on both the aggregate retail sector and also on the difference of ES practice between large and small institutions.

Specific business process

Expert systems are applied within specific business areas. Some further studies on specific processes would improve the understanding of artificial intelligence applications and obtain useful practice guidance. This may involve studying several cases of one particular application area to investigate issues such as adoption predictors, development, evaluation, maintenance and impact which may be interesting and useful for both researchers and practitioners. In this way, it makes comparisons possible among different cases.

Decision making

It is well perceived that the quality of decision making is improved. The issue of centralization or decentralization, however, is not yet resolved, although this research has shown some interesting (but somewhat conflicting) findings on this issue. Different approaches may be used or designed to investigate this further. One approach to resolving this is to demonstrate that expert systems are moderating rather than independent variables. A moderating variable changes the relationship between two other variables and is not responsible directly for changes in the dependent variable. Thus, the structure of decision making may be 'caused' by more fundamental influences such as organizational structure, environmental uncertainty, technology, size of the organization, but expert systems may strengthen this relationship.

Studying the structure of decision making affected by the use of expert systems may be more appropriate as the technology has been regarded as a decision making (support) tool and, therefore, this investigation is useful both for researchers on the nature of the systems and for the practitioners on their improvement and re-engineering of business processes.

Competitive advantage

This research has demonstrated that the use of expert systems can bring competitive advantage to some organizations. However, some questions still need answering: How long can the organization retain the advantage? Does ES' application advantage last longer than other IT systems? How can a business translate the advantage into real business benefits?

Appendix

In this appendix, management's perceptions on ES are presented in *Table A.1.* ES adoption and perception of ES' benefits are given in *Table A.2.*

Table A.1 *Management perceptions on expert systems*

	Abbreviation	Mean	Std Dev.	Min	Max	*N*	% of ''4'' and ''5'' s
They can provide significant clerical time and labor savings	ClrLabSav	3.95	0.97	1	5	19	78.9
They can allow better use of data	DataUse	3.89	0.81	2	5	19	73.7
They can significantly increase bank profitability	BankProfit	3.63	1.01	1	5	19	63.2
Expert systems can be used to centralize decision making	CenDM	3.42	0.96	1	5	19	57.9
Expert systems can increase competitive advantage	ComAdva	3.58	0.90	2	5	19	63.1
Expert systems can improve banking eficiency	BankEffici	3.58	0.61	2	4	19	63.2
Expert systems can devolve decision making to lower management/ clerical levels	DevolDM	3.84	0.90	2	5	19	73.7
Expert systems can promote decentralized decision making	DecenDM	3.68	0.48	3	4	19	68.4
They can improve top management control	MgtContr	3.21	0.98	1	5	19	42.1
There can be improved utilization of management time	UseMgtim	3.58	0.69	2	5	19	57.9
There are no managerial/ organizational benfits	NoMgtBft	2.11	0.94	1	4	19	26.3
They can assist staff to make deeper and wider exploration of alternatives	ExpAltern	3.47	0.70	2	5	19	47.4
They can improve our understanding of problems	UdesPrbm	3.58	0.77	2	5	19	52.6
Top management's commitment towards expert systems is crucial to their success	TopMgtIm	4.21	0.98	2	5	19	84.2
Increase staff productivity	StaffProdu	3.37	1.01	1	4	19	73.7
Increase your market share of your business	Mrkshare	2.84	1.17	1	5	19	31.6
Lead to introduction of new banking products	NewProdu	2.58	1.17	1	4	19	26.3
Improve the quality of decision making	DMQualit	3.84	0.90	2	5	19	73.7
Improve the consistency of decision making	DMConsist	4.21	0.79	2	5	19	89.4
Increase competitive advantage	InrsComAdv	3.11	1.10	1	5	19	42.1
Increase the number of bank customers	BkCustom	2.37	1.21	1	5	19	15.8
Improve product and service quality	ProdSerQli	3.26	0.93	1	4	19	15.8
Increase customer satisfaction	CusSatisf	3.26	0.81	2	5	19	36.9
Provide better risk management	BetRiskMg	4.11	0.81	2	5	19	84.2

continued overleaf

Table A.1 *Continued*

Shorten training cycles for new members of staff	ShortTrain	3.16	1.07	1	5	19	47.4
Allow broader distribution of expertise throughout the organization	ExptsDistr	3.37	1.01	2	5	19	52.6

ES diffusion	Numbers of expert systems that the banking organizations have adopted at the time of postal questionnaire are 8, 3, 1, 20, 2, 2, 6, 2, 2, 3, 1, 1, 2, 0, 0, 0, 0, 0, 0, for the nineteen banks, respectively

Table A.2 *ES adoption and perception of ES' benefits*

	ES adoption		ES adoption		ES adoption
ClrLabSav	0.0789 N (19) Sig 0.691	UseMgtim	− 0.0409 N (19) Sig 0.840	IncrsComAdv	0.1320 N (19) Sig 0.496
DataUse	0.2987 N (19) Sig 0.132	NoMgtBft	0.0458 N (19) Sig 0.816	BkCustom	0.2392 N (19) Sig 0.215
BankProfit	0.2127 N (19) Sig 0.278	ExpAltern	0.1704 N (19) Sig 0.400	ProdSerQli	0.0237 N (19) Sig 0.905
CenDM	0.0157 N (19) Sig 0.937	UdesPrbm	0.0 N (19) Sig 1.000	CusSatisf	0.4500 N (19) Sig 0.023
ComAdva	0.1013 N (19) Sig 0.608	TopMgtIm	0.1421 N (19) Sig 0.478	BetRiskMg	− 0.0560 N (19) Sig 0.780
BankEffici	− 0.0177 N (19) Sig 0.932	StaffProdu	0.2069 N (19) Sig 0.309	ShortTrain	− 0.2904 N (19) Sig 0.136
DevolDM	0.0312 N (19) Sig 0.874	Mrkshare	0.0072 N (19) Sig 0.970	ExptsDistr	− 0.0897 N (19) Sig 0.647
DecenDM	0.0380 N (19) Sig 0.857	NewProdn	− 0.0873 N (19) Sig 0.652	DMQualit	0.0857 N (19) Sig 0.664
MgtContr	0.0075 N (19) Sig 0.970	DMConsist	− 0.1802 N (19) Sig 0.374		