Evidence Analysis Using CAQDAS: Insights From a Qualitative Researcher

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Abstract: In data analysis the qualitative researcher seeks to produce a convincing explanation of the phenomena under investigation. Data analysis is an iterative process and requires reflection and interpretation on the researcher's part on several levels. Interpretation suggests that there are no clear rules and that the researcher's judgment, intuition and ability to highlight issues play an important part in the process. As a result, the issue as to how to analyse qualitative evidence is an area often poorly understood by researchers new to the interpretivist paradigm. The complexity of the data analysis process is increased due to the volume of evidence collected as part of a qualitative research study. The role of Computer Aided Qualitative Data Analysis Software (CAQDAS) in supporting this data analysis process is examined in this paper. It explores how CAQDAS can be used in facilitating the management of an extensive qualitative evidence base. CAQDAS enables researchers to manage qualitative data that would prove onerous through manual "*pen and paper*" methods. The paper examines the author's use of the CAQDAS package N-vivo in managing approximately 400 pages of single spaced interview transcripts resultant from a study on the evaluation of a new student ICT administrative system implementation in the Irish Institute of Technology (IoT) sector. This was an extensive empirical research study conducted across several case study sites and involved 49 informants and multiple sources of case study evidence. The objective was to develop a coherent cross-case primary narrative of the system's implementation from the evidence collected, reduce this to a set of key findings and ultimately develop a theoretical conjecture that provided fresh insights into the ICT investment evaluation process. The N-vivo package served primarily as a support tool in managing the interview transcripts; in reflecting on the emerging themes; and in interpreting the body of evidence. It facilitated the identification of key points, the coding of key concepts that emerged from the body of evidence, and comparison between these concepts. It supported the later reclassification of concepts into a series of categories and sub categories; this helped to organise related concepts in relation to the overall research and facilitated greater understanding of the body of evidence. It supported the creation of memos to clarify emerging concepts and the categorisation of interview material to facilitate cross-case analysis. Further, it facilitated analysis through for example relationship and model exploration. These features of N-vivo played a vital role in producing a series of narrative accounts and ultimately the distillation of a new theoretical conjecture.

Keywords: qualitative data analysis, CAQDAS, N-vivo, coding, categorisation, memos, interpretivist research, research audit trail

1. Introduction

Qualitative data analysis is a complex process, particularly when large volumes of research evidence is gathered and when the researcher is new to the interpretivist paradigm. The iterative nature of analysis and the importance of researcher reflection, interpretation, judgement and intuition mean that there are no clear rules to follow. Nonetheless, when qualitative analysis is conducted in a transparent manner, and when the logic of the researcher's interpretations can be traced, the interpretivist paradigm often leads to more interesting research findings. The interpretivist paradigm is the one followed throughout this research paper. The empirical research study referred to was centred on the field of ICT evaluation and the evaluation of a new Student MIS in a number of Irish IoTs. Some of the IoTs requested to remain anonymous within the final report and hence are referred to as Site One, Site Two etc throughout this paper. The interpretivist paradigm offered the opportunity to develop an in-depth understanding of the ICT system's impact, as it facilitated the capture of contextual depth and detailed, nuanced descriptions. It emphasises qualitative research methods, which are flexible, context sensitive and largely concerned with understanding complex issues. In the past, many researchers relied on pen, paper and highlighters when analysing their qualitative evidence. However, over the past 20 years, CAQDAS packages have evolved and grown in functionality to support the qualitative analysis process. Following a discussion of the interpretivist paradigm and qualitative research methods, this paper explores the value of CAQDAS in supporting analysis of the evidence gathered for the Student MIS project.

2. The interpretivist paradigm discussed

Interpretivist research is sometimes described as non-positivist, post-positive or qualitative. The researcher is not perceived as being entirely objective; rather he/she is a part of the research process (Rowland, 2005). According to Walsham (2006: 321):-

> *"we are biased by our own background, knowledge and prejudices to see things in certain ways and not others".*

Further, Wheatley (2006) stated:-

> *"we inhabit a world that is always subjective ... Our world is impossible to pin down, constantly and infinitely more interesting than we ever imagined".*

The interpretivist stance is holistic and considers numerous variables including the context of the study (Klein and Myers, 1999). Context is regarded critical. As outlined by Clarkson (2004):

> *"people cannot be understood outside of the context of their ongoing relationships with other people or separate from their interconnectedness with the world".*

Hence, this approach aims to grasp the diversity of subjects' experiences (Kvale, 1996).

Interpretivism recognises the difficulty in making research value-free and objective. In terms of this view, a single objective reality does not exist. The social world does not lend itself to being understood by physical-law-like rules (Snape and Spencer, 2003). Multiple realities need to be considered. These include an external reality, which is what actually occurred in the physical world, and internal realities, which are subjective and unique to each individual (Bannister, 2005). Because each situation is different, the researcher needs to delve below the surface of its details to understand the reality. Bannister (2005) suggested that reality is examined through a series of mental processes or filters. These may include perceptual, contextual, linguistic, memory, sequence, personality, agenda, methodological, selection and temporal lenses. Being aware of these filters allows the researcher to understand the evidence supplied by the informant. The meaning derived by the researcher is a function of the circumstances, the people involved and the broad interrelationships in the situations being researched (Saunders et al, 2007; Veal, 2005). Walsham (2006: 325) maintained that:

> *"the researcher's best tool for analysis is his or her own mind, supplemented by the minds of others when work and ideas are exposed to them".*

Unlike the positivist stance, physical-law-like generalisations are not the end product. Rather understanding through detailed descriptions is sought by answering questions such as "*what*?", "*why*?" and "*how*?"

3. Qualitative research methods

The interpretivist paradigm emphasises qualitative research methods which are flexible and context sensitive (Mason, 2002). In qualitative research, words and pictures as opposed to numbers are used to describe situations. According to Van Maanen (1983: 9) its methods include:-

> *"an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world".*

Hence, it is largely concerned with understanding complex issues (Mason, 2002). In qualitative research, the researcher is actively involved and attempts to understand and explain social phenomena in order to solve what Mason (2002:18) calls "*the intellectual puzzle*". It relies on logical inference (Hinton et al, 2003) and is sensitive to the human situation as it involves dialogue with informants (Kvale, 1996). In general, the researcher collects large quantities of detailed evidence. Thus, qualitative research may achieve depth and breadth (Blaxter et al, 2006; Snape and Spencer, 2003; Veal, 2005). Further, qualitative methods are useful when the researcher focuses on the dynamics of the process and requires a deeper understanding of behaviour and the meaning and context of complex phenomena (Alvesson and Sköldberg, 2009; Snape and Spencer, 2003). It is the most appropriate approach for studying a wide range of social dimensions, while maintaining contextual focus (Mason, 2002).

Conducting qualitative research requires considerable reflection on the researcher's part, and the ability to make a critical assessment of informants' comments. It involves debating the reasons for adopting a course of action, challenging ones own assumptions and recognising how decisions shape the research study. Mason (2002) provided the following guidelines for the qualitative researcher:

- The research should be conducted systematically and rigorously;
- It should be strategic, flexible and contextual;

- The researcher is accountable for its quality and claims;
- He/She should engage in critical scrutiny or active reflexivity;
- He/She should produce convincing arguments.

Qualitative data collection approaches include for example participant observation, observation, documentary analysis, discourse analysis, conversation analysis, biographical methods, case studies, interviews and focus group discussions (Ritchie, 2003). The choice of method is influenced by the nature of the research problem, the researcher's theoretical lens or philosophical assumptions, the researcher's skills and academic politics (Trauth, 2001).

4. The research study and the research methodology

The qualitative research evidence discussed in this paper was collected for a research study in the field of ICT evaluation. The study sought to better understand the ICT evaluation process through evaluating the impact of a large-scale standard student MIS implementation in the Irish IoTs. Interpretivism has grown in importance in IS research in the past decade (Walsham, 2006) and was the predominant philosophical position for this study. The study's research methodology is outlined in *Figure 1*. The case study was the selected research method and was based on data collected from five sources – organisational websites, project documentation, newspaper articles, independent reports and semi-structured interviews. The case study is a key tactic in interpretive ICT research (McBride and Fidler, 2003; Walsham, 2004). It was employed in 36% of research designs studied by Chen and Hirschheim (2004) and was defined by Yin (2009) as:

> *"an empirical inquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between the phenomenon and the context are not clearly evident, and in which multiple sources of evidence are used".*

The case study is appropriate in situations where a single explanation cannot provide a complete account of the research topic. It is suitable for achieving in-depth, holistic knowledge of broad, complex phenomena and in understanding interactive processes, relationships, political issues and influence tactics within specific contexts (Lewis, 2003; Marshall and Rossman, 1999).

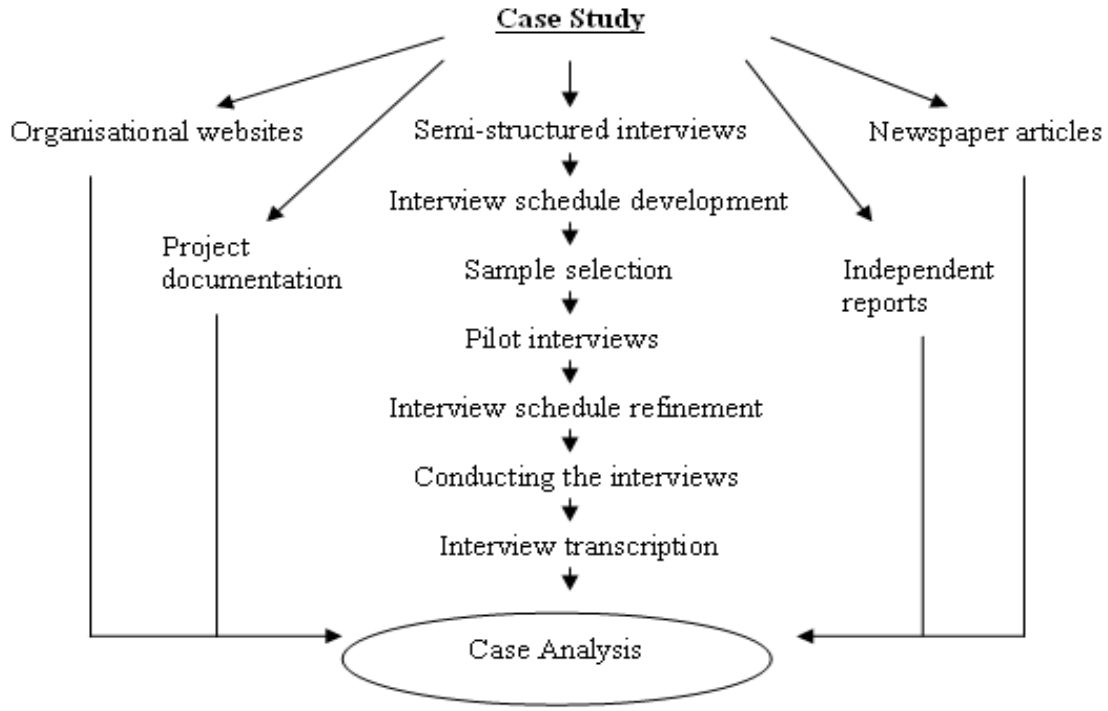

Figure 1: Research methodology

Case studies were conducted within five IoTs. Purposive sampling as opposed to probabilistic sampling was used in case site selection, as this sampling strategy helps ensure that key research themes are addressed and that diversity in each category is explored. The five case sites were

selected due to their diversity in a number of respects. They participated in different implementation waves, were geographically dispersed and differed in their student population sizes and academic programme offerings. The most valuable source of case study evidence was semi-structured interviews.

The interview enables depth, nuance and complexity in data to be captured (Mason, 2002) and is generative in that new knowledge may be uncovered (Legard et al, 2003). Its popularity is linked to its ability to obtain a range of informant views and to communicate multiple perspectives on a phenomenon (Johnson, 2002). It provides an undiluted focus on the informant and offers opportunity for clarification and greater understanding through use of follow-up questions (Legard et al, 2003; Ritchie, 2003). According to Kvale (1996: 1), the interview helps to:-

> *"understand the world from the subject's point of view, to unfold the meaning of people's experiences, to uncover their lived world prior to scientific explanations".*

Interviews involve a dual aspect – personal interrelations between the interviewer and informant, and the knowledge, meaning and understanding that results from their dialogue and interaction. In general, the interview takes place in an interpersonal context which is influenced by power, emotion and the interpersonal process. Hence, in interpreting statements made by informants, the researcher always needs to bear in mind the context in which the interview took place (Ellis and Berger, 2002). As stated by Warren (2002: 98):

> *"in the social interaction of the qualitative interview, the perspectives of the interviewer and the respondent dance together for the moment but also extend outward in social space and backward and forward in time".*

As a result, the interview needs to be considered in terms of biographical, contextual, historical and institutional elements, rather than as a set of discreet questions and responses detached from the interviewer and informant (Fontana, 2002). The nature of interviews is that they may develop or change a person's understanding of phenomena and new subject dimensions may emerge during the process.

Within the IoTs, 49 semi-structured interviews were carried out between 30 November 2005 and 24 May 2006 with senior management personnel, MIS team personnel and system end users. The selected informants were closely involved in the ICT project and had in-depth knowledge of the subject area. The approach I adopted corresponded to what Kvale (1996) termed the "*traveller metaphor"* of interview research. In this approach, the interview process is regarded as the creation of stories; the meaning of informants' stories is uncovered through the researcher's interpretations and these are shaped by the researcher into new convincing narratives of the evidence collected. Hence, the goal was not to extract specific details from individual informants; rather it was to explore questions such as *how?* and *why?*. Each interview lasted between 60 and 90 minutes, was recorded with the informants' permission and was later transcribed. The supporting documentation was valuable in corroborating the evidence collected in the semi-structured interviews. It provided a means of triangulation in that it supplied specific details, and helped to augment and substantiate the interview data.

5. Qualitative data analysis

The challenge for many qualitative researchers lies in analysing the body of evidence gathered. In data analysis the qualitative researcher seeks to produce a convincing explanation of the phenomena, based on a holistic interpretation of the social understandings captured in the empirical data. The difficulty lies in the fact that the researcher is:

> *"faced with a bank of qualitative data [and] has very few guidelines for protection against self delusion, let alone the presentation of unreliable or invalid conclusions to scientific or policy making audiences" (Miles and Huberman, 1994).*

Kvale (1996: 32) suggested that:

> *"precision in description and stringency in meaning interpretation correspond in qualitative interviews to exactness in quantitative measurements".*

Further, Miles and Huberman (1994) stated that:

> *"the strengths of qualitative data rest very centrally on the competence with which their analysis is carried out".*

Data analysis is an iterative process and requires what Alvesson and Sköldberg (2009) termed "*reflexive interpretation*". This is a need for reflection and interpretation on several levels. Reflection requires thinking about the research and as outlined by Alvesson and Sköldberg (2009), it involves examining how:

> *"the theoretical, cultural and political context of individual and intellectual involvement affects interaction with whatever is being researched".*

Interpretation takes place on four levels:

- Interaction with the empirical material;
- Interpretation of underlying meanings;
- Critical interpretation;
- Reflection on text production and language use.

Interpretation suggests that there are no clear rules and that the researcher's judgment, intuition and ability to highlight issues play an important part in the process. Reflexivity is a key requirement for ensuring rigor in qualitative studies (Long and Johnson, 2000). It helps ensure that the researcher considers his/her own values and beliefs, while analysing the evidence collected and acknowledges that his/her actions will impact the context and meaning of the issue being investigated.

6. Exploring CAQDAS – how can computers help?

Computers have played an extensive role in research projects for many years, for example in facilitating interview transcription, in documenting results, and in writing research reports and findings. However, from a data analysis perspective, greater emphasis is placed on the role of computers in analysing quantitative evidence, through use of software such as the Statistical Package for the Social Sciences (SPSS). Many interpretivist researchers are unsure as to how Computer Aided Qualitative Data Analysis Software (CAQDAS) can support the analysis of their qualitative evidence, despite the fact that several books have been dedicated to the topic since the 1990's. Arguments are made by researchers both for and against their merits. Nonetheless, the number of CAQDAS tools available on the market has grown considerably since its first emergence over 20 years ago. Examples of popular tools include N-vivo, N6, HyperResearch, Atlas.ti, MAXqda, Qualrus and many more.

Lewins and Silver (2009) suggest that CAQDAS packages generally encompass some or all of the following tools:

- Content searching tools
- Linking tools
- Coding tools
- Query tools
- Writing and annotation tools
- Mapping or networking tools

The software supports the creation of an efficient data management system whereby large volumes of unstructured evidence can be systematically organised. According to Wickham and Woods (2005)

> *"an efficient and well-structured data management system is critical to tracking, accessing, and documenting the data available and the analyses applied to it".*

This data management system helps the researcher in transforming their research evidence into the final research report in a systematic manner as opposed to "*a disorganised stumble through a mass of data, full of 'insightful' observations of a mainly anecdotal nature*" (Silverman, 2004). CAQDAS can also enhance the transparency of the analysis process: through effective documentation of the researcher's thoughts and interpretations, the logic of the researcher's conclusions can be traced (Wickham and Woods, 2005). It also provides for more rapid and rigorous qualitative data analysis (Rambaree, 2007).

The sophistication of CAQDAS packages have increased considerably over the years; all now have facilities greater than simple code and retrieve functionality. CAQDAS represents an alternative tool to the pen/paper/highlighter/scissors approach previously relied upon. Modern CAQDAS packages

support the administrative mechanics of data analysis, thereby saving time and freeing the researcher from manual, clerical tasks. Activities such as data coding and re-coding; categorising concepts into higher order categories; developing memos of ideas as they emerge, enabling the "write up" of the research to commence early on; annotating pieces of data; creating models; exploring different insights and associations within the data; searching themes; and testing relationships between issues, concepts and themes are easily facilitated. Some CAQDAS also supports work with non-textual data such as pictures, video and audio. CAQDAS enables the researcher to build more easily on his/her existing analysis, through for example adding a new code, or combining codes to create a new category, while still maintaining the "*organisational system's integrity*" (Seror, 2005). Further, the researcher can easily jump between various levels of analysis, for example from a concept, back to the original interview transcripts to explore that concept in context, to a memo exploring the researcher's thoughts on the development of the concept, and so on. This increases the researcher's closeness with the data and ultimately supports development of new theory. In the words of Fielding and Lee (1998: 10):

> *"Of course, one can build theory with paper and pencil, or while in the bath or walking down the street. What the software does is to facilitate and enhance theoretical development, usually by treating codes applied to text segments as building blocks for the production of a set of interrelated conceptual categories…Use of the appropriate software tools allows the analyst to go beyond using codes simply to label or point to relevant themes in the data. Instead, codes become theoretical categories, emerging out of the data, but linked in possibly complex, but theoretically relevant ways.*

Hence, as stated by Richards (2002: 267), CAQDAS enables a researcher to do "more with data" as a result of "a range of techniques and tools that were impossible, unknown or too time-consuming before computers entered the field". However, it is important to note that the software does not do the analysis. The responsibility for deciding on the codes, for the categorisation of concepts etc remains with the researcher. However, it enables the researcher to concentrate his or her energy on the conceptual work of analysis and on reflection and interpretation on the evidence base. As stated by Gill Ereaut, Director of Linguistic Landscapes, UK:

> *"the fact that computers don't think is not a limitation at all; in fact, it leaves the researcher doing what they most want to do - the thinking."*

7. N-vivo discussed

N-vivo (version 7) was the CAQDAS used in this study's data analysis. This package is developed by QSR International, a leading developer of qualitative analysis software, whose products are used by more than 400,000 individuals in over 150 countries. This section provides a brief overview of some features of this tool prior to examining how it supported analysis of the research evidence.

N-vivo's project pad is focused around Documents and Nodes. It supports the direct importing of documents in text only or rich text formats (.rtf). The researcher has full editing rights on all documents, enabling annotations to be added to any point in a document, and links from textual documents to external files can be inserted. It also offers a number of versatile linking devices such as databites, doclinks and nodelinks which increase integration between documents, coded data and memos, which can be created as blank documents and linked to relevant documents or nodes. For example, N-vivo's external databites folder facilitates the storing of large files that the researcher may need to refer to, thereby enabling him/her to maintain contextual richness. N-vivo's coding structure may be un-hierarchical (as represented by its free node structure) or hierarchical (as represented by its tree node structure). The free node feature enables the researcher to code data under a new theme without the need to decide immediately where it fits in relation to the overall hierarchical structure or taxonomy of tree nodes. Unrelated concepts may later be categorised into categories and sub categories facilitating structural organisation of the data. Further, coding stripes in the document margins, offer a high level view of how documents have been coded, visually highlighting which data has been categorised at specific topics.

All data coded under a single node can be retrieved by browsing the node, which takes all coded sections from their original positions and presents them together in one window. The researcher can easily return from this window to the original document to view the concept in context. Various attributes can be assigned at both a document and node level enabling certain characteristics of the data to be defined. The data can be interrogated in various ways, for example qualitative cross tabulations or matrix searches displays search results in frequency table format; its assay tool

provides a high level view of the presence or absence of certain codes, attributes etc in a document or document set; while its modelling tool enables insights and theories linked to the data to be presented in a visual format.

8. Using N-vivo in the student MIS research project

The following sections provide examples of how N-vivo supported the analysis of the student MIS project research evidence.

8.1 Concept creation and management through N-vivo

The N-vivo software package served primarily as a support tool in managing the 387 pages (230,663 words) of single spaced interview transcripts; in reflecting on the emerging themes; and in interpreting the body of evidence. The initial step in using N-vivo involved importing all 49 interview transcripts from Microsoft Word in rich text format. Each transcript was examined to identify key ideas, words or points raised by informants. The concepts that emerged were coded in one of two ways, i.e. using *in-vivo codes* or *in vitro codes*. The terms *in-vivo* and *in-vitro* codes were derived by Strauss (1987) and were explained by Alvesson and Sköldberg (2009). *In-vivo* codes are those that emerge directly from the informants' interview transcripts, in other words they are terms stated by the informants themselves. On the other hand, *in vitro* codes are terms the researcher creates to encapsulate a concept discussed by an informant. Ritchie et al (2003: 221) compared the importance of this coding process to a building's foundation:

> *"If that foundation is ill-conceived or incomplete, then at best it could jeopardise the integrity of the construction, or at worst bring the whole structure crashing to the ground".*

Initially the concepts appeared unrelated and they were coded in N-vivo's *free node* structure (*Figure 2*). This *free node* structure is commonly used for holding nodes early in the coding process, when new ideas do not appear to have clear logical relationships with other nodes. Examples of initial unrelated nodes in the student MIS project included the perceived change required in organisational culture, the issue of integration with other systems, the return on investment potential, the project timescale, and the learning process required for system operationalisation.

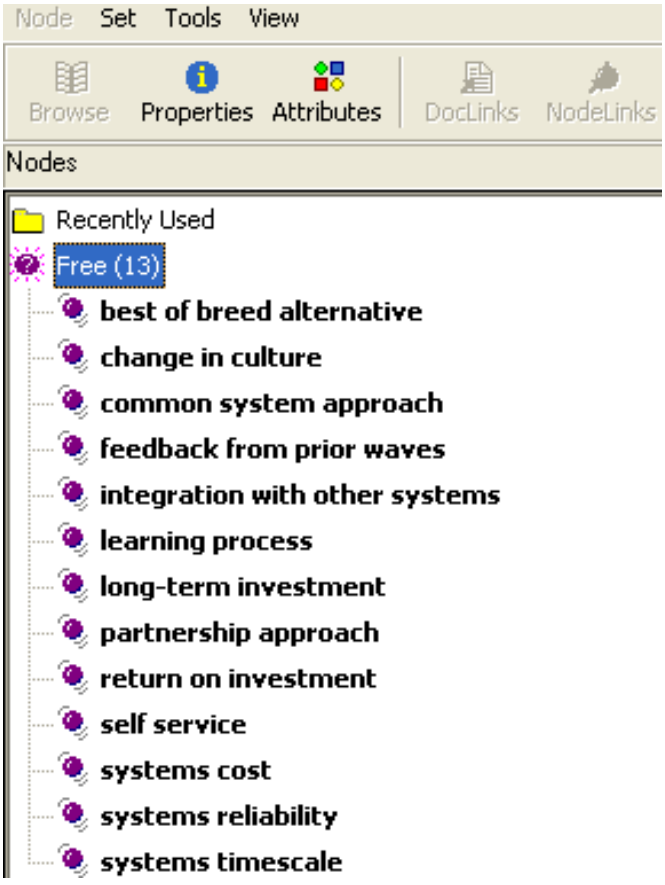

Figure 2: N-vivo's free node structure

As coding progressed, it became apparent that many concepts were related. These were reclassified into a series of categories and sub-categories in N-vivo's hierarchical *tree structure*. This organised related concepts in relation to the overall research and facilitated greater understanding of the body of evidence through examining the key themes. *Figure 3* provides an example of this. Here, the various problems experienced in systems operationalisation, such as a lack of support, a lack of training, problems or glitches in the system's functionality and the issue of staff movement to other functional areas, are grouped under the "*current problems*" tree node. Additional high level categorisations used throughout the project included for example, legacy systems, system implementation, server hosting, human change issues, system start-up problems, system benefits, project evaluation, and system functionality. Many categories were further decomposed, for example the sub categories *"functionality exploitation"* and *"functionality requirements met"* were further branches from the *"system functionality"* tree node.

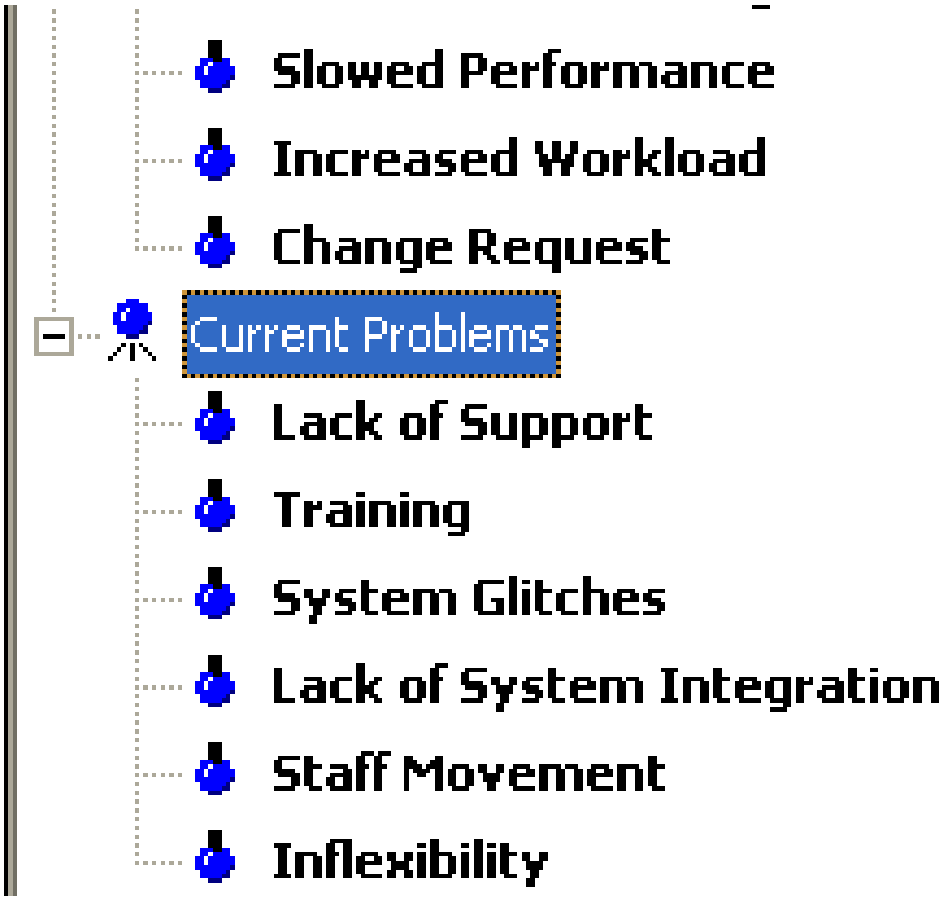

Figure 3: Category creation through N-vivo's tree structure

8.2 Memo creation and development

Memos were created during data analysis to clarify emerging concepts. These were standalone documents; however through N-vivo's *DocLink* and *Nodelink* facilities, these memos were related to relevant documents or nodes. *Figure 4* shows a memo outlining the nature of system commissioning problems; through the Nodelink facility this was linked to the "*Problems at System Start-up*" tree node. The memo feature also enables the researcher's thoughts and reflections on the evidence to be recorded and is therefore a key tool for reflexivity. Memos recorded included not just notes on emerging concepts, but also memo's on the researcher's reflections and experiences, and observations made concerning the context and constraints in which research participants provided information. It therefore aids more conceptual and theoretical thinking about the data.

8.3 Defining document attributes

To facilitate cross-case analysis, various document attributes were defined in N-vivo's *attribute* facility. The documents were categorised according to case-study site, implementation wave and informant type. *Figure 5* shows the creation of the case study "site" attribute while *Figure 6* highlights attribute

values (site 1, site 2, site 3 etc) being created. The relevant values were then assigned to the project documents, thereby enabling a filtering of evidence related to a particular institution, informant etc.

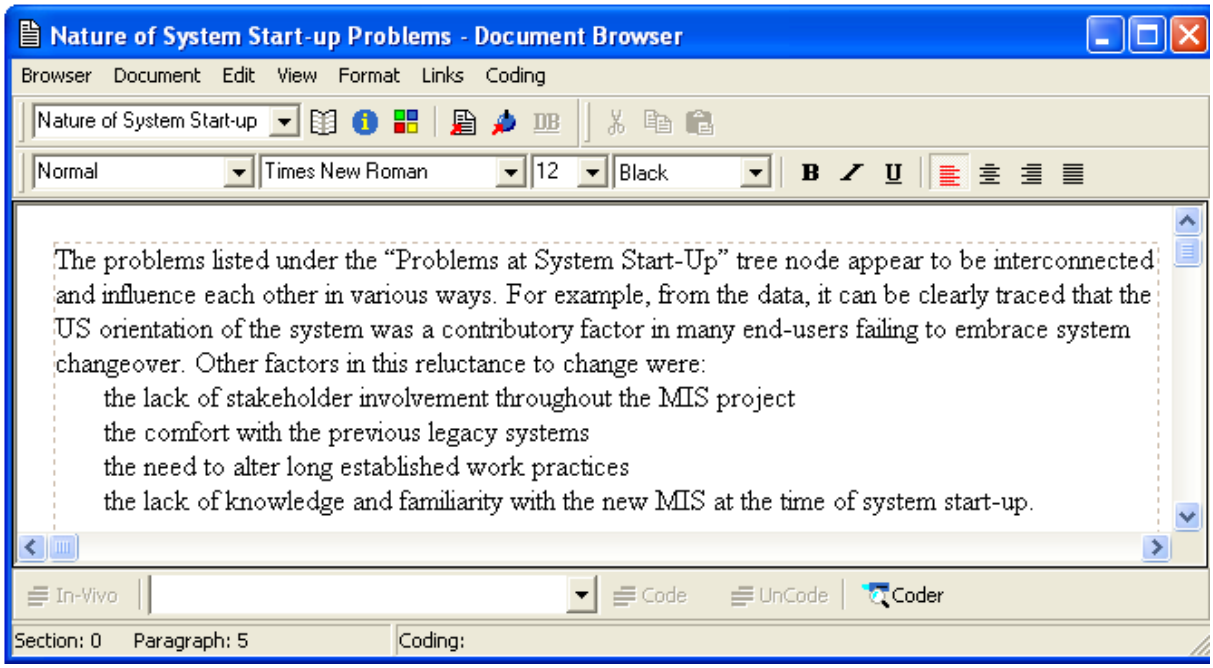

Figure 4: Memo creation in N-vivo

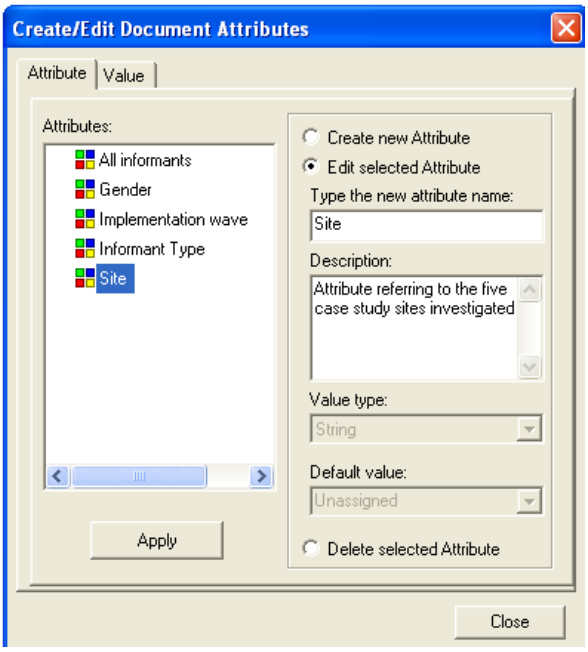

Figure 5: Defining Attributes

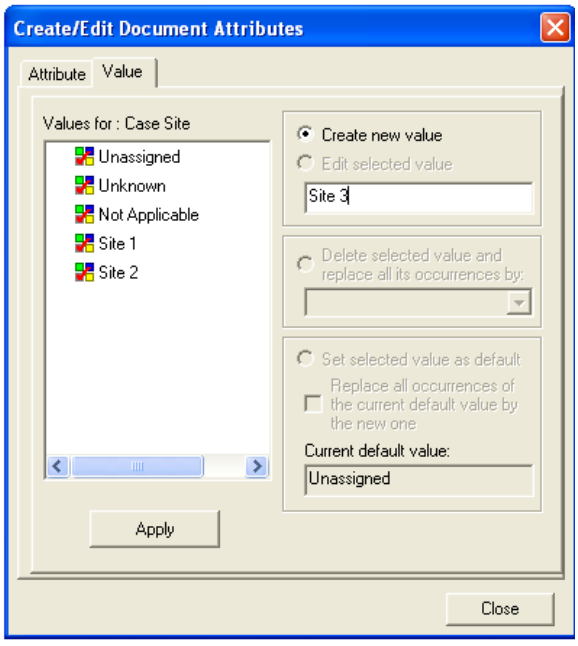

Figure 6: Defining Attribute Values

8.4 Interrogating the data example 1 - cross case tabulation of key issues

The various attributes defined later facilitated cross-case analysis by enabling data to be examined according to different variables. N-vivo's *Matrix Intersection* facility was the most useful application of this, whereby particular text characteristics could be cross tabulated with others. For example, *Figure 7* shows various system benefits categorised according to the case study site in which they were experienced.

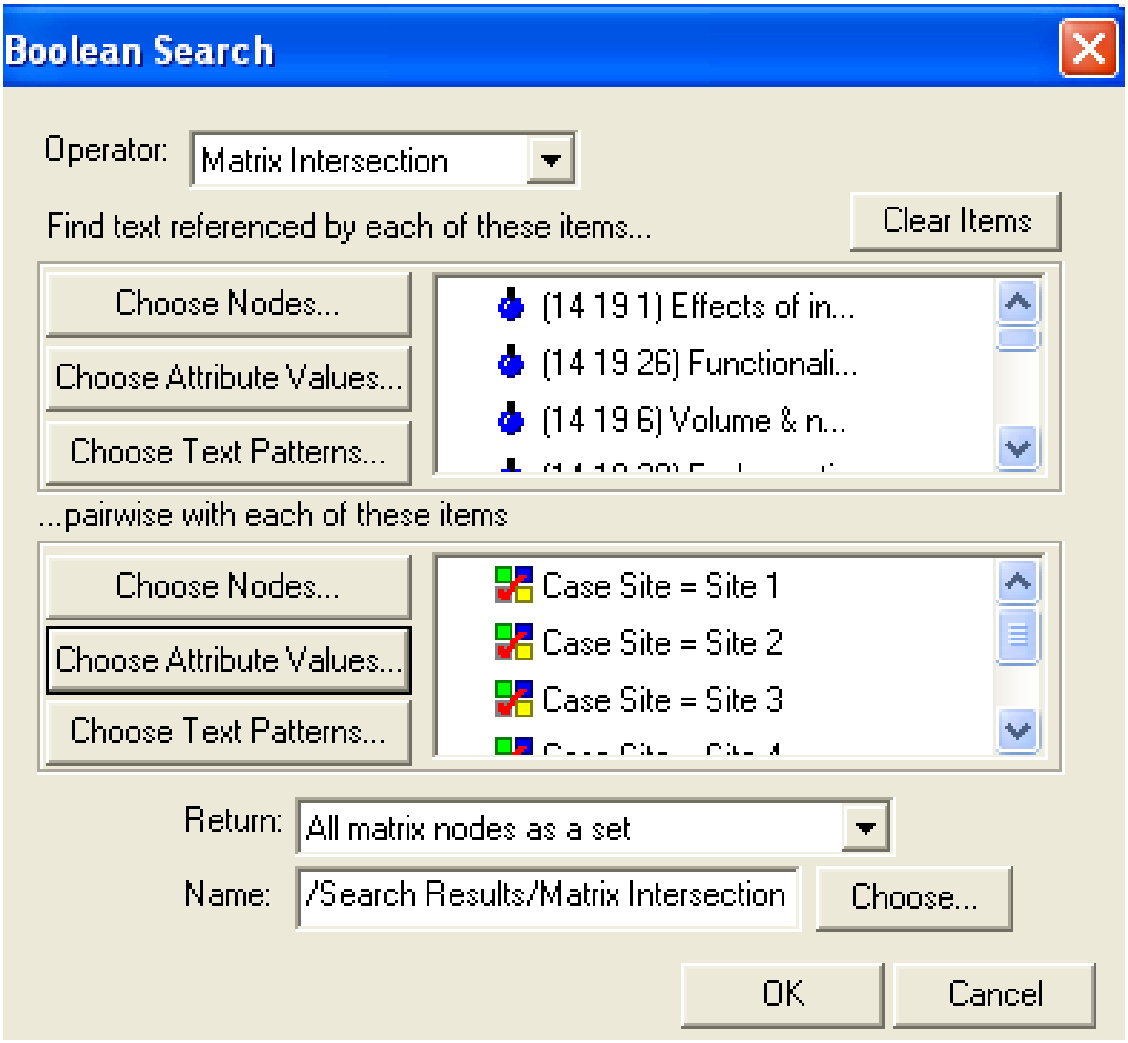

Figure 7: Matrix intersection boolean search

Matrix - (10 36) /Search Results/Matrix Intersection 2

File Matrix Selection

Display: Number of documents coded Show Statistics

Row Header:

Column Header:

Matrix Table	1: Case Site = Site 1	2: Case Site = Site 2	3: Case Site = Site 3	4: Case Site = Site 4	5: Case Site = Site 5
1:(14 19 1) Effects of integration	8	9	6	0	4
2:(14 19 26) Functionality related benefits	2	4	2	7	3
3:(14 19 6) Volume & nature of data	4	5	2	2	4
4:(14 19 20) End reporting	5	2	4	4	0
5:(14 19 10) Improved data access1	2	2	5	2	0
6:(14 19 3) Support related benefit	2	3	1	2	2
7:(14 19 15) Job related benefits	1	1	3	2	1
8:(14 19 4) Improved quality procedures	0	1	3	2	0
9:(14 19 18) Improved structure	1	1	2	0	2
10:(14 19 31) Management related benefits	2	2	1	0	0
11:(14 19 37) Staff empowerment benefits	1	0	2	1	1

Figure 8: Matrix intersection search results

This exercise resulted in a comparative analysis of the nature and frequency of benefits realised in the five IoTs (*Figure 8*). From this we can see for example that the beneficial effects of integration were widely experienced in Site One and Site Two, but failed to be experienced in Site Four, thereby prompting further investigation into the reasons behind this. This enabled exploration of benefit variances between sites and provided a further way to interrogate the data in producing a holistic primary narrative.

8.5 Interrogating the data example 2 – the model explorer tool

The explore model tool facilitates the creation of models. Nodes, documents, attributes, sets etc can easily be dropped on the model template, model layers can be explored, and links between items established. These illustrations of the relations within the data can be readily exported to the final project report. *Figure 9* shows an example of the application of N-vivo's model explorer tool. This model visually depicts a number of the nodes coded, reflecting the key problems and benefits experienced from system implementation, and the various interconnections, as inferred by informants statements, that exist between these issues. For example, the fact that the MIS was an "Americanised System" contributed to the "System Usability" problem, resulting in an "Increased Workload" and "Slowed Performance" for system users. Similarly, the benefit of "System Integration" was the catalyst in the realisation of improved data standards and data access, improved quality procedures, and job and management related benefits.

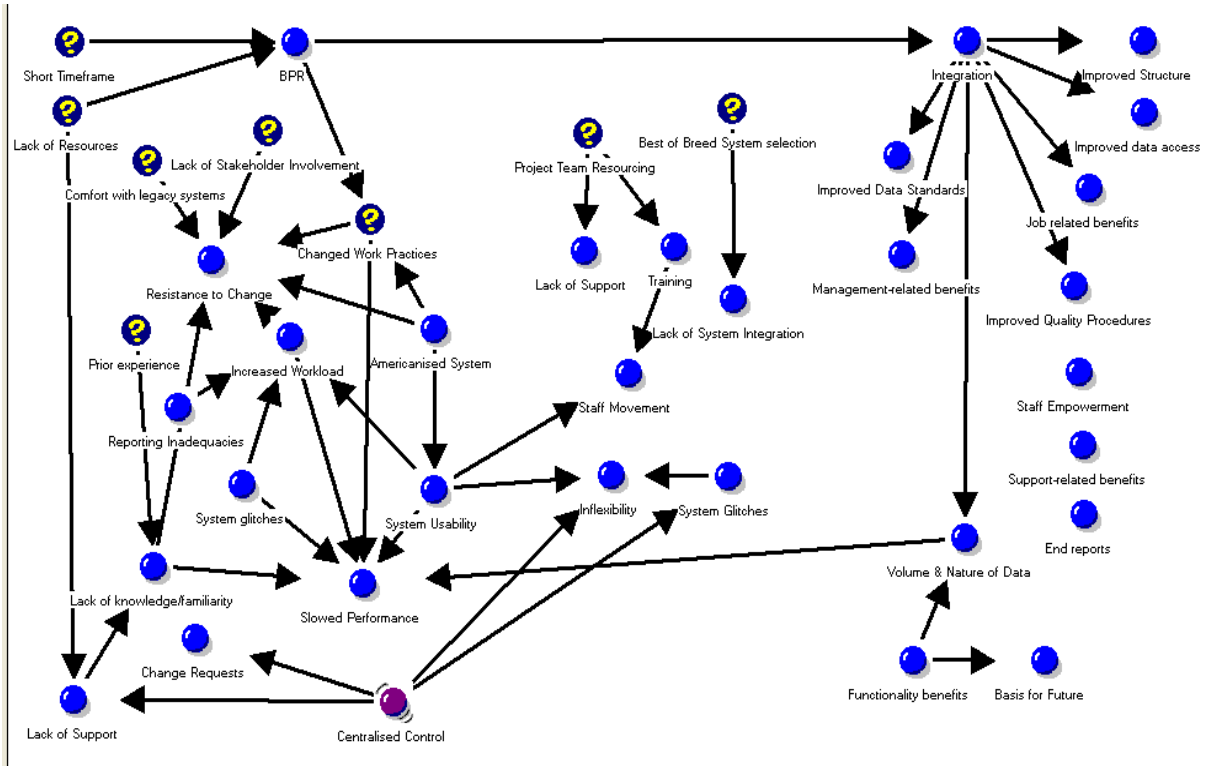

Figure 9: Model explorer example

9. From N-vivo to new theory

The ability to interrogate the data in various ways and to create memo's on the researcher's interpretations in N-vivo were important initial steps in working towards new theory. The key concepts and categories identified through N-vivo coding were initially synthesised into a cross-case primary narrative of the Student MIS project. The use of narratives was key; they are a form of knowledge and communication (Czarniawska, 2004) as complex situations can be better understood in story format. The narrative plays a central role in social life as according to Roland Barthes (1977) (quoted by Czarniawska (2004: 1)), the:-

> *"narrative is present in every age, in every place, in every society; it begins with the very history of mankind, and there nowhere is nor has been a people without narrative…narrative is international, transhistorical, transcultural: it is simply there like life itself".*

They assist in developing a meaningful whole from a series of scattered events (Alvesson and Sköldberg, 2009). Openness to different interpretations is important in order to gain a fuller understanding of the situation (Czarniawska, 2004). Phenomena can be placed in context and key relationships explored (Remenyi, 2005). Hence narratives are a useful means to understand and make sense of interview material. They enable the researcher to shape various interview stories into a coherent account of the key themes (Kvale, 1996). The processes involved in producing this detailed description from the body of evidence are shown in *Figure 10*. The procedures followed in identifying and coding key concepts in N-vivo suggest that the story produced closely relates to the actual events as perceived by informants. This increases the potential for the research having direct theoretical implications.

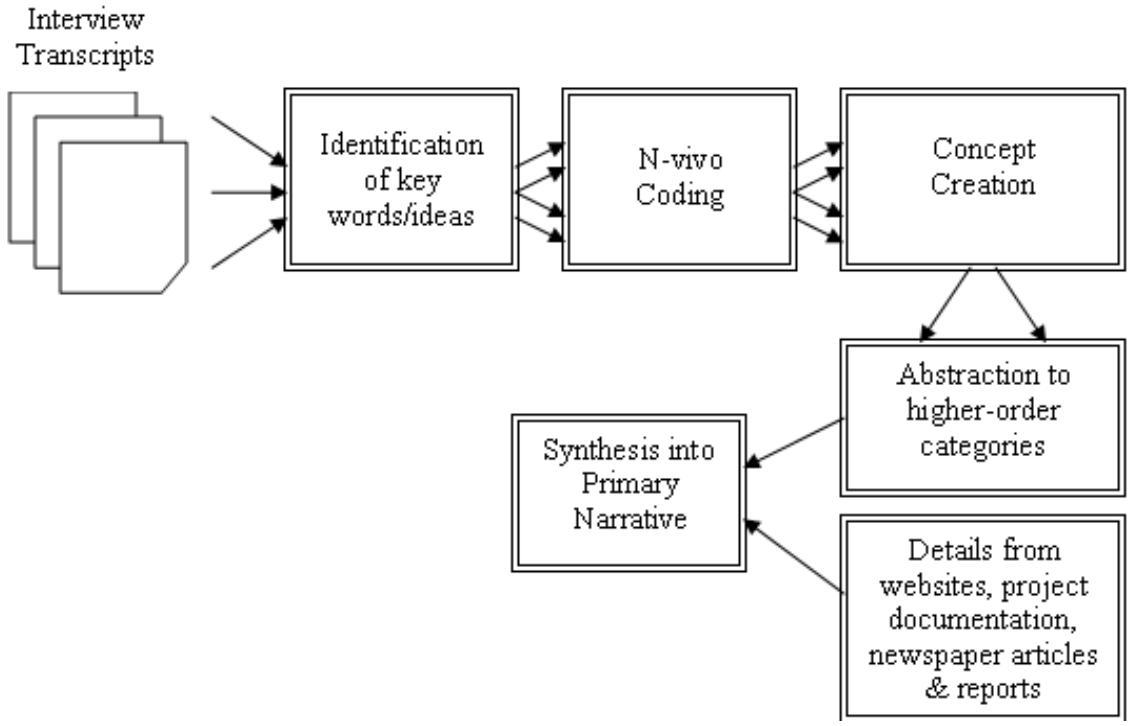

Figure 10: Development of primary narrative

Progression to the higher-order narrative involved significant reflection on the empirical evidence and the primary narrative. A higher order narrative was defined by Remenyi et al (1998: 126) as:

> *"a description which both captures the essential aspects of the information represented in the primary narrative but provides a more parsimonious conceptual framework in which the ideas, concepts and relationships have been defined".*

Reflection on the primary narrative involved considering three questions: "*what does the text say*?" "*why does the text say what it does*?", and "*what is my understanding of what is taking place*?". This approach was useful in providing a conceptual separation of three ways of examining the primary narrative and in expanding my interpretation over a series of stages. Through this process the primary narrative was reduced to the principal findings or key themes, and the nature of relationships was interpreted. This process involved both creativity and flexibility (*Figure 11*). Diagrammatic representation was important in understanding the phenomenon's diversity and in exploring relationships and complex processes.

Re-trawling the higher order narrative, to establish relationships between the findings and the extent to which they influenced each other, was the basis for developing the theoretical conjecture. The theoretical conjecture reflected a distillation of the knowledge acquired through data analysis. Its development and refinement were based on iterative reflection. Further, the in-depth analysis process suggests that it was a convincing approximation of the truth (Bannister et al, 2006).

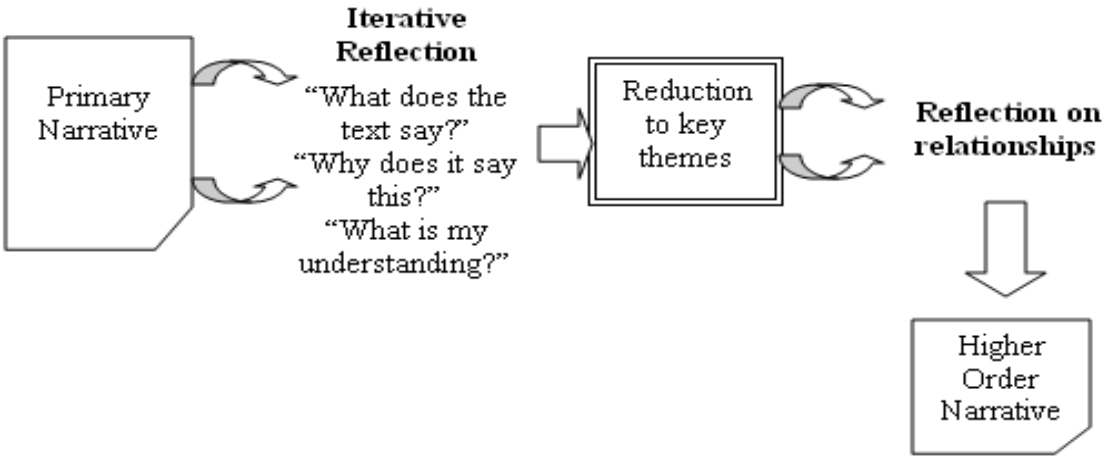

Figure 11: Development of higher order narrative

10. Conclusions – what are the implications of using CAQDAS for the qualitative researcher?

This paper has provided insights from a qualitative researcher's perspective on the value of the N-vivo IT package in supporting evidence analysis for the large scale student MIS research project. Distilling a new theory from hundreds of pages of empirical research evidence is a considerable challenge. CAQDAS plays an important role in this analysis process through supporting the systematic organisation of unstructured evidence and in helping the researcher to develop a detailed understanding of the data.

For interpretivist researchers, the principal issues in ensuring high quality research are consistency and integrity in the study's design. Qualitative researchers emphasise the importance of reflection on the body of evidence, the ability to make critical assessments of informants' statements, and the importance of producing convincing arguments and explanations (Mason, 2002). CAQDAS software facilitates this by supporting efficient management, reflexivity and interrogation of a large body of evidence. CAQDAS functionality is now far greater than simple code and retrieve processes, and offers the researcher various tools to interrogate the data, experiment with various interpretations, and keep notes on his/her insights and the logic of his/her interpretations. Essentially, CAQDAS enables the researcher's analysis and write-up of research findings to begin early on, as the researcher's closeness to the data is increased.

In terms of evaluating the research output, use of CAQDAS may also improve a research project's internal validity (Lewis and Ritchie, 2003). Internal validation is enhanced by adopting a constant comparative method; CAQDAS facilitates this by supporting a researcher's iterative reflection on the body of evidence in light of concepts previously coded, the coding of new pieces of data in relation to the boundaries of these codes or the creation of new nodes. Mason (2002) also emphasises the importance of the qualitative researcher demonstrating the validity of his/her interpretations, which is contingent on the approaches taken in data analysis and the transparency of the researcher's interpretations. In this respect, CAQDAS facilitates the transparency of the analysis process, through the documenting of key interpretations in memos and the use of direct quotations to support those interpretations. From the point of view of the reliability construct, qualitative researchers are concerned with demonstrating that the researcher has not invented or misrepresented data or been careless in data recording or analysis (Mason, 2002). CAQDAS also plays a role here – it offers support for systematic evidence analysis and provides transparency on the interpretations recorded in memos that lead to the research findings; these memos facilitate checking through the researcher's interpretations and enable a tracing through the research logic.

The above highlights the value of CAQDAS in supporting evidence analysis. In the final research output it is useful to document the role/value of CAQDAS in a comprehensive research audit trail. This is particularly true for researchers new to the interpretivist paradigm. An audit trail enables a researcher to reflect on how a study unfolded, and enables a reader to follow each stage of the process and trace through the research logic; it may be intellectual or physical in nature (Carcary,

2009). In an intellectual audit trail, where the researcher reflects on how his/her thinking evolved throughout the research process, the role of CAQDAS in supporting iterative interpretation of and interaction with the evidence should be explained. In a physical audit trail, which documents all stages of the research process and reflects key methodology decisions, the role of CAQDAS in managing and analysing the empirical evidence should be documented. This activity provides clear justification and evidence of why and how CAQDAS was used in supporting evidence analysis in a research study.

This paper has largely reflected on CAQDAS in a positive light; its value greatly aids the analysis of large evidence volumes. However, despite the sophistication of CAQDAS tools, it is important not to over emphasise the power of the technology through assuming that it will do the analysis itself. CAQDAS is merely a support tool, but when used effectively it enables the researcher to concentrate his or her energy on the conceptual work of analysis.

11. Avenues of further research

N-vivo is only one such CAQDAS package. An avenue of possible further research involves conducting a comparative analysis of the features of other qualitative analysis tools such as N6, HyperResearch, Atlas.ti, MAXqda, and Qualrus. This would help to increase researcher awareness of the software available, identify the strengths and limitations of the various tools and enable researchers to select the software best suited to their needs. For this study, only interview material was imported to N-vivo software. A further study may report the value and drawbacks of the software in supporting analysis of various evidence types, such as emails, published reports, and pictures.

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