2005

Complexity in systems and organisations: problems of new systems' implementation

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Complexity in Systems and Organisations: Problems of new systems' implementation

A thesis submitted in fulfilment of the requirements for the award of the degree

Doctor of Philosophy

from

UNIVERSITY OF WOLLONGONG

By

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MIS (honours), MIS, MBA, BSc

INFORMATION SYSTEMS

SCHOOL OF ECONOMICS & INFORMATION SYSTEMS

2005

CERTIFICATION

I, Wannapa Suratmethakul, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in Information Systems, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

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March 2005

Abstract

When an organisation is looking for a computer-based system to support part of their operation it is not uncommon for them to consider purchasing an application software that is already in use in an organisation similar to itself. Those responsible for the system's acquisition are considerably influenced by any advice they receive on experiences with the proposed new system from those who have successfully used the application. Such communication between organisations may only occur at management level so that actual end-users are rarely involved. Issues of system usability are therefore assumed to be unproblematic, as the system has been used in a comparable real world situation. Even less of a consideration is whether the context of use in the receiving organisation is similar to those where the system is currently being used so that systems implementation can take place with ease.

The study presented in this thesis confirms the importance of critical contextual factors that affect the capability of people in an organisation and the performance of the whole organisation when a complex new system is implemented. It also demonstrates the relationships between contextual factors and the importance of these factors.

The research has used a grounded theory approach to reveal details within complex phenomena in an organisation when a substantial new system was implemented. This approach has been shown to be eminently suitable for the study which involved a new timetabling system in an educational institution. Furthermore, Activity Theory was seen as an appropriate framework to display and interpret large amounts of inter-related data in a holistic and comprehendible way.

The study revealed three critical issues: Knowledge Transfer, System Capability, and Organisational Context that appeared to be related to the problems of implementing the new information system in the organisation. These three issues are the main categories emerging from the data analysis leading into the effect of 'influencing capability and thereby organisational performance' which was designated as the core category. From a holistic view, the Activity Theory interpretation revealed that the dominant activities of the organisation in the case, teaching and learning were distorted by the new system as people in the organisation put more effort on getting the system to work rather than doing their own job.

This research adds to the understanding of a common situation where management have an over simplified view of organisational work and assume that implementing a new computer based system can quite easily improve the performance of the organisation. However the nature and the processes of most work are more complicated than they realise so that it is rarely simple to implement a system to support a job that is inherently complex. Traditional organisations, which rely on a 'command and control' approach to management, do not handle complexity well thereby restricting the ability of staff to use their knowledge of the real conditions to adapt their work to suit changing organisational systems.

PUBLICATION FROM THE RESEARCH

The following papers have been produced from the research reported in this thesis.

1. Suratmethakul, W. and Hasan, H. (2005) The challenges of introducing off-the-shelf systems into complex work organisations, *accepted for ECIS2005, Regensburg, Germany.*

2. Suratmethakul, W. and Hasan, H. (2004) Usability of complex systems in the organisational context, Proceedings *of OZCHI 2004, 22-24 November, Wollongong, Australia.* (Appendix K)

3. Suratmethakul, W. and Hasan, H. (2004) An Activity Theory analysis of a case of IT-driven organisational change, *Proceedings of DSS 2004,1-3 July, Prato, Italy, pp.773-781.*(Appendix L)

Acknowledgements

Thanks and considerable appreciation is due to the following people for their kind assistance and support. This thesis could not be completed without them.

First of all, I would like to express my gratitude to my supervisor, Associate Professor Helen Hasan, for her invaluable guidance, support, and encouragement throughout this study. Without her, this completing this thesis would not have been possible.

I would like to thank all the participants in this study. They volunteered to be interviewed and were very generous with their time and very open in their opinions.

I would also like to thank Mr. Joseph Meloche for his advice, support, and his help in proofreading some chapters from my thesis. I also would like to thank his wife and daughter for their kind hospitality when I visited their house.

To all my best friends who have been great supporters. Thank you for your friendship, concern, and encouragement. Especially I am very happy to acknowledge the deep friendship and help of Thanaporn Jingjaikul and Sophon Jingjaikul. They were always there for me every time when I needed them. I am also grateful to Mr. Santipat Arunthari for his sympathy and encouragement.

Finally and most importantly, I would like to express my largest gratitude to my parents, Mr. Niyom Suratmethakul and Mrs. Duangjai Suratmethakul, and my brother, Mr. Jakphan Suratmethakul, for always being there when I needed them most, and for their love, understanding, encouragement, and support. Thank you for always believing in me.

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Chapter 1

Introduction

Model systems often do not roll out as planned, leaving managers with an array of puzzles and a myriad of related issues, which make it hard to make any sense of what went wrong during the implementation.

(Ciborra, 2004, p.18)

1.1 Background to the research problem

It is widely accepted that computer-based information systems in organisations have become extremely complex and should be adapted to their context of use. Taking context into account allows us to increase the effectiveness, support, and the efficiency in the work performance of the users. However there is little evidence that the efficiency of the user's work and the satisfaction of users are increasing. This may be because most of the research into computer systems usability is done within the confines of the laboratory and not where the software is used in the real context of the user.

From my master research (Suratmethakul, 2002), I have found that user's characteristics, particularly their personality influence the way they use the software. In that research it was the characteristics of users that effect how software was used. Even though modern software interfaces are developed to be intelligent and friendly to users,

their use is affected by a user's characteristics. My previous research was based on laboratory experiment only and thus gave only limited results. It was clear that context was absent from the laboratory study and that it has a significant effect on the use of the systems for operations in real organisations.

This is not just an academic issue, a recent statement for Standards Australia's business describes: *Australia's Flawed business systems cost industry more than $12 billion each year with purchase orders, invoices and other business forms wreaking havoc across industry sectors* (Godfrey, 2005, p.11).

There are many contextual factors that can affect the efficiency of computer systems and the way users use systems in the workplace. By context is meant the various characteristics of users, such as, personality and attitude, their experience both of the work and of the computer, as well as, environmental aspects of the organisation. The influence of these aspects of the user's context on the use of computer systems is a matter of concern for the performance, sustainability and growth of organisations.

This thesis describes research in both the fields of Human Computer Interaction (HCI) and Information Systems (IS). HCI is concerned about how to design efficient interface system software that provide more usefulness to users as well as support users' activities to increase their productivity. To maximise the usability of a product, traditional HCI wisdom recommends participatory design methods with regular usability testing of systems prototypes (for example Ehn 1988; Bannon & Bodker 1991). These should start as early as possible in the design process and involve future scenarios of use with surrogates or representatives of real users. Even though designers

of organisational computer-based systems are concerned about the context of their use, most usability testing takes place either a laboratory or under conditions which cannot take account of all possible contextual issues. As Thomas and Macredie (2002, p.71) state: *most usability testing regimes assume the context of a person facing a computer, the luxury of the person's full attention, and a comfortable environment with minimal distraction.* The organisational environment is dynamic, complex, changeable and unpredictable. People, particularly those working under pressure of tight deadlines and performance targets, will invariably interact with a system in different ways depending on the particular context at the time and place of use. These contexts might be difficult to take into account when designing new systems but they are worthy for consideration when management decides to adopt new technology or implement a new system in an organisation. The usability of the system in context may severely impact on its success and hence its viability in the organisation.

The field of IS is concerned with the development and use of human-computer systems in organisations. When an organisation is looking for a computer-based system or application software to support part of their operation it is not uncommon for them to consider a system that is already in use in an organisation similar to itself. Those responsible for system's acquisition are strongly influenced by any advice they receive on experiences with the intended system from those who have successfully used it. Such communications between organisations may only occur at management level so that actual end-users are rarely involved. Issues of system usability are therefore assumed to be unproblematic in the organisation, as the system has been used in a real world situation. Even less of a consideration is whether the context of use in the

receiving organisations is similar to those where the system is currently being used so that systems transfer can take place with ease.

1.2 Research question

This research began with the question "What are the critical contextual factors in organisational systems' use and how does context influence system usability and organisational performance?"

This question arose from my previous research experience that concerned the usability testing of systems in a context-free laboratory. The limitations of this type of research were realised in its poor contribution to the understanding of how systems are used in the messy situation that exist in the context of real organisations.

1.3 Aim and purpose

This research is expected to confirm the importance of the context, not only for designing an efficient system for users and other stakeholders, but also for improving the productivity of employees and the performance of the whole organisation.

Furthermore, it aims to demonstrate the importance of contextual factors, and the relationships between these factors, the system usability and the work performance of individuals and the performance of the organisation as a whole.

A suitable case was found that could be used to answer these questions. It involved the introduction of a new system into an organisation with the aim of improving the efficiency of operations. However as arrangements were made to gain permission to

use this case it was soon realised that the new system implementation was encountering severe problems that were probably broader and more complex than the initial research question. It was then decided to investigate this case using Grounded Theory where there would be no presupposed hypotheses, theories or frameworks.

In this thesis the terms 'system' and 'software' are given distinctively different meanings. The word 'system' in Information Systems is meant as *a way of seeing the set of interacting component, such as, people, objects, and procedures* to accomplish a goal (Avison & Fitzgerald, 2003, p. 18). Whereas the word 'software' is restricted to *the computer programs that govern the operation of the computer* (Stair & Reynolds, 2001, p.16).

1.4 Overview of the research design and method

The approach taken in this research is to identify a particularly informative case that relates to the research problem and then use grounded theory to examine it. A particular case study, where the introduction of a new system in an organisation was beginning to cause problems, was considered ideal. This particular case had the potential to provide evidence which could explain unexpected phenomena within an organisation when a complex new system is implemented.

The research was planned as an extensive field study, in which a variety of data would be collected through various methods in an effort to cover the work of all stakeholders with no preconceived research questions or hypotheses. Using a grounded theory approach has been shown to be suitable for this type of research (Glaser and Strauss, 1967; Glaser, 1998; Dey, 1999; Martin & Turner, 1986). It enables the revelation of details within complex phenomena in an organisation related to the implementation of a

substantial new system. This approach allows concepts to emerge from the data, which are then organised by the researcher into core categories. These can then be investigated further through literature searches and, possibly, additional data collection and use of a suitable theoretical framework.

An important strategy in a grounded theory research is not to read the literature on the topic and related areas beforehand (Glaser, 1998) and then *enter the field with as few predetermined ideas as possible* (Glaser, 1978, p.3). The researcher will then be more sensitive and remain open to all events that happen in the field study and also be able to start the research faster (Glaser, 1978). As Goulding (2002, p. 56) suggests *the danger lies in entering the field with a prior disposition, whether conscious of it or not, of testing such existing work rather than developing uncoloured insights specifically pertinent to the area of study. In order to avoid this, it is generally suggested that the researcher enters the field at a very early stage and collects data in whatever form appropriate.* Therefore, in this study, the literature review follows the data collection and analysis on the emerging themes and at that stage a suitable theoretical framework is chosen.

1.5 Thesis structure

This thesis is organised into eight chapters as follows:

Chapter 2 describes the epistemological and methodological positions of the research. The justification of selecting qualitative, interpretive, and grounded theory approaches for this research is discussed. Furthermore a description and justification of data collection methods: interviews, usability tests, and personality tests are also included in

this chapter.

Chapter 3 explains the background of the selected case and then describes the procedures used in collecting and interpreting data in the field study.

Chapter 4 describes the analysis process. It is divided into two parts. The first part presents a preliminary holistic analysis using Activity Theory framework which was identified as a suitable framework. It includes an explanation of Activity Theory and its interpretation. The second part presents the results of the grounded theory analysis of the data. The analysis reveals three main categories which lead to a core category regarding organisational performance that emerged from the data.

Chapter 5, 6, 7 present details of three main categories including their subcategories and properties. They include a discussion of a selection of the significant literature on the relevant category.

Chapter 8 presents the summary of the research and significance of the core category. Then the discussion of the research findings follows. Finally, the contribution to academia, Implications for management and suggestions for future research are also discussed in this chapter.

Chapter 2

Research Design

2.1 Introduction

This chapter explains the epistemological and methodological positions of this research. It justifies of the selection of qualitative, interpretive and grounded theory approaches as appropriate for this research. The chapter also includes a description and justification of the data collection methods that were employed in this research, namely interviews, usability tests, and personality tests. Furthermore, the data analysis procedure using a form of grounded theory is presented.

2.2 The decision on research strategy

This research was designed to be consistent with the assumptions of qualitative research as defined by various scholars as follows:

The first is that a major characteristic of qualitative research, reflected in its designs, is that it is naturalistic, preferring it to study people, things and events in their natural settings (Punch, 1998,p.148-149).

Qualitative research we mean any type of research that produces finding not arrived at by statistical procedures or other means of quantification. And Qualitative methods can be used to explore substantive areas about which little is known or about which much is known to gain novel understandings. In addition, qualitative methods can be used to obtain the intricate details about phenomena such as feelings, thought processes, and emotions that are difficult to extract or learn about through more conventional research methods. (Strauss & Corbin, 1998, p.10-11)

Qualitative research sets out to provide an impression: to tell what kinds of 'something' there are; to tell what it is like to be, do or think something. Qualitative researchers exercise great discipline to find out 'What is going on here?' from the perspective of those who are in the situation being researched. (Bouma & Ling, 2004, p. 165)

In the information systems discipline, the factors that influence a researcher to choose qualitative research methods, as suggested by Trauth (2001, p.4-11), are:

- *The Research Problem.* The nature of the research problem should be the most significant influence on the choice of a research methodology. It is also claimed by Strauss and Corbin (1998, p.11) that what one wants to learn determines how one should go about learning it. Studies using qualitative methods are replete with this rationale for the choices that have been made.
- *The researcher's Theoretical Lens.* It is clear that another important influence on the choice of research method is the theoretical lens that is used to frame the investigation.
- *The degree of Uncertainty Surrounding the Phenomenon.* The amount of uncertainly surrounding the phenomenon under study is another important factor in the choice of qualitative research methods.
- *The Researcher's Skills.* An individual's level of skill, knowledge and experience in using qualitative research methods is a significant influence when deciding whether or not to employ them in Information Systems research.
- *Academic Politics.* It relates to the norms and values of the information systems field, the institution at which one works and the status that one holds there, and the country in which that institution is located. These all serve to influence the choice of qualitative methods for information systems research.

According to the five factors explained above, the significant factors that influenced my decision to employ the qualitative research method were:

- *The Nature research problem*: in particular its complexity as a socio-technical phenomenon with multiple groups of stakeholders and focus on individual and organisational perspectives.
- *The researcher's Theoretical Lens:* Emerging from a traditional human-computer interaction perspective into a situated activity, theoretical one.
- *The degree of Uncertainty Surrounding the Phenomenon:* hence the need for a grounded theory approach.
- *The researcher's skills:* experience from a Masters thesis using quantitative methods in a human computer interaction laboratory indicated the need for the greater depth that comes from qualitative research.
- *Academic Politics:* interpretive approaches based on Activity Theory are well accepted at my institution.

2.3 Research paradigms

According to Orlikowski and Baroudi's (1991) classification of the research paradigms as cited by Trauth (2001, p.6), there are three paradigms: Positivist, Interpretive, and Critical, which based on the work of Chua (1986). This classification is described in the Information Systems research, which is often cited by many scholars in the discipline, such as Klein and Myers (1999) and Trauth (2001).

Trauth (2001, p.6) has briefly described the three paradigms of Orlikowski and Baroudi's (1991) classification in her book as follows:

- *Positivist studies* are premised on the existence of a priori fixed relationships within phenomena that are typically investigated with structured instrumentation. Such studies are primarily to test theory.
- *Interpretive studies* assume that people create and associate their own subjective and intersubjective meanings as they interact with the world around them. The intent is to understand the deeper structure of a phenomenon in order to increase understanding of the phenomenon within cultural and contextual situations.
- *Critical studies* aim to critique the status quo, through the exposure of what are believed to be deep-seated, structural contradictions within social systems, and thereby to transform these alienating and restrictive social conditions.

Based on Orlikowski and Baroudi's (1991) classification, this research is most related to the interpretive approach because the research aims to gain a greater understanding of the situation and identify contextual issues that affect the usability and usefulness of complex systems in a real working environment as explained in Chapter 1.

2.4 Theory and research

The relationship between theory and research consists of *theory guides research (known as a deductive approach);* and *theory is an outcome of research (known as an inductive approach),* as suggested by Bryman (2001, p.3).

May (2001, p. 33) describes *deductive* approach as *rejects the idea that we can produce research on the basis of initially rejecting theory or, to put it another way, that there is a simple distinction to be made between the language of theory and the language of observation. It seeks to fuse the empiricist idea that there are a set of rules of method by which we proceed as researchers, with the ideas of deductive reasoning which hold that if our hypothesis or ideas about social life are 'true', then they will be substantiated by the data produced.*

Figure 2.1 presents the process of deduction as Bryman (2001, p.8) states: *theory and the hypothesis deduced from it come first and drive the process of gathering data.*

1. Theory
   ↓
2. Hypothesis
   ↓
3. Data collection
   ↓
4. Findings
   ↓
5. Hypotheses confirmed or rejected
   ↓
6. Revision of theory

Figure 2.1: The process of deduction (Bryman, 2001, p.9)

Whereas an *inductive* approach that *it is based on the belief, as with empiricism, that we can proceed from a collection of facts concerning social life and then make links between these to arrive at our theories. The first point of consideration in this process refers to the relationship between theory and data in order to demonstrate that the*

'facts' can speak for themselves and are distinct from the interpretation of researchers (May, 2001, p. 32).

In considering the relationship between theory and the current research, it falls into the *inductive* approach. As explained in Chapter 1, the aim of the research was to gain an understanding of the phenomenon and contextual issues that affect the usability and usefulness of complex systems in an organisation.

2.5 Choice of research method

There are a variety of alternatives or methods to choose from to do a research; however, there is no right or wrong direction to choose one specific method (Denscombe, 2003, p.3). Denscombe (2003, p.3) purposes that the good research *is a matter of 'horses for courses' where:*

- *Approaches* are selected because they are appropriate for specific aspects of investigation and specific kinds of problems.
- *Strategic* decisions aim at putting the social researcher in the best possible position to gain the best outcome from the research.
- In good research *the choices* are (a) reasonable and (b) made explicit as part of any research report.

In qualitative research, there are different research methods to be considered while conducting the research. The research methods that are often employed in the qualitative research are ethnography, case studies, phenomenology, and grounded theory (Creswell, 1994, pp.12-13). However advantages and disadvantages of each

method need to be considered before making any decision. The chosen method should be suitable and fit in the research aims and problems as Denscombe (2003) suggests.

The research method to conduct this study is grounded theory. It has been shown to be suitable for the research and was planned as an extensive field study, in which a variety of data would be collected through various methods in an effort to cover the work of all stakeholders with no preconceived research questions or hypotheses (Glaser and Strauss, 1967; Glaser, 1998; Martin & Turner, 1986; Punch, 1999). It enables the revelation of details within complex phenomena in an organisation when a substantial new system is implemented.

Grounded theory begins with a research situation. Within that situation, the task of the researcher is to understand what is happening there, and how the players manage their roles. This approach was shown to be suitable for information system's research, which characterises the organisation's experiences in terms of process of incremental or radical change, in the award winning paper by Orlikowski (1993). Because the situation chosen for this research involved and organisations were undergoing change on the implementation of a new information system, a grounded theory approach was deemed to be eminently appropriate.

2.5.1 Grounded Theory

Grounded theory is *an inductive, theory discovery methodology that permits the researcher to develop theoretical accounts of general features of a topic while grounding the account in empirical observations or data* (Martin and Turner, 1986, p. 141). Theory can emerge from data which is collected from a suitable site based on a

research problem (Dey, 1999; Glaser and Strauss, 1967). Strauss and Corbin (1998, p.12) state that, *Theory derived from data is more likely to resemble the "reality" than is theory derived by putting together a series of concepts based on experience or solely through speculation. Grounded theories, because they are drawn from data, are likely to offer insight, enhance understanding, and provide a meaningful guide to action.*

Punch (1999, p.166) describes that *Grounded theory was developed by Glaser and Strauss when they were doing research from a sociological perspective in organisational contexts. That is, it was developed as a method for the study of complex social behaviour. It was initially presented as a method for the analysis of qualitative data, and has inevitable become associated with qualitative research*.

An important issue to do grounded theory is to, *enter the field with as few predetermined ideas as possible* (Glaser, 1978, p.3). The reason is that a researcher is able to be more sensitive to the data and detect all events that happen in the field study, *without first having them filtered through and squared with pre-existing hypotheses and biases* (Glaser, 1978, p.3). Glaser (1978, p.3) explains: …to *remain open to what is actually happening.*

Bryman (2001, P. 389) mentioned that, … *grounded theory are often described as iterative-that is there is a repetitive interplay between the collection and analysis of data.* When a researcher starts to collect some data, the analysis process begins to shape the research for the next steps in the data collection process (Bryman, 2001, p. 389). Glaser and Strauss (1967) call it 'theoretical sampling'. They explain that *theoretical sampling is the process of data collection for generating theory whereby the analyst*

jointly collects, codes, and analyses his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges. This process of data collection is controlled by the emerging theory…(Glaser, 1978, p.36; Glaser & Strauss, 1967, p. 45). The process of theoretical sampling in this research is described in the data collection phase 3 in Chapter 3.

In grounded theory, a 'constant comparative method' is employed to analyse data by comparing incident to incident which is called 'coding', in order to identify categories and properties (Glaser & Strauss, 1967, p.105; Dey, 1999,p.7). Coding, as Bryman (2001, p.391) mentioned, is *the key process in grounded theory, whereby data are broken down into component parts, which are given names.* It consists of, 'open coding', 'theoretical coding', and 'selective coding' from Glaser's approach. This type of coding will be explained later in this chapter. According to Glaser and Strauss (1967, p. 36), *a category stands by itself as a conceptual element of the theory and a property is a conceptual aspect or element of a category*.

Glaser and Strauss (1967, p. 61) propose that *the criterion for judging when to stop sampling the different groups pertinent to a category is the category's theoretical saturation. Saturation means that no additional data are being found whereby the sociologist can develop properties of the category*. Strauss and Corbin (1998, p. 212) define 'theoretical saturation' as the point in the research that: *(a) no new or relevant data seem to emerge regarding a category, (b) the category is well developed in terms of its properties and dimensions demonstrating variation, and (c) the relationships among categories are well established and validated.*

Dey (1999, p.8-9) suggests the way to conclude the research is as follows:

- Stop collecting data when they no longer produce significant conceptual variations ('theoretical saturation')
- Identify a 'core' category or main 'story line' for the study
- Integrate the analysis around this framework
- Use memos and coded data to amplify and modify the resulting analysis
- Stop when an adequate theory has emerged

2.5.2 Justification of the approach to grounded theory

I started my research by using grounded theory based on the original book, 'The discovery of grounded theory by Glaser and Strauss, 1967', unaware of the dispute between Glaser and Strauss. However, when I searched for more literature to learn more about this method, I found many books from Glaser (1978, 1992, 1998) and from Strauss and Corbin (1998). However, I read Srauss and Corbin's book (1998) first because it was easy to read and understand. Until the time I had to analyse my data, I found that it was difficult to follow the step doing analysis based on Strauss and Corbin's approach. Thus I decided to turn to Glaser's books and also look for other books and journal articles related to grounded theory. I came across a journal article by Melia (1996) about the debate between the two originators of grounded theory. Furthermore, there are other relevant publications such as Dey (1999) and Urquhart (2001) that discuss the difference between the two approaches of the originators of grounded theory. Glaser especially (1978, 1992, 1998) discusses the difference between his idea and Strauss and Corbin's. From these publications, it led me to the decision to adopt Glaser's approach to do my research.

2.6 Data collection methods

Methods to collect data in the research are interview, observation, relevant documentation, usability test, and personality test. The first three methods are commonly used for qualitative research (Punch, 1999, p. 174). The usability test and the personality test were conducted in the process of theoretical sampling in the grounded theory approach. In this section, the description of three methods: interview, usability test, and personality test are explained respectively. However, details of the data collection process will be explained in Chapter 3.

2.6.1 Interview

The data collected in this research is mainly from the interview. As Punch (1999, p.174-175) describes, the interview *is one of the main data collection tools in qualitative research. It is a very good way of accessing people's perceptions, meanings, definitions of situations and constructions of reality*, which is the main objective for this research as explained in Chapter 1.

There are different types of interviewing processes depending on the purpose and situation in the research (Punch, 1999, p. 176). This research employed three types of interviews which are:

- Unstructured interview: The researcher has a role in introducing the topic interest to interviewees, and allows the interviewees to express their minds (Denscombe, 2003, p.167). Punch (1999, p. 178) suggests that an unstructured interview *is used as a way of understanding the complex behaviour of people without imposing any a priori categorization which might limit the field of inquiry.* For this research, this type of interview was employ when some key

stakeholders in an organisation in phase 1 of data collection were interviewed. This detail will be explained in Chapter 3.

- Semi-structured interview: Denscombe (2003, p. 167) explains this type of interview: *the interviewer is prepared to be flexible in terms of the order in which the topics are considered, and perhaps more significantly, to let the interviewee develop ideas and speak more widely on the issues raised by the researcher.* This type of interview was mostly employed in this research.
- Structured interview: Denscombe (2003, p. 166) explains that *structured interviews involve tight control over the format of the questions and answers*. This research employed this type of interview when interviewing a senior manager, in order to gather his opinion on specific issues after interviewing other key stakeholders. The detail will be explained in Chapter 3.

2.6.2 Usability testing

Usability testing is the principle method in providing information on how users employ computers, and the problems they have as stated by Nielsen (1993, p.165). Ferre et al. (2000, p.27) state that, *the term usability testing describes the activity of performing usability tests in a laboratory with a group of users and recording the results for further analysis*.

The purpose of conducting usability testing varies. Lindgaard (1994, p.24) suggests, *whatever the reason for, or purpose of, a usability study or evaluation may be, it must be clear what is done, why it is done and what might be gained from it*. It might be to improve and develop existing software products or to ascertain the problems users have when running a system. An accurate analysis of usability, including using appropriate

methods and tools to gather information, is important in order to improve an existing software, or create a further version of a software application.

Furthermore, this method is employed in business to compare the usability of several softwares before making a decision to buy, or use, one of these applications (Lindgaard, 1994, p. 24). The purpose of the current research is to investigate the usability of the new timetabling software application, as stated by the school timetabling officers who said it is an unusable application and not user friendly, and the usability of the simplified software module. All detail of the finding will be presented in Chapter 3.

2.6.2.1 Six stages of conducting a usability test

- *Developing the test plan*: It is a basic element of the test. It contains the details and reasons for using the usability testing. The test plan includes the purpose of the test, problem statement and objectives, the user profile, the method or design of the test, the task list, the test environment and equipment, the test monitor rule, the collected data, and the report contents.
- *Selecting and acquiring participants*: This is the stage to consider the characteristics of the users. It can be called the user profile.
- *Preparing the test materials*: The test materials are important to conduct the test. They will be used to communicate with the participants and to collect the data from the test. These materials should be developed well in advance. The test materials, for example, are a pre-test questionnaire, a post-test questionnaire, task scenarios, and data collection instruments.
- *Conducting the test*: After preparing the test plan, selecting the participants, and having the required test materials, the actual test can be conducted.

- *Debriefing the participant*: This session is to reveal the participants' problems that occurred while they performed the test. The participants are requested to explain and expose their thought process and rationale behind their actions.
- *Transforming data into findings and recommendations*: This is the stage to analyse the data from the test and develop recommendations and produce the final report (Rubin, 1994, p.79).

For the research, one pilot test was conducted before conducting the actual test to develop the test materials, the procedures, and the time period including the problems that may have occurred during the test (Lindgaard, 1994, p.214; Nielsen, 1993, p.174). As Nielsen suggests (1993, p.174) to carry out one or two pilot tests will be enough, although large tests may need more pilot tests.

The number of the tests to be carried out is considered during the test plan stage. There were five tests to be carried out for the research. Nielsen (2000) proposes, *the best results come from testing no more than 5 users and running as many small tests as you can afford* and *As you add more and more users, you learn less and less because you will keep seeing the same things again and again. There is no real need to keep observing the same thing multiple times.*

The usability tests for the current research were carried out in a specifically equipped Usability Laboratory (see appendix C and D). The time period of the test is about 40 minutes. This is acceptable for participants, because they are generally volunteers doing the test (Shneiderman, 1998, p.129, 131).

The test materials are:

- *Software application*: the new computer-based timetabling software application and the simplified software module (Data collection Wizard).
- *The given tasks*: A scenario was designed and explained to participants. He/she is a timetabling officer in his/her academic unit. They were asked to input data for a subject as shown on the accompanying sheet, using the selected systems. The task was divided into 2 parts. One is for data collection wizard and another one is for the timetabling application (see appendix G).
- *The guideline for the software*: This guideline will briefly provide instructions for the new system to assist participants in performing the tasks in the usability test.
- *Pre-test questionnaire*: Participants will be asked to complete this questionnaire before performing the usability test. The aim of this questionnaire called a user profile was to gather information about participants. The questionnaire was divided into 3 parts. The first part was demographics. The second part was about their experience with computers. The last part was about their experience with the softwares that were being used in the test (see appendix E).
- Post-test questionnaire: will be given to participants when they finish their tasks in order to gather their opinions about the softwares that were being used in the test (see appendix F).

Participants, who participate in the experiment, are considered as real users (Dumus, Redish, 1993, p.23). The word ‘users’ in this research means people who employ the computer systems to accomplish their work.

2.6.2.2 Conduct of the usability test

The usability test was conducted in a formal Usability Laboratory (see Appendix C and D). Participants are notified that the software application is being tested, not the participants. Information about the experiment is explained to them clearly. A scenario of a given task is described to the subjects so that they understand what they are going to do.

Participants had to complete the pre-test questionnaire and then started performing a given task. During the test they were encouraged to speak out when they wanted to express their thoughts, opinions, and comments, while performing a given task. This technique is called, 'Thinking aloud'.

The thinking aloud technique is an efficient Usability technique that allows participants to express their opinions or suggestions and feelings, or asking why they are doing these actions (Shneiderman, 1998, p.130). It contains the users' comments, which are vivid and explicit (Nielsen, 1993, p.195). The strength of this technique is in its ability to collect an abundance of qualitative data from a small number of users.

The participant's behaviour and activities are observed and recorded on videotape while he or she is working on a given task. The reason of videotaping is to capture some important events that the observer may miss it while he/she is taking notes, or coding data in a complicated situation that is difficult to record manually (Lindgaard, 1994, p. 99; Shneiderman, 1998, p. 131). After Participants have finished the given task, they will be asked to complete the post-test questionnaire.

2.6.3 The personality test

The IPIP-NEO (International Personality Item Pool Representation of the NEO PI-R^{TM}) was developed by DR. John A. Johnson, Professor of Psychology, Penn State University (see appendix H). With the intention of educating the public about the Five-Factor Model (FFM) of personality, the questionnaire of the test was made readily available to the public. It is based on the NEO PI-R that was developed by Costa and McCrae (1992). NEO Personality Inventory Revised (NEO PI-R) is widely used to measure personality according to the Five –Factor Model (Rossier, et at, 2004).

The standard personality test "the IPIP-NEO", which was suggested by an experienced psychologist, was employed to collect data. There are two versions of the IPIP-NEO used, 'The original IPIP-NEO' inventory and 'The new, short version of the IPIP-NEO'. The original IPIP-NEO inventory contains 300 items, while the short version uses 120 items from the original inventory. The current research employed the short IPIP-NEO inventory because it takes a short period of time to finish the questionnaires and thereby suites the volunteers.

2.6.3.1 The Five-Factor Model (FFM)

McCrae and John (1992, p.175) state that, *the five-factor model of personality is a hierarchical organization of personality traits in terms of five basic dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience.* Howard and Howard (2004) describe the five- factor model as, *each of the Big Five dimensions is like a bucket that holds a set of traits that tend to occur together.* The most widely accepted dimensional approach to personality is that developed by Costa and McCrae in 1992 (Howard & Howard, 2004).

McCrae and Costa (2002, p.52) found that the five-factor model is comprehensive in that it accounts for the traits identified by other psychological systems, such as the evidence from analyses of the California Q-Set (CQS). It was developed by several panels of psychologists and psychiatrists, as defined in Table 2.1 (McCrae & Costa, 2002, p. 52).

Table 2.1 California Q-Set Items Defining the Five Factors

Factor	Low scorer	High scorer
Neuroticism	Calm, relaxed	Thin-skinned
	Satisfied with self	Basically anxious
	Clear-cut personality	Irritable
	Prides self on objectivity	Guilt-prone
Extraversion	Emotionally bland	Talkative
	Avoids close relationships	Gregarious
	Overcontrol of impulses	Socially poised
	Submissive	Behaves assertively
Openness	Favors conservative values	Values intellectual matters
	Judges in conventional terms	Rebellious, nonconforming
	Uncomfortable with complexities	Unusual thought processes
	Moralistic	Introspective
Agreeableness	Critical, skeptical	Sympathetic, considerate
	Shows condescending behavior	Warm, compassionate
	Tries to push limits	Arouses liking
	Expresses hostility directly	Behaves in a giving way
Conscientiousness	Eroticises situations	Behaves ethically
	Unable to delay gratification	Dependable, responsible
	Self-indulgent	Productive
	Engages in fantasy, daydreams	Has high aspiration level

(McCrea & Costa, 2002, Table 5 p.53)

The meaning of each factors of the FFM defined in this research is from the IPIP-NEO Narrative report received when each participant completed the IPIP-NEO personality test online. It is explained as follows:

1. **Extraversion**: It is marked by pronounced engagement with the external world. Extraverts enjoy being with people, are full of energy, and often experience positive emotions. They tend to be enthusiastic, action-oriented individuals who are likely to say ‘Yes’ or ‘Let’s go!’ to opportunities for excitement. In groups they like to talk, assert themselves, and draw attention to themselves.

   Introverts lack the exuberance, energy, and activity levels of extraverts. They tend to be quiet, low-key, deliberate, and disengaged from the social world. Their lack of social involvement should not be interpreted as shyness or depression; the introvert simply needs less stimulation than an extravert and prefers to be alone. The independence and reverse of the introvert is sometimes mistaken as unfriendliness or arrogance.

2. **Agreeableness**: It reflects individual differences in concern with cooperation and social harmony. Agreeable individuals value getting on well with others. They are therefore considerate, friendly, generous, helpful, and willing to compromise their interests with others. Agreeable people also have an optimistic view of human nature. They believe people are basically honest, decent, and trustworthy.

   Disagreeable individuals place self-interest above getting along with others. They are generally unconcerned with others’ well being, and therefore are unlikely to extend themselves for other people. Sometimes their skepticism

about others' motives causes them to be suspicious, unfriendly, and uncooperative.

3. **Conscientiousness**: It concerns the way in which we control, regulate, and direct our impulses. Impulses are not inherently bad; occasionally time constraints require a snap decision, and acting on our first impulse can be an effective response. Also, in times of play rather than work, acting spontaneously and impulsively can be fun. Impulsive individuals can be seen by others as colourful, fun-to-be-with, and zany.

   The benefits of high conscientiousness are obvious. Conscientious individuals avoid trouble and achieve high levels of success through purposeful planning and persistence. They are also positively regarded by others as intelligent and reliable. On the negative side, they can be compulsive perfectionists and workaholics. Furthermore, extremely conscientious individuals might be regarded as stuffy and boring. Unconscientious people may be criticized for their unreliability, lack of ambition, and failure to stay within the lines, but they will experience many short-lived pleasures and they will never be called stuffy.

4. **Neuroticism**: It refers to the tendency to experience negative feelings. Those who score high on Neuroticism may experience primarily one specific negative feeling such as anxiety, anger, or depression. They are likely to experience several of these emotions. People high in neuroticism are emotionally reactive. They respond emotionally to events that would not

affect most people, and their reactions tend to be more intense than normal. They are more likely to interpret ordinary situation as threatening, and minor frustrations as hopelessly difficult. Their negative emotional reactions tend to persist for unusually long periods of time, which means they are often in a bad mood. These problems in emotional regulation can diminish a neurotic's ability to think clearly, make decisions and cope effectively with stress.

Individuals who score low in neuroticism are less easily upset and are less emotionally reactive. They tend to be calm, emotionally stable, and free from persistent negative feelings. Freedom from negative feelings does not mean that low scorers experience a lot of positive feelings. Frequency of positive emotions is a component of the Extraversion domain.

5. **Openness to Experience**: It describes a dimension of the cognitive style that distinguishes imaginative, creative people from down-to-earth, conventional people. Open people are intellectually curious, appreciative of art, and sensitive to beauty. They tend to be, compared to closed people, more aware of their feelings. They tend to think and act in individualistic and nonconforming ways. Another characteristic of the open cognitive style is a facility for thinking in symbols and abstractions far removed from concrete experience.

> People with low scores on openness to experience tend to have narrow, common interests. They prefer the plain, straightforward, and obvious over the complex, ambiguous, and subtle. They may regard the arts and sciences with suspicion, regarding these endeavours as abstruse, or of no practical use. Closed people prefer familiarity over novelty; they are conservative and resistant to change.

(The description of each factor in the FFM is from the IPIP- NEO Narrative report online see example of the report from appendix I.)

2.7 Data analysis

Strauss and Corbin (1998, p.11) explain that … *about qualitative analysis, we are referring not to the quantifying of qualitative data but rather to a nonmathematical process of interpretation, carried out for the purpose of discovering concepts and relationships in raw data and then organizing these into a theoretical explanatory scheme.* Grounded theory is employed as an analysis method for this research as explained by Punch (1999, p. 163) that grounded theory can be *a strategy for research and a way of analysing data.*

Grounded theory employs a constant comparative method of *generating and analysing data* as Glaser and Strauss proposed (Dey, 1999, p. 7). There are four stages for doing the analysis as Dey (1999, p.7) suggests: *(1) generating and (2) integrating categories and their properties, before (3) delimiting and then (4) writing the emerging theory*. Punch (1999, p. 210) also describes that grounded theory analysis involve in three steps: *The first is to find conceptual categories in the data, at a first level of abstraction. The second is to find relationships between these categories. The third is to conceptualise and account for these relationships at a higher level of abstraction*.

2.7.1 Open coding and selective coding

Data analysis begins with open coding to generate emergent categories and properties from collected data (Glaser, 1978, p.56, Strauss & Corbin, 1998, p.101). It is a first step of analysis as mentioned by Dey (1999, p. 97). The aim of open coding is to allow a researcher to see the direction of the next step of the study by theoretical sampling (Glaser, 1978, p.56). Glaser (1978, p. 57-58) purposes rules to be success in doing open coding as follows:

1. To ask a set of questions of the data which must be kept in mind from the start.
    - What is this data a study of?
    - What category does this incident indicate?
    - What is actually happening in the data?
2. To analyse the data line by line, constantly coding each sentence.
3. The analyst must do his own coding.
4. To always interrupt coding to memo the idea.

After open coding, a researcher may not know when to select codes for a core variable and to cease open coding (Glaser, 1978, p.61). As suggested by Glaser (1978, p.61) that, *while an analyst can see the prospects for a theory that does cope with the data entity, it often seems wise, given human finiteness, to delimit the theory to one core variable*. Glaser (1978, p.61) states that, *the core variable becomes a guide to further data collection and theoretical sampling.*

Grounded theory is based on a 'concept-indicator model' as suggested by Glaser (1978, p.62). The concept-indicator model provides the link between data and concept that derive from a theory generated (Glaser, 1978, p.62). This concept is based on constant

comparing of *(1) indicator to indicator, and then when a conceptual code is generated (2) also comparing indicators to the emerging concept* (Glaser, 1978, p.62). Figure 2.3 presents the diagram of the model.

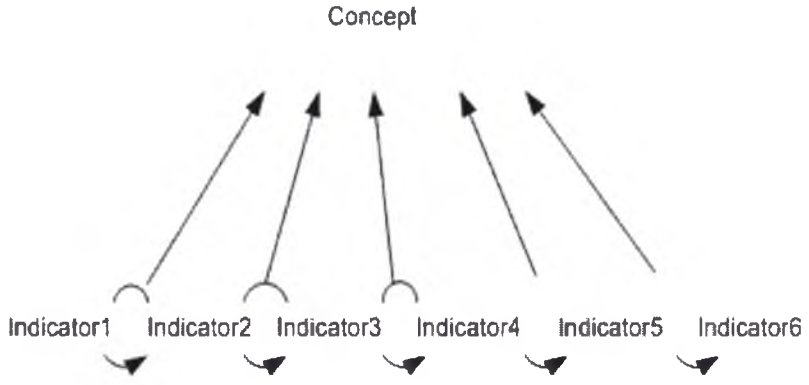


Figure 2.2: A concept-indicator model adapted from Glaser (1978, p. 62)

The comparisons of indicator to indicator generate a coded category and properties until the code is verified and saturated (Glaser, 1978, p.62).

2.7.2 Theoretical coding

Glaser (1978, p.72) states that theoretical coding is *used purposefully in grounded theory* because theoretical codes provide a new perspective and is often an original about theory. In doing grounded theory, a researcher needs to *know many theoretical codes in order to be sensitive to rendering explicitly the subtleties of the relationships* in the data and to be more sensitive to *the myriad of implicit integrative possibilities in the data* as Glaser suggests (1978, p. 72-73). Glaser (1978, p. 73-81) proposes coding families to assist a researcher to aware of certain kinds of relationships in the data, as shown in Table 2.2.

Table 2.2: Theoretical coding families adapted from Glaser (1978, p.74-81) and Dey (1999, p.107)

Family	**Examples**
Six Cs:	Causes, context, contingencies, consequences, covariances, and conditions
Process	Stages, Phases, progressions, etc.
Degree	Limit, range, intensity, etc.
Dimension	Elements, divisions, properties, etc.
Type	Type, form, kinds, styles, classes, etc.
Strategy	Strategies, tactics, mechanisms, etc.
Interactive	Mutual effects, reciprocity, mutual trajectory, etc.
Identity-Self	Self-image, self-concept, self-worth, etc.
Cutting Point	Boundary, critical juncture, turning point, etc.
Means-Goals	End, purpose, goal, etc.
Cultural	Norms, values, beliefs, etc.
Consensus	Clusters, agreements, contracts, etc.
Mainline	Social control, recruitment, socialization, etc.
Theoretical	Parsimony, scope, integration, etc.
Ordering or Elaboration	Structural, temporal, conceptual
Unit	Collective, group, nation, etc.
Reading	Concepts, problems and hypotheses
Models	Linear, spatial, etc.

2.7.3 Core category

To identify a core category is an important part of grounded theory as Glaser (1978, p. 93) states that, *the goal of grounded theory is to generate a theory that accounts for a pattern of behaviour which is relevant and problematic for those involved* and *the generation of theory occurs around a core category.* Glaser (1978, p. 93) mentions that the first delimiting analytic rule of grounded theory is that *only variables that are related to the core will be included in theory.* He also suggests that *another delimiting function of the core category occurs in it necessary relation to resolving the problematic nature of the pattern of behaviour to be accounted for* (1978, p.93). Criteria to make a judgement on the core category that suggested by Glaser (1978, p. 95- 96) are:

1. It must be central, that is related to as many other categories and their properties as possible and more than other candidates for the core category. This criteria of centrality is a necessary condition to make it core.
2. It must reoccur frequently in the data. By its frequent reoccurrence it comes to be seen as a stable pattern and becomes more and more related to other variables.
3. By being related to many other categories and reoccurring frequently, it takes more time to saturate the core category than other categories.
4. It relates meaningfully and easily with other categories.
5. A core category in a substantive study has clear and grabbing implication for formal theory.
6. Based on the above criteria, the core category has considerable carry-through. By this we mean it does not lead to dead ends in the theory nor leave the analyst

high and dry, rather it gets him through the analyses of the processes he is working on, by its relevance and explanatory power.

7. It is completely variable.
8. While accounting for variation in the problematic behaviour, a core category is also a dimension of the problem.
9. The criteria above generate such a rich core category, that in turn they tend to prevent two other sources of establishing a core which are not grounded, but without grounding could easily occur: (1) sociological interest and (2) deductive, logical elaboration.
10. The above criteria also generate a false criterion yet which indicates it is core. The analyst begins to see the core category in all relations, whether grounded or not, because it has so much grab and explanatory power.
11. The core category can be any kind of theoretical code.

2.8 Interpretation of the categories

As this research was an emergent study using a grounded theory approach there was no way to know at the beginning which literature or theoretical framework may later turn out to be relevant. In grounded theory, literature is not given a position of privilege when compared to the data and is treated as data, with the same status as other data. So as not to prejudice the open analysis of the data, the choice of research framework and literature was made after the categories had been identified. Therefore in this research, the selection and justification of an appropriate theoretical framework and the identification of key literature on each main category was only made once the categories had been determined, as will now be described.

2.8.1 Selection of a theoretical framework

In this research, once the initial themes were identified using grounded theory analysis, it was clear that a suitable theoretical framework would be needed to provide some structure to the large amount of data. Activity Theory was considered as an appropriate framework to display and interpret large amounts of interrelated data in a holistic view as will be described in Chapter 4.

2.8.2 Identification and use of the key literature in each category

Strauss and Corbin (1998, p.49) suggest that, *it is not until they are able to let go and put trust in their abilities to generate knowledge that they finally are able to make discoveries of their own.* It is only at this point that they should access and use literature. In this research, following normal grounded theory practice the literature was not studied until after the main and core categories were revealed in the data analysis. At this stage, the researcher went back to the literature to augment the data on each category and revisited the collected data to find evidence in the form of quotes from the case which could be used to support and augment the findings already published in the key literature. . While it is beyond the scope of the thesis to cover all relevant literature in the identified categories, a selection is made based on the relevance to the findings and contribution to the field of Information Systems.

2.9 Ethical issues in the research

Bouma and Ling (2004, p. 198) mention that,… *since participants provide researchers with personal data they need to be protected from infringements on their privacy*. This research applied for approval from Human Research Ethics Committee of University of Wollongong before conducting the data collection. The privacy of all participants has

been kept confidential. This thesis will not mention names of participants, the site studied, and the name of the software that being used for implementing the new system.

2.10 Conclusion

Qualitative research is considered suitable research strategy for the research according to the research problem and aim to gain a greater understanding in complex situation and identify context issues affect the usability and usefulness of complex system in an organisation. From Orlikowski and Baroudi's (1991) classification of the research paradigms, the meaning of interpretive approach can explain the nature of this research due to the research aim.

Grounded theory is the chosen research method based on Glaser's approach. It is employed as the research method and analysis to analyse the qualitative data. The data collection methods employed in this research have been described here as interview, observation, relevant documentation, usability test, and personality test. Following the identification of themes from the preliminary data analysis a theoretical framework was chosen to help structure the variety of data. Only after the establishment of categories was data collected from the literature to extend and confirm the findings from the case. The background of the chosen case and data collection processes will be explained in detail in the following chapter.

Chapter 3

Data collection

3.1 Introduction

This chapter begins with the background to the two-year long field case involving a project to introduce a new computer-based timetabling system. It then describes the procedures used in collecting and interpreting data in the field. As explained in Chapter 2 a grounded theory approach has been adopted to collect and analysis data. A variety of methods were applied to collect data: interviews, usability tests of the computer application, personality tests of key stakeholders, and the accumulation of relevant documents. Key stakeholders in the field case, who were affected both directly and indirectly by the new timetabling system, participated in providing significant data concerning the events that occurred and their attitudes to them.

3.2 Background of the case

The selected case for this research was the introduction of a new computer-based system to substantially automate the complex timetabling process in a large educational institution. This large educational institution, which is henceforth called, 'the university', was established more than 50 years ago and currently has over 18,000 enrolled students spread across three campuses and five access centres. There are 9 faculties, which comprise 25 departments and schools, providing more than 200 degrees for undergraduates and postgraduates in both research and course work. The

instruction takes place not only on the main university campus, where this study was undertaken, but also in numerous other locations both nationally and internationally with a wide variety of class arrangements, timing and duration.

The scheduling of the annual timetable of classes for the main campus in the university is a complex and time-consuming task let alone the need to be consistent with those scheduled in other locations and configurations. The number of students increases every year, while resources are stretched to the limit demanding increasing efficiency in fitting classes to space and time within numerous other constraints. Furthermore, class numbers and course offerings frequently change after the timetable has been initially created to match real time demand.

In the current changeable environment, there are every-increasing economic pressures on the university to achieve efficiency with the use of resources and produce an effective flexible timetable. In 2000 university senior management, in consultation with the university's timetabling officer, determined that a sophisticated scheduling system was required to achieve this goal. A new computer-based timetabling application was purchased with the promise to increase efficiency and transform the use of both physical and human resources by automating much of the effective timetable processes for classes. As claimed by the vendors, the application was designed to automate all logistical aspects of the institution's teaching activities under every conceivable constraint, including the allocation of class space, time and teaching staff. Because this software package had been used for some time on other similar institutions, the university's senior management decided to purchase the package in the hope that it would revolutionise the running of the teaching program.

The senior management, the registrar and the timetabling officer were also involved in the planning of the mode of introduction of the new timetabling system. They hoped that the new automated system would change old habits of teaching staff who avoided running classes at unpopular times leading to gross under utilisation of resources at these times. They relied heavily on advice from an external consultant, who had assisted with the introduction of this application elsewhere. According to the external consultant, the new system's implementation in other similar educational institutions was highly successful in doing this.

In the timetabling process before the implementation of the new system, the school timetabling officers sent information about each subject, which was to be run in their school the coming year, in a standard spreadsheet template to the university timetabling officer. The information included time, place, academic teaching staff, number of lectures for each subject, an estimate of the number of students, and any special constraints or requirements. This was done in July each year for the following year's calendar. The university's timetabling officer would then manually create the timetable using the current year's schedule as a starting point, as the bulk of requests did not change from year to year. This process became more onerous each year as the institution diversified with online student cohorts, multiple-campus arrangements and offshore offerings of a wider range of courses whose range of starting times and duration continued to expand.

The specifications of the new timetabling system indicated that it could both streamline the processes of data entry of upcoming course offerings and generation of the timetable, handle the increasing diversity of request and automatically generate a timetable, which maximised the use of space and time resources to satisfy all constraints. With the new timetabling system the school timetabling officers should be able to enter class details, resources needed and any special constraints directly into the application. The university timetabling officer would only need to check the consistency of the data from the application instead of collecting and entering data. Once all the data had been entered, the university timetabling officer would run a system function, which would automatically allocate a time slot and space for all classes in an annual comprehensive timetable. This could be done later in the year when the information provided would be more accurate.

In 2001/2002 an initial trial of the system was conducted with two of the smaller faculties in the university. The trial used experienced and cooperative timetabling officers in two small faculties to enter data directly into the system. Little formal evaluation was done of the trial outcomes with no real feedback from those responsible for the whole timetabling and teaching process.

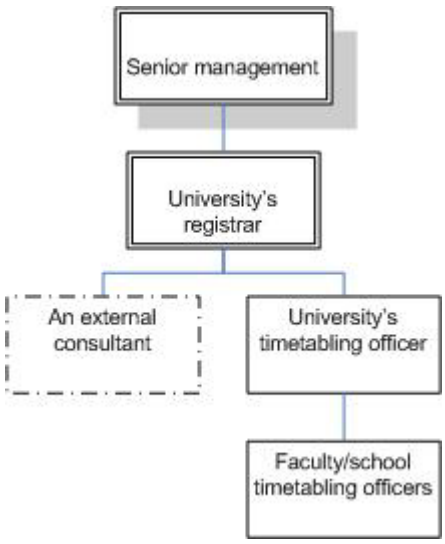


Figure 3.1: Part of the university's organisation chart showing those closely involved in, or affected by, the implementation of the new system

Those closely involved in, or affected by, the implementation of the new system are shown in Figure 3.1. The university's senior management was responsible for the decision to purchase the new application package. They based the decision on the capability of the systems as stated by the vendor and their belief that it met the university's aims. The university's registrar then took overall responsibility for the planning of the implementation. An external consultant and the university timetabling officer were responsible for the actual implementation of the new system, according to the registrar's plan. Finally, the school timetabling officers would be critical players in the acceptance of the new system as they would be responsible for data entry and checking of the new timetable involving their schools classes when it was produced.

3.3 Designing the data collection

The research reported in this thesis commenced shortly after the initial stage of the university's project to implement the new timetabling system when it was recognised that severe yet unexpected problems were being encountered by several sets of key stakeholders. The research plan was to collect data through the various methods listed above over the period from mid 2002 to end of 2003 covering the preparation of the 2003 and the 2004 timetables. Some follow up data was also gathered during 2004 to clarify the results of the grounded theory analysis and to continue to monitor the progress of the project.

There were 4 phases of data collection as follows:

1. Phase 1: Data collection began with the identification of relevant documents and initial interviews with key players: the registrar, the university timetabling officer and the external consultant.
2. Phase 2: Extensive and in depth interviews with the principle direct users of the system: the school timetabling officers to tease out the themes for coding and category identification in the grounded theory analysis.
3. Phase 3: Selective interviews with senior management, academic teaching staff, and students, regular discussions with the university timetabling officer including usability tests of the application itself and a simplified data entry module developed in house in an attempt to alleviate usability problems. In this phase personality test were undertaken with key stakeholders.

4. Phase 4: Follow up interviews with the school timetabling officers, monitoring of feedback from indirect users and comparison of evaluations of resource use with the old and new systems.

The remainder of this chapter describes these phases, giving details of the procedures used and presenting the story of the project as told by each stakeholder. This leads to the detailed grounded theory analysis presented in the following chapter of the thesis.

3.4 Phase 1: The initial exploratory phase

In this phase, data was collected through gathering relevant document and interviewing key stakeholders responsible for the implementation of the new system. The key stakeholders interviewed were the registrar, the external consultant, and the university timetabling officer. The interviews were conducted at the times and places shown in Table 3.1. The interviews were not recorded but notes were taken during, and immediately after, each interview. These interviews provided valuable pointers to other sources of data, both documented and key people to interview, that were subsequently followed up.

Table 3.1: The schedule of the interviews for phase 1

Interviewee	Date/Time	Place
The registrar	25-02-03/ 10.00 am	Administration building
The external consultant and The university timetabling officer	21-03-03/2.00 pm.	A meeting room, Administration building

3.4.1 Documentation

All available background material about the case and appropriate recorded information was important for planning the data collection process. During mid 2002, relevant documentation was collected that would provide information about the intent and strategy for the changes to the timetabling process. This included the university's aims and reasons for implementing the new timetabling system, and the plans for the project to update the timetabling process in 2002 for 2003. Furthermore, it also included the names and roles of all people responsible for the success of the implementation of the new system.

The collected documentation included system documentation, user manuals, instructions to staff, and evaluations of the utilisation of space before the introduction of the new system. These evaluations would be later compared with those done after the new system was in place. This documentation guided the planning for the subsequent data collection and was also used as reference material in the data analysis process.

3.4.2 The initial interview with the registrar

The registrar held an important role in the planning for the implementation of the new timetabling system. The interview was conducted (see table 3.1) as an unstructured interview. It was mainly about the aims of the project to implement the new timetabling system, her expectations for the new system, and her understanding of who were responsible for the actual implementation. Furthermore, permission to conduct the research about the project was requested and received.

The registrar's main concern was that the best possible learning environment be provided for the students in the university. Her perspection of the new computer-based timetabling application software package was that it would help her university achieve the improvements to the running of classes that was reported by other universities using the package. The registrar had complete faith in the senior management decision to go ahead with this project and trusted the advice of the external consultant, who had assisted other universities with the implementation of the new system, and was hired here to take care of the implementation along with the university timetabling officer. She had little contact with school timetabling officers or involvement with teaching staff during the timetabling creation process and so was not aware of the problems that they encountered.

According to information from the registrar, it was important that the next interview be with the external consultant and the university timetabling officer. They were responsible for the actual implementation of the new timetabling system and were widely recognised as the system experts.

3.4.3 The initial interview with the external consultant and the university timetabling officer

The external consultant and the university timetabling officer were interviewed together (see table 3. 1) in an unstructured format that let them explain the timetabling system, its process of implementation, and problems already encountered as well as those anticipated. Furthermore, university timetabling officer's contact details were requested in order to plan for future interviews, ongoing observation and usability testing. Even

at this stage it was apparent that the consultant considered that most of his work was completed and that future contact with him would be intermittent.

The university timetabling officer had frontline responsibility for the university timetable and the implementation of the new timetabling system. He had been responsible for creating and maintaining the university timetable for about 5 years. During much of this time he had knowledge of the new computer-based application and therefore he has had more experience with it than any other staff in the university. The consultant is an expert in the application package having assisted other universities with the introduction of their new timetabling system.

At the time of this initial interview the consultant and the university timetabling officer had been working together to plan the actual implementation of the new system and decide on ways to deal with any problems that occurred during its implementation. They were also part of the technical development team of the new application. They described how they had held a meeting with the current school timetabling officers to explain to them about the new system presenting images of the interface of the new application on Power Point slides. They had prepared for them a hard copy manual to provide guideline for data entry.

The consultant and the university timetabling officer explained how the application was already well established to support timetabling systems in many universities in different countries, such as England and New Zealand, for more than 10 years. As the consultant mentioned, active users from many universities had formed a user group to share experience and knowledge about the system. From his experience, as a consultant,

found that similar problems had occurred during the implementation in every university. The problems, as he mentioned, were:

- Infrequency of use: because end-users may only enter data into the application once a year, they may forget about how to operate it between uses.
- Difficulties in getting accurate data entered into the application: it was common experience among the user community that rates of errors and incorrect data were invariable high with this application.
- Issues of the culture change in the organisation. The timetable is so central to the operations of an educational institution that a change to the system requires fundamental changes to ways of working that often strongly resented and resisted.

The consultant was however adamant that, despite these drawbacks there were obvious reasons, predominantly improvements in efficiency, flexibility and accuracy, why timetables should be scheduled automatically by such a system and not manually by people.

3.5 Phase 2: The interviews with the school timetabling officers

In this phase, the principal direct users of the system, the school timetabling officers, were interviewed extensively in this phase of the research. These interviews provide in depth details of the operation of the new application package and the timetabling job processes from the direct users' point of view.

The university timetabling officer indicated that it was intended that the school timetabling officers would be direct users of the computer application package for the new timetabling system. This group is considered important for the research because they can provide detailed insight into the new application package, the timetabling job processes, and many other issues related to the implementation of the new timetabling system.

For this phase of the research, interviews were conducted with the school timetabling officers in their workplace as semi-structured interviews during the first half of 2003 (see table 3.2). Most of the interviews were recorded however some of the school timetabling officers refused to record during the interviews. The data from the interviews in phase 1 guided the decision on the issues to be covered in this phase, for example: perceived benefits of the new application, problems of using the new application and the new timetabling system, and suggestions for improvements.

Table 3.2: The schedule of the interviews for phase 2

Interviewee	**Date/Time**
1	17-04-03/3.00 pm.
2	24-04-03/2.00 pm.
3	29-04-03/2.30 pm.
4	01-05-03/10.00 am.
5	02-05-03/9.30 am.
6	02-05-03/2.30 pm.
7	05-05-03/9.30 am.
8	05-05-03/2.30 pm.
9	07-05-03/10.00 am.
10	09-05-03/10.30 am.
11	12-05-03/10.30 am.

3.5.1 Data summary from the interviews with the school timetabling officers

The interviews with 11 school timetabling officers provide significant information of the new application, the timetabling job processes, and problems encountered. This section presents an account of the events that occurred as determined by summarising the interviews.

A summary description of each school timetabling officers: job experience, computer literacy, the need of training, how they finished the job, and other conditions is presented in Table 3.3

Table 3.3: A summary of the school timetabling officers' detail

Interviewee	Job experience		Computer literacy		Need for Training		Job's completion		
	Yes	No	Yes	No	Yes	No	Manual	System	
1	×			×	×		×		
2	×			×	×		×		Did not have the application installed in her computer.
3	×			×	×		×		
4	×			×	×		×		
5	×			×	×			×	
6		×	×			×	×		Just been assigned to do the job temporary
7	×		×		×			×	
8		×		×	×		×		Took over the job after the first draft.
9		×		×	×		×		
10		×		×	×		×		
11	×			×		×	×		Will be assigned to do another job soon.

The school timetabling officer is responsible for collecting information from the teaching staff in his/her academic unit on classes scheduled to be run during both Autumn and Spring sessions of the following year. This information included details of class numbers and resource requirements as well as requests for the preferred place and time for each class. In the past each school timetabling officer has prepared this information for his/her academic unit in a predefined spreadsheet form and sent it to the university timetabling officer each July for the following year. He/she would continue to act as the point of contact between the school staff and the university timetabling officer as the timetable was developed, adjusted and finalised to meet as far as possible all requests and requirements. Throughout the year the school timetabling officers are also responsible for any requests for changes or ad hoc demands for space resources.

The school timetabling officers understood that when the new system was implemented, they would be able to enter data directly into the application for classes in each subject and also be able to use some other functions of the application, such as looking for available rooms for ad hoc bookings for any special meetings within his/her school. However, they would only be able to input certain data: number of lectures, estimate of number of students, academic teaching staff, lecture duration time, and special equipment if needed for each subject. They would not be able to indicate requests for the time and place for each class based solely on staff preference. This was a significant change that would be unpopular with teaching staff but greatly assist the management objective of better resource utilisation by scheduling more classes at less convenient times, such as early mornings.

There was a presentation by the university timetabling officer and the consultant to introduce the new system to the school timetabling officers. This outlined the benefits they would get when using the new system and included a brief instruction of the new computer application in power point slides. This presentation took about 30 minutes. Some of the school timetabling officers were impressed by the presentation because it appeared easy: in just one click the application would automatically produced an outcome (timetable). Some, however, wondered if it would work as promised. After the presentation, the university timetabling officer came to each school timetabling officers' workplace, one by one, to install the new application. The university timetabling officer also gave them a manual of the new application and briefly told them how to operate the application.

The installation, however, did not run smoothly. A problem for some academic units was that the application is not compatible with the Macintosh and, despite encouragement to the contrary they only had the Macintoshes. Thus, they had to buy a new computer just for this job. These officers had to learn how to use a PC, as well as how to operate the new application.

In addition many school timetabling officers were confused and frustrated when using the application because they had not been provided with any hands-on training. They only had the instruction manual to show them how to operate it. Some of them were also new in the timetabling job. Therefore, they were not only frustrated by the application, but also by the job itself.

The general consensus was that the application is not easy to use without training and definitely not user friendly. All the school timetabling officers had to spend additional time learning to use it on their own. Many of them were already overloaded with work are responsible for not only the timetabling job, but also many other demanding tasks. With all the problems and pressure they could not concentrate on the timetabling enough to get the job done in the time allotted.

The university determined a particularly short time frame for the school timetabling officers to input data into the application in the introductory year and this pressure exacerbated the usability problems. When the school timetabling officers encountered problems using the application, they asked the university timetabling officer to help them. He was the only one who had sufficient expertise to do this but had to help more than 20 school timetabling officers as well as do his own job. It was impossible to fix the data entry problems for all of them at the same time. In many cases they ended up resorting to the only spreadsheet system and the university timetabling officer did most of the data entry by hand with some clerical assistance and much overtime.

However problems did not end once the data was entered. There were many drafts of the 2003 timetable produced by the scheduling function of the application causing an adverse reaction from teaching staff and students who rejected them outright. It was difficult to know which complaints were genuine intractable problems and which were just from people taken out of their comfort zones. Many of the academic staff wheel a great deal of power to which the timetable officer had no comeback. As a result, much of the actual timetabling ended up being done by the old the manual process with negotiations and compromised. The need for the university timetabling officer to do

most of the data entry and then redo the timetable by hand as he had always done, caused the 2003 timetable to be delayed and some teaching staff could not get the correct information for their subjects in time for the start of session. Many complaints and requests for changes from academic staff were received and school timetabling officers were not able to respond to them promptly. It was a difficult time for both academic staff and timetabling officers.

At this stage, the school timetabling officers had a negative attitude towards both the new timetabling system and the university management but not the university timetabling officer as they appreciated the effort he had put in under difficult circumstances. They felt that they had not been provided with clear information about the new system. The management just gave them information about the benefit of the system to university according to the university's aims. Furthermore, the management ignored their need and their conditions. To the school timetabling officers, using the new system increased their workload.

Once the 2003 timetable was finalised the university timetabling officer organised several meetings between the school timetabling officers and the technical development team to gather information about their problems and their suggestions. This made some school timetabling officers feel that someone was finally paying attention to their problems.

There was a diversity of attitude among the school timetabling officers. Some of them were willing to learn more about the application if they were provided with a training session. They believed the application would help them to work more efficiently, if

they knew how to operate it properly. However, some of them did not want to use the new application at all. They only want to get the timetabling job done by the old manual process, which they knew worked well from their perspective and would not increase their workload.

3.5.2 Initial analysis of data in phase 2

An initial data analysis in this phase was based on the constant comparative method in the grounded theory analysis as described in Chapter 2. Each interview was compared to identify the themes for coding and category.

The first three interviews with school timetabling officers were conducted with the purpose of determining their perspectives on the new timetabling system, the implementation of the computer application, and the problems encountered in doing their jobs. Among these three interviews, interviewee 2 did not provide enough data to the researcher, because she did not use the new system or even have the application installed on her computer. The reason was because there are only three subjects offered by her academic unit and students must choose subjects from other units to complete their courses Thus, she could continue to provide the small amount of information to the university timetabling officer using the old manual process.

Themes derived from these interviews are:

- Culture change
- Change to the job process
- Organisational rules
- Complexity of the task

- Expectation to decrease workload
- Expectation to increase work performance (i.e. to have an efficient timetable)
- Training requirements
- Document and instruction
- Communication between the management and the staff in the university
- Software compatibility with existing software and hardware

Interviewee 1 provided additional information that a user group of the new timetabling system: all school timetabling officers had been established in order to provide information on problems and suggestions to the technical development team.

The next three interviews (interviewees 4-6) provided more themes for the research. They are:

- Attitude toward key stakeholders
- Job description
- Interruption to workflow
- Staff conditions
- Personal belief
- The difficulty in using the new software

Interviewee 4 suggested about a simplified software module called, 'Data Collection Wizard' for data entry. It was introduced to the school timetabling officers in the meeting for the user group. However, they have not used it. A question arose: why did the technical development team have to create this software? To answer this question, the technical development team, who are the university timetabling officer and the

consultant, will be interviewed. Thus, the next phase of the data collection will include an interview with the technical development team.

The last five interviews (interviewees 7-11) of this phase were conducted with the hope that they would provide a new theme to the research. However, they did not provide any new theme. They just added more data to support the existing themes from the previous interviews. A summary of themes derived from the interviews with school timetabling officers is shown in Table 3.4

Table 3.4: The summary of themes derived from the interviews with school timetabling officers

Data collection	Concept	Theme
Interview 1-3	- The process of producing a timetable has been changed and it changed the way they had done things in their academic units. - The timetabling officers provide subjects' details and input into the new software package. - Time frame to work out the new system was too short. - Difficult to collect and provide the accurate information to input into the new software package. - The timetabling officers expect the new system to assist them to complete the job easily and quickly. - The timetabling officers expect to have an efficient timetable. - Lack of training and knowledge to use the new system. - The timetabling officers were provided with the software manual and system's instruction. - Management did not clearly provide information about the implementation of the new system and did not listen to staff about their concern and did not understand their situation. - The new software package was not compatible with the Macintosh and it was not automatically update the timetable on the web timetable.	-Culture change -Change to the job process -Organisational rules -Complexity of the task -Expectation to decrease workload -Expectation to increase work performance -Training requirements -Document and instruction -Communication between the management and the staff in the university -Software compatibility with existing software and hardware
Interview 4-6	- Mistrust in the consultant who always said how wonderful the system was. - The officers have other jobs to do which they are responsible for besides the timetabling job. - From the observation, there were a lot of interruptions during the interviews. - Some of them were new for the job, or were even assigned the job temporary.	-Attitude towards key stakeholders -Job description -Interruption to workflow -Staff conditions

Data collection	Concept	Theme
Interview 4-6	- Some staff were willing to use the system, because it makes the job more interesting and easy. Also they were willing to learn new things to increase the job efficiency. - The software is too complicate and it is not user friendly.	-Personal belief - The difficulty in using the new software
Interview 7-11	No new theme was identified. However, some data was developed for supporting the above themes.	

3.6 Phase 3: Selective data collection

In this phase, various methods were applied to collect a broader set of data (interviews with other stakeholders, the usability test, and the personality test). The objective of this phase is to fill the gaps in data collected from phase 2. Consequently the design of this phase of the research was planned during the interviews with the school timetabling officers in phase 2.

There are three key points that shape the continue investigating:

- Perspectives of all key stakeholders: the senior university management, the university timetabling officer, academic staff, students, and the technical development team. These key stakeholders were mentioned by school timetabling officers on many occasions.
- Usability of the software. The school timetabling officers stated that the new application package is difficult to use.
- Varying Personalities of the users. The school timetabling officers expressed a variety of attitudes and beliefs toward the job and other key stakeholders that may be due to different personalities.

3.6.1 The interviews with other stakeholders

In this phase, the interviews were conducted with the indirect users of the new system and other stakeholders. After completing the interviews and initial data analysis in phase 2 representation of the university management, academic staff, students, and the technical development team were interviewed (see table 3.5). The university timetabling officer was also interviewed and observed helping the others on several occasions. The interviews were guided by the points mentioned by school timetabling officers and the questions that arose from phase 2 analysis.

Table 3.5: The schedule of the interviews in phase 3

Interviewee	Date/time
The senior management	07-07-03/11.30 am.
The university timetabling officer	02-07-03/10.00 am.
The academic staff	05-11-03/2.30 pm.
The development team	09-07-03/10.00 am.

3.6.1.1 The senior management

In phase 2 of the data collection, many school timetabling officers mentioned that the management do not listen to them and ignore their problems and suggestions. Thus, it is worth investigating this further by interviewing management in order to understand their perspective.

The senior manager, who had overall responsibility for the task of implementing of the new system, was interviewed. It took time to make an appointment with him and so the interview was conducted after the 2003 timetable was released. This interview was a structure-interview. It provided a strategic perspective on the management of the system, the implementation, and staff.

The manager stated that the new system would be able to provide information and allocate resource more effectively, in accord with the strategic aims of the university. He had received feedback on the problems that had been encountered with the production of the 2003 timetable. However, he was of the view that any new system is bound to create some problems initially. He reasoned that in other universities with which he is familiar, it took some time to implement the system successfully. Therefore, he estimated that it may take about 3 –4 years before their system would run well.

The senior management mentioned that the problems from his perspective that had occurred during the implementation were:

- The project was not planned well and not long enough before the implementation
- Not enough people were allocated to work on the implementation
- Hardware caused problems for the new application
- They did not have any education program to prepare people for change

The senior manager believed the staff understood the benefit of the new timetabling system even though they do not like it. He assumed that they appreciated that the system will be beneficial to them in terms of flexibility and efficiency. He acknowledge that the system is causing them to change the job process they have done for a long time and that academic staff, especially, do not like it because will force them to run classes at unpopular times. He felt sure the administrative staff that actually use the system understand its benefits and what it is trying to do.

Research themes derived from this interview are:

- Culture change
- Software compatibility with existing software and hardware
- Communication with staff
- Communication with external parties

3.6.1.2 The university timetabling officer

The university timetabling officer was the only person that was mentioned as the key stakeholder by all interviewees in phase 2. He was the one expert in the university that the school timetabling officers could ask for help to fix the many problems that had occurred in the first year of operation both on the data entry into application package and the new timetabling process as a whole. A significant interview was conducted in his office as a semi structure interview, after the release of the 2003 timetable that will be described here.

The university timetabling officer understands the university's aim make more effective use of its resources using the new application package for the new timetabling system to allocate space and time efficiently. However, he admits that it did cause more problems than expected regarding the change in the process of producing the timetable for key stakeholders, especially the school timetabling officers. In hindsight he said that many of the problems could have been avoided if the change had taken place more gradually because key stakeholders would have become less frustration and been more open mind to accept the new way of doing things. He believes that in 3 – 4 years the application for the timetabling system will be used to its full capacity and work well. By this he envisaged that data would be entered directly into the application by the

academic staff themselves and school timetabling officers would be just there to help and check. It was apparent however that this view was more influenced by the software vendors and other technical users rather than experience of the application by administrative and academic staff in other institutions using the system.

He described what had happened as follows. The process before implementation was that school timetabling officers sent information on each class to be delivered in the next year in their unit in spreadsheet template to the university timetabling officer. When the new timetabling system was first implemented, school timetabling officers were to enter the class details data directly into the application. He assumed that he would only needed to check the consistency of the data then run the application's function that would automatically allocate time and space for all classes in the annual timetable.

As an expert both in the use of the application and of the complex timetabling process as a whole, he did not anticipate and still had difficulty understanding how novice users would struggle to use the system as he did. For the 2003 timetable he had spend an inordinate amount of time outside his normal duties helping school timetabling officers to fix their problems with the new application. However, he could not fix all problems for every school timetabling officer as promptly as they expected. This caused undue angst across the university and delayed the release of the 2003 timetable. This in tern distressed him greatly as he was an extremely conscientious employee of the university and realised the importance of the timetable.

After receiving many complaints from the school timetabling officers about the difficulty of using the new application, the university timetabling officer had allowed most of them to send him a first draft of the 2003 timetable using the old manual process. Then he spent more unanticipated time inputting the data into the application himself. He also produced some basic instructions on how to use the new application and provided this to all school timetabling officers. Furthermore, he has held meetings with school timetabling officers to gather a list of their problems, opinions and suggestions concerning the system. He eventually realised that the application is too complicated for most of the school timetabling officers.

Themes derived from this interview are:

- The difficulty in using the new software
- Change to the job process
- Communication with the users

3.6.1.3 Academic teaching staff

In the stage of the implementation it was thought that academic teaching staff could be direct users of the new system as mentioned by the university timetabling officer. He anticipated that they could enter their class details directly into the new application and could check a timetable from the application. However, this did not happen due to poor usability of the application and the inherent complexity of the timetabling process of which most academic staff had little knowledge. In the past they had simply given the school timetabling officer their requests for their own classes and either accepted the timetable when it was produced or asked for changes. They had little reason to consider the big picture.

In mid 2002 the academic teaching staff in the process of producing the 2003 timetable provided class details to school timetabling officers in their academic units as usual and most were unaware that a new application was being used. However when the first draft timetable was released the school timetabling officers received an inordinate number of complaints about the timetable from academic teaching staff. In the past each years timetable was very similar to the previous year and was based on many constraints that were never formally requested. These ranged from mandatory conditions for particular arrangements to personal preferences for time and place. The 2003 timetable was completely different from previous years. It was only after many iterations of requests for changes that the academic teaching staff received a workable timetable for their subjects and even then they were not happy with many of the changes enforced by the new timetable. It was well into 2003 that informal interviews were conducted with academic teaching staff to gather their perspective on the new system and the change in the timetabling process because they were affected by the change caused by the new timetabling system.

A semi-structured interview with a suitable member of the academic teaching staff was conducted during the preparation of the 2004 timetable. The chosen person was a head of an academic unit and also a member of the academic teaching staff. Her responsibility regarding the timetabling process was to provide information, as collected from teaching staff, to the school timetabling officer about subjects, lecturers, and the conditions needed for each class, for instance, who teaches which subject in her academic unit. Also, she had to check the timetable draft for her academic unit.

She had a problem with collecting information because the timeline for preparing the 2004 timetable had been brought forward because of the problems of the previous and it was too early to get accurate information. She still did not know which elective subjects were going to run the coming year as that would depend on which academic staff might be on leave. This problem had been exacerbated due to staff turnover which meant that new staff for 2004 had not yet been determined. When the timetable draft did come out it had to be changed many times in a short period before releasing the finalised timetable to academic staff in order for them to check if they had any comments on it. They in turn had many requests for changes of varying importance, a factor which itself caused problems.

This academics staff member understood the university's aim and reason for the implementing of the new timetabling system in producing its timetable more efficiently. However, she does not know why this particular application is chosen as it seems to have caused more problems than it should considering it had been used in other universities for some time. She was however appreciative that the university timetabling officer has worked very hard to get a workable timetable completed for 2003 and felt that he had received unfair criticism from some staff.

She was of the opinion that the new software application could not automatically create a reasonable timetable because there are many conditions that could not be entered into the application easily. For instance, repeat lectures have many reasons which affects when they are held. If it is simply because the class is too large for any one room they should be held on the same day with a break. If the repetition is to accommodate full and part-time students, room should be allocated for a large group during the day and a

smaller one in the evening as part time students that cannot come during the day. If the class is held on different campus with the same lecturers they may need to be scheduled on different days.

In her role as head of unit this staff member also had got comments and requests from some academic staff after the release of the timetable because they were not happy that they could not get their preferred place and time. She said academic staff should be more concerned about students before making any changes based on their personal requests. However she had to decide which requests were reasonable and which ones needed to be changed in order to sent the appropriate requests to the school timetabling officer in her academic unit.

Themes derived from this interview are:

- Organisational rules
- Complexity of the task
- Software flexibility
- Culture change

3.6.1.4 Students

Even though students do not have any role in producing the timetable, their perspectives on the timetable are also important. The university's key stakeholders: the senior management, the university timetabling officer, the school timetabling officers, and teaching staff always mentioned their concern about students' needs and living conditions. They want to produce an effective timetable that provides greater benefits for students.

To receive more feedback from students regarding the timetable, questions were posted on a newsletter sent via email to students in a big faculty in the university. It was conducted after the 2003 timetable was released. Unfortunately, only one part time student replied to this email telling about her experience with the 2003 timetable.

Her story was that she enrolled in a subject that did not actually run in the 2003 school year. However, this subject was shown in the 2003 timetable. This would probably not have happened under the previous timetabling process. She was told upon arriving at the first lecture that the subject was not actually running that year (2003). In fact, it had not run for two years, and would not be running in the foreseeable future due to unavailable suitable staff member. As a result, she had to waste her time looking for another suitable subject. There was not any class available for that session that she had not already done. As she was disadvantage she made some inquiries about the changes to the systems and was told that there was no testing of the new system prior to its introduction on-line. She mentioned that if this was true, then the whole process of introducing change at the university must be looked at.

As there was little feedback from students, it was assumed that most students were unaware or unaffected by the changes to the process. It did however indicate that part time students are more sensitive than full time students in terms of the timetable issue. Thus, the university has to be considerate towards part time students and provide an effective timetable for everyone at the university.

3.6.1.5 The technical development team

The technical development team as mentioned in phase 2, consisted of the university timetabling officer and the consultant joined by a member of the university's IT staff. The team was first of all responsible for implementing the chosen software application package, overseeing the entry of the university's data and running it to generate the timetable. Following feedback from the user group the team saw the need to develop a simplified software module for the school timetabling officers to carry out routine data entry. They designed this as a 'Data Entry Wizard'.

An interview was conducted with the technical development team principally to determine their views on the need to create the simplified software module (the Data Collection Wizard). As there appeared to be usability issues involved, permission was sought, and obtained, to install the applications (the populated application package and the Data Collection Wizard) on the computer in the usability laboratory for testing.

The interview was more focused on the simplified software module than the regular timetabling application. The university timetabling officer was interviewed alone because it was difficult to make an appointment with the others. He admitted that he now realised the application was too complicated for the staff. Therefore, the development team had created the simplified software module a new application called the 'Data collection wizard' which eased the data entry process by providing a step by step approach to input the data. Furthermore, it was produced on top of a spreadsheet template in a format with which the school timetabling officers are familiar. It would be used for the 2004 timetable process. It was decided then to conduct usability tests of the two products as regard data entry.

3.6.2 Usability tests

This part of the data collection is focused on the usability of the regular software application and the simplified software module (Data Collection Wizard), which was created by the technical development team. As the school timetabling officers mentioned in the interview in phase 2, the regular application is difficult to use and not user friendly. To investigate the usability of the regular application and Data Collection Wizard, usability tests were conducted in a formal usability laboratory as explained in Chapter 2. Permission for installing the applications on a computer in the laboratory was made during the interview with the technical development team. The chosen participants were academic staff in the university who understood the importance of producing a timetable, or providing information to produce a timetable. Each participant was asked to enter data familiar to them into both applications. The appointments made to do the usability test are listed in table 3.6.

Table 3.6: The schedule of the usability test

Subject	Date/time
1	18-07-03/10.00 am.
2	22-07-03/10.30 am.
3	23-07-03/10.00 am.
4	28-07-03/10.30 am.
5	29-07-03/10.30 am.

3.6.2.1 Findings from the usability test

The data collected from the usability tests included direct observation, video recording, and questionnaires and was analysed and interpreted. The analysis was made to compare the regular application and data collection wizard.

Table 3.7 presents the results from the pre-test questionnaire that the participants completed before doing the tests.

Table 3.7: The summary of the pre-test questionnaire

Subject	Gender	Experience with the computer	Experience with the software		Experience with the timetabling job
			The new application	Data collection wizard	
1	Female	Experienced	No	No	No
2	Female	Experienced	No	No	No
3	Female	Novice	No	No	No
4	Male	Novice	No	No	No
5	Male	Experienced	No	No	Yes

3.6.2.1.1 The regular application

The regular application (see figure 3.2) is used by many universities in different countries across the world. The vendors claimed that universities do not need to change their way of working to use the application to construct the timetable. Instead, the application can match the way universities do things. They claim that it is easy to input and transfer data, publish the timetable and to roll forward data from one timetabling year to the next. The data collected in phase 2 of this research from the school timetabling officers contradicts these claims and indicates instead that the application is complex and difficult to use.

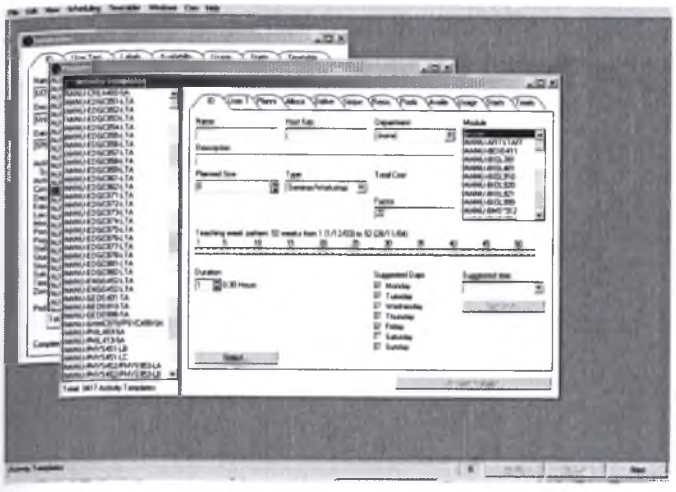


Figure 3.2: A typical screen from the regular application

The usability tests were conducted using a 'thinking aloud technique'. Participants were encouraged to speak their minds about the applications as they attempted to enter data so that the observers could gather the participants' opinions, suggestions and problems while using the application. After the tests, participants were asked to complete the post-test questionnaire.

3.6.2.1.2 Finding problems of the regular application from the usability test

Usability tests confirmed that the regular application was very complicated to use, confirming the statements made by the school timetabling officers in phase 2. Participants were frustrated and confused. They could not find the desired functions, or successfully complete required tasks. Not even an experienced timetabling officer, who was one of the participants, was able to do this.

The problems identified from the usability test are:

1. Terminology and/or wording using in the application is not clear to users.
2. Too many procedures for data entry for one subject.
3. Too many menu options in one window.
4. Users take time to find pre-entered items from the long pick lists in the drop down boxes.

3.6.2.1.3 The simplified software module

The purpose of the simplified software module (Data Collection Wizard) was created to assist and simplify the school timetabling officers' data entry for the timetabling system. It was created by the technical development team after receiving many complains from the school timetabling officers about the difficulty in using the regular application. The Data Collection Wizard (see figure 3.3) provides a simplified step-by-step process for entering a routine subset of data. This application stored the data in a spreadsheet template that would be sent to the university timetabling officer to import into the main application.

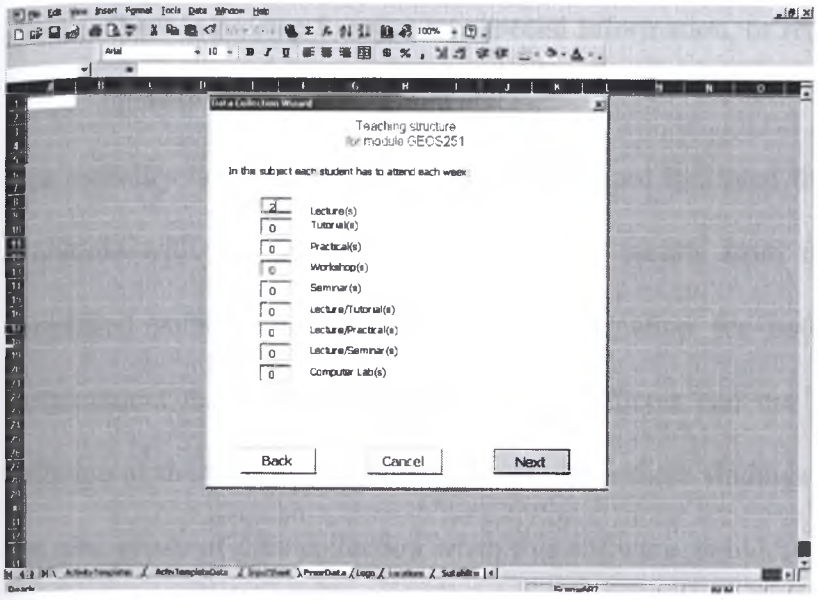


Figure 3.3: A screen from the simplified software module, 'Data Collection Wizard'.

3.6.2.1.4 Problems of the simplified software module identified from the usability test

The results from the usability test showed that the simplified software module was easy to use in terms of entering subject's very routine details, such as number of lectures and number of students. However, participants were frustrated that it would not allow them to enter more information; for example, information about a repeat lectures and breakdowns of tutorial grouping.

The problems concluded from the usability test are:

1. The terminology and/or wording, used in the data entry field is not clear to users.
2. The 'Back' button does not allow users to go back to a previous page. Instead, it goes back to the first page of data entry.

3. There is no step to input any special information, or repeat lectures available in the software.

The usability tests of the Data Collection Wizard indicated that there were still some problems with this simplified software. The results from the usability test of the simplified software module were new information for both the research and the development team. The school timetabling officers had not yet used this simplified software at the time of the usability tests. Thus these findings would be used to guide the next phase of data collection when this software would be employed by the school timetabling officers for the 2004 timetable data entry.

3.6.3 Personality tests

This phase of the data collection was conducted in the belief that person's personality is a factor that might affect how they use an application. The interviews in phase 2 revealed that some of school timetabling officers really wanted to learn how to use the new application. They believed that once they knew how to use the application, it would help them to finish the job easily and quickly. However, some did not want to learn to use the application because they only wanted to get the job done on time the way they had always done. They, therefore, preferred to avoid using any complex system. Some had a negative attitude toward some key stakeholders, such as management and the technical development team, and they did not want to use the application at all. It was thought that personality test would provide an explanation of this behaviour. The standard personality test "the IPIP-NEO" as explained in Chapter 2 was employed to collect personality data. The school timetabling officers, usability test's participants, and the university timetabling officer were asked to complete the personality test questionnaires.

3.6.3.1 Findings from the personality test

Table 3.8, 3.10, and 3.11 present the results from the IPIP- NEO personality test of the school timetabling officers, usability test's participants, and the university timetabling officer respectively.

Table 3.8: Results from the personality test for the school timetabling officers

Subject	Extraversion			Agreeableness			Conscientiousness			Neuroticism			Openness to Experience		
	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
1	×					×		×				×		×	
2		×		×			×					×		×	
3	×				×		×				×			×	
4	×			×			×					×			×
5	×			×			×					×		×	
6		×		×					×			×	×		
7			×		×		×					×		×	
8	×			×			×				×			×	
9		×		×			×					×		×	

H = High, A = Average, L = Low

Table 3.9: The summary of attitude of the school timetabling officers

Subject	Attitude					
	Software	Management	University Timetabling officer	New job process	Want to learn/use the software	
1	Not too bad	-	Positive	-	Want to know some functions	
2	-	-	Positive	-	-	Doesn't use the new system
3	Negative	Negative	Positive	Negative	No	
4	Negative	Negative	Positive	Negative	Want to know a short cut	
5	Positive	Positive	Positive	Positive	Yes	Small faculty and use the software before others
6	Negative	Negative	Positive	Negative	No	Temporary job
7	Positive	Positive	Positive	Positive	No	Can use the software
8	Negative	Negative	Positive	Negative	Want to know some functions	
9	Negative	Negative	Negative	Negative	No	

A comparison of the personality test results in Table 3.8 with the attitudes presented in Table 3.9 show no obvious connection. This suggests that the personalities of the school timetabling officers, who are direct users of the system, do not influence their attitudes toward the software, the new job process, and towards other key stakeholders (see Table 3.8 and Table 3.9). For example Subject 5 and 9 have very similar in personality however they are absolutely different attitudes as shown in Table 3.9. Another example involves subjects 5 and 7 who are the only ones to have positive attitudes however they are different in personality. Although this in only a small sample there is reason to believe that in this type of work situation the attitude of users of the system does not relate to their personality There are indication that users attitudes may relate to their culture, experience, and a complexity of their tasks.

Table 3.10: Results from the personality test for the usability test's participants

Subject	Extraversion			Agreeableness			Conscientiousness			Neuroticism			Openness to Experience		
	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
1	×				×			×				×		×	
2	×				×			×		×				×	
3		×				×			×		×			×	
4		×			×			×				×	×		
5			×			×			×		×				×

H = High, A = Average, L = Low

Table 3.11: Result from the personality test for the university timetabling officer

Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness to Experience
Low	Low	Average	Average	Low

The personality of the university timetabling officer is interesting because he is scored low on agreeableness and extroversion, i.e. is introverted, but not low on neuroticism and only average on conscientiousness. However he was in the front line dealing with all school timetabling officers during the time of major crisis. His personality is

suitable to the meticulous job of manipulating the timetable, as he is very well-organised and able to overcome reluctance to begin tasks and stay on track despite distractions. It is not suitable to tasks of training and trouble shooting where people are concerned and yet he was the one who was required to do this and managed to eventually succeed.

3.6.4 Summary of phase 3

As explained above, the method of data collection in this phase varies. The findings from the data collected in this phase are summarized in Table 3.12.

Table 3.12: The summary of themes derived from the data collection in Phase 3

Data collection	Concept	Theme
Interview The senior management	- The system may cause the staff to change the way of working they have done for a long time, and they would not like it. - There is a hardware problem that does not support the application. - Not planning well before the implementation and not enough people to work on it. - There was no education program to prepare people for change.	- Culture change -Software compatibility - Communication with external parties -Communication with staff
The university timetabling officer	- Basic instructions for using the new application are produced after receiving many complaints from the staff. - The timetabling process was changed from a manual to an automatic system. - In order to gather the school timetabling officers' problems and suggestions, the meetings were held.	-The difficulty in using the new software -Change to the job process -Communication with the users
Academic Teaching staff	-The timeline for preparing the timetable was too short. Thus, it was difficult to get accurate information. -The new software cannot provide a reasonable timetable because	-Organisational rules -Software flexibility

	there are many conditions the software does not understand. -Some academic staff were not happy with the timetable and therefore wanted to change it based on their particular preferences.	-Culture change
Student	There was only one response from a part time student, which was about a problem with the timetable.	
The development team	The simplified software module was created to help the timetabling officers enter data more easily.	The difficulty in using the new software
Usability test The regular application	The software is very complicated to use even to finish one data entry job for one subject.	The difficulty in using the new software
The simplified software	Special requests for repeat lectures cannot be input into the software.	Software flexibility
Personality Test	The attitude of the direct users of the system is not influenced by their personality. It is possibly influenced by their culture, background, and a complexity of their tasks.	

3.7 Phase 4: Follow up interviews and an evaluation of resource usage document

The phenomenon of this field study continued to change throughout the course of the research. The interviews revealed that there were many unexpected events occurring during the implementation process such as, the development of the simplified software module. It was necessary to continue with data collection to follow these changes.

3.7.1 Follow up interviews

The follow up interviews were conducted (see Table 3.13) during the preparation of the 2004 timetable. Six school timetabling officers were interviewed on topics emerging from the first round interviews. One of them was reluctant to tell anything and this interview has been cut from the final analysis.

Table 3.13: The schedule of the interviews in phase 4

Interviewee	Date/Time
1	18-11-03/11.30am.
2	19-11-03/10.00am.
3	20-11-03/10.00am.
4	21-11-03/2.30pm.
5	01-12-03/9.00am.
6	03-12-03/10.00am.

These interviews show that staff were provided with training and instruction for the 2004 timetabling processes and the use of the software application. They were more familiar with the job, the processes, and the application. They felt the situation was getting better. However, problems were still encountered with the application's inflexibility. They also perceived that the new system increased their workload.

The school timetabling officers mentioned that the simplified software module did not allow them to enter some special information on some subjects. They had to follow a step by step process to enter the routine information for each subject into the software but had to produce another document in Microsoft Word for special information and then send it to the university timetabling officer. This problem was confirmed by the usability test in Phase 3.

As the application did not take some special condition or information into account many problems resulted in the timetable, where lectures and tutorials did not run at a reasonable time and place. Timetabling officers and Heads of Units had to recheck the timetable drafts many times and repeatedly request changes which greatly increasing their workload.

The school timetabling officers were constantly under pressure from the university timetabling officer, academic staff, and students. The university timetabling officer did not always appreciate that they had other jobs to do besides the timetabling one. Academic staff and students complained about the timetable, and were disappointed that the school timetabling officers could not make the changes immediately on the system that was supposed to improve the process.

Meetings between the school timetabling officers and the technical development team were held more often which they said was good because it allowed them to express their problems and suggestion to the technical development team.

Themes for the research that came from this phase are summarised in Table 3.14. The data collection was completed with this phase, as there is no little information, or any new question, that arose during the interviews.

Table 3.14: the summary of themes derived from the interviews in phase 4

Data collection	Concept	Theme
Follow up interview	-Extra documents were provided and sent to the university timetabling officer, because the staff could not enter any special request, or repeat lecture, into the simplified software.	-Software flexibility
	-The staff were provided with training and information for the application and the processes in the job. This made the situation better than the previous year, in their opinion.	-Training requirement
	-The workload was increased because the staff had to recheck the timetable draft which was produced by the application, many times to have a workable timetable.	- Disadvantage of the system

3.7.2 An evaluation of resource usage document

The university timetabling officer and the external consultant produced a document comparing the resource usage between the old system and the new system. This document was sent to university management with the intention to point out the benefits of the new system in term of more efficient allocation of space in the university thereby increasing the overall usage of the available resources.

In the Year 2002, the university used the old system to allocate all location for teaching activity. In the document, it shows that Tuesday is the busiest day of the week in teaching activity as shown in Figure 3.4. Space usage is high but unevenly spread across the day, and indeed across the week as shown in Figure 3.5.

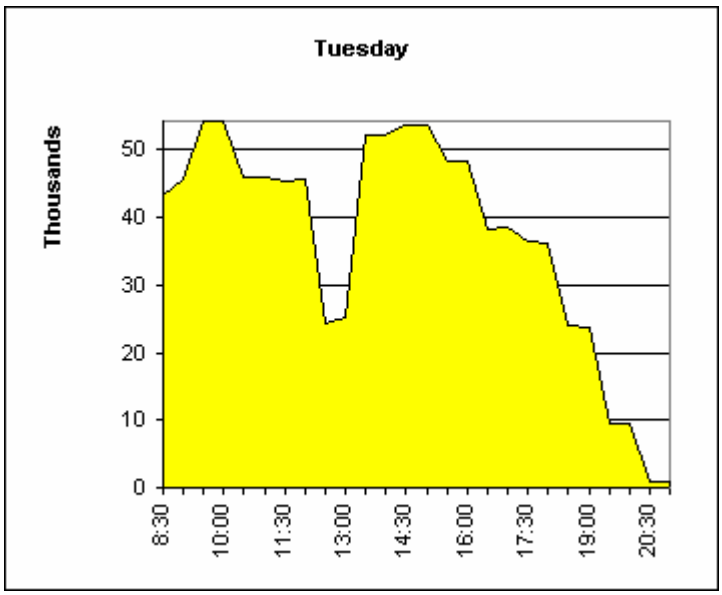


Figure 3.4: Teaching activity on Tuesday in Year 2002

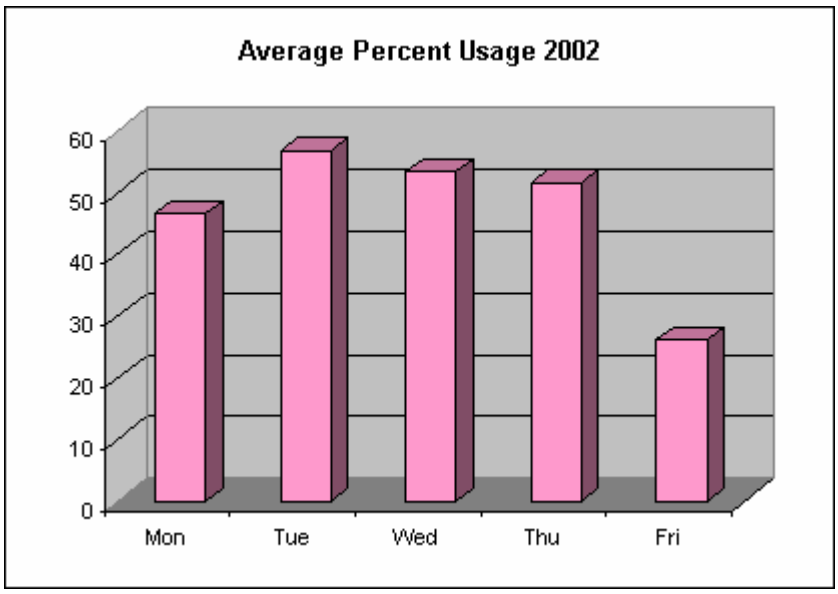


Figure 3.5: The Percent Usage of all location on each day of the week in Year 2002

In 2003, the new system controlled the usage of all location in the university. Figure 3.6 presents the teaching activity on Tuesday in Year 2003 and Figure 3.7 presents the Percent Usage of all location on each day in Year 2003.

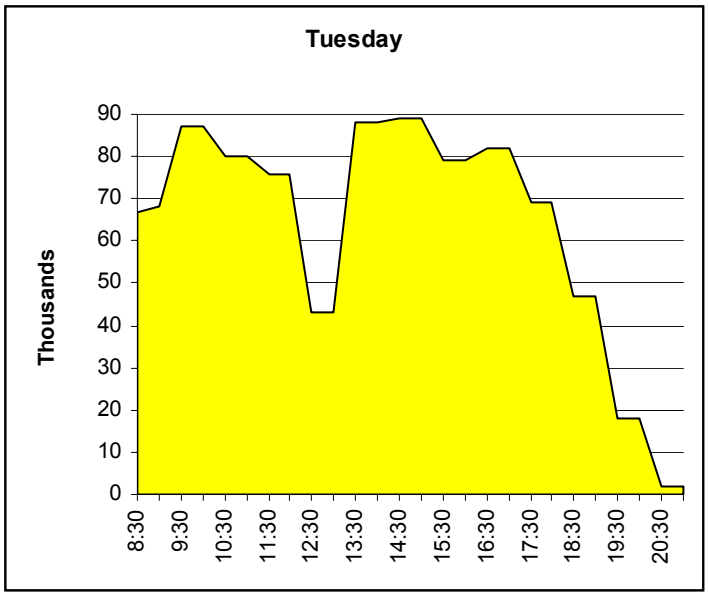


Figure 3.6: Teaching activity on Tuesday in Year 2003

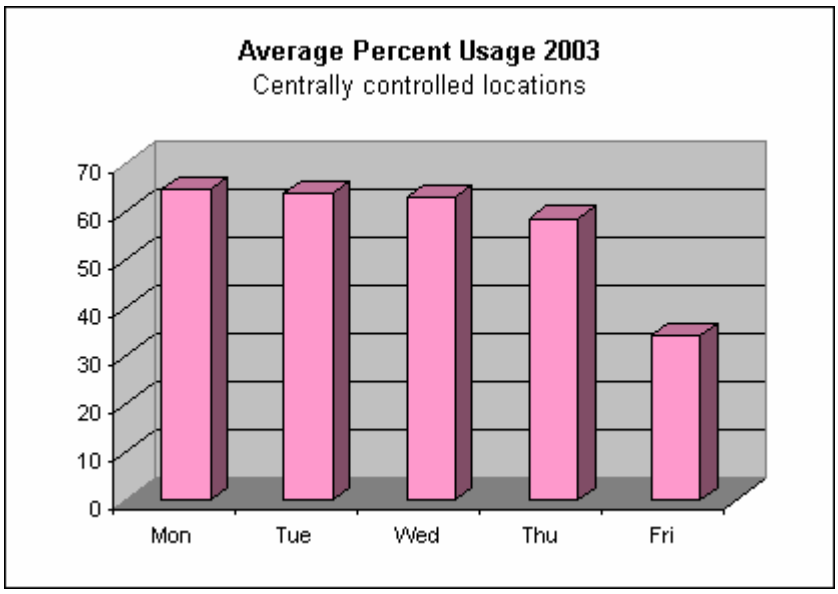


Figure 3.7: The Percent Usage of all location on each day of the week in Year 2003

The university timetabling officer and the external consultant claimed in report that "The centrally-allocated teaching locations are being very effectively and efficiently used (with the new system) but may be approaching saturation usage at various times of the week". Although "Friday has a relatively low usage rate at all times and more classes could be scheduled for this day".

In my opinion however it is clear from Figures 3.4-3.7 that the new software package did not make as big a different to the percent usage of all location in the university when as the university timetabling officer and the external consultant claimed. The acknowledgement concerning Friday is evidence that the new system did not have as much influence in changing work practices as had been anticipated.

Another shortcoming in the report is evident. The data looks at teaching locations in general and tells us nothing about pressure on particular types of teaching space, for example large lecture theatres, computer laboratories, flat-floor tutorial rooms, etc.

While the current software package is able to pick out these categories of location type for the centrally-allocated pool, the database needs to be expanded and refined to allow such an analysis for all teaching locations on the main campus. When this is done (not a major task) then a more detailed location usage report based on types of teaching location could be produced. This would also be of assistance in planning and establishing priorities for future building expansion however no such report has yet been undertaken.

3.8 Conclusion

This chapter explained in detail the data collection activities in the research conducted in 4 phases. A variety of data was collected through various methods in the field case: interviews, relevant documentation, usability tests, and personality tests. This chapter also presents the themes that emerged from the data during the collection phases.

The next chapter presents the data analysis using Activity Theory and Grounded Theory concepts. These two methods are used to analyse the data from complementary aspects.

Chapter 4

Data Analysis

4.1 Introduction

This chapter describes the analysis process that followed the data collection and initial identification of main themes presented in Chapter 3. The chapter is divided into two parts. The first part is a preliminary holistic analysis which uses an Activity Theory framework to structure the data. The second part is a more detailed grounded theory analysis of the data. These two methods of analysis present different but complementary aspects of the results.

At the analysis stage of the research, a framework is needed to provide some structure to the large amount of data, which were collected from different stakeholders in the university, to analyse the situation of the whole organisation. In keeping with the grounded theory approach, the choice of framework was made after the data collection and in light of the initial analysis of that data. Activity Theory was seen as an appropriate framework for this study as it deals with human activity within a complex dynamic and contextual situation where tools mediate what people can do. Thus, this framework is eminently suitable for the current research in order to display and interpret large amounts of inter-related data in a holistic and comprehendible way.

The activity theory analysis presents relationships and activities of key stakeholders in the university as they change during the implementation of the new timetabling system. It is useful for understanding the situation and problems in the field study in a holistic way. The subsequent grounded theory analysis, on the other hand, can identify core concepts that emerged from the data to explain a pattern of behaviour in the case.

4.2 Preliminary holistic analysis and theoretical framework

The activity framework is used here to provide a holistic view of the relationships between stakeholders emerging from data collected as described in Chapter 3. The data is now interpreted and displayed through the Cultural-Historical Activity Theory lens. Activity Theory provides a unifying approach to the study of what people purposefully do and is a meaningful unit of analysis of human doing, which is both situated and contextual incorporating culture and history. According to Kuutti (1996) Activity Theory is a philosophy and cross-disciplinary framework for studying different forms of human practices and offers a set of concepts, structures and terms that are eminently suited to research in areas related to Information Systems.

The collected data were displayed within a framework of interacting activity systems in order to explain the dynamics of the situation within the whole organisation. Thus the Activity Theory analysis provides a holistic view of all stakeholders' activities regarding the problems occurred during the implementation of the new timetabling system.

4.2.1 What is Activity Theory?

Activity Theory is a social-psychological theory that has its roots in the work of the Russian psychologist Vygotsky during the first half of the 20th century. Vygotsky's important insight into the dynamics of consciousness was that it is essentially subjective and shaped by the history of each individual's social and cultural experience (Vygotsky 1978). In addition, Vygotsky saw human activity as quite distinct from that of non-human entities in that it is mediated by tools, the most significant of which is language. Vygotsky's work was continued by others, amongst them Leontiev who developed a conceptual framework for a complete theory of human activity (Leontiev 1981). According to Leontiev (1981), activity is a system that has structure, its own internal transitions and transformations, and its own development.

Kuutti and Virkkunen's research (1995) has used activity systems as a representation of the common object of organisational work which cannot be studied by reducing the scope to one or another element, but where a minimum meaningful system as a whole should be taken as the unit of analysis and intervention. Engeström (1987) gave a more concrete expression to this structure in the triangular representation, shown in Figure 4.1, which is commonly used to depict an activity. The core of an activity is a dialectic relationship between subject (human) and object (purpose) mediated by tools and community. There is a two-way concept of mediation where the capability and availability of tools mediates what is able to be done and tools, in turn, evolve to hold the historical knowledge of how the communities behaves and is organised. This is particularly powerful when the tools are computer-based (Kaptelinen 1996). The formal, or informal, rules and division of labour of the community, in which the activity occurs, also dynamically mediate the subject-object relationship.

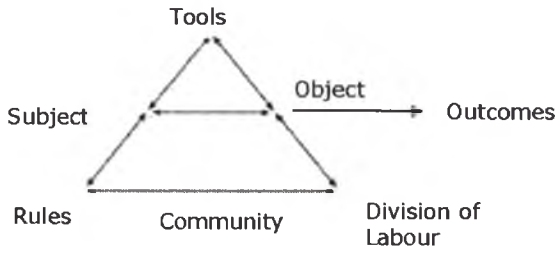


Figure 4.1: The subject-object relationship, which defines the activity, is mediated by tools and community through rules and division of labour. The subject may be individual or collective and outcomes of the activity are distinct from its object or purpose. (Engeström 1987)

Leontiev (1981) proposed that "activity" should be placed at the top of the hierarchy shown in Figure 4.2, associated with sustained human endeavour that has a long-term purpose and strong motives. This is a conceptual level above that at which most business analysis takes place, which is at the level of actions, undertaken towards specific, and often short-term, goals. Under certain conditions, conscious actions can be driven to a lower level of automation, often in computer systems, as they become standardised as operations. An activity is comprised of sets of actions (towards specific goals) and operations (routine and well known habitual cognitive or behavioural processes, now commonly the domain of IT systems). Where as an activity is defined by purpose and motive and is typically a long-term affair, actions are more planned with specific goals and a more limited time span. Actions are not meaningful in themselves unless they are part of an activity. For example it makes no sense to drive to work (an action) unless there is a work activity to go to.

There may be legitimate alternative sets of actions that can enable the successful performance of an activity, for example: it is common practice in IS development to assess the feasibility of different design solutions to an organisational problem and then choose one solution to implement based on a cost benefit analysis. However there may

be instances where it is feasible to allow concurrent different solutions (i.e. different sets of actions) for an activity under different circumstances (eg in different countries where cultures vary or in different divisions of a company). It is important however to have a common understanding of the object (purpose) of the activity at the top of the hierarchy.

Figure 4.2: The definitive hierarchy of Leontiev (1981)

In addition to Engestrom's structure of activity (Figure 4.1) and Leontiev's hierarchy of activity, actions and operations (Figure 4.2), there are several groups of researchers (Kuutti & Virkunnen 1995; Hasan & Gould 2001, Engeström 1999) who use frameworks of interrelated activities to represent complex organisational situations as shown in Figure 4.3. Taken together the three aspects of human activity will be used to analysis and present the case.

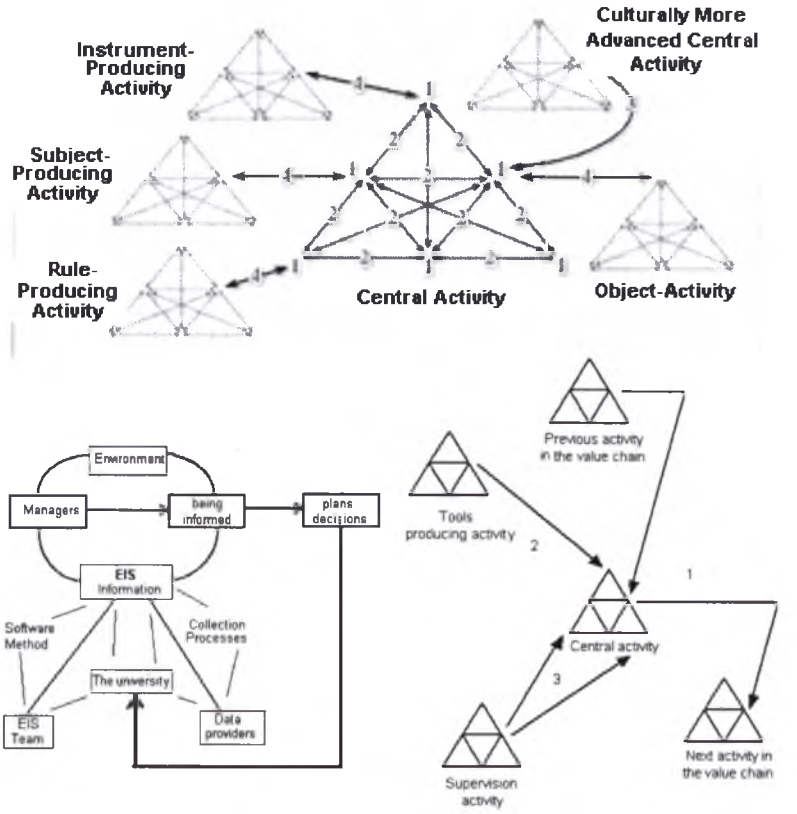


Figure 4.3: Sets of interrelated activities in the research of Engestrom (1999), Hasan & Gould (2001) and Kuutti & Virkunnen (1995)

4.2.2 The Activity Theory interpretation

It is apparent that the mix of interacting stakeholder activities, emerging from the study field, needs to be analysed and better understood. Such an analysis begins with identification, from the data, of the contributing activities, defined by the relationship between subject and object, i.e. who is doing what. A summary of the expected activities of the main stakeholders is shown in Table 4.1. This does not reflect the extra activities that the introduction of the new timetabling system caused in the work of all stakeholders.

Table 4.1: A summary of expected stakeholder activities

Subject	Object	Desired Outcomes	Mediating Tools	Context
Senior manager	Resource utilisation	Lower teaching costs, no problems	Administrative staff and procedures	Pressure from above
Registrar	Running of Teaching Program	Contented managers, teaching staff and students	Unit staff and procedures	Pressure from the senior manager, dealing with problems of staff and students
External Consultant	Implementation of the system	Working system	Timetable system documentation, University requirements	Limited to interest in the system
University Timetabling officer	University Timetable of class space and time	Smooth, trouble-free timetabling process	The system, management demands	Responsible for smooth running of Timetable.
School Timetabling Officers	Communicate between teaching staff and administration	Satisfactory timetable with ability to update as needed	School procedures, the Timetable system	Variety of responsibilities in own school, conflicting needs of staff and students
Teaching Staff	Teaching courses	Good educational outcomes	The timetable and other systems	Changing educational environment
Students	Education	Good grades, learning	The timetable and other systems	Pressure to succeed

Figure 4.4 depicts the expected relationship between the normal activities of teaching and learning recognising that education, alongside research, is a dominant purpose of a university. These activities should take centre stage in what takes place within the faculties and schools of the university while the timetable, and the other work of the registrar's unit, occupy a lesser, supporting role. In this activity–based representation the registrar undertakes a sideline activity of providing a supportive environment for

the main players, the teaching staff and students and timetabling is only a purposeful activity for the university timetabling officer with the timetable as the outcome.

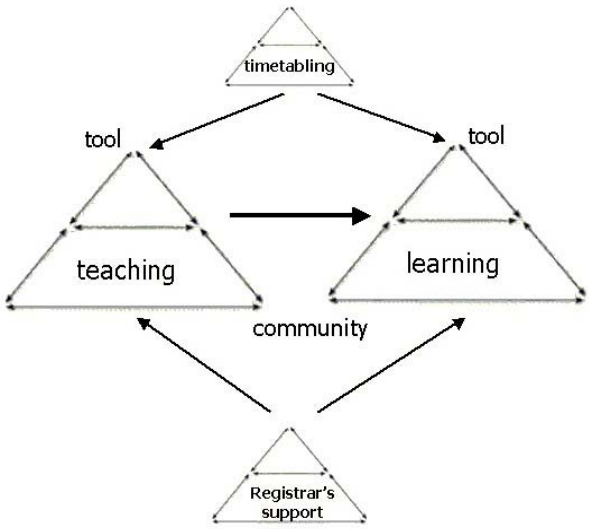


Figure 4.4: The ideal relationship between the dominant educational activities

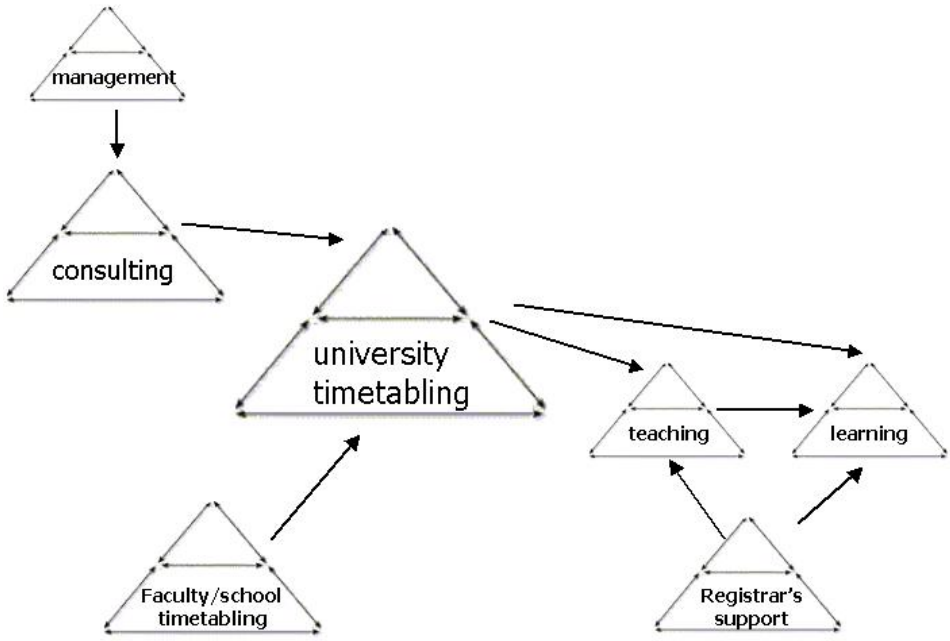


Figure 4.5: The distorted relationships between actual activities of stakeholder during the introduction of the new timetabling system.

What appears to have happened with the poorly planned introduction of the new timetabling system, was that the timetabling activity took centre stage and dominated the attention of most of the stakeholders as shown in Figure 4.5. The supposedly dominant activities of teaching and learning were pushed to one side as everyone made an effort to get data into the new system and then get it to produce an acceptable timetable. The activity of the consultant, engaged by senior management to advise the university timetabling officer, was far removed from the end users and he was unaware of most of their specific problems. The senior management and the consultant seemed to have one view and that was to automate an efficient timetabling system that would change the organisation from its previously, somewhat chaotic, state into a well-oiled machine. They saw a need to even out the popular times for classes, when resources were at a premium, and other times, when there were plenty of free classrooms. They also hoped to reduce the constant requests for changes to room allocations.

With the introduction of the new system, everyone was adversely affected either by the difficulties of getting data into the system or by the time consuming effort of checking for anomalies in the unworkable timetables it created. The former problem was due mainly to the poor usability and other shortcomings of the system and by the long time between the training of end-users and their use of the system. The latter problem was mainly due to the extreme difficulty of making sure all data and constraints were captured in the system. Several runs of this timetabling process were made before even a remotely feasible timetable was created causing great concern to the faculty and teaching staff.

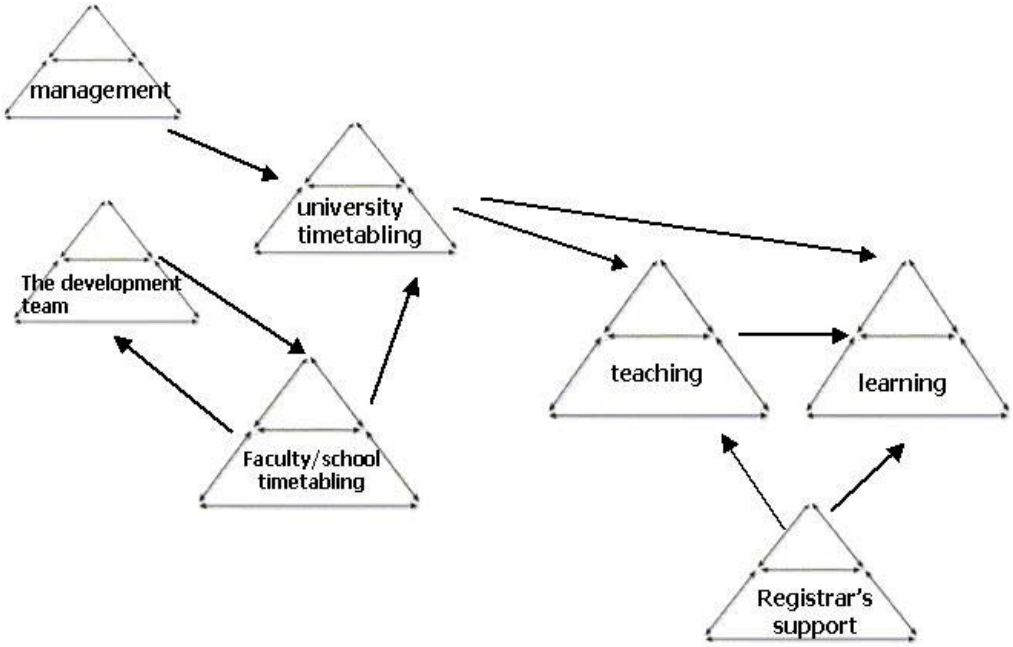


Figure 4.6: The distorted relationships between actual activities of stakeholder after implementing the new timetabling system.

The second year of operation of the new timetabling system was, in many ways, similar to the introductory year. As shown in Figure 4.6, the dominant activities of teaching and learning, although somewhat more prominent, are kept in one side because the attention of many stakeholders in the university is still focused on the new system as an inordinate effort is still needed to make the system to work. The activity of the consultant finished after the introductory year and so his activity is removed from the framework. The university timetabling officer has sole responsibility in the role of making the system to work and making sure that all constraints are captured in the system. Thus, he has put more pressure on the school timetabling officers to input data into the software package.

The technical development team have a role in assisting the school timetabling officers to operate the new software easily. They receive comments and suggestions from the school timetabling officers. Then they have created a simplified software module to assist the school timetabling officers in the data entry process.

As all academic teaching staff have to provide data of their subjects including class structure and requirements to send to their school timetabling officers, they are now considered as indirect users of the new timetabling system. Once the timetable is created, it directly affects the workload school timetabling officers and academic teaching staff, as they have to check for anomalies in the timetable and these have been substantial.

This preliminary analysis using an Activity Theory framework pulls all the strands of the research together and gives an integrated picture of the work of all stakeholder. Figures 4.4 to 4.6 form a dynamic framework showing how the picture changed over time and enables a comparison between the ideal and real situations.

4.3 Grounded Theory analysis

In grounded theory, data is analysed using the constant comparative method following the approach described in Chapter 2. According to this method, data analysis begins with fracturing the data into analytic pieces to identify categories through the process that is called coding (Dey, 1999, Glaser, 1978). The data is analysed line by line for incidents and then comparing each incident to incident and code to code. In this research, the analysis was done while collecting the data and presented as themes in Chapter 3. In this Chapter the analysis is continued as similar incidents and codes are

grouped into one or more main categories. These categories are then investigated further through a literature review of the area, comparing the findings from the case with the existing literature on the topic. These emergent categories are treated in the following three chapters of the thesis.

4.3.1 Open coding and initial categorisation

Table 3.4, 3.12, 3.14 in Chapter 3, presented themes that were coded from the collected data. These themes are the result of open coding using the constant comparative method in the grounded theory approach.

The total list of themes is as follows:

1. Culture change
2. Change to the job process
3. Organisational rules
4. Complexity of the task
5. Expectation to decrease workload
6. Expectation to increase work performance
7. Training requirements
8. Document and instruction
9. Communication between the management and the staff in the university
10. Software compatibility with existing software and hardware
11. Attitude towards key stakeholders
12. Job description
13. Interruption to workflow
14. Staff conditions
15. Personal belief
16. The difficulty in using the new software
17. Communication with external parties
18. Communication with staff
19. Communication with the users

20. Software flexibility
21. Disadvantages of the system

The relationships between these themes were analysed in order to categorise and grouped them into a limited number of main categories as will now be described.

Themes 9, 18, 19 refer to the communication between various stakeholders within the university, considered more generally as 'Communication within organisation'. Theme 17 was considered as 'Communication between organisations'. These four themes were therefore placed in a category of 'Communication' with two sub-categories as shown below.

Category	Subcategory
Communication	Communication within organisation
	Communication between organisations

Themes 7 and 8 refer to practical ways of providing knowledge to staff in an organisation. Therefore, they were placed in a category labelled 'Sources of Knowledge'.

Category	Subcategory
Sources of knowledge	Training
	Document and instruction

Themes 1 and 2 deal with the changes that happened in the university during the implementation of the new timetabling system. Therefore, these two themes were placed in a category labelled 'Change in an Organisation'.

Category	Subcategory
Change in an Organisation	Culture Change
	Change to the job process

Themes 10, 16, and 20 are related to the new software package. They were categorised as the 'characteristics of the software'.

Category	Subcategory
Characteristics of the software	Software compatibility
	Software flexibility
	Software complexity

The results of the personality testing in phase 3 in Chapter 3 indicate that users' attitude and their beliefs in this case do not appear to relate to their personality. Instead, users' culture, background, and complexity of their tasks with the new system appeared to have considerable influence their attitude and belief. Therefore, themes 11 and 15 are omitted at this stage.

Themes 5 and 6 are concerned with the expectation of the users that the new system would decrease their workload and increase their work performance. These themes refer to the advantages that the users expected from the new system. However, the study has shown that in reality the new system increased users' workload, which is a disadvantage of the system in accord with theme 21.This also relates to the complexity of the task (theme 4) that could decrease or increase the users' workload while using the new software application. This can be explained as a function of the whole new system which as defined by Avison & Fitzgerald (2003).

Category	Subcategory
System capability	Advantages of the system
	Complexity of the task

Theme 13 'Interruption to workflow' was coded from observations during the interviews. Most of the interruption did not relate to the timetabling job but other jobs that school timetabling officers had responsibility for because of their job description (theme 12). Therefore, this theme can be omitted.

Themes 12 and 14 relate to organisational rules (theme 3) so that it can become a category for these two themes.

Category	Subcategory
Organisational rules	Job description
	Staff conditions

Therefore from 21 themes, the findings of the study can now be grouped into 6 categories as shown in Table 4.2.

Table 4.2: The summary of the initial categories that emerged from data

Category	**Subcategory**
Communication	• Communication within organisation • Communication between organisation
Sources of knowledge	• Training • Document and instruction
Change in an organisation	• Culture change • Change to the job process
Characteristics of the software	• Software compatibility • Software flexibility • Software complexity
System capability	• Advantages of the system • Complexity of the task
Organisational rules	• Job description • Staff conditions

4.3.2 Re organising the categories

After categorising themes into 6 initial categories (see Table 4.2), I decided to revisit all the data again to remind myself of the central research question that "what is going on here?" as Glaser suggests (1978). I also returned to the textbooks of grounded theory to update and strengthen my ability to analyse data in this way. The results of this re-analysis are now presented.

I realised that the initial categories of 'Communication' and 'Sources of knowledge' were closely related. What really happened in the case was that all the key stakeholders tried to communicate with each other to share the knowledge and information they had. This is evidenced by the documentation and the training aimed at providing knowledge to both direct and indirect users of the new system. Furthermore, this is similar to the concept of communication between organisations as a practical way to transfer knowledge from one organisation to another organisation when they share the same interest, as in this case using the same timetabling software package. Although this was not done well in this case it would fall under the heading of knowledge transfer issues.

Therefore, these two categories can be re-categorised as 'Knowledge Transfer' as shown here.

Category	Subcategory
Knowledge Transfer	Communication
	Sources of knowledge

Similarly, the categories ‘Change in an organisation’ and ‘Organisational rules’ can be considered as a complementary aspect of context in an organisation. Therefore, the new category encompassing these two categories identified as ‘Organisational Context’.

Category	Subcategory
Organisational Context	Change in an organisation
	Organisational rules

The last two categories have a relationship between them as well. The category ‘Characteristics of the software’ is considered as one factor that influences the ability of the system. Thus, this category is become a subcategory of the category ‘System capability’, reiterating that the software application is only one component of the new timetabling system which included people and processes.

The six initial categories are now re-categorised into three as shown in Table 4.3.

Table 4.3: The summary of categories re-organised from section 4.3.1

Category	**Subcategory**
Knowledge Transfer	• Communication • Sources of knowledge
Organisational Context	• Change in an organisation • Organisational rules
System Capability	• Characteristic of the software • Advantages of the system • Complexity of the task

4.3.3 Participants' concern within the research field

Looking back to the data, it is clear that the main concern of school timetable officers, who are the direct users, is that they cannot get their job done on time because of a lack of knowledge and understanding of the new system which included the software and the whole timetabling process that seems to have changed to meet the constraints of the new software package.

This raised some issues in the main categories that I had to rethink theoretically in a way would indicate how the data analysis would contribute the field of study. The main concern of participants can be stated as follows:

> Users both directly and indirectly cannot use a computer-based system to support their work efficiently if they do not have knowledge of the whole new system which included the software and the process of a job that has changed to meet the constraints of the software. Furthermore, software characteristics and complexity of a task also affect users' work performance.

School timetabling officers would receive knowledge about the new timetabling system from people who are responsible to this project. This knowledge should be transfer from outside party, for example organisations who have supposedly used the software successfully, to the management level including all people who are involved in the project. It is useful for the management to understand the characteristic of the software and context of its use. Furthermore, this also assists the planning process to prevent some problems caused by technical and human issues.

4.3.4 Core category

After reorganising the category, it is shown that there are three main categories emerging from the data. They are Knowledge Transfer, System Capability, and Organisational Context.

To identify Core category is a part of developing grounded theory (Dey, 1999, p. 109). Therefore, the three main categories were brought to consider one more time to identify the core category for the research based on the criteria that is suggested by Glaser (1978, p. 95 – 96) to assist making a judgment on the core category.

I went back to the pattern of behaviour of the participants and their concern and realised that the main three categories are factors that influencing users to use a system to support their job efficiently and this also increases the organisational performance.

Thus, I propose 'Influencing capability and thereby organisational performance' is the core category for this research which three categories: 'Knowledge Transfer, System Capability, and Organisational Context', are fit in.

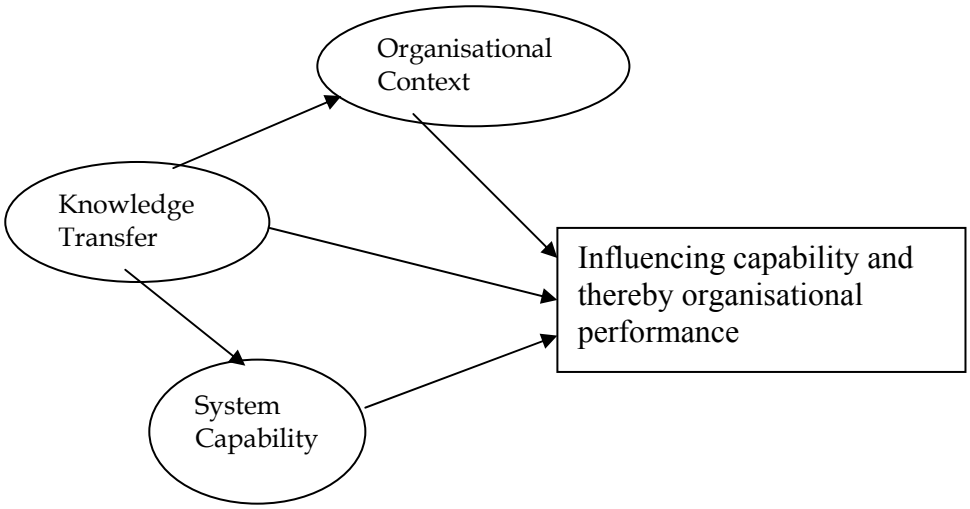


Figure 4.7: The relationships of sub core categories and core category.

The relationships of three main categories and the core category are presented in Figure 4.7. Knowledge about a system (System Capability) and context of its use would be transfer from outside an organisation and this would assist management to plan (Organisational Context) for resources required for implementing the new system using the new software package including the plan to transfer knowledge to officers in the organisation especially direct users of the system. This would influence an ability of users in order to perform their tasks more efficiently with the support of the system and thereby increase an organisational performance which is ultimate goal.

Table 4.4:The summary of main categories emerged from the data in the research

Category	Subcategory	Property	Data
Knowledge Transfer	Communication	• Within organisation • Between organisations	- All key stakeholders tried to provide useful information to improve the situation by establishing the user group and setting more meeting. -Key stakeholders knew that the timetabling system was already well established in other universities.
	Sources of knowledge	• Training • Document and instruction	- Timetabling officers required training to improve their ability to use the system. - The development team provides document and system's instruction to officers in order to assist them using the system more efficiently.
System Capability	Characteristics of the software	• Flexibility • Complexity • Compatibility	- The software cannot take some important conditions into account. - The software is complicate for staff to use it. - The software is not compatible with some hardware and existing software packages.
	Advantages of the system	• Improve work performance • Decrease the workload	- Key stakeholders expect to have an efficient timetable. - Officers expect the software to assist them to complete the job easily.
	Complexity of the task		- School timetabling officers could not provide accurate information in order to input into the software.
Organisational Context	Change in organisation	• Culture change • Change to the job process	- Staff lose their control after using the system. - The job process has been changed to meet the constraints of the new system.
	Organisational rules	• Job description • Staff conditions	- The officers have other jobs to do which they are responsible for besides the timetabling job. - Some of them were new for the job, or were even assigned the job temporary.

4.4 Activity Theory analysis and the emergent categories

The activity theory analysis revealed that both direct and indirect users of the timetabling system were affected by the implementation of the new timetabling system. Their activities were changed in order to get the timetabling system to work rather than their critical activities by supported by a workable timetable. The ideal relationship between the dominant activities in the university, as presented in Figure 4.4, is intended. However, the distorted relationships between actual activities of stakeholder still continues happening in the university after the introductory year as key stakeholders put their effort to force the system to work (see Figure 4.6).

To make the dominant activities of teaching and learning be, once again, the central activities of the university, the three categories: 'Knowledge Transfer, System Capability, and Organisational Context' have been identified from the grounded theory analysis. These will be considered in more depth in the subsequent chapters of the thesis as they critically influence the ability of users both direct and indirect users to use the system to support their job thereby enabling the organisation to perform more effectively and efficiently.

4.5 Conclusion

The data collected in the research has been analysed using two different methods: Activity Theory and Grounded Theory. These two methods provide different perspectives that are useful in explaining 'what is going on' in complex situation in a substantive area.

The Activity Theory analysis revealed that what was planned to be a mere operation had become a dominant activity of implementing a new system, occupied the attention of administration and teaching staff alike. This was not only very disruptive to the normal activities of the university, teaching and learning, but also distorted the relationships between administrative and educational activities.

The Grounded Theory analysis revealed the core category 'Influencing capability and thereby organisational performance' which has three main categories: 'Knowledge Transfer, System Capability, and Organisational Context' which explain the pattern of behaviour of the case. Each main category will be explained in depth detail in the next three chapters.

Chapter 5

Knowledge Transfer

5.1 Introduction

The grounded theory analysis has identified one core category and three categories as explain in Chapter 4. This chapter presents detail of the category identified as 'Knowledge Transfer' together with its subcategories, attributes and properties. The chapter begins with a description of these as identified in the case, using quotations and examples to illustrate the findings. This is followed by a discussion of a selection of the significant literature on this category relevant to the findings of the case.

Before exploring the category of knowledge transfer it is useful to clearly articulate the use of terms in the area as there is much diversity among these. Some relevant definitions from AS5037 (2005) *Knowledge management – a guide*, A Business Standard from Standards Australia.

Data: Any manifestation in the environment, including symbolic representations that, in combination, may form the basis of information.

Information: Data in a context to which meaning has been attributed.

Knowledge: A body of understanding and skills that is constructed by people. Knowledge is increased through interaction with other people and with information.

Knowledge management (KM):

> A trans-disciplinary approach to improving organisational outcomes and learning, through maximising the use of knowledge. It involves the design, implementation and review of social and technological activities and processes to improve the creating, sharing, and applying or using of knowledge.
>
> Knowledge management is concerned with innovation and sharing behaviours, managing complexity and ambiguity through knowledge networks and connections, exploring smart processes, and deploying people-centric technologies.

The Standard also states that developing and sustaining a positive KM focus in an organisation can be achieved through facilitating continuous learning, identifying sources of knowledge, understanding the mediators that facilitate knowledge sharing, and facilitating information and knowledge transfer. Sharing of stories can build trust, assist with knowledge transfer and seed the generation of new ideas.

5.2 Knowledge Transfer category

Knowledge and understanding of all key stakeholders is important to the successfully introduction of any new system into an organisation. Lack of knowledge and misunderstanding about the system, and the job it performs in the organisation, can lead to resistance of the new system. Particularly important is shared information about how the system works and about any changes to organisational processes caused by the introduction of the system. A summary of the aspects of Knowledge Transfer emerging as significant from the study is shown in Table 5.1.

Table 5.1: Subcategories and properties of 'Knowledge Transfer'

Subcategory	Property
Communication	• Within organisation • Between organisations
Sources of knowledge	• Training • Document and instruction

In the study it was noticeable how restricted were the knowledge flows between different stakeholders in the timetabling project and how many of their problems could have been avoided with appropriate knowledge transfer protocols. There seemed little awareness of the need to identify who has relevant knowledge, who needs that knowledge and how it could be effectively transferred. Two aspects of problems with knowledge transfer stood out. One was the lack of communication between universities about experiences with the system, particular the flow of knowledge from the universities where the system had been used to the university in the case. The other was the lack of first-hand knowledge of other working environment among various stakeholder groups within the university.

Knowledge and information can be shared by communicating both within organisation and outside organisation. Furthermore, users of the new system both direct and indirect users receive knowledge through training and documentations that provided by an expert of the system and key stakeholders who are responsible for the timetabling project.

5.3 Communication

Communication is the first subcategory of 'Knowledge Transfer'. There are two properties in this subcategory (see Table 5.1), which are:

- Communication within organisation
- Communication between organisations

5.3.1 Communication within the organisation

Communication between key stakeholders in an organisation is a significant process for providing and receiving knowledge and understanding of context of a system implementation. Users will be prepared for the implementation of a new system by receiving clear information and knowledge from management and a development team. They must be confident and understand the benefits from the new system. Furthermore, management and a development team need to understand users' concern, their condition, difficulty in collecting data for a system because some data is difficult to collect and express explicitly.

In the field study, the communication within the university occurred:

- Between management and the timetabling officers
- Between the development team and the timetabling officers
- Between the timetabling officers

5.3.1.1 Communication between management and timetabling officers

School timetabling officers did not receive clear information and knowledge from the management once the new timetabling system was implemented. Thus, they could not clearly see a benefit of the system and how it works. As one school timetabling officer said,

> "I am anxious about the system about the source of timetable that it produces."

Another school timetabling officer also said that,

> "I am confused because I do not know what I am doing."

Furthermore, the management did not pay attention to school timetabling officers' concern and the impact of changes on the working site as one of the officer stated,

> "I did not get the feeling that people were listening to my concern.
> It was like… this is it you have to do it, we do not care how you do it."

The management did not understand all the problem and condition of officers both academic staff and timetabling officers. The management thought that people resisted the new system because they did not like the changes that were caused by the new system. As the senior management said,

> "I do think that they have an understanding of it but it does not mean they like it. They do understand that the new system will have benefits in term of flexibility. They do understand that the system will give the information for planning they all understand but because the system may cause them to change something that they have done for a long long time. They understand it but they do not like it. And I am talking here about the academic staff not the general staff. The lecturers, Associate professor, Professor, they do understand what the issues are and what the potential benefits are but because this is causing them to change thing that they have done for long time. They do not particularly like it. The staff that actually use the system, I think they do understand the benefits of the system and what the system is trying to do."

5.3.1.2 Communication between the development team and timetabling officers

Communication between users and the development team will let the development team know about users' problems and enable them to solve problems and improve the quality of the system.

The first year of the introductory of the new timetabling system was encountered the problems by key stakeholders in the university especially by the school timetabling officers and the university timetabling officer. The school timetabling officers had very little knowledge of the new job process and how to use the new system. They asked the university timetabling officer, who became the only expert on the system in the university, to fix their problems. However from his personality test, it indicates that he is not suitable to tasks of training and troubleshooting because he is introverted that has not much communication skill.

As the university timetabling officer is one of the development team, he collected the problems from school timetabling officers and tried to solve all problems and improve the quality of the system and also the ability of school timetabling officers to use the new system. He had set a meeting with all school timetabling officers to gather the problems and suggestions. The meeting between the development team and the school timetabling officers continue happening in order to share information.

The university timetabling officer and the development team understood the problems of school timetabling officers. As the university timetabling officer said,

> "We know that the system is too complicate for them. So we try to help them to use the system."

However, the new timetabling software application is an off-the-shelf package, therefore the development team could not modify the software application itself. Instead they produced user instructions that easily to understand by following simple steps.

Furthermore, the development team created a simplified software module in an attempt to overcome the complexity of the data entry task. It was developed in order to assist the school timetabling officers entering data into the system easily. For the previous timetable process, the school timetabling officers produced the timetable in a spreadsheet form and sent to the university timetabling officer. Therefore, the development team tried to create the software that the school timetabling officers understand and easy to use. As the university timetabling officer said,

> "This software is easy to use because they just follow the steps like a wizard in Microsoft and it shows the information in a spreadsheet form that they are more familiar with."

5.3.1.3Communication between timetabling officers

School timetabling officers shared knowledge between them especially when they encountered the problems with the system. Even though the university timetabling officer could help them to fix the problems but he could not fix all problems for all school timetabling officers promptly. Thus, they had to seek for assistance from whoever knows how to solve their problems.

The communication between timetabling officers is both formal and informal. They discussed about the problems and the new job process. Some of them could fix the problems for others because they had experience with the same problems and be fixed by the university timetabling officer. As one of the school timetabling officer said,

> "Sometimes I talked to another timetabling officer in my faculty when I had a problem because I could not wait for (the university timetabling officer's name) to come and fix it."

After the university timetabling officer set the meeting with school timetabling officers, they decided to establish a user group. All school timetabling officers were able to share information and send this information to the development team to improve or do something to assist them to use the system more efficiently. As one of the school timetabling officer mentioned,

> "Well, we have a user group now and what we are doing is suggesting ways to improve it like it needs to be totally compatible with the web timetable. Need to have automatic process every time we change a time. It needs automatically update that. Before, we have to wait a couple days for the change need to be done. So that need to happen and I believe they are working that now."

5.3.2 Communication between organisations

Communication between organisations is required to provide significant information when adopting a new system that is already well established in other organisations. This will help management with planning and prevent problems that may occur during an implementation.

In the field study, the new timetabling system has already been used in many universities as the university timetabling officer said,

> "I know that many universities are using it and it is working well. It is quite a good system."

And one school timetabling officer said,

> "I have heard that (university's name) is using this system. They said it is working well."

However, the knowledge did not transfer from outside to the university because the problems were encountered during the implementation as the senior management mentioned,

> "We had a lot of problems because any new system creates the problem. First of all we had hardware problems because the new system had to be adapted to the university hardware and information systems. Not all of the faculty had the right hardware to be able to the system effectively. The system also was not role out properly. We did not plan enough for it. We did not have enough people working on it when we first started it and we did not think for enough ahead as what we wanted to do. So the combination of planning problems, hardware problems, and people problems created difficulty when they first came in."

He also admitted that,

> "We did not prepare them well enough when we first introduce the system. We did not prepare people well enough for the culture change."

5.4 Sources of knowledge

The second subcategory of 'Knowledge Transfer' is source of knowledge (see Table 5.1). Its properties are:

- Training
- Document and instruction

These are essential components of any bureaucratic organisation and are formalised in human resource management processes and procedures. They are particularly relevant when associated with employee use of new technology within revised business systems.

Users have varying levels of computer literacy, therefore, training and documentation are useful in providing them with the knowledge to use software applications as part of work systems.

5.4.1 Training

The training is a method that allows users to get familiar with a system before actual using it. Users gain knowledge through training sessions, not only how to use it but also what a system can do for them to increase their work performance.

School timetabling officers did not train to use the new timetabling system. They had a little knowledge about the system and the new job process. They required the training as school timetabling officers who participated in the research mentioned that,

> "I need a lot more training definitely need a lot more training because there are a lot of things on the image I cannot change anything I only have an image so I need a lot more training so I will be able to print as well print out sheet of the actual week by week timetable."

"Problem with the new system is lack of knowledge and training mainly."

"As long as I have training and practice, it should be ok to use the new system."

5.4.2 Document and instruction

Document and instruction is a source of knowledge that flows between the management and all staff in an organisation. The organisation provides document and instruction to staff to distribute information and knowledge especially general information and instruction. It is useful to prepare staff in the organisation and allow them to know what happen in the organisation. Furthermore, the management also receive feedback and report from staff for an evaluation of staff's performance and organisational performance.

The document that related to the timetabling project was collected in the current research. There are 3 kinds of document, which are:

1. Document for the management: They are report and schedule of the project, such as the evaluations of the utilisation of space before and after the introduction of the new timetabling system. They were produced by the project manager, the consultant, and the development team.

2. Document for all staff in the university: The messages and instructions of the new timetable process and other general information were sent via email to all academic and general staff in the university.

3. Document for school timetabling officers: The school timetabling officers received document for the new timetabling system in general and information for the new job process including who is responsible for the implementation of the system. Furthermore, they also received system's manual and system's instructions, which were produced by the development team.

5.5 The identification and discussion of selected relevant literature

Literature on the topic of knowledge transfer covers a broad spectrum from practice to theory. As can be seen from the analysis of the practical case presented above there are problems and shortcoming of knowledge transfer in organisations. At this level Singley and Anderson (1989) define knowledge transfer as *how knowledge acquired in one situation applies to another*. There are several mechanisms for knowledge to transfer (Argote et al., 2000). Karlsen and Gottschalk (2004) explain that *these mechanisms include movement, training, communication and observation of personnel, technology transfer, replication routines, patents, scientific publication and presentation, interaction with suppliers and customers, alliances, and other forms of inter-organizational relationships.*

Clear communication channels between key stakeholders in an organisation are important in providing and receiving knowledge and understanding the influence of context in a system implementation. End users are often overlooked in this process and need to be prepared for the implementation of a new system by receiving clear information and knowledge from management and the development team. They must be confident and understand the benefits from the new system. Furthermore,

management and the development team need to understand users' concern and the conditions under which they will use the system.

While the need for these mechanisms is well accepted, their application in practice is less well understood as can be seen in the case described here. At a theoretical level the understanding of knowledge transfer issues and processes is less obvious. The remainder of this chapter address the issue of knowledge transfer from a theoretical perspective in order to develop a deeper understanding.

5.5.1 Knowledge, knowledge management and knowledge transfer

In the introduction to this chapter Standard definitions of data, information, knowledge and knowledge management were presented leading to the description of knowledge transfer in the Australian Standard for KM. A particular problem in Information Systems now a challenge in the field of knowledge management has been the distinction and relationship between information and knowledge. A popular model in Information System is a the simple DIKW hierarchy with Data at the bottom level, Information defined as processed data, knowledge as processed information with wisdom at the top of the hierarchy. The model of Callioni (2003) shown in Figure 5.1 assumes a nested relationship connecting data, information and knowledge, extending to wisdom. Of particular relevance to this study is the position of knowledge with the implication that knowledge produces information and enables action. Knowledge is itself a product of belief applied to information, which is in turn meaningful data.

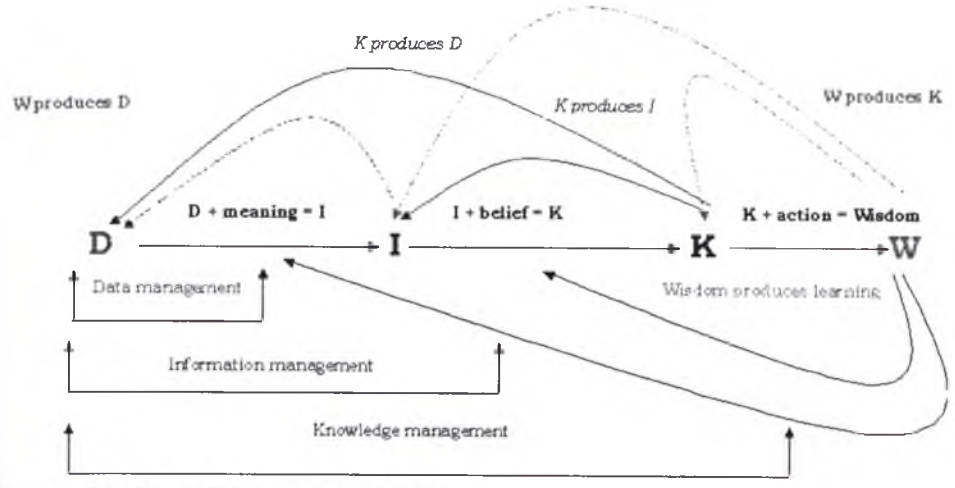


Figure 5.1: The DIKW model of Callioni

The growth of the field of knowledge management, within that of Information Systems, is a reaction to the recognition of the critical importance of knowledge in the work of organisations. Some significant research in this area, particularly relevant to the concept of knowledge transfer is as follows:

- The work of Boland and Tenkasi (1995) was notable in its assumption that the ability of IT to provide support for KM is best understood as the interrelationship of organisational, cultural and technical elements.
- Karl Weick (1995) introduced the powerful concept of sense-making in organisations. If knowledge is viewed as enabling action, sense making and knowledge sharing can be considered two sides of the same coin as part of sharing knowledge is having something that makes sense and is worth sharing. According to Cecez-Kecmanovic et al (2003) knowledge can be considered as both a subject where what we know enables us to act, and as a product of sense-making by individuals, groups and organisations leading to learning from those acts. Both Weick and Cecez-Kecmanovic regard sense-making as occurring at fours different levels:

- Individuals – professionals actions, decision-making, tacit knowledge/experience
- Groups/teams – activities, trust, combinations of knowledge and skills, informal/agile networks
- Organisations – allocation of resources, funding, lessons learnt, discipline and co-ordinating, authority,
- Society/community – amateurs, focus of danger, culture, motivation, panic

- The distinction between explicit and tacit knowledge as promoted in the work of Nonaka as will be discussed in more detail below. There can be difficulty in collecting data and requirements for a system because so much of the way work is done is not express explicitly. Knowledge that cannot be expressed explicitly is referred to as "tacit knowledge" (Nonaka, 1994).

5.5.2 Knowledge management in organisations

The field of knowledge management recognises both the importance and challenges in dealing with tacit knowledge. This has built on Nonaka's (1994) model of knowledge sharing and creation in organisations and is based on the assumption that knowledge has a dimensional structure that covers:

- *Tacit knowledge* is highly personal and hard to formalize, making it difficult to communicate of share with others. Subjective insights, intuitions and hunches fall into this category of knowledge. It is deeply rooted in and individuals' actions and experience as well as in the ideals, values, or emotions he or she embraces.

- *Explicit knowledge* is codified or codifiable knowledge that can be transmitted in formal, systematic language. It can be captured in records of the past such as libraries, archives and databases and is assessed on a sequential basis. It can be expressed in words and numbers and shared in the form of data, scientific formulate, specifications, manuals and the like. This kind of knowledge can be readily transmitted between individuals formally and systematically.

This model describes a dynamic process in which explicit and tacit knowledge in organisations are exchanged and transformed through four modes:

- socialisation, which enables tacit knowledge to be transferred from one individual to another. In this socialisation mode, knowledge transfer is effected through teaching, training, coaching, guiding, sharing, learning-by-doing, mentoring, adoption of values and beliefs through sharing. Tacit to tacit transfer through socialisation processes, commonly involves the use of models, metaphors and analogy to facilitate sense-making and to understand the intent and nature of the change.
- combination, which allows the existing explicit knowledge to be combined into new explicit forms. In this mode, research processes such as experimentation, hypothesis formation and testing are written up as results that lead to interpretations, knowledge claims, and conclusions. Explicit to explicit transfer of knowledge combines newly externalised models with the intended change strategy.
- externalisation, which converts tacit knowledge into explicit knowledge in the form of concepts and models. In this mode, process and practice are codified (written down) and recorded as 'best' practice, models, recipes, know-how rules

and regulations, databases, manuals, routinisation, and person to document actions. Tacit to explicit transfer through externalisation processes, commonly involves facilitation tools to enunciate issues and concerns to be dealt with in making a change.

- internalisation, which allows individuals to absorb explicit knowledge and broaden their tacit knowledge so that new knowledge could be developed. In internalisation, creative thinking, learning, individual reading and note taking, pattern recognition among data elements, speculating and surmising, trialling and testing are prominent. Explicit to tacit transfer, helps people internalise the new way of doing things through training and mentoring, and creative idea generation to make the change a positive experience.

Together they form the knowledge creation spiral of Nonaka and Takeuchi (1995), shown in Figure 5.2, which views organisational knowledge creation as a process involving a continual interplay between explicit and tacit dimensions of knowledge growth as it moves through individual, group and organisational levels.

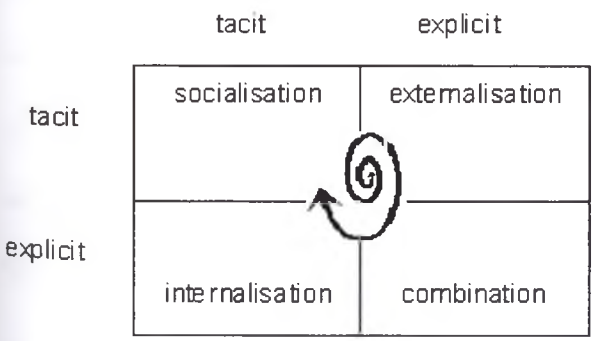


Figure 5.2: The knowledge creation spiral of Nonaka

It is not unusual to attempt to provide explicit knowledge concerning a new IT system by means of documentation and training. Training and documentation are a practical way to provide common knowledge to users as they have varying levels of computer literacy. Training promotes the internalisation of knowledge where users can absorb explicit knowledge from the training and expand their tacit knowledge in order to develop new knowledge about the use of a system (Handzic & Hasan, 2003, p.12). However there can be difficulty in managing much of the knowledge related to a system because so much of the way work is done is tacit.

Tsoukas (2003) expresses concern of the uncritical adoption of the Nonaka SECI framework and argues (p.425) that *tacit and explicit knowledge are not the two ends of a continuum but the two sides of the same coin: even the most explicit kind of knowledge is underlain by tacit knowledge*. He suggests that *we stop insisting on converting tacit knowledge and, instead, start recursively drawing our attention to how we draw each other's attention to things* (Tsoukas, 2003, p.425). However Walsham (2005) points out that Nonaka's work is a seminal in the field of Knowledge Management to explain the distinction between tacit knowledge and explicit knowledge. He believes that *although Nonaka himself was concerned with individual and group communication processes, it is arguable that his view of knowledge as an object, able to pass between different states, contributed to the idea that 'knowledge management systems' could be used to 'externalise' and combine tacit forms of knowledge* (Walsham, 2005, p.6).

More recent aspects of knowledge management theory may be applicable to understanding this category. Snowden (2002) identifies three generations of

knowledge management. The first generation clearly associated with increased ICT capabilities focussed on timely information provision for decision support. The second generation, triggered by the SECI model, focussed on the tacit-explicit knowledge conversion as the one process of knowledge creation in organisations. The emerging third generation uses complex adaptive systems theory to create a sense-making model of collective knowledge creation. This recognises that most systems in the organisational context have a degree of complex behaviour that cannot be predicted or fully designed and assumptions to the contrary can lead to difficulties in transferring systems from one context to another.

Within organisations, the facilitation of knowledge sharing is seen by the KM literature to be a source of competitive advantage (see eg. Oliver & Handzic 2001). Most of this literature focuses on the need to overcome the inherent self-interest notion that knowledge is power. What is often not acknowledged is the complementary attribute that allows people, particularly senior managers and experts in various areas, to admit that there are things outside their area of understanding and that they should be willing to receive knowledge from others. This is related to their absorptive capacity (Cohen & Levinthal 1990). One example of this in the field study was that management had a lack of knowledge in Information Systems and technology transfer and did not consult expertise in those areas. At a more basic level of knowledge sharing there was a lack of real understanding of the work culture, priorities and traditions among different stakeholder groups or even between staff in different discipline units within the university. While this is understandable, it is also undeniable that more understanding between these groups would have ameliorated many of the problems and so a forum for knowledge exchange could have helped.

5.5.3 Knowledge management between organisations

In respect of knowledge transfer between organisations, noticeably missing in the current research, Bhatt (2001) observed that it is generally not easy to receive knowledge from other organisations because they have their own unique history and culture. In the field study however the specific reason for purchasing this timetabling package was because of its apparent successful use in other universities. It seems incomprehensible that, with all this experience, more was not known about difficulties users would have in with data entry. The obvious channel for communicating this knowledge was the consultant and management, after initial contact with management in the other universities using the system, left it to him. Although diligent in his task, the consultant had no particular concern for the work of the organisation. His focus was on the capability of the technical aspects of the system and the work needed in making it operational. His world-view was that the system was successfully operational in other universities and would work the same way here. It was just a question of getting people to enter the data and the system would do the rest.

There is considerable interest now in the concepts of Competitive Learning and Knowledge Exchange Networks (COLKENs) (Angehrn & Loebbecke 2003). In a COLKEN the benefits of knowledge sharing between organisations is balanced against the need to retain knowledge for competitive advantage. In the field study managers from different universities communicated although perhaps unaware of, or reluctant to admit, any problems experienced with the system. There seems also to be communication between university timetabling officers and some IT people who were members of the system's user group who extol the immense capability of the system.

The knowledge however that was not communicated was at the level of the work of the organisation with school administrators and academic teaching staff.

The phenomenon that has sometime brought together people across organisational boundaries to share knowledge in a specific area of work is that of Communities of Practice. Communities of Practice is a term made popular by Wenger (Wenger et al 2000) and the concept is becoming a core knowledge strategy for global organisations.

Communities of Practice are everywhere and most of us are familiar with the experience of belonging to one although our participation may take different forms, from core membership to that on the periphery. As groups of people who come together to share and learn from one another face-to-face and virtually, communities are held together by a common interest in a body of knowledge and are driven by a desire and need to share problems, experiences, insights, templates, tools, and best practices. Community therefore implies a shared practice and shared knowledge and are boundary-spanning units in organisations. A community is fundamentally a self-organising system embodying the key elements of communities, namely practice and identity.

Wenger (ibid) suggests that a Community of Practice defines itself along three dimensions:

- What it is about – its joint enterprise as understood and continually renegotiated by its members
- How it functions - mutual engagement that bind members together into a social entity

- What capability it has produced – the shared repertoire of communal resources (routines, sensibilities, artifacts, vocabulary, styles, etc.) that members have developed over time.

5.6 Conclusion

Knowledge Transfer is the category from the grounded theory analysis where is seen to be comprised of communication and source of knowledge as its subcategory. Communication can occur within an organisation and between organisations which provide knowledge to flow in the organisation. In the case practice, training and documentation were intended to be sources of knowledge for providing knowledge and information to stakeholders in an organisation.

The KM literature was discussed in order to provide explanations and to support the incidents that occur in the field study. The timetabling project did not run smoothly because knowledge did not transfer from outside to the university and the lack of clear knowledge and understanding between key stakeholders in the university. A review of prominent literature in this area was presented to emphasis the complex nature of the problem and advances that have been made in relevant theoretical constructs.

The next chapter will present the category 'System Capability' and its subcategories and properties including the literature discussion.

Chapter 6

System Capability

6.1 Introduction

This chapter presents detail of the category 'System Capability' and its subcategories and properties. The chapter begins with a description of the category and its subcategories and properties. Then the collected data is revisited in conjunction with a selection of the relevant literature in a discussion of this category informed by the research.

6.2 System Capability category

A system is by definition a collection of components that work together to achieve a purpose. From an organisational perspective a good system is one that increases efficiency and effectiveness of organisational processes and improves business performance. It is also clear that a new system should be as far as possible compatible with existing systems. An information system is, by definition, a specialised system used to collect data and transform it into information. Most information systems in today's organisations are supported by computer-based technology and there are a wide variety of business applications that can be purchased as complete software packages.

From the users' perspective, a good information system decreases their workload and increases their ability to do their jobs. Desirable characteristics of software that

supports a new system are ease of use, flexibility, and a close match between the system design and their mental model of the work. Users prefer to use a software application that does not complicate their work and provides a user-friendly interface. The inherent complexity of a job is more of a concern for the users. Therefore, they want to have a complete work system that can help them to work more easily on complicate tasks.

The timetabling package in this case is a sophisticated software application, which can handle in a large institution a wide range of conditions of class space requirements, semester lengths, class times and size matched to resource availability of space and staff. However it is both rigid, in that the design is fixed and highly structured in the way all these conditions are specified. This makes for an extremely complicated user interface that requires both an advanced understanding of the timetabling process in the context of the particular organisation and a high level of IT literacy in manipulating the interface. It is questionable whether any such application can be designed to be easy enough to use so that all stakeholders would be able to access it directly. In this case it was the intention that eventually all teaching staff would be able to deal directly with the software, enter their class requirements directly, receiving and updating thereby doing away with the need for school timetabling officers. It was evident from the analysis of the data in this case that the process is inherently too complex for all but a few experienced academics to have the capability to do this.

Table 6.1: Subcategories and properties of the main category 'System Capability'

Subcategory	Property
Characteristics of the software	• Flexibility • Complexity • Compatibility
Advantages of the system	• Potential for an increase in work performance • Potential for a decrease in the workload
Complexity of the task	

A summary of the properties of the category of system capability emerging from the study is shown in Table 6.1. These properties will now be discussed with support from data collected from the study.

6.3 Characteristics of the software

Although a prime unit of analysis of this study is the whole timetabling system and its effect on organisational performance the software application supporting the new system plays an important role. The characteristics of the software can enhance the benefits of the new timetabling system and lead to the successful implementation of the software package. There would then be benefits to the organization as a whole through increased performance and productivity. In order to decrease their workload and increase work performance the staff, who are users of the new software, prefer to have an application that is simple to use, flexible, and compatible with the existing hardware and software.

The characteristics of the software emerging from the study are now discussed in more detail with illustrations from data collected.

6.3.1 Software flexibility

When the job is complex and not stable, as is the case with university timetabling, the software, which supports the job, needs to be flexible. Unfortunately, the timetabling software package, despite its extensive functionality was not flexible enough to anticipate all timetabling requirements and hence did not support the job efficiently. The timetabling software package itself did not, and probably could never, take into account all of the tacit knowledge of special conditions or information. An example of this is the varied reasons for repeat lectures. The software was programmed on the assumption that lectures were repeated because the class was too large for any available room whereas often the repeat lecture catered for different groups of students, such as part-time working students or to fit in with off-campus classes. This type of problem caused the officers to recheck the timetable drafts many times, greatly increasing their workload.

6.3.2 Software complexity

One of the characteristics of the software that is important for the whole system to function well is its usability or ease of use. In the case, the timetabling software package was not usable or easy to use. This was not helped by the fact that the school timetabling officers were not provided with any training and only received the manual of the software application. However it is more likely that they were not able to complete the job using the application because the task itself is inherently complex and the software in trying to capture all possible aspects of the problem became too complicated to use. As one of the school timetabling officers said during the interview:

> "I do not use it because I do not know anything about (name of the software). It is extremely hard to use it. It is too complicate without training."

The usability tests described in the data collection phase 3 in Chapter 3 confirmed that the timetabling software application was indeed too complex for most users and the development team produced a much simpler module for used to enter the bulk of the straightforward data. This system however frustrated those who had less straightforward requests.

6.3.3 Software compatibility

When a new system is adopted, it should be compatible with existing systems in the organisation, including procedures, hardware and software. For one thing it is easier for users to learn a new system if they do not need to concentrate on new procedures or new modes of interaction with the software. In this case many problems with incompatible software characteristic would have been anticipated if the organisation had received better knowledge about software from outside organisations who were already using it.

Another compatibility issue of the new timetabling software package was that the software would not work on some of existing hardware and software in the university. There were many academic units that only had Macintosh computers, with which the new software package was not compatible. Thus the university had to buy a new PC for them just for this job. However, this only compounded the problem because the school timetabling officers of those units had to learn to use a PC as well as to learn to operate the application. As one of the school timetabling officers said,

> "I did not like it because it cannot be used on a Mac. Here, there is no PC and we have to get one for this software."

Furthermore, the new timetabling application was not compatible with the existing software of the university, such as the courses database and the Web-based timetable to inform students and staff. There was no easy way to check if data stored about courses was consistent with the course information in the timetable. For example the course records could show 3 hours of class time for a subject and only be allocated on the timetable. In addition it would seem logical that making any change in the timetabling software, should be automatically changed in the web timetable. However this was done manually and so mistakes were made. Even as late as 2005 students were arriving for two classes which appeared to clash on the web-based timetable because one had been wrongly transcribed from a printout of the timetabling software onto the web information system. It seems incongruous to have such a complex piece of timetabling software and still have such incompatibility problems.

6.4 Advantages of the system

An organisation decides to implement a new system with an expectation that it would increase organisational performance and productivity. There should also be benefits to staff in the organisation especially the ones who directly use the new system as it should decrease their workload and increase the efficiency of the task.

However in the timetabling case, the new timetabling system failed to benefit the university as key stakeholders expect it should. It increased the workload of direct and indirect users that they had to recheck the timetable draft many times before the workable one was released to students. Even then there were errors because of the

manual transcription process. Obviously, it did not increase the performance of the university as management expected as there were only small changes to the spread of resource allocation as described in Chapter 3.

6.4.1 Increase work performance

The university implemented the new timetabling system to increase the efficiency of the resource usage and produce an efficient timetable. As the senior manager mentioned during the interview (phase 3, Chapter 3) that,

> "What will happen is as we get better and better at the new system. It will enable the university to do 2 things
>
> 1. It will enable university to use its present resources its classrooms much better than it does now.
> 2. It will give information about resource uses, room's uses and we will be able to use that information to plan for future building, classrooms.
>
> So increasing the number of students we will know what size of the classroom we need."

The school timetabling officers expected to have a system that increased their work performance in a way that increased the ability to create an efficient timetable for their academic units. As one of the school timetabling officers said,

> "…become more efficient in management of the room so we do not have rooms sitting empty… to make efficient used of all the space."

However, the real situation was the new system produced an unworkable timetable which needed to be rechecked and changes made many times. Therefore, instead of the system having the advantage of increasing the work performance it became the disadvantage of decreasing the whole performance of the university because of the delayed and unworkable timetable.

6.4.2 Decrease in workloads

The first expectation of the users of the system was that it would decrease their workload and assist them to finish the job easily and quickly. As discovered in the study, the school timetabling officers expected to have a system that would decrease their workload as one school timetabling officer said,

> "My expectation is the system will be as efficient as the old process and not require any more work to produce timetable like the previous year and we will end up with timetable that works and to do the job easier."

> "It would cut my work down (laugh) from year to year."

However, the new system did not decrease the workload as they expected. In stead, it increased the workload as the process of the job had changed and the unworkable nature of the initial timetables it produced. The school timetabling officers had to recheck the timetable draft many times. Furthermore, the new timetabling process caused the task to be more complex and they had to put more effort into producing a timetable that works.

6.5 Complexity of the task

Even though a system is claimed to be automatic which should help users improve their work performance and organisational performance it may not be. In some point, a system cannot accurately capture all of the tacit knowledge or conditions that are held by various groups or individuals or the complexity of the job process under consideration. It may even make false assumptions which leads to an unworkable result.

In this case, the university determined a particularly short time frame for the school timetabling officers to input data into the software package. Therefore, the school timetabling officers had to gather all required information in a much shorter period of time than previously and much of the data would not be accurate when inputted into the application. Furthermore, the amount of information had increased in the attempt to use all the functions of the software such as lecturer availability and so the whole exercise became too complicated.

6.6 The identification and discussion of selected relevant literature

The literature on information system capability that could be relevant here is very broad and so a selection has been made based on its relevance to the case presented above. This begins with a definition of the term 'system' taken from the Information Systems discipline to be more than just the software application. The remainder of the literature reviewed here focuses on the important issues of ease of use and usability that are of high relevance to the situation in the case.

6.6.1 The definition of a system and software

In this thesis the words 'the timetabling system' and 'the timetabling software application or package' have two different meanings. The following is presented to make them clear:

A system as defined by Alter (2002, p.8-9) is *a set of interacting components that operate together or accomplish a purpose* and this include:

- *A system's purpose* is the reason for its existence and the reference point for measuring its success.

- *A system's boundary* defines what is inside the system and what is outside.
- *A system's environment* is everything pertinent to the system that is outside of its boundaries.
- *A system's inputs* are the physical objects and information that cross the boundary to enter it from its environment.
- *A system's outputs* are the physical objects and information that go from the system into its environment.

The meaning of a system in Information discipline as defines by Avison and Fitzgerald (2003, p. 18) that *the 'system' part of 'information systems represents a way of seeing the set of interacting components, such as:*

- *People* (for example, systems analysis, business users, line managers);
- *Objects* (for example, computer hardware devices, a user interface, telecommunications networks, the World Wide Web);
- *Procedures* (for example, business processes, an information systems development methodology, business rules).

Software is *the computer programs that govern the operation of the computer* as Stair & Reynolds (2001, p.16) define and divide the software into two types*: system software (which controls basic computer operations such as start-up and printing) and applications software (which allows specific tasks to be accomplished, such as word processing and tabulating numbers*). The timetabling software package is one example of application software.

The timetabling system therefore is highly dependent on the software package used but includes the hardware and infrastructure; all those stakeholders mentioned in this study

and the procedures used to carry out the entire process. As mentioned in Chapter 1 care has been taken throughout the thesis to distinguish between the whole system and the software package.

6.6.2 TAM, usability, and a significant of the system

Davis' Technology Acceptance Model (TAM) (Davis 1985, 1989) has been the foundation of much of the research into the acceptance and adoption of information technology. TAM, as shown in Figure 6.1, is a specific adaptation, to the study of computer software usage, of the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) which have long provided useful conceptual frameworks for dealing with the complexities of human social behaviour. The two important variables in TAM are:

- Perceived Ease of Use (PEU), defined as "the degree to which a person believes that using a particular system would be free of effort" and
- Perceived Usefulness (PU), defined as "the degree to which a person believes that using a particular system would enhance his or her performance".

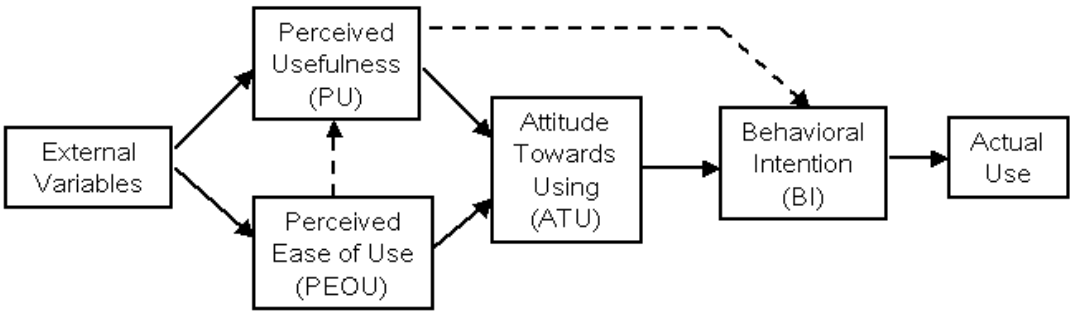


Figure 6.1: The technology acceptance model

Taken as independent variables PEU and PU together influence a person's attitude towards using a specific application of information technology. TAM implies that behaviour of IT use is determined by the intention to perform the behaviour and intention itself is determined by the attitude towards the behaviour. A large body of research has verified this core set of relationships in a wide range of applications. Figure 6.1 also displays possible linkages between PEOU and PU, (from Davis 1985), and between PU and intention to use, (from Davis 1989) that have also been widely confirmed. It is widely accepted that many of the relationship in TAM are likely to be stronger when the use of the technology is optional rather than mandatory as is the case in the workplace of this study.

The longevity of TAM is testimony to the significance of its message. In this case there were obvious links from perceived ease of use to perceived usefulness to attitude towards the software application and the task in general. While theses constructs and the relationship between them is well-accepted by IS researchers the concept of usability is a broad concept that forms a large part of the literature of the Human-Computer Interaction (HCI) community.

Usability of computer systems, according to Shackel (1991), can be defined as "*the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, with the specified range of environmental scenarios*"(as cited in Lingaard, 1994, p.19). Preece, et al.(1994, p.14) also propose that "*Usability, a key concept in HCI, is concerned with making systems easy to learn and easy to use*". Lindgaard (1994, p.21)

has suggested "*Usability is related to human performance in the specific tasks supported by the computer system and to the user's attitude towards the system…*".

Usability can be categorised and reviewed in the literature as five attributes which are:

1. Learnability (Lindgaard, 1994; Nielsen, 1993; Preece et al., 1994; Rubin, 1994)
2. Effectiveness (Lindgaard, 1994; Rubin, 1994)
3. Memorability (Nielsen, 1993)
4. Flexibility (Lindgaard, 1994; Preece et al. 1994)
5. Satisfaction or Attitude (Lindgaard, 1994; Nielsen, 1993; Preece et al., 1994; Rubin, 1994)

Learnability: "*The system should be easy to learn so that the user can rapidly start getting some work done with the system*" (Nielsen, 1993, p.26).

Effectiveness: "*Effectiveness refers to levels of user performance, measured in terms of speed and/or accuracy, in terms of proportion of task(s), proportion of users, or probability of completion of a given task*" (Lindgaard, 1994, p. 29).

Memorability: "*The system should be easy to remember, so that the casual user is able to return to the system after some period of not having used it, without having to learn everything all over again*" (Nielsen, 1993, p.26).

Flexibility: "*The extent to which the system can accommodate changes to the tasks and environments beyond those first specified*" (Preece, et al., 1994, p.401).

Satisfaction: "*The system should be pleasant to use, so that users are subjectively satisfied when using it; they like it*" (Nielsen, 1993, p.26).

Together the ease of use and usefulness concepts of TAM and the usability constructs of the HCI community are significant to this research and so an overview has been presented to highlight its importance. TAM provides a detailed, empirically testable model which the concept that make up usability give a broad view which takes more of the human issues involved.

6.6.3 The aspect of complexity of the task

The timetabling case has shown another component that consider important in the system which is 'complexity of the task'. A critical publication that should be taken into account when analysing this category is the work of Jack Carroll on the "Task Artifact Cycle" (Carroll et al, 1991). This adds consideration of the task to be performed to that of human-computer interaction. It is therefore not usability of a system in isolation that is important but usability in the context of the organisational work to be performed.

Information systems have evolved over the years to cover a broad spectrum of types, sizes, complexity and uses in an environment increasing in both complexity and dynamism (Neumann, 1997). It is a contention that a process such as this one which is complex and dynamic cannot and should not be fully automated. Just because a system has the capability to address a range of contingencies foreseen by the designer does not mean that the most effective way to use the system is to compel workers to adapt what they do to use as much of its capability as possible. There are limits to the value of

integrating all of a company's data, so that some authors have recommended a pragmatic solution. Goodhue et al (1988) advise that data integration should be done for specific business reasons. They talk of long and short-term trade offs, observing that 80% of the benefits from data integration can be brought about for 20% of the effort. The integration of the remaining 20% of the data will require 80% of the effort and is almost certainly not worth it. The more sophisticated decisions are almost certainly better left to people who have long experience and expertise in the matter.

Even though a system is claimed to automate the work process should help users improve both their work performance and organisational performance this may not always be case. As this study shows there is a limit to how accurately a system can capture tacit knowledge or special conditions that are held by various groups or individuals, in the complexity of a job process. The distinction, between systems that automate and those that "infomate" was comprehensively discussed in the work of Zuboff (1988). In complex environments this suggests that more decision-making should be left to people who are informed by the system rather than rely on the system to do so.

6.7 Conclusion

System Capability is one of the main categories of significance that emerged from the grounded theory analysis. It is comprised of subcategories which are: the characteristics of the software, the advantages of the system, and the complexity of the task. One of the main reasons that organisations consider implementing a new IT-based system is because they want to increase their organisation's performance. However, the organisation needs to consider the complexity of the tasks before considering the

software that is able to support the job and whether it is just efficiency or also effectiveness that they want. Some key literature on the holistic nature of systems the concept of system usability is discussed in order to provide explanations for the incidents that occurred in the field study.

The following chapter will present the category ‘Organisational Context’ and its subcategory and properties including an appropriate literature review.

Chapter 7

Organisational Context

7.1 Introduction

This chapter presents detail of the category 'Organisational Context' and its subcategories and properties. The chapter begins with a description of the category and its subcategories and properties. The data collected in the study relevant to this category is revisited in conjunction with and analysis of significant literature on this topic. This leads to a discussion of this category informed by the findings from the study and the literature

7.2 Organisational Context category

The category 'Organisational Context' refers to the environment and culture, which is unique to a particular organisation. The decision to adopt a new IT-based system is often made in the belief that it will increase productivity and improve organisational performance. However management rarely appreciate that they will only receive benefits from this change with due consideration of the human components of the system and how it will impact on the culture and environment of their organisation.

IT applications such as the timetabling system are designed to automate processes on the assumption that everything about the processes is knowable. The senior manager,

the external consultant and perhaps to some extent the registrar, hoped that the implementation would drive change to essentially improve efficiencies through automation. They failed to realise, on the one hand, that the process was inherently too complicated, complex and unstable to be so completely automated, and hence relegated to the realm of operations, and on the other, that the outcome of any such automation would have a profound effect on academic culture, reducing the flexibility and agility of the teaching activities. Rather than professionals, teaching staff would be seen as tradespersons whose work can be automatically controlled and structured.

Among the human stakeholders in the new timetabling system of the study, there is a variety of capability and support. Staff in the university have varying levels of job experience and hence knowledge of the timetabling process. Some had just have been appointed to temporary positions or had just been assigned to a new position from a different area of the university. In addition, experienced staff often had responsibilities for many other tasks as part of their workload which mad them unwilling to get involved in the difficulty of using a new system especially when the old process was already working well. Therefore, the degree of attention staff were willing or able to give to learning the system varied greatly or was in some cases even none existent. People were more inclined to reject the system when management gave them only a short time frame to finish the timetabling job without any concern for their situation. A summary of the subcategories and properties of organisational context is shown in Table 7.1.

Table 7.1: Subcategories and properties of 'Organisational Context'

Subcategory	Property
Change in organisation	Culture change Change to the job process
Organisational rules	Job description Staff conditions

A summary of the properties of the category of organisational context emerging from the study is shown in Table 7.1. These properties will now be discussed with support from data collected from the study.

7.3 Change in organisation

According to management the new timetabling system, significantly automated by the new software application, would drive change in the organisation to increase organisational performance through more efficient use of resources. The resulting changes affect stakeholders across the organisation especially staff in those units where the new system is being implemented.

Culture change is a controversial issue for organisations because organisational culture is a difficult construct to describe or measure let alone affect. Moreover every unit in an organisation has its own work culture, which is transformed along with changes to job processes introduced by the new system.

7.3.1 Culture change

In this case culture change was apparently an issue for both direct and indirect users of the timetabling system who had traditionally had a great deal of discretion on the processes and their outcomes. With the implementation of the new timetabling system, they have lost much of their control of their work because it is now dictated by the constraints imposed by the software package. The changes to the timetabling processes have changed the way staff had done many things in their academic units involving the school timetabling officers, other administration staff, unit managers and academic staff.

The school timetabling officers had an important role in producing the timetable in their units. The school timetabling officers controlled all information to be in the timetable and could response to academic staff promptly when they made a request or change in their subjects. However, when the new timetabling system was implemented, the situation had changed. The school timetabling officers lost that control because the new system with the support of the new software package took all control of producing the timetable. They were only to gather required information and input to the new timetabling application. When they received requests from academic staff what they could do was report this to the university timetabling officer. They could not response to academic staff immediately as before. As one of the school timetabling officers said,

> "(Name of the application) is a bit too centrally controlled and I think, I would like to be able to independently enquire about problems with timetable in particular the availability of rather than rely on people like (the university timetabling officer's name) to resolve that problems."

And another one said,

> "… before we could ask for an activity to be scheduled in particular time. It is now the timetabling system that does the allocation and that will require the culture change in staff requests."

Similarly, academic staff lost control of their subjects when the new system was implemented. They could not specify the space and time for the subjects and this made them resisted the new system. The school timetabling officer said,

> "The other thing was culture change for actual lecturers. They can no longer have the room that they have been having for a long time. Their favourite room ….they are now can end up with rooms all over campus."

7.3.2 Change to the job process

The new IT based system would drive change not only the culture of the organisation but the job process as well. In the case, the timetabling job process was changed from a manual to an automatic system. The process had been changed when the new system was implemented in order to meet the constraints of the software package. The school timetabling officers could only enter data that requested by the university timetabling officer into the application. As the school timetabling officer mentioned,

> "…under (name of the application), there will be a major different that we will not identify the day and time that to be delivered."

This in turn affected the roles of the academic teaching staff and the university timetabling officer who had previously negotiated times of classes.

7.4 Organisational rules

An example of an issue in this subcategory is as follows. For many years the university of the study had established a regime and timeframe for the production of the annual class timetable. The organisation expends much effort in setting its 'rules' clearly sending information to all staff in the organisation on job descriptions, standard procedures, structures, and closing dates for tasks. In the case, once the new timetabling system was implemented the new time frame of doing the timetabling job was set. This conflicted with the existing job descriptions of the school timetabling officers so they were frustrated by however they having to finish the job in a short time frame with the new system with no let up on their other tasks. As the school timetabling officer mentioned,

> "The time frame was too short. Suddenly, we found we had to have a timetable out on the web for students but none of us would ready I do not think. I think the time frame was very short."

7.4.1 Job description

As just mentioned the organisation takes great pains to describe staff's responsibility in their position in a clear understanding between staff and the organisation. The school timetabling officers had many administration jobs including their responsibilities for the timetabling and these were being increased as it was assumed that the new timetabling system would make that task easier. In reality it was the opposite as the new timetabling system not only required extra time to learn the new software package but also requested more information regarding the timetabling process on an ongoing basis because of the functions of the new software package. For this reason, the school timetabling officers had to spend more time on processing the timetable with the new system especially the new application which they initially had to learn on their own.

This was made more difficult as they could not concentrate only on the timetabling job because they were interrupted by other urgent requests of other jobs under their responsibilities. As one of the school timetabling officers said,

> "I have other jobs to do. It needs too much information. I do not have time to do it."

Other anomalies regarding job description involved the university timetabling officer and the senior manager responsible for the project. The university timetabling officer's job was to create the timetable based on data supplied by the school timetabling officers. This was then extended to taking a leading role in the design and implementation of the new timetable system, including the selection and installation of the software. Not mentioned in his job description was the major task he was required to perform in helping the struggling school timetabling officers. As the personality test of this individual shows he was not the best person for this role even though he was diligent in attempting to do this. The senior manager did also not have the role of oversight of the implementation of a new IT system in his job description and with no IT background did not have suitable skills or knowledge to perform this role.

7.4.2 Staff conditions

The school timetabling officers had varied experience of doing the timetabling job. Some of them were new to the job and did not have any knowledge or understanding about the job. Some were assigned to doing the job temporarily and so did not want to spend a lot of time learning a job that would not continue. Some had the experience with the job however they were soon get a new position and would not be doing the timetabling job anymore. The level of experience and condition of doing the job influenced the school timetabling officers' enthusiasm for the job.

These are statements made by school timetabling officers in describing their experience:

> "It is a new job and nobody did this before in a faculty level. It used to be done by department. So now it changes a structure from department to faculty does it."

> "I am new in my role and I have to understand quickly about the course and the timetabling system."

> "I have just taken over this job temporary. It is now my main job. I am a technical support in this faculty. Um… it will have someone to get this job."

> "Yes, I have an experience with this job but I will not do this job anymore next session."

When confidence of the school timetabling officers was low the situation of the academics staff deteriorated as they relied on the administrative staff to take care of routine detail allowing them to concentrate on their teaching role. They in turn were under pressure of increasing student staff ratios and greater scrutiny of their work as the university was becoming more business orientated with a higher percentage of fee-paying students.

7.5 The identification and discussion of selected relevant literature

The significance of organisational issues on the successful implementation of complex new systems has been studies in research into the introduction of enterprise systems usually known as Enterprise Resource Planning (ERP) systems into large organisations. Haines and Goodhue (2000) found that most organisations are faced with not having the necessary knowledge and skills to implement an enterprise system successfully and

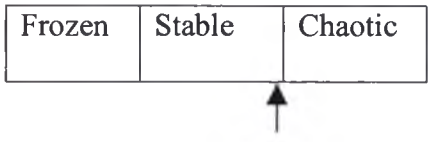
are becoming conscious that managing organisational context is one of the most significant costs of an ERP project. What the creators of ERP strive to do is combine all possible functions that every company requires to do its job and integrate them all together in one software package that can be implemented in any organisation. Company managers invest millions in acquiring ERP systems in the hope of increasing productivity and efficiency, particularly for global operations. However, research (Pan et al 2001) has identified that knowledge integration is a key problem in ERP implementation and that this is a contextual issue that does not happen automatically. The degree of complexity, together with the uniqueness of each organisation confounds the hopes of managers that an ERP will drive organisational change to a more productive, efficient operation.

There is little doubt that organisations must understand how to continually expand their capacity to learn, supported or enabled by information systems (Markus & Benjamin 1997). This presents quite a challenge and Schultze and Boland (2000) report low success rates of around 30% for advanced systems, attributable to technologists' lack of understanding of the situated work practices of user communities. They believe that systems designers do not have accepted models for the large invisible and complex nature of work that such systems are expected to support. The management literature suggests that traditional conceptions of work place and community conditions are becoming obsolete (Bishop 1999). Productivity in the industrial age was measured in terms of volume and cost efficiency. In the information era, where information is no longer a 'scarce' commodity, quality and innovation are a priority.

The managers in this case were still looking to IT to improve efficiency and still failed to understand the organisational impact of new systems despite numerous experiences. Even when it goes smoothly the adoption of a new system drives change in an organisation affects different sets of stakeholders in an organisation in different ways. In the case study problems with the introduction of the system were disruptive not only to timetabling officers but also teaching staff and students. Every unit in an organisation has its own culture which is potentially challenged the introduction of a new system.

Changes to job processes brought about by the introduction of a new system are a major issue for both direct and indirect users of the system. There may be an increase in job complexity and apparent loss of control of a job as the system takes over. Many of these issues have been addressed by literature in the field of computer-supported co-operative work (CSCW) (see for example Ehn 1988, Bannon & Bodker 1991) and more recent work on complexity and sense-making (see for example Kurtz & Snowden 2003)

The recent proliferation of literature on complexity theory is introduced here because it describes how organisations act when they affect and are affected by their environment (Murray, 1998, p.277), particularly when there is prevailing change and uncertainty. Complexity is seen at 'the edge of chaos' which is a state in between 'frozen' regime that is ordered and a 'chaotic' regime (Murray, 1998, p.277).



Edge of Chaos

Figure 7.1: The Edge of Chaos (adapted from Gibbons, C, 2004)

Gibbons (2004) explains about 'Edge of Chaos' that it is the fine line between stability and chaos, as shown in Figure 7.1, 'where innovation and survival are most likely to take place'. The meaning of each term presenting in Figure 7.1 is defined by Gibbons (2004) as follows:

- In the frozen regime: no information gets transferred and no new activity takes place, so it is impossible to adapt.
- In the chaotic regime: information and change takes place so fast that nothing is stable enough to retain its identity.
- In the stable regime: there is a regular rhythm of activity in which identity is retained but adaptation to changing conditions is slow. While humans may favour stability, nature favours the line between stability and chaos (edge of chaos) because it is here that constant adaptation goes on which allows an organism to survive over the long run.

Self-organisation is one of the main principles in complexity theory (Gibbons, 2004; Murray, 1998). Gibbons (2004) makes the comparison between 'self organisation' and 'command-and–control' approaches to organisational management suggesting that most organisations employ a command-and-control model which similar to the approach in the study case where the management 'just ordered it' and assumed that everything was under control. In reality a great deal of 'self organisation' took place via

a ‘just do it’ concept where people in organisation who was having great difficulties came together to share ideas and be a part of advise to the development team in making the system work.

The Cynefin model of Snowden (2002) is useful framework for understanding complexity and self-organising systems Rather than implying that chaos is the natural outcome of the self-organising capabilities of workers, Snowden has faith in the human capability to create order and predictability though collective and individual acts of freewill. As shown in Figure 7.2 the Cynefin model is a knowledge space with four domains which set the context for collective decision making: two domains of order, the known and the knowable, the domain of complexity and the domain of chaos. Each has a different mode of social behaviour and each implies a different form of management and a different leadership style with the adoption of different tools, practices and conceptual understanding. Snowden emphasises that in place of control and rules, work in complex settings is better managed through the use attractors and boundaries

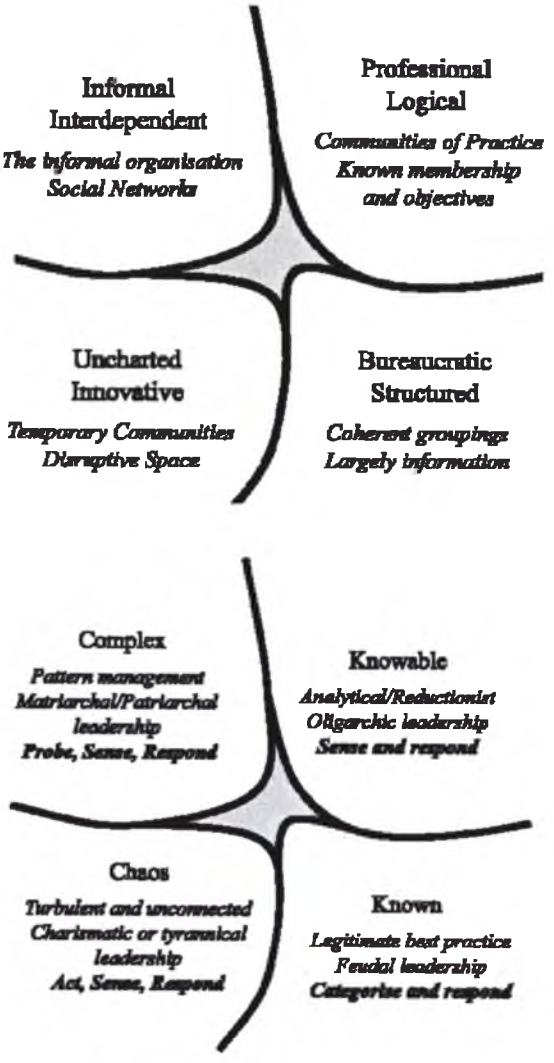


Figure 7.2: Snowden (2002) The sense-making and decision-making Cynefin frameworks

Kurtz and Snowden (2003) look at the Cynefin framework from the perspective of the types of component connections as shown in Figure 7.3 In both ordered domains there are strong connections between a central director and its constituents. In the complex domain these are weak so that attempts at control through hierarchical organisational structures often fail. On the other hand connections among constituent components are strong and stable group patterns can emerge and resist change through repeated interaction, mutual goals and experiences. The sophistication of modern IT applications enable complex work systems such as the timetabling system in the study where provide capability where it is no longer necessary to sacrifice effectiveness for

efficiency. This is a challenge for managers who are accustomed to domains where there is an unquestioned assumption of order and control (Hasan 2003).

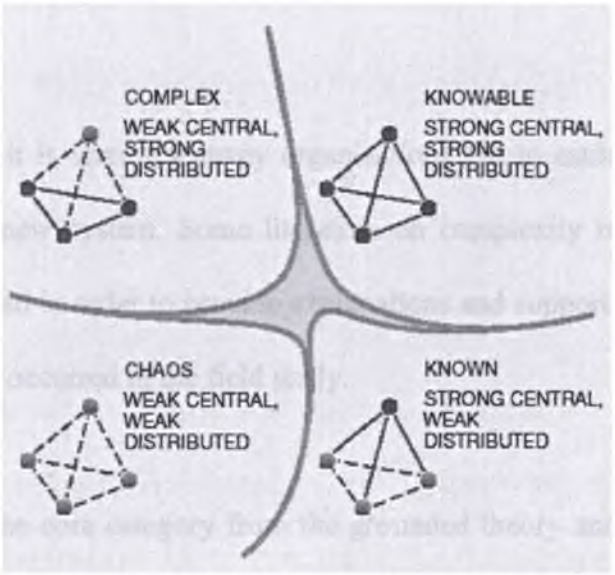


Figure 7.3: Connection strengths of Cynefin domains (Kurtz and Snowden 2003)

Finally, Marion (1999, p. 213) mentions that the dominant activity of an organisation is affected by technological change. In the timetabling case, the main activity of the university is teaching and learning as explained in Chapter 4. However those activities were moved aside in the attempt to push the new timetabling system to work. There was more effort expended on the timetabling activity rather than focusing on the main activity.

7.6 Conclusion

The third category in the grounded theory analysis is 'Organisational Context'. The data collected and analysed in the case study showed that the new IT based system in attempting to drive change in the organisation it causes changes the work process and impacted on the organisational culture. Management decided to implement a new system to increase organisational performance however they forget to consider their

staff's job description and condition especially the staff who are direct users of the new software application but also many others who are direct and indirect users of the whole timetabling system.

From the literature it is seen that many organisations fail to estimate the human and cultural impact of new system. Some literature on complexity in the organisational context was discussed in order to provide explanations and support for a complex view of the incidents that occurred in the field study.

The discussion of the core category from the grounded theory and the activity theory perspective including the research implications will be presented in the following concluding chapter.

Chapter 8

Discussion and Conclusion

8.1 Introduction

This chapter begins with a summary of the topic, method and justification for the research. It then continues with a discussion of the framework of thematic categories that emerged from the research where three major concepts appear to be critical factors that influence organisational capability and performance. The contribution of the research findings to academic knowledge and their implications for management are then presented. Finally, the implication for further research is discussed.

8.2 Summary of the research

As stated in Chapter 1, the topic of this research is the importance of understanding the context of information systems users not only for designing efficient, usable systems but also for improving the productivity of employees and the performance of the whole organisation.

Chapter 2 contains a discussion of possible research approaches that could be used to deal with the problems that are found under this heading. It justifies of the selection of qualitative, interpretive and grounded theory approaches as appropriate for this research.

The implementation of the timetabling system case was chosen as a suitable problem for a Grounded Theory study due to the unanticipated difficulties encountered when the

computer-based system was introduced. As grounded theory allows for the examination of complex problems such as those experienced when the scheduling system was introduced into the organisation. It was assumed that the implementation of the system would proceed smoothly based on supposed successful use of the system in similar organisations. However the context of any particular organisation is invariably unique and differences need to be anticipated when the transferring a sophisticated system between even apparently similar organisations.

A research regime of data collection followed by data analysis that employed two modes of analysis: an Activity Theory framework, and a grounded theory analysis. As demonstrated in Chapter 4 the Activity Theory framework was employed to display and interpret the large amounts of interrelated data collected in a holistic and comprehendible way. It presented a dynamic framework showing how the picture changed over time and enabled a comparison between the ideal and real situations as shown in Figures 4.4-4.6.

Grounded theory analysis in this case revealed three inter-related categories that summarise the main aspects of the problem: 'Knowledge Transfer', 'System Capability', and 'Organisational Context'. These three categories advance into the theme 'Influencing capability and thereby organisational performance' which is a proposed core category in this research. The breadth of these findings is attributed to the use of grounded theory methods in the research which enabled themes to emerge from the data that were not anticipated at the outset. Although a different case or a different analysis of this case may yield different themes, the review key literature

confirms that those identified are significant and may be of application to academics and practitioners in the field.

The failure of the flow of knowledge together with the highly structured design of the system and the complex and dynamic nature of organisational work were identified as significant issues that resulted in the failure of the new system to improve capability throughout the organisation and hence organisational performance. The data collected and analysed in this case demonstrate this relationship. Reference to some key literature has echoed much of what was found in this case and indicates that the findings may have a much wider application than this single case.

8.3 Significance of the core category

The case analysis by means of grounded theory reveals that the core category involving the influence of a new information system on organisational capability and performance is related to three important aspects: Knowledge Transfer, System Capability, and Organisational Context. When an organisation wants to increase performance through improved efficiency and transform itself to be competitive in the business and improve the organisational performance, one of the first alternatives to consider is to implement a new computer-based system into the organisation. Management often assumes that the introduction of a sophisticated new computer-based system used in other similar environments will be a straightforward event and result in noticeable improvements to the performance of the organisation and be highly valued by the organisation.

Organisational performance is commonly evaluated by financial measures such as profit, revenue growth, return of investment, or market share (O'Regan, 2002). According to Gautreau and Kleiner (2001), broader measures of organisational performance can be based on the concepts of a balanced scorecard (Kaplan & Norton, 1992) and benchmarking which is now widespread as an instrument of managerial practice (Drew, 1997; Lee & Choi, 2003).

However in the study case, there is no attempt by the university to set in place any procedure to determine how organisation performance was affected by the introduction of the new system. They put a great deal of effort into the implementation and to push the new timetabling system to become operational without considering the outcome or evaluating the resulting change to the performance of the university. They assumed that the system would bring improvements but made little attempt to determine whether or not the new timetabling system made it more efficient to produce the timetable and subsequently provide a more efficient timetable.

As mentioned above, there are three main areas where there were deficiencies in the case that appeared to be detrimental to the core category concerning improved performance of the organisation. Lessons from the case in these areas are as follows:

- Knowledge does not transfer easily between organisations especially from one where an application package was apparently already implemented successfully to the organisation in the process of introducing it to support a new system. This case would have benefited from improving the communication between organisations at the managerial level and at lower levels where direct and indirect users of the new software could gain an understanding of the whole

system and the problems that encountered by others who had implemented systems using the same software.

- Knowledge transfer within the organisation often does not occur nearly as well as it should. In this case progress could have been improved if there had been better communication between all stakeholders in the organisation so that management and other key stakeholders of the new system were able to exchange knowledge. This would lead to greater understanding between stakeholders during the planning, implementation and ongoing use of the new system.
- The holistic nature of a system is rarely appreciated. It should be consistent with the complexity of the task that is supported by the system. Management in the case did not understand how all aspects of the system inter-relate and interact before implementing the new system and proceed accordingly
- Traditional management tend to employ a 'command and control' approach to managing their organisation. This is no longer applicable as changeable organisational contexts become unstable and unpredictable which affect and are affected by their environment. Modern organisations are too complex for management to believe that they can control situation and everything that happens in the organisation. This situation can be explained by complexity theory and one of its main principles, 'self organisation'. Accordingly management needs to consider allowing all stakeholders in the organisation to share ideas and be part of the decision-making on how the system works and have input to improve the performance of the organisation.

The problems observed in this case and categorised by the analysis has been recognised as common issues even in the twenty-first century as explained by Ciborra (2004, p. 17): *When dealing with the deployment and management of complex information and communications infrastructures, managers at the turn of the twenty-first century seem to lack the words to describe, let alone capture, the multiplicity of unexpected consequences, serendipitous occurrences, and emergent, disappointing features of the new technological systems they are busy installing.*

8.4 Discussion of the research findings

This section presents the findings of the research in terms of the research question articulated in Chapter 1, namely "What are the critical contextual factors in organisational systems' use and how does context influence system usability and organisational performance?"

The findings discussed from the Activity Theory and grounded theory analyses are broader than initially anticipated for this question. These are in line with recent statements made by Baskerville and Land (2004, p.263) concerning the *tacit assumption* that *the construction of IT-based systems supports and benefits the organisation* and that *the possibility that the application of IT can harm, and even destroy, the organisation has received far less attention*. They further observe: *Any introduction of IS that does not take into account the socio-cultural dynamics in the organisation setting in which it is used has the potential to destroy the organisation it was intended to support (ibid).*

Although this statement is extreme the message is clear and aligned with the findings of the research. This indicates the potential general application of the research findings.

8.4.1 The critical contextual factors in organisational systems' use

From the research question in Chapter 1: 'What are critical contextual factors in organisational systems' use', the research has found three critical concepts that were revealed in grounded theory analysis. The three concepts are 'Knowledge Transfer', 'System Capability', and 'Organisational Context'. These appear to be the critical contextual factors to consider when implementing complex IT-based systems in an organisation.

The problems within 'Knowledge Transfer' concept are:

- The lack of knowledge transfer between organisations is a critical issue demonstrated in this case. When one organisation decides to purchase a software application which already well established in other organisations similar to itself, it is not uncommon for those responsible for the project to consult current users for their opinion. Such communication may occur at management level but rarely happens with the end users of the system. It does not mean that the system will transfer easily and implement successfully even with such knowledge. Less of a consideration by management is whether the context of use in the receiving organisations is similar to those where the system is currently being used so that systems transfer can take place with ease.
- The lack of knowledge that transfers between different system stakeholders within the organisation is exacerbated by the lack of communication or even awareness of the need for such communication. If stakeholders' had a better understanding of each others perspectives, a better knowledge of the new

system, the purpose of implementing the new system, and the benefits they would receive from the new system, it would decrease their resistance to the new system.

In the 'System Capability' category, there are three different issues to be considered:

- The usability of the application software of the new system that being employed to support the job is considered important especially for end users. Users prefer to use software that does not complicate their work and provides a user-friendly interface.
- The system itself should be able to provide a significant benefit to users (both directly and indirectly). Of most concern to users of the new system is the degree of increase in their workload and its potential to make their work more complicated.
- The nature of the task that supported by the new system need to be considered. Management underestimate the difficult of automating the actual task and do not appreciate the complexity of the timetabling system.

The problems within this 'Organisational Context' concept are:

- Change in the organisation due to the new system affects the whole organisation but is especially evident at the level of the work unit where the new system is being implemented. The stakeholders would accept change that is driven by the new system if they understood the benefits from this change and if it does not complicate their job or increase their workload.
- The organisation is accustomed to use a command and control approach to management that provides little discretion to other stakeholders, especially the

lower level. The staff must accept the decision of the management and are not encouraged to comment. There is little sharing of opinions or information between the management and the staff. This leads to the resistance of the staff or negative attitude towards management resulting in many unauthorised work-practices that employees adopt to get the work done. It is likely that a less autocratic managerial approach would enable more flexible for staff to adjust their work to the new system.

8.4.2 The relationships between the critical contextual factors in an organisation

The Activity Theory interpretation revealed that the dominant activities of the university were distorted by the new system as people in the organisation focus heavily on how to get the new timetabling system to work. The findings concerning the three concepts: 'Knowledge Transfer', 'System Capability', and 'Organisational Context' can be used to explain this distortion of activities where the core activities of teaching and learning are dominated by the activity of getting the new timetabling system to work.

As explain above, one of the critical issues in the implementation of the new system is knowledge transfer between organisations especially knowledge from where the system is already implemented successfully. Even though the organisations have a similar context of use and there was communication at management and IT staffing levels important knowledge at the user level was not transferred in this case. Management rely on the advice of the consultant who only explained the significant aspects of the system in technical terms and ignored the details of the activities, which it should support. Moreover as each organisation has its own unique context knowledge, thus transfer

from outside is not enough to ensure good planning for the implementation of the system in a new organisation. The lack of people to assist all stakeholders with the implementation and the lack of understanding the whole nature of the new system inevitably led to problems in the introductory stage of the implementation.

The senior manager with the ultimate responsibility for the implementation of the new timetabling system had no IS background or experience with IS. The motives for his activities were mostly to improve efficiencies and to save on costs. Therefore management did not have enough knowledge of the activities involved in implementing a new system and how its implementation would affect the existing work activities of all stakeholders. The university timetabling officer though conscientious did not have the required skills or personality to deal with the problems people were having with the system although he assumed that role by default. The remaining staff especially the direct users of the new system did not receive the right knowledge in the right form needed to understand the benefits of the new system for themselves and the motives for adoption of the new system. Furthermore, the management ignored all issues of the usability of the application software used for the new system. The software was assumed to be unproblematic, as it has already been used in a comparable real world situation. In fact, usability issues cause problems to the activities of both direct and indirect users. The direct users suffered from the difficulty of using the software without enough support from management. The indirect users suffered from the faulty assumptions that resulted in the software creating bad outcomes in the form of an unworkable timetable that was vital as a tool for the teaching activities.

The university is a traditional and conservative organisation that normally employs a 'command and control' approach to manage the whole organisation. The management prefer the staff to accept management decisions and follow the procedures set out by management. They do not encourage staff to share opinions or organise the work themselves. Lack of understanding from management about the conditions experienced by the staff and complexity of the task led to resistance from staff in accepting the changes caused by the new system. Allowing staff to self-organise would increase their acceptance of the new systems and probably result in better work practices informed by the staff knowledge of their own activities.

The management want to improve the performance of the organisation by implementing the new computer based system assuming the timetabling activity was a simple routine job and would thus make it easier. However the nature and the processes of the job are more complicated than they thought. It is not simple to implement a system to support a job that is inherently complex without allowing staff to use their knowledge of the real conditions.

8.5 The contribution to academia

This study provides significant contributions to academic research as follows:

1. The method of the study illustrates how the Activity Theory framework can be used to present a holistic view of human activity within a complex dynamic situation like in an organisation. It displays the relationships between the activities of stakeholders in an organisation and can also show how they change over time. This has been used to enable a comparison between the ideal and real situations.

2. Grounded theory has been employed in this research and it has been shown to be useful for this type of research. This is because a grounded theory analysis has the potential in analysis to uncover issues and relationships that would not obviously be derived from establishing hypotheses and doing deductive research. In this research, the focus when starting the research was solely on the usability aspects and the user's context that affect the system usability and the organisational performance. However when using the grounded theory, the focus of the research changed to included a broader range of issues that appear to be as important as the usability and the user's context in the consequences of introduction of the new system.
3. The model resulting from the grounded theory analysis presents the relationships between three critical aspects that influence capability and organisational performance as shown in Figure 8.1, adapted from Figure 4.7 in Chapter 4 in this thesis. These three aspects: Knowledge Transfer, System Capability, and Organisational Context appear to be critical for the situation described research. Similar problems of the introduction of the new system occur in most organisations however there little research has been done that results in such a broad analysis of these particular aspects associate with new system implementation. This model may be a useful starting point for future research to look at these different issues within organisation and understand the relationships among them.

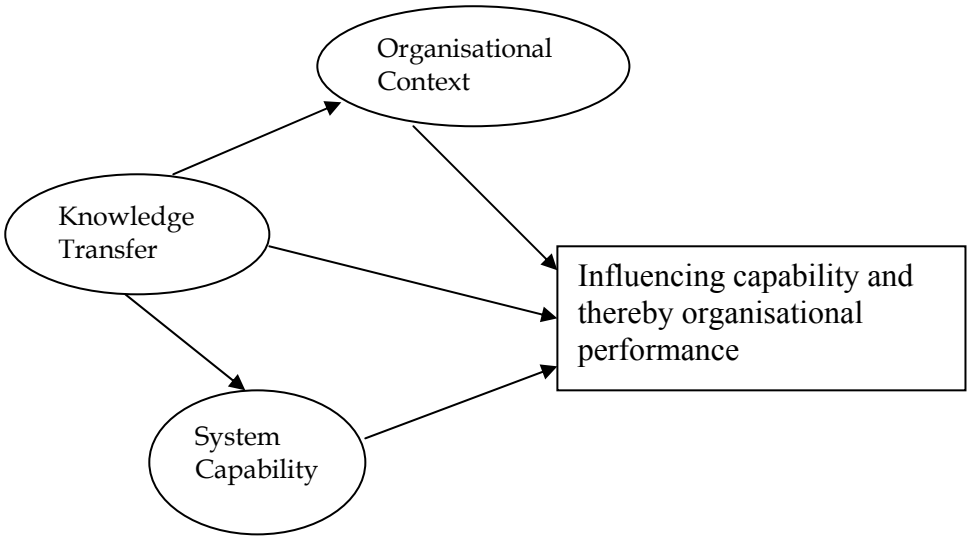


Figure 8.1:The relationships between three critical contextual factors under the new computer based system.

8.6 Implications for management

The analysis of the problems in the study has the following message for organisational management:

1. The management need to be concerned with the knowledge that needs to transfer from outside parties when deciding to implement a new computer based system that is being used in other similar organisation. It should include knowledge that come from the people who are the actual users of the system to understand the real problems at the coalface in combination with management's advice from that organisation.
2. Knowledge and understanding need to be clear for all key stakeholders. There is a lack of real understanding of the work culture, priorities and traditions among different stakeholder groups or even between staff in different discipline units within an organisation.

3. It seems that much of the complexity of the job process is still being handled by people and indeed is done by system workarounds. As the system attempts to automate too much of the process that is not as stable and specifiable as the system demands.
4. Management have a lack of knowledge in information systems and technology transfer and tend not to consult expertise in those areas.
5. The management need to consider how to measure the effects of anticipated improvement of the organisation when the new system is implemented. This can assist the management to understand problems and improve the organisational performance that is supposed to be supported by the new system.

8.7 Implication for further research

Future research could be undertaken not only on each of the concepts in the model of Figure 8.1 but also on the relationships between them which emerge as patterns of use when a workplace adjusts to a new system in the organisation. The degree of the lack of understanding by managers of the IS implementation process or even the recognition that they needed expert advise in this area was surprising. It could be that organisational managers should value education matters of IS research and practice and this could be a matter both for research and management education.

Finally, although both Activity Theory and grounded theory are conceptually challenging for a novice researcher they have considerable potential as tools for IS case study research.

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Appendix A

Questions for interview with school timetabling officer

1. What is your opinion of the job that this new system is designed to support?
2. Did you do this timetabling job before?
3. Are you familiar with this timetabling job?
4. How much experience do you have with this job?
5. Could you please describe in as much detail as possible how you do this job using the new application?
6. How did you feel when this new system was introduced?
7. Were you provided with any training courses before using this application?
8. What problems did you have when using this application?
9. Could you please describe any difficulties you had using this system?
10. What did you do to solve the problems?
11. What is your expectation from this system? (and the new application?)
12. In what ways-if any-did you find this system useful?
13. What changes would you suggest-with training or the system?

Appendix B

The interview with the senior management

1. What problems can you identify the previous timetabling system?

2. How do you think the use of the new system will benefit the university?

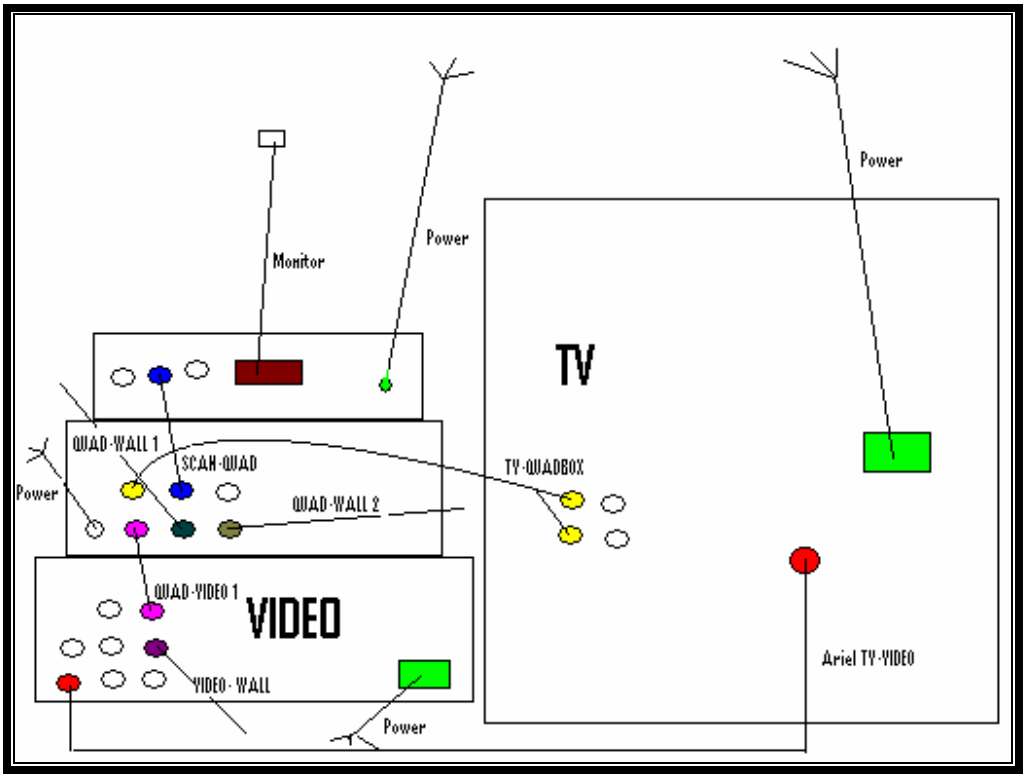
3. What are your views on the process of adoption of the new system and any problems encountered?

4. Do you think that staff, in general, have an understanding of the benefits of the new system?

5. What advice would you give to someone in your position in another university wanting to adopt the system?

Appendix C

TV, Video, Scan Converter, & Quad Box Setup



TV-QUADBOX Cable

- Goes into the TV INPUT, with red on the top and black on the bottom
- On the QUAD BOX the red goes into the MONITOR OUTPUT socket

QUAD-WALL 1&2

- For the video camera, labeled A and V for audio and visual plugs into the camera

Setup to view and record

- When video is turned off, switch to channel AV to display the QUADBOX output
- When video is turned on, switch to channel 0 to display QUADBOX output
- Can only see 4 quadrants on the video

Recording

1. Switch the power on at the power point for all devices
2. Turn the VCR on
3. Put a tape in the VCR
4. Plug the camera in – A for audio, V for video
5. Turn the computer on
6. Turn the TV on, channel 0
7. Press record

Appendix D

Diagram of Usability Laboratory

This appendix contains a paper presented as a Laboratory Overview at INTERACT 2001.

Activity Theory Usability Laboratory (ATUL)

University of Wollongong, Northfields Ave, Wollongong NSW 2500, Australia

Abstract: Current research in HCI highlights the need for a usability laboratory whose focus is on individual and group user activities in realistic contexts. The Activity Theory Usability Laboratory at the University of Wollongong provides a facility for this type of research by its two distinguishing characteristics: a realistic office setting in the testing room, rather than a sterile laboratory environment; and the equipment set up which allows the capture of, not only individual users, but also group interaction as they undertake activities for which the product being tested is being used as a mediating tool.

Keywords: usability testing, Activity Theory, context

1 Overview

The Activity Theory Usability Laboratory (ATUL) was established recently at the University of Wollongong (Australia) to carry out usability testing of software and information systems that support practical human activities, either as individuals or in groups. The research conducted at ATUL employs an innovative approach to usability evaluation particularly suited to highly interactive and complex systems. This approach is the direct outcome of original research into the application of Activity Theory to information systems.

2 Background

Current usability testing methods primarily involve observations of individual computer interacting with software or information systems prototypes in especially equipped laboratories or less formal settings. The metrics employed in this traditional usability testing process relate to mainly to human cognitive abilities such as memory, perception and motor skills, while types of measurements include time taken to complete tasks, error-rates and scaled perceived ease of use. These methods are deemed suitable for transaction processing and similar operational systems, however, they fail to account for several factors critical to the success of leading edge IT. Currently there is no method or facility that effectively evaluates:

- The ability of an information system to support user tasks involving complex decision-making
- How users will perform in the future when they graduate from novice to experienced use
- How well a system supports activities involving groups of users
- How the use of a system is affected by the environment and context of use.

ATUL provides a usability evaluation facility and assessment procedure that allow researchers to capture and analyse group activities mediated by computer tools in a specific context of use by

- providing rich feedback on the usability of systems supporting complex group activities
- allowing facilitators to work with users to simulate experienced use of the system
- recording the activities and interaction of groups using the system as a mediating tool
- simulating a natural user environment and context of use.

3 Objective and Services

The principal objective of ATUL is to conduct HCI research through formal usability testing and product evaluations in a realistic context, which provides for the analysis of group activities and interaction, using an Activity Theory methodological approach.

The services offered by ATUL, in relation to existing software products, websites or prototypes, include:

- setting the product usability goals and identifying key user activities
- test planning, with or without a facilitator
- enlisting typical users to conduct tests
- conducting the usability evaluation in the laboratory
- interpreting results in terms of activities

4 Layout and Set Up

Currently, ATUL is housed in a cottage located on the university's main campus and consist of two rooms. The testing room has been set up to simulate a typical office environment, however, the layout is flexible to accommodate any type of scenario or environment. Two cameras have been unobtrusively positioned at selected points from which the activities taking place in the room can be captured. One camera is focused on the user or participant, capturing facial expressions, hand movements on the mouse, keyboard and related documents, and any sound or verbal comments made by the users, while the other camera provides a wide shot angle of the entire room in simulating group activities. The associated computer screen images and actions are captured using a scan converter to create a synchronised

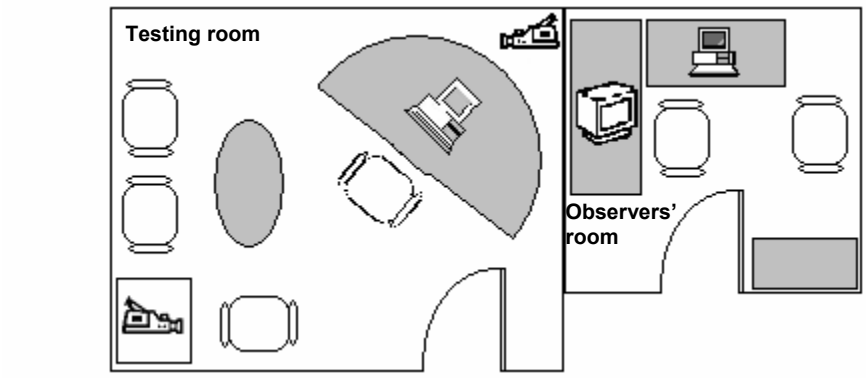


Figure 1: ATUL layout

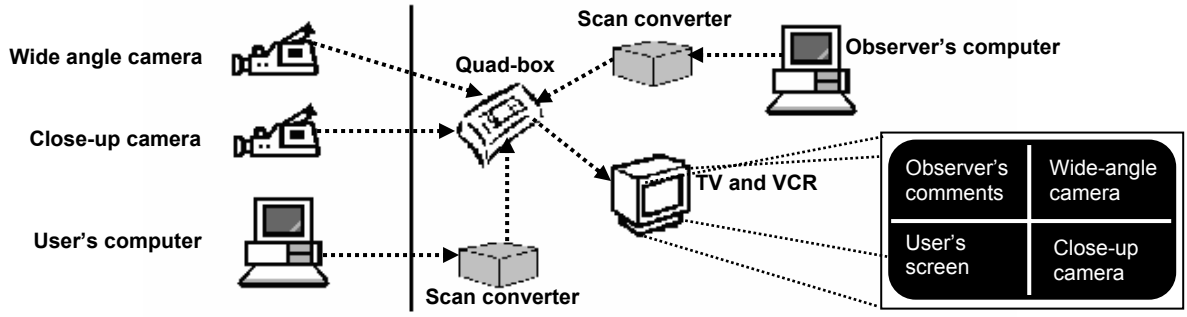


Figure 2: Equipment configuration

high-quality video image that is recorded. This set up permits either real-time viewing and discussion or delayed analysis of the recorded sessions. The video input from the scan converter is fed through a quad-box in the control room, allowing synchronised multiple views on the TV screen at once. The observer also has the ability to add his/her comments using a computer in the control room and display those on the TV screen simultaneously through a second scan converter. A diagram of the lab layout and the equipment configuration are shown in Figures 1 and 2 respectively

5 Laboratory Personnel

ATUL is operated by the research unit "Information Systems in Organisations: Activity Theory and E-Commerce" in the Department of Information Systems at the university. The members of this group have a considerable record in researching the area of HCI as well as practical expertise. Technically the group specialises in the development of interactive GUI prototypes and quick web page development, in particular those interfaces used to access database information. The research group has been invited to present workshops and tutorials on their methods at several prestigious conferences including Interact97, the DSS99, ACIS98 and OZCHI2000.

6 Current Projects and Partners

ATUL personnel are involved in developing and evaluating innovative software products in the areas of education management and training, management and executive information systems, group support systems and knowledge management tools. There is also a demand for commercial use of the facility by potential clients dissatisfied with formal reporting methods from existing usability laboratories. Interviews with these potential clients indicate their preference for interpretive analysis of users interacting with product prototypes in realistic settings. In particular, the clients have an interest in monitoring the quality of thinking and decision making supported by technology and the ways in which contextual factorsimpact on the ways people interact with the technology. ATUL is able to provide either videotaped records of usability testing sessions alone or accompanied by an expert interpretation.

ATUL also supports the work of a Cross-Institution team who study and develop innovative distributed technologies to support knowledge architectures in organisations. The collaborating partners include

- the Novae Research Group at National Innovation Centre in the Australian Technology Park
- the Enterprise Social Learning Architecture Task Group, DSTO Canberra
- The Performance Technologies Group Sydney

Appendix E

Pre – test questionnaire

This research project concerns the use of the timetabling system and Data Collection wizard.

Please answer the following questions by placing a TICK in front of the appropriate answer.

1. What is your age?
   21 – 30 years
   31 – 40 years
   41 – 50 years
   51 or above

2. Your gender:
   Male
   Female

3. You are:
   English speaking background
   Non-English speaking background

4. You highest level of education
   School certificate
   Higher school certificate
   Undergraduate degree
   Postgraduate degree
   Other (please specify) _____

5. How long have you been using computer?
   Approximately one year
   Approximately 2 – 3 years
   More than 5 years
   Other (please specify) _____

6. On average, how often do you use computer?
   Daily
   Once or twice a week
   Once or twice a month
   Other (please specify) _____

7. What kind of computer do you use?
   IBM PC
   Macintosh
   Both
   Other

8. Have you had experience using the timetabling system?
   Yes
   No (go to question 13)

9. How long have you been using the timetabling system?
   Approximately one year
   Approximately 2 – 3 years
   More than 5 years
   Other (please specify)_____

10. How experienced are you in using the timetabling system?
    I have much experience to use
    I am not bad at using it
    I have a little experience
    I do not know much about it

11. On average, how often do you use the timetabling system?
    Daily
    Once or twice a week
    Once or twice a month
    Other (please specify) _____

12. What do you usually use the timetabling system?

_____
_____
_____

13. Have you had experience using Data collection wizard?

Yes

No

Appendix F

Post – test questionnaire

Please answer the following questions after finishing the task.

Data Collection wizard

1. How easy or difficult was it to use Data Collection wizard?
   Very easy
   Easy
   Some part easy/some part difficult
   Difficult
   Very difficult

2. The terminology used in Data Collection wizard was:
   Very easy to understand
   Easy to understand
   Some part easy / some part difficult to understand
   Difficult to understand
   Very difficult to understand

3. What did you like most about Data Collection wizard?
   _____
   _____
   _____

4. What did you like least about Data Collection wizard?
   _____
   _____
   _____

5. What changes would you suggest about Data Collection wizard?
   _____
   _____
   _____

The timetabling system

1. How easy or difficult was it to use the timetabling system?
   Very easy
   Easy
   Some part easy/some part difficult
   Difficult
   Very difficult

2. The terminology used in the timetabling system?
   Very easy to understand
   Easy to understand
   Some part easy/some part difficult to understand
   Difficult to understand
   Very difficult to understand

3. How easy or difficult was it to find information in the timetabling system?
   Very easy
   Easy
   Neither easy nor difficult
   Difficult
   Very difficult

4. How easy or difficult was it to find desired meno choices in the timetabling system?
   Very easy
   Easy
   Neither easy nor difficult
   Difficult
   Very difficult

5. The Guide to Data Entry and room booking in the timetabling system was:
   Very easy to understand and follow the steps
   Easy to understand and follow the steps
   Some part easy/ some part difficult to understand
   Difficult to understand and follow the steps
   Very difficult to understand and follow the steps

6. What did you like most about the timetabling system?

_____
_____
_____

7. What did you like least about the timetabling system?

_____
_____
_____

8. What changes would you suggest about the timetabling system?

_____
_____
_____

Appendix G

Scenario

You are a timetabling officer of your academic unit. In order to complete the 2004 timetable, you are asked to use a new timetabling application.

Task 1: Please choose one subject of your academic unit to enter the data (subject's description and estimated number of students) into Data Collection Wizard.

Click on " Start Data Collection" button and then follow steps to enter data for selected subject.

Task 2: Please choose one subject of your academic unit to enter the data (subject's description and estimated number of students) into the timetabling application.

Task 3: There will be a seminar on Friday 5th December 2003 at 10.30 – 12.30. You have to make a booking for a room, which provides an overhead projector and screen, for 30 people. This task is performed by using the timetabling application to check for a suitable room for the seminar.

Appendix H

The IPIP-NEO
(International Personality Item Pool
Representation of the NEO PI-R™)

You can now choose between two versions of the IPIP-NEO

The original IPIP-NEO

- **The original IPIP-NEO inventory contains 300 items.**
- **Most people complete the inventory in 40-60 minutes.**
- **Over 200,000 persons have successfully completed this online inventory since it was first posted on the Internet.**
- **The original IPIP-NEO will provide somewhat more reliable and valid results than the shorter version.**
- **Best estimates indicate that the scoring program for the original IPIP-NEO executes properly and provides feedback over 99% of the time.**
- **Computer experts have been unable to identify the malfunctions that occasionally prevent scoring and feedback from taking place.**
- **Follow this link if you wish to complete the original IPIP-NEO.**

The new, short version of the IPIP-NEO

- **The short IPIP-NEO was designed to measure exactly the same traits as the original IPIP-NEO, but more efficiently with fewer items.**
- **The short version of the IPIP-NEO inventory uses 120 items from the original inventory.**
- **Most people complete the inventory in 15-25 minutes.**
- **Responses from over 20,000 persons were used to insure that the short version possesses acceptable measurement reliability.**
- **Although the short version meets professional standards of reliability, the longer version is even more reliable.**
- **The short IPIP-NEO provides an alternative for persons who do not have time to complete the original inventory.**
- **Persons may also wish to try the short version if they experience difficulty receiving results from the scoring programs of the original IPIP-NEO.**
- **Follow this link if you wish to complete the short version of the IPIP-NEO.**

Appendix I

Example of the report for the personality test

IPIP-NEO Narrative Report

NOTE: The report sent to your computer screen upon the completion of the IPIP-NEO is only a temporary web page. When you exit your web browser you will not be able to return to this URL to re-access your report. No copies of the report are sent to anyone. IF YOU WANT A PERMANENT COPY OF THE REPORT, YOU MUST SAVE THE WEB PAGE TO YOUR HARD DRIVE OR A DISKETTE, AND/OR PRINT THE REPORT WHILE YOU ARE STILL VIEWING IT IN YOUR WEB BROWSER. If you choose to save your report, naming it with an .htm extension (example: *Myreport.htm*) as you save it may help you to read it into a web browser later. If you choose to print the report, selecting landscape orientation for your paper will display the graphs properly. Using portrait orientation (normally the default for printers) will cause the graphs to wrap around and render them unreadable.

This report compares A from the country Australia to other women between 21 and 40 years of age. (The name used in this report is either a nickname chosen by the person taking the test, or, if a valid nickname was not chosen, a random nickname generated by the program.)
This report estimates the individual's level on each of the five broad personality domains of the Five-Factor Model. The description of each one of the five broad domains is followed by a more detailed description of personality according to the six subdomains that comprise each domain.
A note on terminology. Personality traits describe, relative to other people, the frequency or intensity of a person's feelings, thoughts, or behaviors. Possession of a trait is therefore a matter of degree. We might describe two individuals as *extraverts*, but still see one as more extraverted than the other. This report uses expressions such as "extravert" or "high in extraversion" to describe someone who is likely to be seen by others as relatively extraverted. The computer program that generates this report classifies you as low, average, or high in a trait according to whether your score is approximately in the lowest 30%, middle 40%, or highest 30% of scores obtained by people of your sex and roughly your age. Your numerical scores are reported and graphed as *percentile estimates*. For example, a score of "60" means that your level on that trait is estimated to be higher than 60% of persons of your sex and age.

Please keep in mind that "low," "average," and "high" scores on a personality test are neither absolutely good nor bad. A particular level on any trait will probably be neutral or irrelevant for a great many activites, be helpful for accomplishing some things, and detrimental for accomplishing other things. As with any personality inventory, scores and descriptions can only approximate an individual's actual personality. High and low score descriptions are usually accurate, but average scores close to the low or high boundaries might misclassify you as only average. On each set of six subdomain scales it is somewhat uncommon but certainly possible to score high in some of the subdomains and low in the others. In such cases more attention should be paid to the subdomain scores than to the broad domain score. Questions about the accuracy of your results are best resolved by showing your report to people who know you well.
John A. Johnson wrote descriptions of the five domains and thirty subdomains. These descriptions are based on an extensive reading of the scientific literature on personality measurement. Although Dr. Johnson would like to be acknowledged as the author of these materials if they are reproduced, he has placed them in the public domain.

Extraversion

Extraversion is marked by pronounced engagement with the external world. Extraverts enjoy being with people, are full of energy, and often experience positive emotions. They tend to be enthusiastic, action-oriented, individuals who are likely to say "Yes!" or "Let's go!" to opportunities for excitement. In groups they like to talk, assert themselves, and draw attention to themselves.
Introverts lack the exuberance, energy, and activity levels of extraverts. They tend to be quiet, low-key, deliberate, and disengaged from the social world. Their lack of social involvement should not be interpreted as shyness or depression; the introvert simply needs less stimulation than an extravert and prefers to be alone. The independence and reserve of the introvert is sometimes mistaken as unfriendliness or arrogance. In reality, an introvert who scores high on the agreeableness dimension will not seek others out but will be quite pleasant when approached.

```
Domain/Facet..... Score 0--------10--------20--------30--------40--------50--------60--------70--------80--------90--------99
EXTRAVERSION.............33 *********************************
..Friendliness.............30 ******************************
..Gregariousness...........50 **************************************************
..Assertiveness............28 ****************************
..Activity Level...........52 ***************************************************
..Excitement-Seeking.......22 **********************
..Cheerfulness.............50 **************************************************
```

Your score on Extraversion is average, indicating you are neither a subdued loner nor a jovial chatterbox. You enjoy time with others but also time alone.

Extraversion Facets

- *Friendliness*. Friendly people genuinely like other people and openly demonstrate positive feelings toward others. They make friends quickly and it is easy for them to form close, intimate relationships. Low scorers on Friendliness are not

necessarily cold and hostile, but they do not reach out to others and are perceived as distant and reserved. Your level of friendliness is low.

- *Gregariousness*. Gregarious people find the company of others pleasantly stimulating and rewarding. They enjoy the excitement of crowds. Low scorers tend to feel overwhelmed by, and therefore actively avoid, large crowds. They do not necessarily dislike being with people sometimes, but their need for privacy and time to themselves is much greater than for individuals who score high on this scale. Your level of gregariousness is average.
- *Assertiveness*. High scorers Assertiveness like to speak out, take charge, and direct the activities of others. They tend to be leaders in groups. Low scorers tend not to talk much and let others control the activities of groups. Your level of assertiveness is low.
- *Activity Level*. Active individuals lead fast-paced, busy lives. They move about quickly, energetically, and vigorously, and they are involved in many activities. People who score low on this scale follow a slower and more leisurely, relaxed pace. Your activity level is average.
- *Excitement-Seeking*. High scorers on this scale are easily bored without high levels of stimulation. They love bright lights and hustle and bustle. They are likely to take risks and seek thrills. Low scorers are overwhelmed by noise and commotion and are adverse to thrill-seeking. Your level of excitement-seeking is low.
- *Cheerfulness*. This scale measures positive mood and feelings, not negative emotions (which are a part of the Neuroticism domain). Persons who score high on this scale typically experience a range of positive feelings, including happiness, enthusiasm, optimism, and joy. Low scorers are not as prone to such energetic, high spirits. Your level of positive emotions is average.

Agreeableness

Agreeableness reflects individual differences in concern with cooperation and social harmony. Agreeable individuals value getting along with others. They are therefore considerate, friendly, generous, helpful, and willing to compromise their interests with others'. Agreeable people also have an optimistic view of human nature. They believe people are basically honest, decent, and trustworthy.

Disagreeable individuals place self-interest above getting along with others. They are generally unconcerned with others' well-being, and therefore are unlikely to extend themselves for other people. Sometimes their skepticism about others' motives causes them to be suspicious, unfriendly, and uncooperative.

Agreeableness is obviously advantageous for attaining and maintaining popularity. Agreeable people are better liked than disagreeable people. On the other hand, agreeableness is not useful in situations that require tough or absolute objective decisions. Disagreeable people can make excellent scientists, critics, or soldiers.

```
Domain/Facet..... Score 0--------10--------20--------30--------40--------50--------60--------70--------80--------90--------99
AGREEABLENESS.....26 *************************
..Trust.....48 ************************************************
..Morality.....20 ********************
..Altruism.....14 **************
..Cooperation.....54 ******************************************************
..Modesty.....40 ****************************************
..Sympathy.....31 *******************************
```

Your score on Agreeableness is low, indicating less concern with others' needs Than with your own. People see you as tough, critical, and uncompromising.

Agreeableness Facets

- *Trust*. A person with high trust assumes that most people are fair, honest, and have good intentions. Persons low in trust see others as selfish, devious, and potentially dangerous. Your level of trust is average.
- *Morality*. High scorers on this scale see no need for pretense or manipulation when dealing with others and are therefore candid, frank, and sincere. Low scorers believe that a certain amount of deception in social relationships is necessary. People find it relatively easy to relate to the straightforward high-scorers on this scale. They generally find it more difficult to relate to the unstraightforward low-scorers on this scale. It should be made clear that low scorers are not unprincipled or immoral; they are simply more guarded and less willing to openly reveal the whole truth. Your level of morality is low.
- *Altruism*. Altruistic people find helping other people genuinely rewarding. Consequently, they are generally willing to assist those who are in need. Altruistic people find that doing things for others is a form of self-fulfillment rather than self-sacrifice. Low scorers on this scale do not particularly like helping those in need. Requests for help feel like an imposition rather than an opportunity for self-fulfillment. Your level of altruism is low.
- *Cooperation*. Individuals who score high on this scale dislike confrontations. They are perfectly willing to compromise or to deny their own needs in order to get along with others. Those who score low on this scale are more likely to intimidate others to get their way. Your level of compliance is average.
- *Modesty*. High scorers on this scale do not like to claim that they are better than other people. In some cases this attitude may derive from low self-confidence or self-esteem. Nonetheless, some people with high self-esteem find immodesty unseemly. Those who are willing to describe themselves as superior tend to be seen as disagreeably arrogant by other people. Your level of modesty is average.
- *Sympathy*. People who score high on this scale are tenderhearted and compassionate. They feel the pain of others vicariously and are easily moved to pity. Low scorers are not affected strongly by human suffering. They pride themselves on making objective judgments based on reason. They are more concerned with truth and impartial justice than with mercy. Your level of tender-mindedness is low.

Conscientiousness

Conscientiousness concerns the way in which we control, regulate, and direct our impulses. Impulses are not inherently bad; occasionally time constraints require a snap decision, and acting on our first impulse can be an effective response. Also, in times of play rather than work, acting spontaneously and impulsively can be fun. Impulsive individuals can be seen by others as colorful, fun-to-be-with, and zany.

Nonetheless, acting on impulse can lead to trouble in a number of ways. Some impulses are antisocial. Uncontrolled antisocial acts not only harm other members of society, but also can result in retribution toward the perpetrator of such impulsive acts. Another problem with impulsive acts is that they often produce immediate rewards but undesirable, long-term consequences. Examples include excessive socializing that leads to being fired from one's job, hurling an insult that causes the breakup of an important relationship, or using pleasure-inducing drugs that eventually destroy one's health.

Impulsive behavior, even when not seriously destructive, diminishes a person's effectiveness in significant ways. Acting impulsively disallows contemplating alternative courses of action, some of which would have been wiser than the impulsive choice. Impulsivity also sidetracks people during projects that require organized sequences of steps or stages. Accomplishments of an impulsive person are therefore small, scattered, and inconsistent.

A hallmark of intelligence, what potentially separates human beings from earlier life forms, is the ability to think about future consequences before acting on an impulse. Intelligent activity involves contemplation of long-range goals, organizing and planning routes to these goals, and persisting toward one's goals in the face of short-lived impulses to the contrary. The idea that intelligence involves impulse control is nicely captured by the term prudence, an alternative label for the Conscientiousness domain. Prudent means both wise and cautious. Persons who score high on the Conscientiousness scale are, in fact, perceived by others as intelligent.

The benefits of high conscientiousness are obvious. Conscientious individuals avoid trouble and achieve high levels of success through purposeful planning and persistence. They are also positively regarded by others as intelligent and reliable. On the negative side, they can be compulsive perfectionists and workaholics. Furthermore, extremely conscientious individuals might be regarded as stuffy and boring. Unconscientious people may be criticized for their unreliability, lack of ambition, and failure to stay within the lines, but they will experience many short-lived pleasures and they will never be called stuffy.

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Domain/Facet..... Score 0--------10--------20--------30--------40--------50--------60--------70--------80--------90--------99
CONSCIENTIOUSNESS.....53 ******************************************************
..Self-Efficacy.....34 **********************************
..Orderliness.....68 ********************************************************************
..Dutifulness.....58 ***********************************************************
..Achievement-Striving.....8 ********
..Self-Discipline.....43 *******************************************
..Cautiousness.....82 ***************************************************************************************
```

Your score on Conscientiousness is average. This means you are reasonably reliable, organized, and self-controlled.

Conscientiousness Facets

- *Self-Efficacy*. Self-Efficacy describes confidence in one's ability to accomplish things. High scorers believe they have the intelligence (common sense), drive, and self-control necessary for achieving success. Low scorers do not feel effective, and may have a sense that they are not in control of their lives. Your level of self-efficacy is average.

- *Orderliness*. Persons with high scores on orderliness are well-organized. They like to live according to routines and schedules. They keep lists and make plans. Low scorers tend to be disorganized and scattered. Your level of orderliness is high.
- *Dutifulness*. This scale reflects the strength of a person's sense of duty and obligation. Those who score high on this scale have a strong sense of moral obligation. Low scorers find contracts, rules, and regulations overly confining. They are likely to be seen as unreliable or even irresponsible. Your level of dutifulness is average.
- *Achievement-Striving*. Individuals who score high on this scale strive hard to achieve excellence. Their drive to be recognized as successful keeps them on track toward their lofty goals. They often have a strong sense of direction in life, but extremely high scores may be too single-minded and obsessed with their work. Low scorers are content to get by with a minimal amount of work, and might be seen by others as lazy. Your level of achievement striving is low.
- *Self-Discipline*. Self-discipline-what many people call will-power-refers to the ability to persist at difficult or unpleasant tasks until they are completed. People who possess high self-discipline are able to overcome reluctance to begin tasks and stay on track despite distractions. Those with low self-discipline procrastinate and show poor follow-through, often failing to complete tasks-even tasks they want very much to complete. Your level of self-discipline is average.
- *Cautiousness*. Cautiousness describes the disposition to think through possibilities before acting. High scorers on the Cautiousness scale take their time when making decisions. Low scorers often say or do first thing that comes to mind without deliberating alternatives and the probable consequences of those alternatives. Your level of cautiousness is high.

Neuroticism

Freud originally used the term *neurosis* to describe a condition marked by mental distress, emotional suffering, and an inability to cope effectively with the normal demands of life. He suggested that everyone shows some signs of neurosis, but that we differ in our degree of suffering and our specific symptoms of distress. Today neuroticism refers to the tendency to experience negative feelings. Those who score high on Neuroticism may experience primarily one specific negative feeling such as anxiety, anger, or depression, but are likely to experience several of these emotions. People high in neuroticism are emotionally reactive. They respond emotionally to events that would not affect most people, and their reactions tend to be more intense than normal. They are more likely to interpret ordinary situations as threatening, and minor frustrations as hopelessly difficult. Their negative emotional reactions tend to persist for unusually long periods of time, which means they are often in a bad mood. These problems in emotional regulation can diminish a neurotic's ability to think clearly, make decisions, and cope effectively with stress.
At the other end of the scale, individuals who score low in neuroticism are less easily upset and are less emotionally reactive. They tend to be calm, emotionally stable, and free from persistent negative feelings. Freedom from negative feelings does not mean that low scorers experience a lot of positive feelings; frequency of positive emotions is a component of the Extraversion domain.

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Domain/Facet..... Score 0--------10--------20--------30--------40--------50--------60--------70--------80--------90--------99
NEUROTICISM.....54 ******************************************************
..Anxiety.....76 ********************************************************************************
..Anger.....35 ***********************************
..Depression.....51 ******************************************************
..Self-Consciousness.....57 ***********************************************************
..Immoderation.....42 ****************************************
..Vulnerability.....53 ******************************************************
```

Your score on Neuroticism is average, indicating that your level of emotional reactivity is typical of the general population. Stressful and frustrating situations are somewhat upsetting to you, but you are generally able to get over these feelings and cope with these situations.

Neuroticism Facets

- *Anxiety*. The "fight-or-flight" system of the brain of anxious individuals is too easily and too often engaged. Therefore, people who are high in anxiety often feel like something dangerous is about to happen. They may be afraid of specific situations or be just generally fearful. They feel tense, jittery, and nervous. Persons low in Anxiety are generally calm and fearless. Your level of anxiety is high.
- *Anger*. Persons who score high in Anger feel enraged when things do not go their way. They are sensitive about being treated fairly and feel resentful and bitter when they feel they are being cheated. This scale measures the tendency to *feel* angry; whether or not the person *expresses* annoyance and hostility depends on the individual's level on Agreeableness. Low scorers do not get angry often or easily. Your level of anger is average.
- *Depression*. This scale measures the tendency to feel sad, dejected, and discouraged. High scorers lack energy and have difficult initiating activities. Low scorers tend to be free from these depressive feelings. Your level of depression is average.
- *Self-Consciousness*. Self-conscious individuals are sensitive about what others think of them. Their concern about rejection and ridicule cause them to feel shy and uncomfortable abound others. They are easily embarrassed and often feel ashamed. Their fears that others will criticize or make fun of them are exaggerated and unrealistic, but their awkwardness and discomfort may make these fears a self-fulfilling prophecy. Low scorers, in contrast, do not suffer from the mistaken impression that everyone is watching and judging them. They do not feel nervous in social situations. Your level or self-consciousness is average.
- *Immoderation*. Immoderate individuals feel strong cravings and urges that they have have difficulty resisting. They tend to be oriented toward short-term pleasures and rewards rather than long- term consequences. Low scorers do not experience strong, irresistible cravings and consequently do not find themselves tempted to overindulge. Your level of immoderation is average.
- *Vulnerability*. High scorers on Vulnerability experience panic, confusion, and helplessness when under pressure or stress. Low scorers feel more poised, confident, and clear-thinking when stressed. Your level of vulnerability is average.

Openness to Experience

Openness to Experience describes a dimension of cognitive style that distinguishes imaginative, creative people from down-to-earth, conventional people. Open people are intellectually curious, appreciative of art, and sensitive to beauty. They tend to be, compared to closed people, more aware of their feelings. They tend to think and act in individualistic and nonconforming ways. Intellectuals typically score high on Openness to Experience; consequently, this factor has also been called *Culture* or *Intellect*. Nonetheless, Intellect is probably best regarded as one aspect of openness to experience. Scores on Openness to Experience are only modestly related to years of education and scores on standard intelligent tests.

Another characteristic of the open cognitive style is a facility for thinking in symbols and abstractions far removed from concrete experience. Depending on the individual's specific intellectual abilities, this symbolic cognition may take the form of mathematical, logical, or geometric thinking, artistic and metaphorical use of language, music composition or performance, or one of the many visual or performing arts. People with low scores on openness to experience tend to have narrow, common interests. They prefer the plain, straightforward, and obvious over the complex, ambiguous, and subtle. They may regard the arts and sciences with suspicion, regarding these endeavors as abstruse or of no practical use. Closed people prefer familiarity over novelty; they are conservative and resistant to change.

Openness is often presented as healthier or more mature by psychologists, who are often themselves open to experience. However, open and closed styles of thinking are useful in different environments. The intellectual style of the open person may serve a professor well, but research has shown that closed thinking is related to superior job performance in police work, sales, and a number of service occupations.

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Domain/Facet..... Score 0--------10--------20--------30--------40--------50--------60--------70--------80--------90--------99
OPENNESS TO EXPERIENCE.....14 **************
..Imagination.............7 *******
..Artistic Interests.......19 ********************
..Emotionality.............10 **********
..Adventurousness..........22 **********************
..Intellect................57 ************************************************************
..Liberalism...............49 *************************************************
```

Your score on Openness to Experience is low, indicating you like to think in plain and simple terms. Others describe you as down-to-earth, practical, and conservative.

Openness Facets

- *Imagination*. To imaginative individuals, the real world is often too plain and ordinary. High scorers on this scale use fantasy as a way of creating a richer, more interesting world. Low scorers are on this scale are more oriented to facts than fantasy. Your level of imagination is low.
- *Artistic Interests*. High scorers on this scale love beauty, both in art and in nature. They become easily involved and absorbed in artistic and natural events. They are not necessarily artistically trained nor talented, although many will be. The defining features of this scale are *interest in*, and *appreciation of* natural and artificial beauty. Low scorers lack aesthetic sensitivity and interest in the arts. Your level of artistic interests is low.

- *Emotionality*. Persons high on Emotionality have good access to and awareness of their own feelings. Low scorers are less aware of their feelings and tend not to express their emotions openly. Your level of emotionality is low.
- *Adventurousness*. High scorers on adventurousness are eager to try new activities, travel to foreign lands, and experience different things. They find familiarity and routine boring, and will take a new route home just because it is different. Low scorers tend to feel uncomfortable with change and prefer familiar routines. Your level of adventurousness is low.
- *Intellect*. Intellect and artistic interests are the two most important, central aspects of openness to experience. High scorers on Intellect love to play with ideas. They are open-minded to new and unusual ideas, and like to debate intellectual issues. They enjoy riddles, puzzles, and brain teasers. Low scorers on Intellect prefer dealing with either people or things rather than ideas. They regard intellectual exercises as a waste of time. Intellect should not be equated with intelligence. Intellect is an intellectual style, not an intellectual ability, although high scorers on Intellect score slightly higher than low-Intellect individuals on standardized intelligence tests. Your level of intellect is average.
- *Liberalism*. Psychological liberalism refers to a readiness to challenge authority, convention, and traditional values. In its most extreme form, psychological liberalism can even represent outright hostility toward rules, sympathy for law-breakers, and love of ambiguity, chaos, and disorder. Psychological conservatives prefer the security and stability brought by conformity to tradition. Psychological liberalism and conservatism are not identical to political affiliation, but certainly incline individuals toward certain political parties. Your level of liberalism is average.

Appendix J

Questions for follow up interview

1. Is there any change in the process or the timetabling system to do the timetabling job? (When compare with last year)
2. Were you provided with any training? How long?
3. Do you have any problem with the process, the system, or the timetable?
4. Do you use any function in the application at all? What is it?
5. Do you have any other suggestion or comment?

Appendix K

'Usability of complex systems in the organisational context'

Proceedings *of* OZCHI 2004, Wollongong, Australia.

Usability of Complex Systems in the Organisational Context

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Abstract

This paper describes research into contextual factors that appear to influence the successful implementation of a complex system in an organisation. A grounded theory approach was used to collect and analyse data on the introduction, into a large educational institution, of a timetabling system that was already well established in another similar organisations. The results of the study show that the usability of a system which supports complex tasks can be critically determined by the organisational context but this can be overlooked with detrimental consequences.

Keywords

Usability, organisational context, complex systems

INTRODUCTION

The aim of the study presented in this paper is to gain a greater understanding of contextual issues that affect the usability and usefulness of complex systems in a real working environment. Some of these usability issues may be overlooked in the processes of systems development and implementation but are critical to its success.

To maximise the usability of a product, traditional HCI wisdom recommends participatory design methods with regular usability testing of systems prototypes (for example Ehn 1988; Bannon & Bodker 1991). These should start as early as possible in the design process and involve future scenarios of use with surrogates or representatives of real users. Even though designers of organisational computer-based systems are concerned about the context of their use, most usability testing takes place either a laboratory or under conditions which cannot take account of all possible contextual issues. As Thomas and Macredie (2002) suggest "most usability testing regimes assume the context of a person facing a computer, the luxury of the person's full attention, and a comfortable environment with minimal distraction." The organisational environment is dynamic, complex, changeable and unpredictable. People, particularly those working under pressure of tight deadlines and performance targets, will invariably interact with a system in different ways depending on the particular context at the time and place of use.

When an organisation is looking for a computer system or application to support part of their operation it is not uncommon for them to consider a system that is already in use in an organisation similar to itself. Those responsible for system's acquisition are considerably influenced by any advice they receive on experiences with the intended system from those who have successfully used it. Such communications between organisations may only occur at management level so that actual end-users are rarely involved. Issues of system usability are therefore assumed to be unproblematic in the organisation, as the system has been used in a real world situation. Even less of a consideration is whether the context of use in the receiving organisations is similar to those where the system is currently being used so that systems transfer can take place with ease.

The case chosen for this research was the introduction of a comprehensive, computer-based timetabling system into a large educational institution. This choice of case study site was made shortly after the initial implementation stage of the project when it was recognised that severe problems were being encountered by several sets of stakeholders. No such problems had been anticipated by the project managers as this application was already doing well in several other similar institutions. The main aim of the research was to gain some understanding of the situation and identify issues that were making the successful generation of the timetable so difficult with the new system. It was therefore decided to adopt a grounded theory method of data collection and analysis, which approached the study with no preconceived hypotheses and allowed core categories to emerge from data and which could be investigated further. This method could potentially produce original findings and not just verify or reject predetermined concepts.

The paper begins with a brief description of background of the case. It is followed by an explanation of the research method before the data collection and its analysis is described. The paper concludes with a summary of the research data.

BACKGROUND INFORMATION ON THE CASE

The case chosen for this study was the introduction of a new computer-based system to substantially automate the timetabling process in a large educational institution. The scheduling of the annual timetable of classes in this large educational institution is a complex and time-consuming task. The number of students increases every year while resources are stretched to the limit demanding increasing efficiency in the fit of classes to space and time. Furthermore, class numbers and course offerings frequently change after the timetable has been created to match real-time demand. In order to achieve efficiency with the use of resources and produce an effective flexible timetable a sophisticate scheduling system is required.

In the chosen case, the new computer-based timetabling system had been purchased which promised to increase efficiency and transform the use of both physical and human resources by automating much of the effective timetable processes for classes. The vendors claim that the system was designed to automate all the logistical aspects of the teaching activities of an institution under every conceivable constraint, including the allocation of class space, time and teaching staff. The senior management and the registrar were also involved in the decision on the mode of introduction of the new timetabling system into the institution on advice from an external consultant. According to the external consultant, who had assisted with the introduction of this system elsewhere, the new system was successfully implemented in other similar educational institutions

In the previous timetabling process, school timetabling officers would send information of each subject to be run in their school the coming year in a spreadsheet form to the institution's timetabling officer. He would then manually create a timetable making appropriate adjustments from the current year. When the new timetabling system was implemented, the school timetabling officers were supposed to be able to enter data directly into the system on class details, resources needed and any special constraints. The timetabling officer only needed to check the consistency of the data and then run the function that would automatically allocate a time slot and space for all classes in an annual comprehensive timetable.

At the start of the research described below, the new process was underway but had completely broken down in two respects. Firstly, most of the school timetabling officers had found the system unusable and had not been able to enter data correctly. So the previous spreadsheet process had been reinstated with system data entry done by the central institutional timetabling officer who was an expert user. He was eventually given the services of an extra assistant for this. Secondly, when the timetabling function had been run, the resulting timetable had many problems most of which had to be rectified manually in a rush of overtime at the last minute.

RESEARCH METHOD AND DATA COLLECTION

The research approach was a field study, in which a variety of data would be collected through various methods with no preconceived research questions or hypotheses. A grounded theory approach has been shown to be suitable for this type of research (Glaser and Strauss, 1967; Glaser, 1998; Martin & Turner, 1986). It enables the revelation of details within complex phenomena in an organisation when a substantial system is implemented. It allows concepts to emerge from the data, which are then organised by the researcher into core categories, which are then investigated further through literature searches and, possibly, additional data collection.

The research plan was to collect data through interviews, observations, usability tests and relevant documentation. This process lasted over a year from mid 2002 until end of year 2003, covering the preparation of both the 2003 and the 2004 timetables. Key stakeholders interviewed were the senior manager responsible for the project, the registrar, the external consultant, the institution's timetabling officer, school timetabling officers, IT system support staff, teaching staff, and students. The majority of the interviews were with the school timetabling officers who were considered as the main direct users of the new system. Relevant documentation was collected from the start of the implementation and included system documentation, user training manuals, instructions to staff and a comparative evaluation of resource utilisation before and after the introduction of this new system. The grounded theory analysis involved summary, inspection and interpretation of the data.

RESEARCH DATA SUMMARY

Space restrictions prevent a complete presentation of the development and results of the grounded theory analysis. This section of the paper, therefore, contains a summary of the case emerging from the collected data, concentrating mainly on the interviews and usability tests with the school timetabling officers attempting to use the new timetabling computer-based system in support of the complex timetabling task.

Despite a small trial with two of the smaller schools in the institution, there seems to have been little anticipation that there would by any problems management decided to change completely to the new system in 2002 for the 2003 timetable. A brief introduction was provided to school timetabling officers in only one session (of about 30 minutes) by the external consultant and the institution's timetabling officer. No actual training was provided to the timetabling officers; instead they provided a manual and list of instructions about the system to the officers, most of whom had little knowledge about the system when they were interviewed by the researcher.

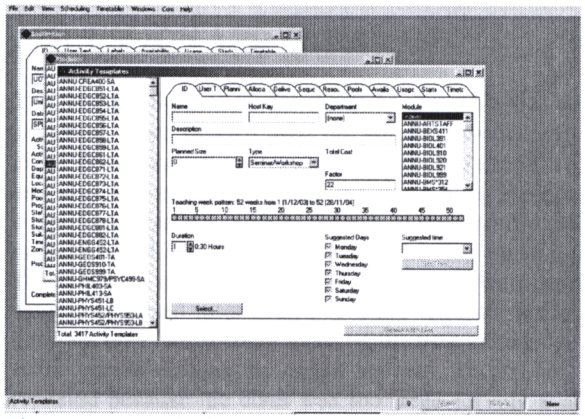

Figure 1. A typical screen of the new timetabling system showing 12 tabs from which to choose and the long pick lists in the drop down boxes. Usability tests confirmed that even experienced timetabling officers were confused and could not find desired functions or successfully complete required tasks.

The institution determined a particularly short time frame for the school timetabling officers to input data into the system (see a typical screen in Figure 1) in the introductory year. Consequently, most of the officers could not finish on time because they had problems with the usability of the new system. Most reported that they had attempted to learn to use the system by themselves. There was only one person, the institution's timetabling officer, that they could ask to help them to fix the problems. He was the one expert on using the system in the institution, and had to help more than 20 timetabling officers as well as do his own job. He was not trained to deal with this task and so it was impossible to fix problems for all of them at the same time. However it was due to his long hours of manual effort that the timetable was eventually created.

The need for the institution's timetabling officer to do most of the data entry caused the 2003 timetable to be delayed and some teaching staff could not get the correct information for their subjects in time for the start of session. When the first draft of the 2003 timetable was eventually produced by the system, there were many problems that much of the actual timetable ended up being created by the old manual process. Many complaints and requests for changes from academic staff were received and school timetabling officers were not able to respond to them promptly. This caused widespread discontent among administrative and teaching staff alike.

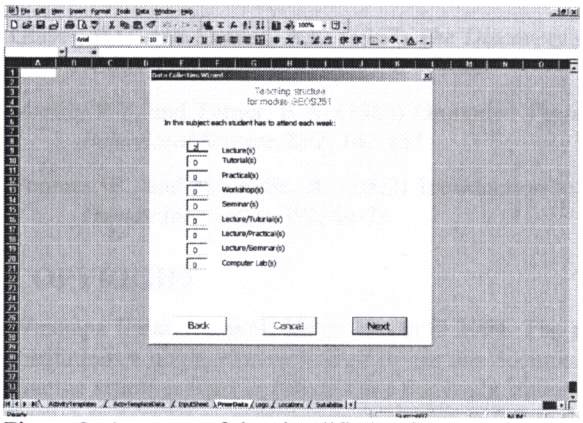

Figure 2: A screen of the simplified software module. Usability testing indicated that users were frustrated that it would not allow them to do anything but enter very routine details of subjects.

The development team, consisting of the external consultant and the institution's timetabling officer then formed a user group to gather information from school timetabling officers' problems and their suggestions. After

receiving many comments from the user group, the development team spent unintended time to created a simplified software module (see Figure 2) to enable the school timetabling officers enter the data easily. This module provides a simplified step-by-step process for entering a routine subset of data, which was stored in a spreadsheet that could be sent to the institution's timetabling officer to import into the main system. The timetabling officers had to provide this sort of information in a separate Word document form. It occurred to us that other institutions using the system must have also encountered this problem and done something similar but the knowledge was not transferred to the institution in this case.

DISCUSSION AND OTHER ISSUES

The timetabling process for the 2004 timetable was somewhat better, because school timetabling officers were becoming more familiar with the job, the process, and the system. They were provided with more training, and given better written instructions, both in the use of the new module that helped them to enter data more easily, and also in some functions of the timetabling system itself. However, there were still problems with the new simplified interface module for data entry and the resulting timetable produced by the system. The data entry process is not as straightforward as the step-by-step process in the module shown in figure 2 would suggest. There is such variety in the way different subjects run and the single simplified interface does not allow users to enter specialised information or other requests for less straight-forward classes. The timetabling system itself does not take into account much of the tacit knowledge of special conditions or information. An example of this is the varied reasons for repeat lectures. The system was programmed on the assumption that lectures were repeated because the class was too large for any available room whereas often the repeat lecture catered for different groups of students, such as part-time working students or to fit in with off-campus classes. This type of problem caused the officers to recheck the timetable drafts many times, greatly increasing their workload.

The main concern of school timetable officers, who are the main end-users, is that they cannot get their job done on time because of a lack of knowledge and understanding of the new system itself and the whole timetabling process that seems to have changed to meet the constraints of the new system. The change of the process using the new timetabling system has increased their workload while the old process was already working well from their perspective. Much of the complexity of the timetabling process may still be best handled by people and indeed are still done by system workarounds. It is generally believed that the system attempts to automate too much of the process that is not as stable and specifiable as the system demands.

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Appendix L

'An Activity Theory analysis of a case of IT-driven organisational change'

Proceedings of DSS 2004, Prato, Italy

An Activity Theory analysis of a Case of IT-driven Organisational Change

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Abstract

The paper describes unexpected problems encountered in the automation of a scheduling process using an IT application already in use in other similar organisations. A grounded theory approach was used to collect and categorise data on the case. Activity Theory was then used to analyse the attempt by management to implement organisational change through the introduction of the system. The findings suggest that it is inadvisable to impose organisational change through the introduction of a complex IT system, particularly when this disrupts entrenched decision-making processes of the organisation.

Keywords

Organisational change, Activity Theory, Grounded Theory, Case Study

1. INTRODUCTION

Although the environment in which we live has always changed, in recent times the nature of change has frequently been revolutionary rather than evolutionary (Artigiani 1987) to the extent that change management is a major concern. Information systems can be variously seen as driving, enabling, constraining or inhibiting the rate and pervasiveness of change and there is much debate as to which of these roles is appropriate or advisable in an organisation undergoing either evolutionary or revolutionary change. While attempts at ICT driven organisational change are fraught with danger, there is little doubt that organisations must understand how to continually expand their capacity to learn, supported or enabled by information and communications technology (ICT) systems (Markus & Benjamin 1997).

A case involving an attempt at organisational change, driven by the introduction of a new IT scheduling system, was discovered by the authors and, through its ensuing and intriguing complications, a grounded theory approach has been adopted to data collection and analysis. In order to present some concepts of interest emerging from this case, an activity framework will be used to analyse and display the data, which will then be interpreted through the Cultural-Historical Activity Theory. Activity Theory provides a unifying approach to the study of what people purposefully do and is a meaningful unit of analysis of human doing, which is both situated and contextual incorporating culture and history. According to Kuutti (1996) Activity Theory is a philosophy and cross-disciplinary framework for studying different forms of human practices and offers a set of concepts, structures and terms that are eminently suited to research in areas related to information systems.

The paper begins with a brief description of Activity Theory and an explanation of its usefulness in the analysis of complex problems such as this case presents. A description of the case follows, together with results of the preliminary grounded theory categorisations, before presenting the Activity Theory interpretation. The paper concludes with a discussion of the findings related to problems encountered when organisational change is imposed by the introduction of a complex IT system, particularly when this usurps the power of the existing custodians of knowledge and disrupts entrenched complex decision-making process of the organisation.

2. ACTIVITY THEORY AND ITS RELEVANCE

Activity Theory is a social-psychological theory that has its roots in the work of the Russian psychologist Vygotsky during the first half of the 20th century. Vygotsky's important insight into the dynamics of consciousness was that it is essentially subjective and shaped by the history of each individual's social and cultural experience (Vygotsky 1978). In addition, Vygotsky saw human activity as quite distinct from that of non-human entities in that it is mediated by tools, the most significant of which is language. Vygotsky's work was continued by others, amongst them Leontiev who developed a conceptual framework for a complete theory

of human activity (Leontiev 1981). According to Leontiev (1981), activity is a system that has structure, its own internal transitions and transformations, and its own development.

Kuutti and Virkkunen's research (1995) has used activity systems as a representation of the common object of organisational work which cannot be studied by reducing the scope to one or another element, but where a minimum meaningful system as a whole should be taken as the unit of analysis and intervention. Engeström (1987) gave a more concrete expression to this structure in the triangular representation, shown in Figure 1, which is commonly used to depict an activity. The core of an activity is a dialectic relationship between subject (human) and object (purpose) mediated by tools and community. This is a two-way concept of mediation where the capability and availability of tools mediates what is able to be done and tools, in turn, evolve to hold the historical knowledge of how the communities behaves and is organised. This is particularly powerful when the tools are computer-based (Kaptelinen 1996). The formal, or informal, rules and division of labour of the community, in which the activity occurs, also dynamically mediate the subject-object relationship.

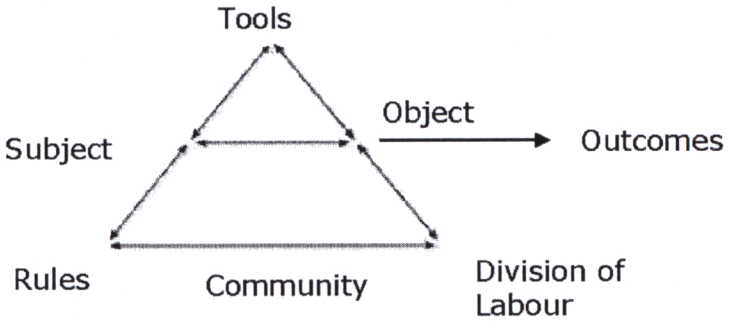

Figure 1: The subject-object relationship, which defines the activity, is mediated by tools and community through rules and division of labour. The subject may be individual or collective and outcomes of the activity are distinct from its object or purpose. (Engeström 1987)

Leontiev (1981) proposed that "activity" should be placed at the top of the hierarchy shown in Figure 2, associated with sustained human endeavour that has a long-term purpose and strong motives. This is a conceptual level above that at which most business analysis takes place, which is at the level of actions, undertaken towards specific, and often short-term, goals. Under certain conditions, conscious actions can be driven to a lower level of automation, often in computer systems, as they become standardised as operations. An activity is comprised of sets of actions (towards specific goals) and operations (routine and well known habitual cognitive or behavioural processes, now commonly the domain of IT systems). Where as an activity is defined by purpose and motive and is typically a long-term affair, actions are more planned with specific goals and a more limited time span. Actions are not meaningful in themselves unless they are part of an activity. For example it makes no sense to drive to work (an action) unless there is a work activity to go to.

There may be legitimate alternative sets of actions that can enable the successful performance of an activity, for example: it is common practice in IS development to assess the feasibility of different design solutions to an organisational problem and then choose one solution to implement based on a cost benefit analysis. However there may be instances where it is feasible to allow concurrent different solutions (i.e. different sets of actions) for an activity under different circumstances (eg in different countries where cultures vary or in different divisions of a company). It is important however to have a common understanding of the object (purpose) of the activity at the top of the hierarchy.

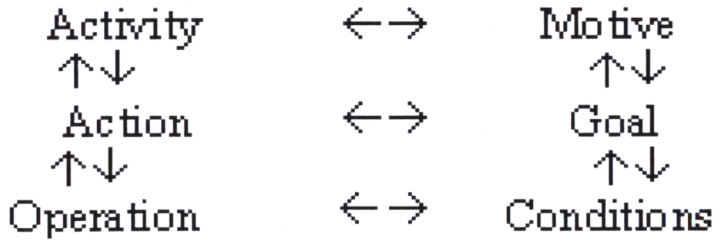

Figure 2: The definitive hierarchy of Leontiev (1981)

In addition to Engestrom's structure of activity (Figure 1) and Leontiev's hierarchy of activity, actions and operations, (Figure 2) there are several groups of researchers (Kuutti & Virkunnen 1995; Hasan & Gould 2001, Engeström 1999) who use frameworks of interrelated activities to represent complex organisational situations

as shown in Figure 3. Taken together the three aspects of human activity will be used to analysis and present the case described in the following section of the paper.

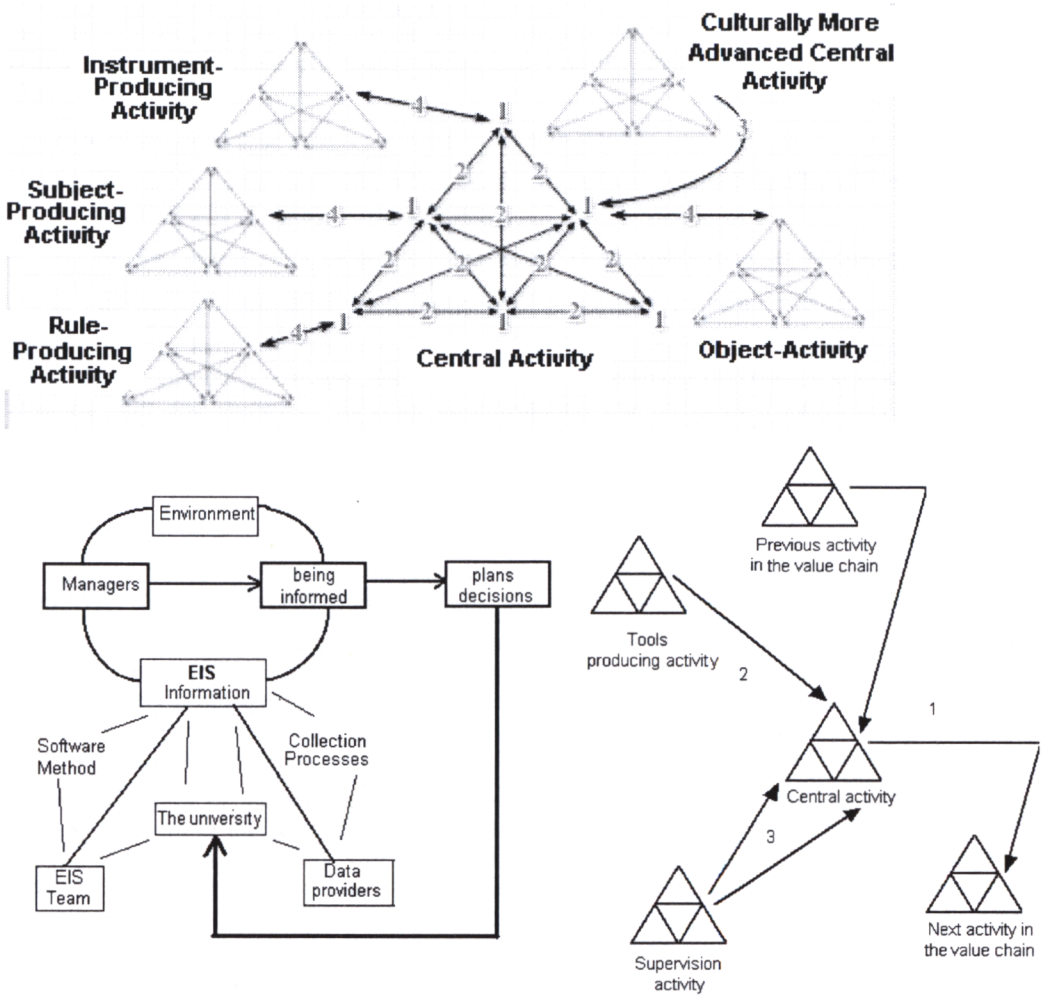

Figure 3: Sets of interrelated activities in the research of Engestrom (1999), Hasan & Gould (2001) and Kuutti & Virkunnen (1995)

3. AN ATTEMPT AT IT-DRIVEN ORGANISATIONAL CHANGE

One of the most complex and time-consuming tasks in a large educational institution, is scheduling the annual timetable of classes, particularly in the current environment where resources are stretched to the limit, course offerings are extremely varied and students numbers are uncertain often up until the day classes begin. The case chosen for this study concerns a decision to introduce a comprehensive, automated timetabling system into a university in order to transform the efficiency of use of both physical and human resources, for on-campus teaching. This decision was made by senior management and the registrar, on advice from an external consultant who had assisted with the introduction of the same technical system in other universities. The system purported to have the capability to automate all the logistical aspects of the teaching activities of the institution under every conceivable constraint, including the allocation of class space, time and teaching staff. From a management perspective the introduction of the new timetabling system would revolutionise the running of the teaching program. A significant change to greater efficiency in this area was therefore the principal motive of senior management in agreeing to the purchase of the system.

3.1 Research Method

This case was chosen for study because, predictably, the first session of full use of the system did not go well and it was clear that an analysis of the case had the potential to produce meaningful insights into the perils of IT-driven change. The research plan was to approach the field study with no preconceived research questions or hypotheses, to collect data through interviews and relevant documents and to use a grounded theory research

approach to induce theoretical concepts and patterns. This approach was shown to be suitable for information system's research, which characterises the organisation's experiences in terms of process of incremental or radical change, in the award winning paper of Orlikowski (1993). It allows concepts to be suggested by the data rather than imposed from the outside and then organised by recurring themes into a set of stable and common categories which can then be combined with the insights from formal theory, in our case Activity Theory.

The field study lasted over a year, covering three main stages:

1. The period from mid-2002, when faculty and school timetabling officers were required to collect, and enter, details of classes to run in 2003,
2. the first half of 2003, using the timetable and dealing with requests for changes,
3. the period in mid-2003 when details for 2004 classes were being entered.

Interviews were held with key stakeholders: a senior manager, the registrar, the external consultant, the university's timetabling manager, faculty and school timetabling officers, IT systems support staff, academic teaching staff and students. Relevant documentation was collected included systems documentation, user manuals, training manuals, some instructions to staff and evaluations of the utilisation of space before and after the introduction of the new system.

3.2 Research Results

The initial findings of the grounded research comprise the following set of concepts identified, as potentially significant, from an interpretive analysis of the data in the interviews and documents.

- From the perspective of the managerial stakeholders, the new timetabling system held the golden promise of IT in that, once it was set up, it would automate all timetabling decision-making, providing the most efficient allocation of resources with least amount of effort with most satisfied stakeholders. It appeared to do everything, storing all "knowledge" of physical and human resources, teacher and student requirements, while being flexible and responsive yet comprehensive.
- The lack of understanding of local cultural and contextual factors in systems implementation was apparent in the problems encountered. The timetabling system was already well established in other universities and there was an active user group, with lots of experience and knowledge of these previous implementations. The system was highly regarded in user group, which was composed mainly of the IT support staff and university administrators. Missing were key stakeholders in the system, those involved directly in the teaching activities.
- Despite the plan to follow an acceptable implementation procedure of conducting a limited initial trial of the system, no-one seemed to anticipate the impact that the sudden full use of the system would cause. The trial used experienced and cooperative timetabling officers in two small faculties. Little formal evaluation was done of the trial outcomes with no real feedback from those responsible for whole timetabling and teaching process.
- Most stakeholders in the faculties and schools were ill-prepared for the subsequent full and complete adoption of the system, which caused chaos and widespread angst. These direct and indirect users of the timetable were suddenly faced with problems of getting the new system to work rather than being presented with a workable timetable that they could use for their classes.
- Much critical knowledge was not in the system. One simple example of this was the varied reasons for repeat lectures. The system was programmed on the assumption that lectures were repeated because the class was too large for any available room whereas often the repeat lecture catered for different groups of students such as part-time working students or to fit in with off-campus classes. This one false assumption alone produced an unworkable timetable for some of the teaching staff. It was however only one of many such items that were mainly held as tacit knowledge by various groups or individuals. While each item in itself was quite small, the quantity, interaction and changeability of these items were indicative of the inherent complexity of the timetabling process that could never be accurately and timely captured in the system.
- Key stakeholders in the timetabling process were school and faculty officers who had varying levels of computer literacy and timetabling experience. Some had just been appointed, unwillingly, to do timetabling and they were completely lost. Others, who had done the job for years, had accumulated vast knowledge on timetabling issues. They were worried that the system would make them redundant.
- The university timetabling manager and the external consultant were experts who failed to appreciate the problems that casual users would have entering data through the complex system interface.

- In the first year of full operation much of the "automation" of the system was circumvented or not implemented for end-users in the schools and faculties as had been originally envisaged. This resulted in a huge workload for the university's timetabling manager who ended up re-entering data and rescheduling classes manually.
- Together with the external consultant, a simplified set of data entry screens was built for the routine entry of required course details and is being used for entry of the 2004 details. It amazed us that the need for this add-on was not known through the system's user-group as other universities, already using the system, must have encountered the same problem.
- Lack of coordination of the timetabling unit with others in the university administration meant that several major systems changes occurred at the same time – right at the beginning of the teaching session for 2003. This included a major redesign of the university's website, upgrades to the student management system and a server migration of the undergraduate student email system. As users made more hits finding their way, the whole university system was severely overloaded just as the timetabling system needed to respond to sudden changes in class sizes due last minute enrolments.
- Initial evaluation has shown that there is no significant improvement in resource utilisation in the first year of operation of the new timetabling system.

The concepts, listed above and drawn from the case data, are deemed to fall into at least the following categories:

- The inherent complexity of the timetabling task
- Communications breakdowns between stakeholders
- Missing information particularly that associated with tacit knowledge
- Local contextual effects on technology transfer
- Systems usability problems due to the design of the interface

The concepts in each of these categories contributed to the adverse organisational impact of the initial use of the new timetabling system. The following analysis from Activity Theory attempts to reveal some of the underlying mechanisms of the case.

4. AN ACTIVITY THEORY ANALYSIS OF THE CASE

4.1 Stakeholder Activities

It is apparent that the mix of interacting stakeholder activities, emerging from the case, needs to be analysed and better understood. Such an analysis begins with identification, from the case data, of the contributing activities, defined by the relationship between subject and object, i.e. who is doing what. A summary of the expected activities of the main stakeholders is shown in Table 1. This does not reflect the extra activities that the introduction of the new timetabling system caused in the work of all stakeholders.

Subject	Object	Desired Outcomes	Mediating Tools	Context
Senior Manager	Resource utilisation	Lower teaching costs, no problems	Administrative staff and procedures	Pressure from above
Registrar	Running of Teaching Program	Contented managers, teaching staff and students	Unit staff and procedures	Pressure from the senior manager, dealing with problems of staff and students
External Consultant	Implementation of the system	Working system	Timetable system documentation, University requirements	Limited to interest in the system
University Timetable Manager	University Timetable of class space and time	Smooth, trouble-free timetabling process	The system, management demands	Responsible for smooth running of Timetable.

Subject	Object	Desired Outcomes	Mediating Tools	Context
Faculty/School Timetable Officers	Communicate between teaching staff and administration	Satisfactory timetable with ability to update as needed	Faculty/school procedures, the Timetable system	Variety of responsibilities in own faculty/school, conflicting needs of staff and students
Teaching Staff	Teaching courses	Good educational outcomes	The timetable and other systems	Changing educational environment
Students	Education	Good grades, learning	The timetable and other systems	Pressure to succeed

Table 1: A Summary of Expected Stakeholder Activities

4.2 Relationships between Activities

Figure 4 depicts the expected relationship between the normal activities of teaching and learning recognising that education, alongside research, is a dominant purpose of a university. These activities should take centre stage in what takes place within the faculties and schools of the university while the timetable, and the other work of the registrar's unit, occupy a lesser, supporting role. In this activity–based representation the registrar undertakes a sideline activity of providing a supportive environment for the main players, the teaching staff and students and timetabling is only a purposeful activity for the university timetabling manager with the timetable as the outcome.

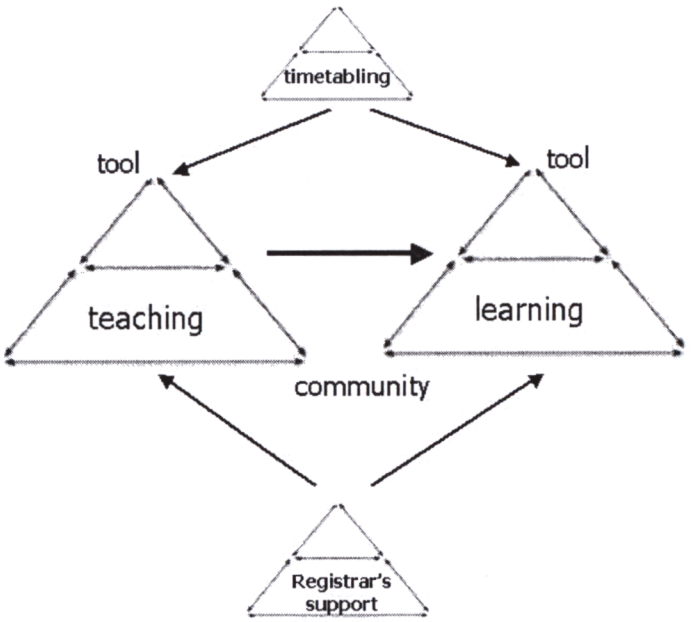

Figure 4 The ideal relationship between the dominant educational activities

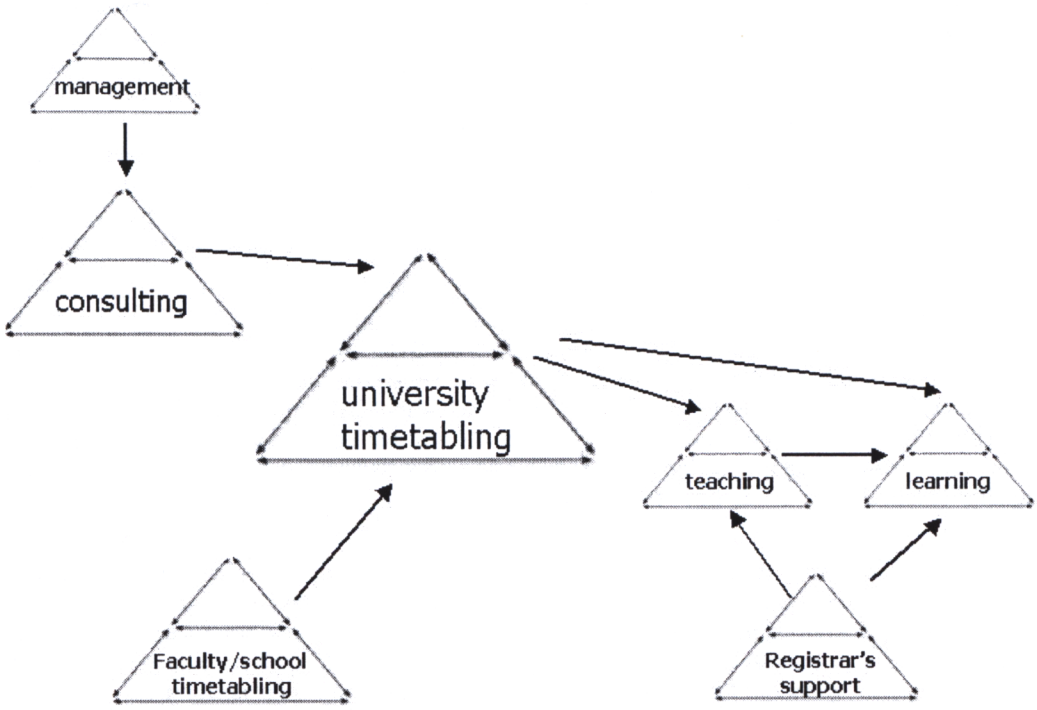

Figure 5 The distorted relationships between actual activities of stakeholder during the introduction of the new timetabling system.

What appears to have happened with the poorly planned introduction of the new timetabling system, was that the timetabling activity took centre stage and dominated the attention of most of the stakeholders as shown in Figure 5. The supposedly dominant activities of teaching and learning were pushed to one side as everyone made an effort to get data into the new system and then get it to produce an acceptable timetable. The activity of the consultant, engaged by senior management to advise the timetabling manager, was far removed from the end users and he was unaware of most of their specific problems. The senior managers and the consultant seemed to have one view and that was to automate an efficient timetabling system that would change the organisation from its previously, somewhat chaotic, state into a well-oiled machine. They saw a need to even out the popular times for classes, when resources were at a premium, and other times, when there were plenty of free classrooms. They also hoped to reduce the constant requests for changes to room allocations.

With the introduction of the new system, everyone was adversely affected either by the difficulties of getting data into the system or by the time consuming effort of checking for anomalies in the unworkable timetables it created. The former problem was due mainly to the poor usability and other shortcomings of the system and by the long time between the training of end-users and their use of the system. The latter problem was mainly due to the extreme difficulty of making sure all data and constraints were captured in the system. Several runs of this timetabling process were made before even a remotely feasible timetable was created causing great concern to the faculty and teaching staff.

5. DISCUSSION

The production of the annual class timetable had previously been an activity of the university timetable manager with input from the faculty, and school, timetabling officers. The Activity Theory analysis revealed that what was planned to be an operation, i.e. the automation of the timetabling processes, had become an activity of implementing a new IT systems and occupied the attention of administration and teaching staff alike. This was not only very disruptive to the normal activities of the university, teaching and learning, but also distorted the relationships between administrative and educational activities. This demonstrates that the object of an activity has a contextual, subjective component in that it is inevitably socially constructed. What people do in organisations is rarely defined by their official job description, but rather is socially negotiated and constrained by circumstance.

IT applications such as the timetabling system are designed to automate processes on the assumption that everything about the processes is knowable. The senior manager, the external consultant and perhaps to some extent the registrar, hoped and even believed that the system would streamline the timetabling and the teaching process. They intended that the implementation would drive change to essentially improve efficiencies through automation. They failed to realise, on the one hand, that the process was inherently too complicated, complex and unstable to be so completely automated, and hence relegated to the realm of operations, and on the other, that the outcome of any such automation would have a profound effect on academic culture, reducing the flexibility and agility of the teaching activities. Rather than professionals, teaching staff would be seen as tradespersons whose work can be automatically controlled and structured.

Similar findings have come from research into the introduction of Enterprise Resource Planning (ERP) systems into large organisations. What the creators of ERP strive to do is combine all possible functions that every company requires to do its job and integrate them all together in one software package that can be implemented in any organisation. Company managers invest millions in acquiring ERP systems in the hope of increasing productivity and efficiency, particularly for global operations. However, research (Pan et al 2001) has identified that knowledge integration is a key problem in ERP implementation and that this is a contextual issue that does not happen automatically. The degree of complexity, together with the uniqueness of each organisation confounds the hopes of managers that an ERP will drive organisational change to a more productive, efficient operation.

In the case of the university timetabling system, management proceeded under the assumption that, although the timetable was large and complicated, all relevant data needed to determine the time, place and staff for classes, could be known and hence put into the system which could then perform the scheduling function. The many inappropriate versions of the timetable that were generated and discarded, based on the initial round of data entry, are evidence that what was thought to be a complicated but rationally manageable system was really a complex and emergent one.

The realm of management decision-making is normally based on the assumptions of rationality and order, which are at odds with processes that are essentially complex and emergent The sense-making Cynefin framework (Kurtz and Snowden 2003) distinguishes four domains which set the context for collective decision-making in organisations. These include two domains of order, the known and the knowable, the domain of complexity and the domain of chaos. In IT implementations, such as the case of the university timetabling system, there is often the assumption that it operates in the knowable domain where all relevant data is available and can captured, and processed, in the system. Moreover, by doing so, the implementation of the system will drive significant changes to improved productivity and efficiency. In a complex world, reality changes too often for a system, such as the timetabling system, to stabilise its data set. An IT system may have the functionality to support work processes but cannot do everything or provide complete knowledge of the situation. In the complex domain, of the Cynefin model, it is acknowledged that not everything can be known and that people can work effectively with partial and emergent knowledge, which defies complete categorisation or definitive analytic techniques. Emergent patterns can be perceived but not predicted leading to the notion of retrospective coherence.

Trying to follow a path assuming that all is knowable, results in much dated information being crystallised in the system and in important information not being captured because it has never been made explicit. Alternatively if the decision-making path is assumed to be in the complex Cynefin domain, the limits of the system are recognised and it is expected that the automatically generated timetable will only be a guide, which will have to be adjusted with intelligent human input from existing custodians of knowledge. This requires a minimalist design of the system. Most systems tend to be over-designed in an attempt to do and know everything, which is just not possible in complex situations. Resultant change will occur, but will emerge through negotiated changes to work patterns rather than be driven by the constraints of the system.

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