Chapter 3 - Research Methodology

Introduction

This chapter discusses the approach implemented in this research. The rationale for using a combined interview and Delphi survey approach is explained. The validity of using the Delphi survey based on previous researchers' implementations is given. The development of the research questionnaire based on the literature review undertaken in the preceding chapter, plus the testing of the questionnaire is elucidated. Finally the research phases are discussed in detail.

Analysis of Research Approach

All research has a philosophical perspective. Neuman (1997) describes three approaches to social science research which can be classified as *interpretivist, posivitist, or critical.* A *posivitist philosophical perspective* is based on formal propositions, quantifiable variables, hypothesis testing and the drawing of inferences, reality is objectively given and described by measurable properties. A *critical philosophical perspective* is an action oriented approach that attempts to empower individuals to transform their situation for the better. *An interpretive philosophical perspective* is based on hermeneutics and phenomenology and infers that the access to reality is through shared meanings, language and consciousness. When implementing an interpretive philosophical perspective the research method needs to focus on utilising the complexity of human understanding of the process and context of the information system.

The philosophical perspective of this research is ***interpretive*** in that

- the dependent and independent variables are not pre-defined, and
- its aim is to produce an understanding of the process whereby the context influences and is influenced by the information system.

Fergusson and Shaw's (1996) analysis of IS research literature found that the research can be classified as either *interpretivist* or *posivitist*. They maintain that it is vital for researchers to describe the relevance of their research and in fact the ability of the researcher to make generalisations, to replicate and to refute their research findings are secondary to its relevance.

> "If the IS discipline wishes to become more 'applied' then the focus will have to be more oriented toward building knowledge by problem solving." (Fergusson and Shaw, 1996, p.226)

For research to be relevant, specification of the target audience and the aim of the research should accompany the problem solving focus. The research method implemented should be subject to the phenomenon and the environment being studied. The audience for this research is the practitioners rather than the theorists, the phenomenon is the *effectiveness of investment in IT in education* and the environment is the secondary school arena.

> "A research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection." Department of Management Science and Information Systems, University of Auckland (1997)

The *qualitative research* approach is chosen because it uses text and data to understand and explain social phenomena. The quantitative research approach is not suitable, to the current research because the goal of understanding the social or institutional context is lost when such methods are implemented (Kaplan and Maxwell, 1994) The motivation to undertake qualitative instead of quantitative research is the unique ability of people to talk and explain their social or institutional context. The sources of data most suitable for qualitative research are interviews and questionnaires; however observations, field work, documents, texts, researcher's impressions and reactions can also be useful. The Case Study is the most common form of qualitative research. It could be argued that given the relatively low number

of participants a Case study approach would be adequate to obtain the information required. Whilst agreeing that a Case Study is suitable for gathering information, the reason for not using it is that in interpreting the results of the interviews the interviewer's bias is more likely to be present. The Delphi Survey provides a method for structuring the group communication process that enables the group to deal with complex issues and problems. The strength of the Delphi Survey is the ability of the group to alter, add or delete any aspect identified by the researcher in the analysis of the interview data thus it ensures that any interviewer bias is minimised.

The modes of analysis for qualitative research refer to the approaches for gathering analysing and interpreting the data, some of these include semiotics, narrative and metaphor, grounded theory and hermeneutics. The interpretive perspective of the current research is based on hermeneutic analysis whose objective is to make sense of the whole, including people's relationships, the organisation, and information technology. In implementing hermeneutics the researcher needs to be aware that the underlying biases of the researcher can affect the outcomes of the research. To attempt to ameliorate this bias the researcher has implemented two techniques. Firstly the interview questions are based on the literature research into IT effectiveness, IT investment, IT in Small Business, IT in Education, and the edicts on the use of IT in schools - Department of Education in Victoria. Secondly the use of the Delphi Survey approach is used after the initial interviews of the participants.

The research approach involves three components:

1. A literature research on which to base the interview questions
2. Interviews of the participants
3. A modified Delphi where the information obtained in the initial interviews is collated and fed back twice to the participants for ranking and rating.

Validity of the Delphi Survey

> "The Delphi Technique is a method of eliciting opinions or judgement which provides respondents with an opportunity to revise earlier views when presented with additional information." (Cary and Salmon, 1976)

The fundamental tools include:

- *The ability of the group to contribute to building the list.* This research implements the interview process for this purpose.
- *The application of specific voting capabilities.* The participants rating of the issues identified by the researcher, plus the ability to delete issues not deemed relevant and add issues considered important is the mechanism used.
- *The sorting of the list by voting results.* The analysis by the researcher of the results of the participants rating and the production of new lists enables this to occur.

The Delphi Survey is not only a method for structuring the communication process but allows the group as a whole to deal with complex problems. The group is usually of thirty to one hundred participants. It is commonly applied using a pen and paper communication, but is also conducted using Computer Mediated Communication Systems. In this research the group is limited to thirteen participants utilising a combination of the pen and paper approach, facsimile, and Computer Mediated Communication Systems, email. The participants chose which medium to use. Some were forced to use the facsimile because of software incompatibilities between the researcher and participant's systems. It has been found that the major contribution to the quality of pen and paper Delphi is the analysis of the results of each round by the researcher.

The objectives of the resulting analysis should be to:

- provide a clear presentation of the views expressed thus improving the

understanding of participants,

- find and reveal biases, disagreements, ambiguities, omissions, information patterns, and sub-group positions,
- enable examination of complex situations,
- focus on critical items

Every effort has been made in this research to ensure that the above objectives have been adhered to in the analysis of the initial interviews and the resulting lists provided to the participants for ranking and rating.

A good Delphi allows each participant the opportunity to express personal judgement about what problem to deal with at any time in the group problem solving process. This *asynchronous interaction* between participants is the most important aspect of a Delphi. It enables the participants to:

- participate when they want to,
- contribute only to those aspects important to them,
- include something they believe is worthwhile,
- revise and add contributions over time.

In this research participants are given opportunities for asynchronous interaction. Firstly the participants only participated in the research if they wanted to. On more than one occasion a principal had given approval for the research to be conducted in the school and the proposed participant declined to be involved. The interview was arranged at a time convenient to the participant, more than once the participant changed the interview time as other more pressing issues had arisen. The subsequent ratings of the issues by the participant did not require the presence of the researcher and so was able to be done when the participant was so inclined.

Secondly the interview questions were deliberately designed to be open ended. This enabled the participants to contribute only those aspects important to them, and include any details they felt worthwhile. Analyses of the interview response views were used to create the initial list containing a rating of issues (See Table 4: The Initial Key Issues) The second list of rated issues (See Table 5: Model #1 Results) was based on the collated responses to the initial list by the participants, and included extra issues provided by participants and indicated where participants had deleted issues and why. The final list of issues (See Table 7: The Final Key Issues) resulted from the analysis and collating of responses to the second list. Thus at all stages throughout the process the participants were given the opportunity to contribute only to those aspects important to them, and include something they believe is worthwhile.

Thirdly providing the participants with a facsimile or email list of issues, to be returned at a later date, facilitated the opportunity for participants to revise and add contributions over time.

> "Perhaps the property that most characterises the Delphi method in the mind of most people is the use of anonymity." (Turoff and Hiltz, 1997)

A pen and paper Delphi provides anonymity because it removes the biases present in face-to-face situations. Thus the participants can contribute knowing that they can raise unsuitable and questionable ideas, and change their minds from their initial ideas, without their status influencing the responses from other participants, nor having the fear of identification. This research has ensured anonymity by having the participants rate, delete and amend issues, and return them to the researcher who collated the results and re-distributed them.

Turoff and Hiltz (1997) stress the importance of the participants of a Delphi believing that they are communicating with a peer group. They maintain the primary factor in motivating involvement is the participant's belief that they will obtain valuable insights from other participants. Great care was taken by the researcher to identify the

secondary schools that are perceived by their peers as leaders in the area of IT. This information was conveyed to the participants so they were aware that their school is perceived as a leader in the area of IT. Interestingly, of the thirteen participants, only one questioned their inclusion in the research.

A primary requirement of the Delphi approach is the need to structure and organise material in a manner to make sense to the group. The most difficult aspect of a good Delphi is the need to define the whole communication structure into a framework so that it produces a group view and synchronises the group process. This was achieved by trialing the initial interview questions to ensure clarity, thus there was rarely any necessity for the interviewer to elaborate on any of the questions. The subsequent lists of issues distributed to participants were accompanied with clear explanations of what was required. One participant remarked as to how easy this process had been.

Similar Research in a Comparable Domain

Use of the Delphi Survey in Identifying Key IS Issues

The Delphi approach has proved useful in obtaining a group view from perceived experts in their fields. This has been used in the IT area to establish key information system management issues by Dickson et al (1984), Watson (1989), and Pervan (1993).

Dickson et al (1984) from the University of Minnesota's Management of Information Systems Research Centre (MISRC) conducted a pen and paper Delphi survey with a leading group of IS professionals. The reason for using Delphi was that it enabled a greater level of consensus on the key IS management issues than would be obtained using a standard survey. Initially the participants were asked to identify and describe five to ten major issues. These were then collated into a combined list of issues and rationales. Participants reviewed the combined list on three subsequent occasions. At each stage the researchers established a new aggregate group ranking. Dickson et al (1984) found that this process provided a systematic way of sharing valuable, diverse

perspectives. They stated of the Delphi survey that

> "Its success here may point to other possible uses in information systems research." Dickson et al (1984, p.145)

The search for a consensus, or group view, on the key issues on investment effectiveness in education was the aim of this research, consequently the Delphi survey as indicated by Dickson et al (1984) was perceived as the most suitable research tool. Their approach for obtaining the initial list was replaced by open-ended questioning at the individual participant interviews. The reason for using an interview, and not simply asking for a list of key issues, was that IT investment in education is relatively new, unlike IS management, and there is not a collective understanding of the issues involved.

Watson (1989) used a three round Delphi study to identify the ten top critical information systems management issues facing IS managers in Australia. The purpose of his research was to indicate to IS managers the problems they are facing and to indicate where they should be directing their resources. He did not start with an open-ended questionnaire but instead used the issues resulting from a 1987 study conducted at the MISRC. His rationale for this decision was that the key concerns of managers in Australia would not be vastly different from those in the USA. He asked the respondents to rate all issues rather than rank the top ten issues. The rationale for this decision was that the information processing power of humans to identify and rank issues is limited if a list of issues is greater than seven. In the current study twenty-six issues were identified on analysis of the interviews, consequently it was decided to ask the participants to rate them rather than rank and select key issues.

Pervan (1993) utilised a three round Delphi approach to rank in order of importance the key IS management issues facing IS managers of large Australian companies. He used an identical approach to Watson (1989) in that the key issues were obtained from the MISRC's 1991 study. Pervan included an appendix with his research tool; the *Key Information Systems Management Issues.* The design of this tool was used as a

basis for the development of the tool used in this research (see Appendices 4 and 5). A list of key issues for ranking was distributed to participants in the two rounds of the Delphi approach.

The Interview

Doukidis et al (1992) used semi structured interviews lasting at least one hour using a questionnaire of forty seven questions with forty IS executives from leading Greek companies. The firms were chosen because they had maintained steady growth over for three years, had a good reputation, were leading firms in their sector, and their IS managers were highly respected. Doukidis et al (1992) found that the interview approach enabled them to produce a picture of the key issues of concern to these IS executives. This research has based its interview approach on the one conducted by Doukidis et al (1992). The schools were chosen in a similar manner, based on their perceived leading role in IT. The interviews were conducted over at least an hour, based on a questionnaire of thirty-six open-ended questions (see Appendix 1 – Interview Questions). The participant's responses were invaluable in producing a picture of the key issues in investment effectiveness in IT in the education arena. To maintain context validity each school participant was interviewed by the same person using the same questionnaire.

Research Phases

The Interview Questionnaire

In attempting to identify whether intrinsic criteria exist and are used by IT management in the school sector for evaluating the effectiveness of IT investments, it was vital to ensure that the questionnaire elicited these criteria.

Thus the development of the questionnaire was perhaps the most difficult task of the whole research project. It was essential that the questions asked were open-ended and did not limit the responses of the participants. The sequence of the questions was carefully analysed to ensure that the preceding questions did not influence the

participants' responses. The initial three questions were easy, unchallenging and closed ended, clearly relevant to the purpose of the study and aimed to build up the participant's confidence that they would be able to answer the rest of the questions. Extensive research into IT effectiveness and IT investment in the business arena, IT effectiveness in small business, and IT in education, was used as a basis for identifying the key issues to be raised as questions and ensure content validity. The subsequent questions were designed to make allowance for the possible total lack of criteria in schools so that the participants could indicate the criteria they believed appropriate even if they were not currently being employed within their school.

> "The wording of questions is perhaps the most difficult and important task in questionnaire construction. Improperly worded questions can only result in biased or otherwise meaningless responses. An essential prerequisite for developing properly worded questions is to have a clear conceptual idea of just what content is to be measured." Judd et al (1991, Page 234-235)

In an attempt to eliminate as many problems as possible with the wording of the questionnaire it was tested for clarity and suitability on a very experienced secondary school teacher, and a manager of a Computing Services Department at a TAFE. After each of the trial interviews amendments were made. The questions were revised until the interviewer was convinced that the questions were being interpreted in the same manner by all interviewees, thus obtaining content validity. The second interview only indicated one ambiguity and it was therefore deemed unnecessary to undertake further trial interviews. The finalised interview questionnaire of thirty-six questions (See Appendix 1 – Interview Questions) was used, unaltered, on all participants. It encouraged free flowing discussion of the issues relating to investment effectiveness in IT in education. The participants were generous in the time they allowed for the interview with many exceeding one-hour. Many commented favourably on the structure and content of the questions.

Interview Questions Sources

The questionnaire was in four sections, the first already mentioned above, and the other three sections to obtain relevant information. At the end of every section there was a question to ensure that nothing had been omitted, (See Appendix 1 – Interview Questions). The content questions were aimed to elicit the impact the philosophy of the school had on IT, gain an understanding of IT investment within the school, and to establish the effectiveness of IT. The questions are based on the findings of previous researchers detailed in Chapter 2, the Literature Review.
Sources are referenced below:

- Question 4 – strategic alignment of IT in schools, Kaplan and Norton (1992), Fink and Tjarka (1994), Berger et al (1988), Fitzgerald (1993) and Singh (1993), Revell (1997), Feeny and Wilcocks (1998), Falconer and Hodgett (1996)
- Question 5 – school's goals for the utilisation of IT, Education Victoria, Goals for Classrooms of the Future (1996)
- Question 6 – actual use of IT, Carter (1996) and Jonassen (1995).
- Question 7 – way teachers are using IT, Rodrigues (1997).
- Questions 8 – educational and technical support available to staff, Rodrigues (1997), Blackmore et al (1996).
- Question 9 – in-house knowledge in schools, Igbaria et al (1997), O'Mahony and Dampney (1996), Riffel and Levin (1997)
- Questions 10 and 11 – involvement of various stakeholders in IT, and their level of satisfaction with IT, Revel (1997), Palvia (1996), Igbaria (1997), O'Mahony and Dampney (1996), Hope (1996)
- Question 12 – adequacy of schools' IT resources, Blackmore et al (1996)
- Question 13 – attempts to subvert IT strategy, O'Mahony and Dampney (1996)
- Question 15 and 16 – proportion of school budget spent on IT, and adequacy of this investment, Mahmood and Mann (1993), Cronk and Fitzgerald (1996)
- Question 17 – basis of IT investment, Rai et al (1997)

- Questions18 and 19 – objectives of investment and priority of those investments, Weill and Broadbent (1994)
- Question 20 – justification for IT investments, Clark (1996), Taninecz (1996)
- Questions 21 and 22 – infrastructure vs non-infrastructure investments, Education Victoria (1996), University of Toronto Advisory Forum on Instructional Technology (1993), Weill and Broadbent (1994)
- Questions 23, 24 and 25 – decision making on investing in IT, Stager et al (1994), University of Toronto Advisory Forum on Instructional Technology (1993),
- Question 26 – stakeholders role in IT investments, Thong et al (1996), Hope (1996)
- Question 28 and 29 – determinants and reflectors / indicators of IT effectiveness, Scott's MIMIC Model (1995)
- Question 30 – importance of external support to effective use of IT, Palvia (1996), Thong et al (1996), Alavi et al (1997)
- Question 31 – impact of school management on IT effectiveness, Igbaria et al (1997), Lang et al (1998), Palvia (1996)
- Question 32 – relevance of size of school to effectiveness in IT, Thong et al (1996), Palvia (1996), Falconer and Hodgett (1996)
- Question 33 – IT's biggest impact, Kearsley (1995), Carter (1996), Jonassen (1995)
- Question 34 – internal and external influences on IT effectiveness, Grover et al (1996)

The process of developing the questionnaire was undertaken concurrently with the canvassing for the "experts". A problem existed because there are currently no clearly established experts in IT in Victorian schools. An initial task was to obtain the names of secondary schools who have a reputation for excellence in IT / IS. The following sources were used to obtain names of suitable "expert" schools to participate in the project: the General Manager of Information Technology Division

Education Victoria, Department of Education, the Information Services Unit of the Catholic Eduction Office, the Independent Schools Union, the Federal Union of Teachers, suppliers of Learning Technologies products and services, and of other IT products in the Education sphere, university lecturers, TAFE teachers and Computing staff, SOFWeb and SOFNet, teachers in State and private schools. The names were ranked according to the frequency of recommendation.

It was hoped that ten participants would participate in this research. Anticipating considerable attrition, the first sixteen schools on the list were approached. Prior to this, approval had to be obtained from Education Victoria, Department of Education (DoE) and the Catholic Education Office to undertake research in their schools. The Learning Technologies section of the DoE requested that their Navigator and Science and Technologies Centres be involved (six in all).

Letters were sent to the principals of the schools requesting approval for the project to be conducted in that school and for access to the member of staff who was the designated "Head of IT" within the school (See Appendix II – Letter of request to School Principals). It was recognised that "selling" the project and obtaining agreement from the schools to participate in the whole Delphi process may be a difficult task. More emphasis was therefore placed on the fact that all participating schools would receive a copy of the resulting model for assessing IT effectiveness in investment thus providing them with valuable information for decision making on investment in IT.

The letter was followed by a telephone call to the principal to ensure that the letter had been received and to obtain verbal approval or rejection of the proposal to participate. Several had not received the letter and so facsimiles of the letters were sent to them. Fifteen principals agreed to participate and gave permission for the researcher to approach the staff person involved. Thirteen of these participants were interviewed and involved in the two round Delphi. There were five State schools, two Catholic schools and six private schools represented.

The Interviews

The participants were contacted by phone to establish a time suitable both to them and to the researcher, at this stage it was stressed that the interview would take at least one hour. Interviews were conducted in Northern Victoria, Geelong and in Melbourne from the inner city to the outer suburbs. Considerable time and travel was involved. It was hoped that the interviews would be conducted over a one-week period as the researcher had taken a week off work to do these. However it took nearly three weeks.

Before starting the interview the participants were asked to read and complete the Participant Agreement Form (see Appendix III – Participant Agreement Form). They were asked to agree to the interview and the two rounds of the Delphi. All participants agreed to the use of a tape recorder and for the researcher to make notes. Both the notes and especially the tapes proved invaluable in the analysis of the interviews.

The participants were furnished with a copy of the questionnaire. This proved very useful as it allowed the participant to refer to the questions as they were answering them and consequently concentrate more effectively on their answers. The initial questions related to the role of the participant. These were deliberately designed to be non-threatening and give the participants time to relax. Interestingly there was a wide variety of roles, the majority had a dual role as Head of Learning Technologies or Curriculum with a small teaching component, the next most common was Director of Computing, finally there was one Business Manager and one principal. Three clearly defined separate sections prefixed by a brief explanation formed the rest of the questionnaire (see Appendix 1- Interview Questions). These were:

- Questions about the relationship of the IT goals and objectives to the school's goals and objectives.
- Questions about investment in IT.
- Questions about IT effectiveness.

There was only one question, number twenty-one, which raised any problems. The researcher identified this with the initial participants and prepared a brief explanation, which was verbally given to all further participants thus ensuring that it was interpreted in the same way by all involved.

There were plenty of opportunities for the participants to expand on issues. At the end of every section they were asked if there were anything they would like to add regarding the aspect under discussion. This was rarely used and a frequent comment was "I think I have covered everything". The participants were very generous with the time they allocated to the interview and were obviously interested to receive a copy of the final ratings.

Round 1

An in depth three stage analysis of the results from the interviews was used to develop the initial key issues, twenty-four in all (See Appendix IV– Model #1). These issues were ranked in order of the frequency of the occurrence in the interview process. These key issues were then emailed or faxed to the participants. They were asked to rate each of them on a ten point scale with ten the highest and one the lowest, to delete any criteria which they considered not relevant, and to add any omissions. The reasons for inclusion of extra criteria or deletion of irrelevant ones was requested. Thus construct validity was ensured. They were asked to return them to the researcher as soon as possible. It was found that the response rate was slow and many emails and phone calls had to be made to get the initial key issues back.

Round 2

The data from the participant feedback to the initial key issues was collated and re-ranked according to the ratings given by the group. When new criteria were added the rationale given by the respondent for the inclusion was included. Any requests for alterations and deletions also were clearly identified with their participant's rationales. Columns were inserted to this list to indicate the group's mean value for the criterion, and the value given by the individual participant, (See Appendix V – Model #2). This

re-ranked list with all the amendments was then forwarded to the participants for re-rating, deleting, and adding. This process was only repeated twice as time did not allow a true consensus to be achieved.

The Key Issues

On completion of the second round the results (See Appendix VI – Model #2 Feedback) were analysed and a set of ten key issues was elicited from this feedback as representing the group view of IT investment effectiveness in education.

The Final Model

Finally the full research findings were analysed in the context of the current literature and a Model of IT Investment Effectiveness in Education was derived. This was included in a report which was then sent to all participants and to the principals of all participating schools. Initial responses to approaches made for finding suitable participants had indicated that the results of this research were eagerly awaited by the schools.

It is anticipated that this model, and the research findings from the interviews will be suitable for further research into investment effectiveness in IT. Recommendations are included in the final chapter of this thesis.

Conclusion

There is currently no established model of assessing investment effectiveness in IT in the education arena. It was therefore decided that a consensus model was the best way to approach this problem using schools designated by their peers as being "expert". Even though the research group was small it was decided to use the Delphi Model. Because of the anticipated difficulty of getting the "experts" together at the one time it was decided to use the *Pen and Paper* Delphi methodology, used via facsimile and email. It is to be hoped that in future research such as this will be able to be conducted using the Internet chat facility / discussion arena as it is an ideal

medium for experts communicating with each other on a topic.

The use of a set of open-ended interview questions was a necessary pre-requisite to the consensus process as currently there is no agreed criteria available in either the education sector or in the business arena addressing explicitly the effectiveness of investment in IT. This use of open-ended questions was considered most likely to obtain ideas that the researcher has not even considered important but could well be highly valued by the majority of participants.

The following chapter discusses the research results obtained by implementing the research methodology discussed in this chapter.