A Study of Business User based Information Systems Development, and Modelling Success Factors

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This thesis describes research into business user involvement in the information systems application building process. The main interest of this research is in establishing and testing techniques to quantify the relationships between identified success factors and the outcome effectiveness of 'business user development' (BUD). The availability of a mechanism to measure the levels of the success factors, and quantifiably relate them to outcome effectiveness, is important in that it provides an organisation with the capability to predict and monitor effects on BUD outcome effectiveness. This is particularly important in an era where BUD levels have risen dramatically, user centred information systems development benefits are recognised as significant, and awareness of the risks of uncontrolled BUD activity is becoming more widespread.

This research targets the measurement and prediction of BUD success factors and implementation effectiveness for particular business users. A questionnaire instrument and analysis technique has been tested and developed which constitutes a tool for predicting and monitoring BUD outcome effectiveness, and is based on the BUDES (Business User Development Effectiveness and Scope) research model - which is introduced and described in this thesis.

The questionnaire instrument is designed for completion by 'business users' - the target community being more explicitly defined as 'people who primarily have a business role within an organisation'. The instrument, named BUD ESP (Business User Development Effectiveness and Scope Predictor), can readily be used with survey participants, and has been shown to give meaningful and representative results.

Keywords: End User Computing, Information Systems Development, survey instrument , Business User Development, modelling success factors

This thesis is dedicated

to the memory of
my father

Edgar George Faraday Lawrence

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CHAPTER 1 : Introduction

The purpose of this chapter is to: -

- provide a brief background to this research
- define the main aims of the research
- discuss the selection of the method of research for the project
- give an outline summary of the structure and content of this thesis
- summarise the thesis findings
- outline the contribution to I.S. research made by this project

1.1 Background

This research began with a seed of interest borne out of personal experience in the use and development of information systems, and a wish to contribute in a meaningful manner to what appears to be an endless search (by academics and practitioners) for ways to significantly improve the effectiveness of information systems development (ISD).

Time spent working in the numerous roles that comprise those involved in the development of information systems (analyst, designer, programmer, project leader, user) has illustrated that existing ISD methods are simply not producing outcomes of a predictable high quality. Confirmation of this state of affairs is also all too easy to find by referring to articles found in the leading 'computer related' press publications, and in academic/technical publications and presentations (Swatman & Swatman 1992). It is clear that many people and organisations in academia and from within the 'industry' have and are investing a great deal of time and money into researching into ways of improving this situation.

Contemporary and previous research efforts can be placed into two main categories: -

i) attempting to improve the detail of methodologies, techniques, and tool support employed within the 'traditional' framework of ISD.

ii) looking at alternative ISD methods - and typically those approaches that are user centred in nature.

The latter category has an inherent attractiveness in that it provides the opportunity to look at the problems faced by ISD from a 'fresh' viewpoint. The business user and the IT specialist both have particular and important attributes to offer - all of which need to be optimised as much as is possible. As with most things in life, it is likely that the most favourable position is one where the power and activities of business users and IT specialists reach a natural and effective balance.

This thesis describes research into gaining a further understanding of business user-led ISD, and the factors involved in contributing to outcome effectiveness. It has a central aim of quantifying links between identified success factors and outcome effectiveness, and providing a mechanism whereby factors and outcomes can be measured and monitored. Furthermore, the research has the aim of enabling the outcomes to be predicted based on planned or expected changes to the success factors.

1.2 Selection of research method

There is a rich variety of research approaches utilised in the field of IS research (Jordan 1994), and it is important to consider the available options carefully before embarking on any research project. Although the IS research community is very active, it does not have a generally accepted dominant research method (Avison *et al.* 1994). This reflects the widely differing nature of the various aspects which are targeted by IS research, and the fact that this area has to deal with a complex set of issues associated with human and organisational systems.

There are several sources of guidance for researchers needing to select a suitable

method (or methods) - and these have been used to assist with the process of selection for this project (Galliers 1991,1993; Avison *et al. 1992*; Preece 1994; Mumford *et al.* 1985).

The main categories of research methods that could be considered for this type of project are as follows: -

- Case study
- Action research
- Interviews
- Questionnaire survey

Each of these method types have characteristics which make them useful in IS research projects - they each have the inherent flexibility and *person centredness* necessary to help deal with the social and organisational complexities.

The task of selecting a research method is made particularly difficult in that there is not a universally *agreed* framework for the identification of appropriate methods (Avison *et al.* 1994). Indeed, Land (1992) states that there is no single framework which encompasses all the domains of knowledge needed for the study of I.S. systems.

The possibilities of using the *case study* and *action research* approaches were discarded essentially because the findings from these types of research are very often not generally applicable. The *case study* approach provides information that relates to a particular organisation, and often to a particular project/department. *Action research* is suited to studying a prescribed practical situation - again appertaining to a specific department/organisation. The research issues to be addressed by this project (see 4.1) require a much broader

base for information sourcing. With one of the target deliverables being to produce an instrument to measure and predict BUD (business user development) effectiveness, it was essential for a wide range of business users to be included in the information gathering process - so that the instrument could be adequately validated and tested. A combination of *interviews* and *questionnaire survey* approaches would seem the most appropriate research methods to be adopted for *this* project.

Galliers (1993) argues that the organisational/managerial aspects are best researched using methods based on interpretation rather than pure observation. The taxonomy of IS research approaches produced by Galliers (1993), indicates that the use of surveys is well suited for research in this area. Further support for the adoption of a 'survey research' approach for this project is that Galliers (1992) indicates that survey research is appropriate for theory building (following the identification of research questions).

In considering which research method, or methods, to be adopted, it is recommended that three conditions should be considered (Yin 1989): -

a) the type of research question posed
b) the extent of control over events
c) the degree of focus on contemporary (as opposed to historical) events

Yin (1989, p.17) provides a table showing how the three factors relate to the different research strategies available (experimental, survey, archival analysis, history, and case study). The table indicates that the use of a questionnaire survey approach is a suitable strategy for this research project, in that this approach is deemed appropriate when the research goal is to describe the prevalence of a phenomenon or when it is to be *predictive* about certain outcomes (Yin 1989).

Questionnaire surveys are ideal instruments for gathering reasonably large amounts of structured data from a number of individuals with varying experiences and working within a variety of environments. This type of research

is regarded as being able to encompass a wide range of situations, and be fast as well as economical (Avison & Nandhakumar 1995). Interviews are of general use, and for this project are utilised largely for verification purposes - particularly during instrument validation stages.

It is recognised that the more interpretative (sometimes referred to as 'non-positivist') type of research approach (e.g. role playing, action research, subjective review, etc.) also has strengths - such as addressing change-over-time for particular case studies, and taking into account personal issues, etc. (Avison & Nandhakumar 1995; Easterby-Smith *et al.* 1991). These alternative research approaches may well be useful for projects which might follow on from this research (please refer to Chapter 9).

The nature and scope of the issues to be addressed in this project were such that there was a need to elicit information about, and from, a wide range of business users - encompassing those that perhaps have little to do with creating, or even using, computerised information systems through to those that are very skilled and active in that area. It was necessary to establish a deeper understanding of the categories of business user skills/experience, and to find out in what kind and range of IT activities business users were involved. It was important to learn much more about end user application implementation success factors (how they relate to each other and to outcome effectiveness). An awareness was needed to be gained of how the control of contributing factors might make systems directly created by business users more effective.

In these relatively 'early' days of user empowerment in ISD, it is appropriate to target research at experiences and issues related to the development of typical *business related* information systems - specifically excluding safety critical and real time systems. This has the advantage of setting a realistic scope for the research in what is by definition a very complex and difficult area. It is regarded here, however, that given the appropriate level of knowledge in the domain area (and of the organisational context of the application in question), and the appropriate mix of technical and automated skills in ISD activities, then there are no limits to the scope for BUD.

It was regarded as imperative that the findings should be of a type that would readily enable organisations to make practical use of them - in addition to adding to academic research knowledge. Much of previous work in this area has been of a subjective nature - an aim of this project was to produce results that included relevant quantifiable data, and to derive techniques that can enable tangible improvements to be made to the BUD process. The questionnaire survey was designed so that the data could be statistically analysed to give objective quantitative results - adjudged to be of more use than purely subjective and descriptive outcomes. An intention of the project was to identify and test several hypotheses - quantitative approaches are regarded suited to testing hypotheses (Preece 1994, p.44). A series of survey studies have been used to test questions used, confirm/validate the model, and also provide interesting evidence on important issues related to the factors studied.

The overall conceptualisation and the design of the approach of the project has benefited from the rigorous testing in the form of exposure at numerous conferences and in recognised research publications (Appendix IV). Positive and constructive feedback, via various discussion sessions around the world (and via Internet) - mainly with experienced researchers in this area, has been an important ingredient to the development of this project.

1.3 Structure of report

Following this introductory chapter, the next two chapters describe and discuss previous research in areas related to this project (user centred ISD and end user computing). The discussion leads to the identification of research issues central to the new research described in this thesis.

Chapter 4 provides further explanation of the issues addressed by this research, and establishes a set hypotheses and deliverables to be targeted by this project. A simple research model is detailed which illustrates the relationship between BUD success factors and BUD outcome effectiveness, and places this into the context of generalised ISD in an organisation. The adopted research approach, of developing questionnaire instrument and analysis techniques and surveying

business users, is also described in some detail.

Chapters 5 to 7 give full accounts of three quite distinct surveys carried out during this project - including details of the evolving questionnaire instrument design and the findings and interim conclusions. It is shown how the work culminates in producing what is termed a 'BUD Effectiveness and Scope Predictor (BUD ESP).

Chapter 8 comprises a comprehensive summary of the research conclusions, including a review of how the findings specifically relate to the targeted issues, hypotheses and deliverables.

Chapter 9 suggests possible future and subsequent research in this area, and discusses some preliminary ideas regarding some of the aspects.

1.4 Summary of thesis findings

Searches of published literature, detailed in chapters 2 and 3, reveal that although there is significant potential for business users playing a greater role in ISD, it is an area that is not very well understood and not particularly well served by academic research. The possible gains from exploring this area are significant - although due to the 'organisational' and human issues involved, it is a route that carries its own special difficulties. Many years of systems being developed by teams following traditional methods and fulfilling traditional roles has created what will later be described as an 'information system crisis'.

Chapter 2 discusses the impacts of CASE tools and expert technology on the addressing of this crisis. It is noted that although there is a wide range of research effort in this area, the emphasis is clearly on tools and technology targeted at IT specialist use (as opposed to business users). The very active area of ISD methods research is also investigated, with indications that the most promising findings are related to user centred approaches of development. A further trend is the realisation that communication/culture gaps between business users and IT specialists are significant contributors to the tendency of poor

effectiveness levels in implemented systems.

To consider the changing of the roles or at least the *emphasis* of those roles appears to be vital and inevitable. It is likely that the desired optimal position for future ISD projects will be where IT specialists and business users undertake a variety of roles and responsibilities depending on the project type, the nature of the problem domain, and the characteristics and availability of particular personnel.

Chapter 3 comprises an in-depth study of the findings of previous research into the business (end) users direct involvement in ISD. It reveals that this work provides little evidence about the potential capabilities of business users with regard to increasing their direct involvement in ISD, nor about the factors which determine the success of business user led projects.

A summary of the growth of end user computing (EUC) and the types of activity involved, shows that EUC is already a prominent feature of ISD in modern businesses, and that the roles played by business users is quite diverse. Reports on the impacts of user-led development vary, but there is a tendency to consider that the associated greater system 'ownership' by the users, and the more direct opportunity to translate requirements knowledge into implemented specifications, as being benefits which override the potential 'risks' (mainly being that users tend to lack specialist systems development skills).

Chapter 3 also includes reviews of research into methods of measuring the effectiveness and quality control of BUD. Various questionnaire instruments are being developed to measure the effectiveness of BUD outcomes, and are at relatively early stages of maturity. A range of possible ways to improve quality control in BUD has been investigated. They include using 'quality assurance agents/groups', providing systems development 'good practice' training for BUD participants, the adoption of 'business work' centred analysis techniques, the use of 'Information Centre' specialist support services, and the use of improved (intelligent) tool support.

After discussing advances made in previous research into improved business user tool support, Chapter 3 concludes by summarising the main findings from the literature search - and identifying a likely new research direction.

Chapter 4 begins by detailing BUD research issues that are identified as being important and central to the interests of the new research described in this thesis - which are borne out of a comprehensive literature search (discussed in Chapters 2 and 3):

- what range, and frequency, of IT related activities do users carry out in typical organisations (and in particular, what are the experiences in the UK)?

- what are the characteristics, experience and systems development potential of business users ?

- what are the main contributing factors that help determine the effectiveness of BUD activities, and what are the quantified links between them and BUD outcomes ?

- to what extent do the existing BUD support tools satisfy the needs and aspirations of user-developers, and how could tool design be improved?

In Chapter 4, a set of hypotheses and related deliverables are defined which in turn form a focus for the study of the targeted issues. The newly constructed BUDES model is described which represents how the four identified BUD success factors relate to BUD outcome effectiveness.

The chapter then continues by outlining the approach adopted for collecting data necessary for validating the BUDES model and quantifying links between BUD success factors and BUD outcome effectiveness. The principle features of the

questionnaire instrument design, sample selection, and analysis techniques are outlined.

Chapter 5 describes the scope and results of a survey to validate the BUDES questionnaire instrument. The results of the survey demonstrate, via statistical analysis, that the 'ordinal' questions used in the questionnaire appear to be well defined in that they successfully target distinguishable aspects, and that the groups of questions (sectioned to relate to specific factors) seem to give cohesive responses. The text-based responses support the conclusions drawn from the ordinal responses.

The ordinal-based data collected from the survey is shown to be suitable to test the BUDES model (described in Chapter 4, section 4.2). The links between the BUD success factors and BUD outcome effectiveness for the surveyed business users are quantified, and the results indicate that the Business/IS knowledge and the Tools factors are particularly significant (for the users surveyed). It is also shown how the business users can be categorised into potential for BUD success (based on the *personal* factors of Business/IS knowledge and IT experience).

A cross reference is made between the findings of this initial survey and the set of issues, deliverables and hypotheses targeted by this research. It shows that the only aspect which was not particularly well served was establishing the range and frequencies of IT activities carried out by the survey participants.

Chapter 6 discusses the findings of a second survey, which further explores the validated BUDES questionnaire instrument. The evidence provided shows that the instrument can be reliably used to monitor and model BUD outcome effectiveness. Improvements to the questionnaire and analysis technique used in the initial survey are outlined, including refinements aimed at the *prediction* of BUD outcome effectiveness.

The survey results indicate that all four of the identified factors (*IT expertise, Business/IS knowledge, Role power/freedom*, and *Tools suitability*) have highly, or very highly, significant correlations with BUD effectiveness. Regression

analysis suggests that the latter two factors may be dominant, and *path analysis* reveals that each factor has *indirect* as well as *direct* influences on BUD outcome effectiveness. An outline is also given of how different levels of statistical techniques can be used to predict BUD outcome effectiveness based on measured or planned values for the contributing success factors. There are indications that BUD effectiveness tends to be constrained due to role restrictions, and unsuitable tool support.

Chapter 7 describes the findings relating to the last of three business user surveys - using the BUD ESP instrument (including a few enhancements as a consequence of experiences in the previous survey). The findings further demonstrate that this research project provides the 'infrastructure' of an instrument and analysis technique which can be used to identify and quantify relationships between factors and outcomes (including the opportunity to calculate, or predict, outcomes based on factor values). The statistical analysis is used to provide further evidence suggesting that the Role (power and freedom) and Tools (suitability) factors are dominant in the determination of BUD effectiveness, but that all four identified factors influence BUD outcomes.

The survey results are also used to categorise the business users in terms of 'BUD potential', and to form a profile of IT activities carried out by the business users. A high majority of the surveyed participants have moderate or high levels of IT expertise and Business/IS knowledge, but it is noted that over 50% reported low ordinal scores for both *Role* and *Tools* factors. Bearing mind that the surveys have repeatedly indicated that these factors are dominant in determining BUD effectiveness, these low ratings could represent significant restrictions to users wishing to take part in BUD.

In IT activity terms, the business users surveyed (the combined samples surveyed in the second 'exploratory' survey and the final survey) mainly carry out word-processing, spreadsheet, and database work. Also, there is evidence that some business users are involved in building simple and complex applications. User satisfaction with the tool support tends to be moderate or low, which is of particular cause for concern bearing in mind that tool suitability has

been identified as a dominant factor in the determination of BUD effectiveness. Text-based responses reveal that a common wish of surveyed users is for tools with improved user friendliness, and a greater emphasis on the perspective of the business user.

In Chapter 8, there is a summary of the findings and conclusions relating to the work completed within this research project. A comprehensive list of targeted deliverables and hypotheses (as initially set out in Chapter 4, section 4.1) are discussed in the light of the research findings. Built on a wide literature review, the work provides an important breakthrough in terms of knowledge and understanding about the relationship between BUD success factors and the outcome effectiveness of BUD. The analysis of a series of three survey studies has been used to validate both the questionnaire instrument and the (BUDES) model, and also to provide new evidence regarding important issues related to the BUD factors studied. The detailed findings relating to the business users surveyed can be summarised as follows: -

i) The surveys discussed in chapters 5, 6 and 7 successfully demonstrate that the method adopted enables possible links between contributing factors and BUD outcome effectiveness to be evaluated (refer to 5.3.2, 6.4, and 7.3.1) and that the instrument facilitates the *prediction* of BUD outcome effectiveness (refer to 6.4, and 7.3.1).

ii) The main survey produced figures that demonstrate that the correlations between the four identified factors and BUD outcome effectiveness are highly/very highly significant. However, in the final example survey, there is some conflicting evidence regarding the significance levels of IT expertise and business/IS knowledge. It serves as a reminder that the questionnaire instrument does *not* have the purpose of establishing absolute values of links between factors and outcome effectiveness. Its main use is to enable monitoring and prediction of outcome effectiveness for particular users and groups of users.

iii) Statistical approaches have been used to demonstrate that the BUD ESP

instrument can be used to reliably predict BUD effectiveness outcomes for users surveyed, based on measured or planned values for the BUD success factors.

iv) The predominant business user IT activities seem to be at the level of word-processing, spreadsheeting, and database use. There is, however, some evidence that business users are actively involved, to varying extents, in simple and complex application building activities. Satisfaction with regard to BUD tool support tends to be moderate or low.

v) Consistently, over 50% of the participants in the surveys have been found to be in the top category of BUD potential. This indicates that many business users have sufficient personal potential (i.e. in terms of IT expertise, and business/IS knowledge) to be effective in BUD.

vi) The surveys provide evidence that many business users seemed to be constrained in terms of BUD effectiveness due to unsuitable tool support and role power/freedom (refer to sections 5.3.3, 6.5, and 7.3.2). Survey respondents were asked to indicate their "wish list" for BUD tool support characteristics. Generally, there were requests for improved user friendliness, and a greater emphasis on the users (business) perspective (refer to sections 7.3.3 and 7.3.4).

vii) In the third survey, participants were asked a specific question about their interest in BUD. A majority of the respondents (16/29) expressed a clear interest in having a greater involvement in BUD activities.

Chapter 8 also clearly states the benefits (to academics and practitioners) of the findings of this research project. The knowledge about the skills and experience (IT, IS and business knowledge) of individual business users, with respect to their potential for effective involvement in BUD activities, is potentially very useful in both research and organisational terms. In particular this knowledge, together with measures of tool support suitability and role power/authority, and direct measures of outcome effectiveness (where BUD already exists), enables

the following: -

a) The identification of IT training and tool support needs, and the nature of IT specialist support required for organisations evaluating BUD empowerment.
b) The identification of the levels of improvements (if any) needed in the various success factors - to meet BUD outcome effectiveness levels as targeted by the organisation. The BUD ESP instrument also assists with modelling the impact of planned changes to contributing success factors, and/or to monitor the actual effect of any changes to the factors.
c) The matching of business users to BUD projects, using profiles of BUD success factor levels for individual and groups of users.
d) The use of the BUD ESP instrument, and the findings and conclusions described in this thesis, to form the basis for further research into BUD itself and/or into other related areas.

The chapter also briefly comments on the need for business users to be actively involved in progressing knowledge and practice in BUD, and on how the potential of the IT specialist role might also be maximised.

Chapter 9 identifies possibilities for further research, which could be carried out as a direct consequence to the new research described in this thesis. The main suggestions for subsequent research can be summarised as being: -

- further surveys using the BUD ESP instrument
- investigating improvements and enhancements to the BUD ESP instrument
- prototyping advanced tool support for BUD participants
- studying a variety of BUD issues - such as BUD policy, BUD management, BUD infrastructure and support, etc.

A discussion of ideas and suggested preliminary considerations relating to some

of these aspects follows in Chapter 9, which had developed during the project. In particular, a process knowledge framework is described (which helps categorise the levels of knowledge that a user might need to acquire in the 'IS development process'), an argument is presented showing the need for advanced BUD tools, and the features of an envisaged BUD tool (CAUSE tool) are outlined and related to currently existing CASE tools.

1.5 Contribution to I.S. research

The research described in this thesis builds on previous research in this area, and provides an important breakthrough in terms of knowledge and understanding about the relationship between success factors and the outcome effectiveness of ISD completed by business users. In particular, this work provides the following original contributions to research in the area of business user involvement in ISD: -

- identifies the main factors contributing to the success of BUD outcome effectiveness - *IT expertise, Business/IS Knowledge, Role power/freedom*, and *Tools suitability*.
- provides reliable mechanisms to quantify the levels of the success factors and BUD outcome effectiveness for particular business users (in the form of a tested questionnaire and results analysis facility - the BUD ESP instrument).
- establishes quantified links between BUD success factors and BUD outcome effectiveness - which enables a variety of possible outcomes to be predicted, based on measured or planned BUD success factor values (using either of two statistical analysis techniques, applied to the data obtained from the BUD ESP instrument).
- indicates the level of involvement of business users in a range of IT activities, and also indicates the apparent levels of user satisfaction in terms of the outcomes of those activities, and in terms of the tool support available.

The contribution of this research can also be considered from the viewpoint of its pragmatic usefulness to academics and I.S. practitioners. The features of the original contributions of this research, listed above, provide many advantageous opportunities for academics and practitioners who have an interest in studying and optimising the effectiveness of BUD, and can be described in summary as follows: -

a) where an organisation is evaluating whether the levels of existing skills and experience of its business users make it a viable proposition to adopt a policy of user empowerment in IS development terms. Knowledge about these levels would help identify the amounts of IT and/or business/IS knowledge training and/or IT specialist support required (and whether the exercise would be cost effective).

b) where an organisation has already made a policy decision in favour of supporting business user empowerment, but is now selecting which projects/users are appropriate. There would need to be a matching of projects and business users in terms of required BUD success factors (business/IS knowledge, IT experience, role freedom/power and tool support suitability). A profile of BUD success factor levels for individual and groups of users is a vital ingredient to this matching process.

c) where an organisation has already embarked on a user-empowerment programme - to help the organisation identify what levels of improvements (if any) in the various success factors are needed to meet targeted outcome effectiveness levels, and to model the impact of planned changes to contributing factors, and/or to monitor the actual effect of changes to contributing factors.

d) Scenarios a), b), and c) apply directly to practitioners and management in business user organisations. Equally, the BUD ESP

instrument could be utilised by academics and/or industry based researchers to research into issues relating to the specific aspects described. The instrument, together with the findings and conclusions described in this thesis could also form the basis for research into other related areas (e.g. impact on the BUD success factors of human and organisational factors, etc.).

The descriptions, explanations and discussions of the research work completed in order to produce these contributions to the area of IS research begin, with the next chapter (Chapter 2), which reviews published literature relating to *user centred* information systems development.

CHAPTER 2: *User Centred* information systems development - a research review

The purpose of this chapter is to:

- present the scenario of the *information systems* crisis
- outline the impact of computer aided systems engineering (CASE) tools on addressing the issues associated with the 'information systems crisis'
- discuss research into advancing the power and scope of CASE by introducing and incorporating expert knowledge into the tools
- describe the variety of approaches being studied by the research community into information systems development methods
- establish that a major issue in this area, is that of poor levels of communication between analyst/designers and business users

2.1 Introduction

The implementation of a computerised information system (IS) is clearly an issue of significant importance to business organisations (Somerville 1994). Over recent years, across the IT industry, there have been widespread efforts to improve the quality of computerised information systems developed for use by business organisations. The approaches utilised are varied, but notable examples are semi-automated CASE (computer aided system engineering) tools, object oriented and soft systems methodologies, prototyping, and rapid application development techniques.

There is a common theme running through all such approaches - decreasing the

reliance on design decisions made by IT specialists and increasing the involvement of business users in the systems building activity; to make it more *user centred*. It has been suggested that human skills are of more importance than technical tool support (Boehm *et al.*1984). This thesis includes discussion of recent experiences and trends with tool support for ISD, as it is necessary to establish the issues associated with the use of current tools and related to contemporary tool research. The anticipation is that knowledge about these issues is fundamental to understanding how the role of human skills (of business users) affects ISD effectiveness, and how future tools may better support those skills.

This chapter looks at published research which has addressed various issues relating to software applications development, including improving development methods and tool support, the impact of CASE tool support, and increasing attention on the role of the business user in the development process. It is concluded that communication between analyst/designers and business users is inherently and significantly problematical.

2.2 Current problems in software development

The expectations, in terms of how computerised information systems can contribute to the successful operation of an organisation, of business users have undoubtedly increased dramatically over recent years. This increase has been triggered largely by the growing awareness of the potential power and benefits of computerisation, due to the advent of personal computers and their increasingly widespread use in business (Balzer 1985; Amoroso & Cheney 1992).

Unfortunately, these boosts in expectations and awareness are overshadowed by a critical problem. As an industry, we are not yet generally able to design and implement software systems which can effectively solve business problems with a predictably high degree of quality and functional desirability, within acceptable cost and time scales (Bubenko 1986; Rauterberg & Strohm 1992; Nord & Nord 1994).

Previous literature supports this view by explaining that in addition to projects running over budget in terms of time, effort and costs, the relevance, usability, scope, flexibility, and reliability of implemented systems is tending not to meet the expectations of business users (Worden 1989; Highsmith 1987; Balzer 1985; Rauterberg & Strohm 1992). Increasing complexity of systems and current 'analyst/designer' skill shortages are also recognised as problems (Majumdar 1990), and these will tend to accentuate other aforementioned problems. Currently there is a trend for the wider systems development community to find ways of lowering software costs and improve quality (Khoshgoftaar & Allen 1994).

The current state of affairs has been described as a 'software crisis' (Swatman & Swatman 1992). This is probably better regarded, though, as an *information systems* crisis - as the software often works, even though it might not properly address the business needs of the information system. The crisis has been likened to a mythical monster that requires a *silver bullet* to magically put everything 'right', but that it is thought unlikely that one single solution will be found to represent this bullet (Brooks 1987).

Attention has been drawn to the power that 'traditional' IS/IT professionals seemingly have over end users, and that it leads to the risk of designs being built to the preferences, benefits and convenience of the developers rather than those of the end users (Markus & Bjorn-Anderson 1987). Bubenko (1986) suggests that progress on establishing a comprehensive, generally accepted 'theory of information systems' has been considerably less than in, say, hardware or in development environments. A survey (Maass 1988) has shown that business domain expertise is crucial in achieving the required functionality, and that software tools need to be easier to handle and incorporate better standards and design principles (including good features of HCI - Human Computer Interaction).

There have been several breakthroughs which have made significant advances in the development process (Brooks 1987), and these include the development and

introduction of 4GL's, user centred packages (e.g. spreadsheets, databases, etc.), and integrated and interactive software development process environments. CASE tools have been introduced over the last 10 - 12 years with the promise and prospect of clearing the 'development backlog' problem, and providing a more professional, productive, structured, and comprehensive environment for producing effective and high quality software (Boone 1991; Norman & Nunamaker 1989; Majumdar 1990).

2.3 Impact of CASE

In the main, currently available CASE tools support (in terms of improving the documentation and traceability of the analysis and design) the conventional methods and approaches which have been party to producing dissatisfaction amongst software users. Notable exceptions to this are the introduction of methods and tools that support 'rapid prototyping techniques' and the 'soft systems' approach to requirements analysis. This is not to say that CASE tools have little merit, but rather to point out that whatever levels of success are achieved with regard to the design of the tools, their effectiveness will always be limited by the constraints of the methods and approaches that they support and model.

There have been, and still are, many exponents of Case and its rich potential in tackling software development problems (Sumner 1992; Wynekoop *et al.* 1992; Kanapathy 1990) but the reported experiences of software developers and end users indicate that the various tools have not lived up to their promise and that new or enhanced approaches need to be identified (Highsmith 1987; Moran 1992; Boone 1991; Kanapathy 1990; Sumner 1992; Worden 1989; Nour & Yan 1991; Jones 1992).

Even though CASE has had the promise of improving software quality, its adoption is not universal. It is estimated (Boone 1991) that only about 10% of software developers are using CASE tools. Martin (1988) suggests that the main reasons for CASE not being used included difficulties of implementation and integration

of the tools, time consuming graphics procedures, and the need for a more flexible approach to method support. Where CASE is adopted, many feel that obstacles to attaining the full potential rewards include high costs, people resistance, arduous learning curves, and non-integration across life cycles (Sumner 1992).

Two of the most important issues with regard to CASE are the effectiveness of the underlying method of managing the software development activity utilised by the organisation (Curtis 1992), and the effectiveness of the CASE implementation method (Aaen *et al.* 1992; Warren 1993). CASE needs a stable and productive foundation in the form of a well established and effective development method to prosper successfully. The impact of CASE has been impaired due to the lack of inherent support for prototyping, effective acquisition and understanding of user IS requirements, and end user involvement (Sumner 1992). These latter points are crucial to understanding why it is that CASE has not lived up to its early promise. In addition, considerations of how resources are applied to the initial implementation of a CASE tool, and how the event is actively managed and planned are very important factors in its success.

Wynekoop *et al.* (1992) argue that CASE tools have a great deal of promise but seem to fail to deliver to expectations. Their research, involving a user survey, indicates that if the expectations of CASE tool advantages and implementation complexities are accurate/pessimistic (as opposed to being inflated or over optimistic) then outcomes will tend to be more successful. Also, an important finding is that although management commitment is important for the successful implementation of CASE, the information in their communications must be accurate (in particular management claims of 'ease' and 'power' must not be exaggerated).

Leonard-Barton (1987) suggests that the success of introducing CASE is related to how well organisational actions promote the new technological approach and how well the implementation process is managed. Previous research (Allan & Wolf 1978; Rogers 1983) is reported to show that the more complex an individual

perceives an innovation (e.g. a new CASE tool) the less likely it is to be actively used. It is also noted that previous research (Coe & Barnhill 1967; Ginzberg 1981; Rogers 1983; Alexander 1989; Manross & Rice 1986) has considered the issue of the affects of prior perceptions of advantages of innovations. It seems that the greater the perceived benefits prior to adoption, the greater the likelihood of success, but if the expectations are exaggerated then the subsequent disappointing results may have a considerable adverse affect on the implementation success.

Martin (1988) identifies four aspects of CASE tool use that encourage productivity improvements. Namely; methodology training and enforcement, support of analysis type diagrams, a central information dictionary, and consistency checks/reports. Martin (1988) suggests that there should be a 'CASE administrator' who would be responsible for liaising with analysts and implementing standards and conventions to be used with particular applications. Interestingly, Martin (1988) claims that it takes much longer for an analyst to use a tool to draw a DFD or E-R diagram than to type the underlying data in a standard data entry format, and that analysts tend to hand the task of drawing charts over to someone familiar with the tool, but would perhaps be better served by automatically generated diagrams (from a set of text statements). Curtis (1992) and Warren (1993) have completed research which shows that the characteristics of the personnel, the organisational structure, and the management of the CASE implementation process interact and combine to form outcomes having varying levels of success.

It is also clear that the storage of 'business systems design' information within a CASE environment not only enables a structured approach to the development of software applications, but also reduces the risk regarding losing staff who have ownership of business knowledge (Gibson *et al.* 1989). The reuse of modelling information in subsequent projects is an important factor in any potential productivity gains realised due to CASE (Gibson *et al.* 1989). We need to be aware, however, that the impact on the 'knowledge loss' risk and productivity gains is only significant if the encapsulated knowledge can be re-used and adapted with

reasonable ease. The value of the 'stored knowledge' is also reliant on the accuracy with which the information system models have been interpreted and modelled by the IT specialists utilising the CASE tool(s).

Boone (1991) suggests that the industry should move away from the expectation of productivity improvements due to CASE utilisation, to that of *quality* improvements. Boone & Merlyn (1988) have found that the use of CASE seemed to give an improvement in quality rather than productivity. It would be easier for an organisation to justify increases to the current budget levels (to accommodate tool purchase and support) if significant improvements to levels of quality could be predicted. There is a difficulty here, however, in that there is still no universal agreement on how to measure 'quality' - and furthermore it is important that the link between quality and *economic performance* is also established when analysing the metrics.

It is apparent that the 'sands of time' available to the software development community to show that the use of CASE tools can fulfil their early promise are fast running out. Attention needs to be focussed on current and new research which has the potential of reversing the trend that the number of IS executives that regard CASE as a promising technology is drastically reducing (Moran 1992). It also needs to be noted that other research concludes that the impact of software tools is minimal compared to the effects of the characteristics of the personnel involved (Card *et al.* 1987).

Clearly, CASE has not been shown to be a panacea to the problems faced by ISD activities. Possibly one of the most likely developments with respect to CASE tools that will increase reliability and effectiveness is the investigation into incorporating expert knowledge into the design of the tools.

2.4 Expert technology and CASE

Researchers and practitioners within the industry are looking for the next generation of software tools that will more effectively address the problems involved with the prevailing IS crisis. One of the most significant advances in recent years, with regard to software and software development, has been the introduction of expert system and knowledge based techniques to the production and operation of software.

Brooks (1987) defines an expert system as

> "... a program that contains a generalised inference engine and a rule base, takes input data and assumptions, explores the inferences derivable from the rule base, yields conclusions and advice, and offers to explain it's results by retracing its reasoning for the user. The inference engines typically can deal with fuzzy or probabilistic data and rules, in addition to purely deterministic logic."

The elements of uncertainty and probability are important features of expert systems, in that human experts also often have to make decisions on evidence which does not lead to absolute or categorical conclusions. The action and output of an expert system is designed to be similar to that of an expert in a particular field.

Cauvet *et al.* (1990) suggest that as the activity of application design is complex but iterative, with an element of uncertainty and that human designers use experience and formal skills, then it is probably suitable for the application of an expert system approach. Others (Bobrow 1986) suggest that the extent of English language and 'common sense' understanding makes the use of expert system technology inappropriate.

Contemporary research into improvements in the use of CASE tools is wide

ranging. One approach involves investigating methods of enabling IT specialists to benefit from the automation of requirements analysis and modelling (Loucopoulos & Champion 1989; Terashima 1993; Selfridge 1992; Falkenburg *et al.* 1990; Ip & Holden 1992; Sowa 1990; Cauvet *et al.* 1990; Budgen & Friel 1992; Dubois *et al.* 1992; Bosser & Melchoir 1990; Stobart *et al.* 1990).

Work is also being carried out in the area of requirements acquisition, (Shaw & Gaines 1992; Rolland & Proix 1986, 1992; Dhar & Jarke 1993; Bosser & Melchoir 1990), in the area of a 'soft systems' approach (Avison *et al.* 1992), in comparing and evaluating methodologies (Bubenko 1986; Floyd 1986; Palvia & Nosek 1990), and the integration of CASE tool activities (Thompson 1992). This area of work is very important in that it addresses the IT specialist/user communication problem. In other words, if it were to be possible to 'automate' the process of eliciting requirements then the consequences of the poor communication would be largely alleviated. At present, however, it has not been found to be possible to completely remove the need for IT specialists to check and amend the information built up by the tools - therefore it remains the responsibility of the IT specialist to have gained an accurate and complete view of the IS model in question, so that the verification can be possible.

There is a good deal of work being carried out into how perceived business requirements might be automatically translated into various models using expert system and knowledge based techniques. They include diagrammatic models, such as 'conceptual schema' - Entity Relationship type graphical representations (e.g. Falkenburg *et al.* 1990), 'conceptual models', such as object life cycle models (e.g. Ip & Holden 1992), and 'conceptual graphs', which are semi-formal diagrams (Sowa 1990; Cauvet et *al.* 1990). Some of the research includes the use of natural language translation (Rolland & Proix 1986, 1992) as a method of forming diagrammatic models. In most cases, the approaches are supported by tools and many of the models are used as input to 'code generation' tool facilities.

An attempt at replicating the role of the human analyst (based on a study of an expert analyst) by Falkenburg *et al.* (1990), and using three knowledge bases (providing analysis/design, common sense, and domain knowledge) concluded that there are significant difficulties in this task of automation. In particular, in automating the initial analysis stage, and the task of validating conceptual schema produced by the process.

Loucopoulos & Champion (1989) describe a 'support environment' tool which utilises knowledge based techniques to capture and model facts about an application domain, and then proceed to transform them into a 'functional specification' (represented using the Jackson System Development method). Validation of the specification is assisted by animation and prototyping techniques. This work is an important contribution to improving tool-based control over the activity of ISD. However, there is a weakness in that the initial fact gathering task and model checking is carried out by the human analyst - for example via traditional questioning and recording activities. In other words, it is an approach that does not escape the difficulties of an analyst needing to communicate effectively with business users.

Sowa (1990) and Dubois (1990) describe styles of notation which use various symbols and shapes, which can be used to represent the semantics of an information system domain. Sowa (1990) notes that there is the need for the significant manual task of acquiring the knowledge of the information system in question and converting it into the diagrammatic notation. Dubois *et al.* (1992) and others (Balzer 1985; Budgen & Friel 1992) utilise 'formal notation' in order to help represent and manipulate requirements and design information. Sowa (1990) makes the criticism that the use of this type of notation further alienates the typical end user in the process of building and validating the representation of requirements, as the notation is difficult to understand without specialist training. The attempt to encapsulate as much richness of design knowledge and rigour in diagrams as possible tends to result in notations which are difficult for the untrained user to

readily understand. Recent research into automated CASE tool design has shown that several (mainly clerical) aspects of software development can be automated (Ng *et al.* 1996).

Research, then, into advancing the capabilities of CASE tools is extensive and very active. It does, however, reflect that there is a significant emphasis on basing the design of the tools on the fact that IT specialists are expected to be in control and the predominant users of those tools. Hence, success is very much dependant on the IT specialists gaining a complete and accurate understanding of requirements - so that any automated output can be checked.

It is important to consider another major area of research that is targeted at the prevailing IS crisis - that which takes a wider view of current and new approaches to completing the task of ISD.

2.5 Software development methods

Much research has been, and continues to be, carried out into issues related to the activity of applications development. The range of approaches adopted by organisations to develop computerised information systems is very wide (Pressman 1997). Longworth (1985) identifies over 300 methodologies utilised for ISD. Even after several decades of systems development experience the IT community does not recognise a universally accepted method or methodology (Holm & Karlgren 1995). Methods can be categorised, in terms of purpose and application via theoretical frameworks (Mathiassen & Stage 1992). Issues related to software development methods research, are discussed here in the general sense as this thesis has a primary interest in developing an understanding of how to model BUD success factors in a generalised setting - not for restricted or specific methods/ environments.

Floyd (1986) and Bubenko (1986) look at software development process models in

an attempt to understand what is/are the most appropriate method(s) - with a view to issue methodology guidelines and/or to implement the guidelines as part of a tool. Interestingly, this research does not make conclusions about recommending specific methods. Instead, it is revealed that much more work is needed to identify and develop the most appropriate concepts and principles of effective analysis and design. This view is supported by Mostow (1985) who concludes that much more work needs to be carried out to understand the design process itself (Mostow 1985).

Brooks (1987) refers to those 'breakthroughs' which have made significant advances in the development process. It is worth noting here that Brooks (1987) makes a distinction between *essential* and *accidental* difficulties in the software development process. In effect, the former refer to those difficulties which are inherent to the process (largely semantic issues) and the latter to difficulties which relate to the technical production of the software (largely mechanical in nature, and hence 'easier' to address). The paper notes that the identified 'breakthroughs' (e.g. high level languages, interactive and integrated programming environments) all relate to the 'accidental' type of difficulty, and that there is little more potential for advances in this area.

Curtis (1992) describes how the Capability Maturity Model (CMM) for software, detailed elsewhere (Humphrey *et al.* 1989; Paulk *et al.* 1991), can be used as a framework for implementing structured and high quality process methods. It also indicates when various tool capabilities should be introduced. The CMM has proved to be a very useful framework for assessing the progress made by an organisation along the path to robust, effective and dynamic information systems. It does not, however, provide 'instructive' guidance for organisations on the detail of *how* they might reach their ISD performance goals.

There is a great deal of interest in the study of how the strategic planning of IS systems and the methods adopted for their development may be optimised. There is a significant amount of research in this area, including that concerning issues

relating to the study of strategic corporate planning - and the linking of this activity to strategic IS planning (Dingley 1994). Dawson & Dawson (1995) have studied the selection and use of appropriate development methodologies and derived a 'metamodel' approach in which project managers are given guidance on the adoption of particular modelling techniques at various stages during an application development project (according to specific needs at those stages).

Davies & Wood-Harper (1990) discuss issues relating to development methodologies. The characteristics of numerous methodologies are identified, and it is concluded that the *Multiview* methodology may be particularly useful to the development of desktop computing. This approach provides multiple views across users, developers, the problem domain, and the associated technical and organisational requirements, and incorporates the Soft Systems Methodology (SSM).

The SSM approach, essentially attributed to Checkland (1981), attempts to encompass the issues relating to the human element of information systems. It acknowledges the importance of people, and their role/needs within an organisation. The approach leads to an inherent degree of 'fuzziness' in the modelling process (as compared to traditional approaches, where precise goals are identified and defined), with 'problem situations', involving interactions between various roles and aspects of a system, being determined (Checkland & Scholes 1990).

Avison *et al.* (1992) discuss SSM and its benefits, and consider some of the issues relating to tool support for SSM. The paper explains that the most important techniques used in the SSM approach are rich *pictures*, root *definitions*, and conceptual *models*. The 'rich picture' represents the problem situation and typically comprises a mixture of diagrammatic/pictorial and text representations. The root definitions are, in effect, concise text based definitions which represent views of the problem situation(s). The SSM conceptual models diagrammatically show how the various activities in the system 'fit' together and are derived from the

root definition(s).

Avison *et al.* (1992) proceed to note that the design of tools to support SSM is made difficult (compared to conventional methodologies) due to inherent problems which include informality, fuzziness, richness (all aspects of systems environment), variety of views (e.g. of actors regarding responsibility boundaries), uncertainty, addressing organisational issues, and handling multimedia formats. The authors describe how their research includes the development of tools to support the drawing of 'rich pictures', 'root definitions', and 'conceptual models'.

Bosser & Melchoir (1990) have researched into the development of a toolkit (SANE - Skill Acquisition Network) which is aimed at enabling a more 'user centred' design process for interactive applications. The research incorporates work carried out into 'task analysis' (Jeffroy 1988; Mazoyer 1986), where a task is a job or activity that is carried out by a user (this is typically a manual activity which is to be computerised). The SANE toolkit (Bosser & Melchoir 1990) supports a user-centred approach to the modelling of tasks and also of the design of the application, leading eventually to the description of a set of 'user procedures' (somewhat similar in format to 'structured English' statements).

Loucopoulos & Champion (1989) observe that the informal approaches to software development are no longer feasible because the gap between initial requirements and the final implementation is becoming too great. They note that the response over recent years has been the introduction of structured system development methodologies, which have the common approach of developing a conceptual specification of the system before it is developed. Loucopoulos & Champion (1989) suggest that there is a need for more emphasis on the automation and formalisation of the requirements analysis and specification phases.

A technology that has attracted much attention has been that of 'scripting' (Ousterhout 1998). Scripting languages, such as Perl, Tcl, and Visual Basic

(although the latter originally being designed as a 'traditional' programming language) are designed for 'gluing' applications, and are characteristic in that development tends to be speedier mainly due to reuse of existing objects and due to the code being interpreted rather than compiled. Scripting technology and languages are at the moment regarded as 'immature' and expected to improve significantly in the near future (Ousterhout 1998).

Another significant aspect of methodology research is that made into object oriented (OO) based approaches. Proponents of OO claim that its focus on associating functional definitions as part of the data definitions make it an approach which is more easily understood and implemented than traditional approaches.

The concept of OO methods and approaches attracts many practitioners and academics - in terms of utilisation and research. Aalto (1995) claims that the use of OO cuts costs and improves software quality, and discusses how OO affects success when developing large systems. The main difficulties of OO techniques, recognised by Aalto (1995), are in the areas of modelling non-functional requirements, needing to follow loosely defined guidelines, building teams with an appropriate skills base, and managing huge libraries of objects (in terms of mapping and re-use). Hope (1993) suggests that software re-use is one of the main promises of OO, and that consistency of methods/notation and selecting team members with appropriate experience are important problems. Ince (1993) notes the advantages of OO using objects and message passing interface between objects, but also refers to the disadvantages of quality metrics and testing methodologies.

A 'second generation' OO method, SOMA (Semantic Object Modelling Approach), is being developed (Graham 1996) that applies to the whole ISD cycle - including requirements capture, and guidance on managing projects from conception to delivery and beyond. Graham (1996) discusses the concepts of 'use cases', 'scenarios' and 'scripts' in the context of SOMA - an approach which builds business process models based on the OO metaphor of message passing.

It is suggested by Tsai *et al.* (1988), that artificial intelligence (AI) techniques are needed to understand and automate the software engineering (SE) process as there are no known algorithms for solving the SE task. Furthermore, prototyping is recognised as an important technique.

The use of *prototyping* is supported by Parnas (1985) by stating that complete and precise requirements documentation can only be written when the software has been at least partially developed (or if similar software has been developed previously); providing the opportunity for gaining an understanding by exploration. A user centred prototyping technique, used to elicit information about the system's requirements and build models/designs, is utilised as part of an experimental CASE tool by Bosser & Melchoir (1990) - claimed to encourage the attainment of a more complete and accurate set of requirements.

Kinmond & Stephens (1995) surveyed IT specialists at 40 UK organisations, and found that the 'user centred' nature of prototyping was perceived as the most valued advantage, with 'time required for user participation' perceived as a notable disadvantage. Purtilo *et al.* (1991) suggest that prototyping reduces risk and uncertainty associated with development. Palvia & Nosek (1990) state that prototyping has the advantage of improving user-developer communication.

Necco & Tsai (1993) describe how the prototyping methodology can facilitate communications between systems users and system developers to produce a more accurate and complete definition of system requirements.

Rapid application development (RAD) has emerged as an important design strategy, and interactively involves users and developers adopting structured and prototyping techniques to provide accelerated systems development (Whitten & Bentley 1998, p.316). Stapleton (1995) describes the main principles of the Dynamic Systems Development Method (DSDM) which has the aim of providing tool support and a methodology framework to assist the controlled use

of RAD. Active, and prominent, user involvement in the RAD process is regarded as imperative (Stapleton 1995). Joint application development (JAD) also emphasises the participation of users in the development process, but also includes system owners with builders and designers in workshop style sessions addressing design issues and deliverables (Whitten & Bentley 1998, p.316).

Miller *et al.* (1993) describe a method of requirements analysis which involves extensive user participation with minimal input from data processing technicians. They claim that it is an approach that produces outcomes of greater desirability as it focuses on the user's view of their needs rather than the systems analyst interpretation of them.

Dating back as far as the mid 1970s, there has been research in Scandinavia into 'participatory design' (Ehn 1992) - which, for example, has involved the development of strategies for union participation (across a variety of market sectors) in systems design.

Mitchell & Neal (1993) suggest that end user involvement in applications development has yet to be addressed as a corporate policy issue, with results that are often chaotic, and that effective planning and control is essential. Findings from a recent survey (Frances & Stephens 1995) indicate that strategic policies for the integration of end user development activities into corporate-wide IS development is an issue largely not addressed in industry.

The tendency, then, in the various research activities into software development methods is to move towards a greater involvement of business users in the process of developing systems. However, it is important to point out that where systems development is IT specialist-led it is recognised that a significant contributor to poor effectiveness is the difficulties associated with analyst/user communication; A survey study (Stobart *et al.* 1991) has identified that poor user-analyst communication is a key software development problem area, and this is

supported by Joshi (1992). Loucopoulos & Champion (1989) state that we need to "bridge the gap between users and developers".

2.6 Analyst/designer-user communication

Research shows that the issues associated with the roles and interaction of analysts/designers and users are complex and that there are inherent conflicts (Newman & Robey 1992; Shah *et al.* 1994). It has also been suggested that cultural differences are at the root of the difficulties in communication between users and system developers (Shah *et al.* 1994; Ward & Peppard 1994).

It is widely recognised that the more successful analyst/designers are those that, in addition to substantial IT skills, have knowledge of the application area and so can map between the expected business behaviour and the structure of the software needed to create this behaviour (Worden 1989; Curtis 1992). Bosser & Melchoir (1990) note that the appropriateness of an implemented application is a function of the extent to which the representation in the developers mind of the users' requirements is accurate and complete.

There is a considerable amount of current research into the automation of the user requirements elicitation and modelling process - which in effect is partly designed to reduce the negative impact of poor developer-user communication. Some of this research involves investigating methods of enabling IT specialists to benefit from the automation of requirements analysis and modelling (Loucopoulos & Champion 1989; Terashima 1993; Falkenburg *et al.* 1990), and of requirements acquisition using natural language techniques (Rolland & Proix 1992), and system modelling using rich semantics (Sowa 1990; Dubois 1990).

Sowa (1990) observes that it is difficult to replace the need for the significant manual task of acquiring the knowledge of the information system in question before converting it into the diagrammatic notation. It appears that much

work needs to be done for natural language translation tools and knowledge based specification tools to be fully effective, and it is clear that there remains the initial requirement for an analyst to use their skills to produce the input to the tools, and to validate tool output. The need for analyst (IT specialist) intervention means that communication difficulties are likely *still* to arise.

It is clear that more research work is needed to directly address this issue of problematic analyst/user communication - and the resulting detrimental impacts on implementation effectiveness. The automation of analysis operations provides some help, but advancements in this area are unlikely to avoid the need for IT specialists to have to check and verify models and specifications (which in turn presents the hurdle of the two role players needing to attempt to communicate fully and effectively).

A direction of research that may successfully address analyst/user communication problems, is one that looks at empowering the business user such that some projects will not require to be IT specialist-led; and hence circumventing the need for IT specialist analysts to need to elicit, check and validate models/specifications. Research into end users acting as IS developers will be fully discussed in Chapter 3.

2.7 Summarising remarks

It has been shown in this chapter that there are considerable efforts amongst the research community to address the issues thought to be associated with, and central to, the 'information system crisis'. CASE tools have been introduced but seem to be falling short of their perhaps inflated promise - particularly in terms of providing measurable and significant improvements in productivity and quality of systems. Much research is being carried out into automating the various aspects of the life cycle supported by CASE tools. It has been shown that although there is potential for the automation to have a positive impact on ISD activities, it does not completely alleviate what is regarded here as being probably

the most important problem currently faced in this area - incomplete and inaccurate communication between IT specialist developers and business users.

The chapter identifies there are problems with communication between IT specialist developers and the users of the IS, which have a corresponding damaging impact on effectiveness.

Research into software development methods is another important area, and this has also been discussed in this chapter. It has been shown that very promising findings have been gained from research into user *centred* approaches of development (notably prototyping and soft systems based methods). The success of user centred approaches is attributed to the fact that they focus on the user's view of their needs rather than the systems analyst interpretation of them (Miller *et al.* 1993).

It follows that there are clear achievable benefits in concentrating research efforts into further understanding the full potential contribution that the direct involvement of business users might be able to make to the activity of ISD, and in further developing the possibilities for user centred development approaches. The greater the independence of end users in the activity of ISD, the more the problems attributed to poor analyst-user communications are likely to decrease.

The next chapter builds on this recognition, and provides an in-depth study of the findings of previous research into the end user's involvement in ISD - popularly known as 'end user computing'. End user computing (EUC) has been defined as being *user* reliance on IT to personally develop software (Amoroso & Cheney 1992).

CHAPTER 3: Research into End User Computing (EUC)

The purpose of this chapter is to: -

- use previous research literature to demonstrate the importance of EUC - not only in research activity terms, but also with regard to the impact of EUC within organisations
- introduce and define the term Business User Development (BUD)
- outline previous research into the measurement of BUD effectiveness
- discuss the findings of research into the risks associated with BUD, and into ways to improve the quality control of BUD outcomes
- summarise research into the development of advanced tools targeted for use by business users
- conclude by crystallising the various findings from the literature to indicate the areas of knowledge which appear to be lacking and require particular attention by new BUD research.

3.1 Growth of EUC

The introduction of networked personal workstations in recent years, together with the proliferation of PC-based software, has precipitated the trend of transferring powers of choice and operation of software away from centralised IT departments to the business personnel intending to utilise or benefit from the implementations (Huff *et al.* 1992; Amoroso & Cheney 1992). A survey in 1991/2, of UK's top 2000 IT consumers found that 12% of systems were developed by end-users, and that this

was expected to rise to 18% by 1994 (Bray 1992). There is a clear increase in demand for individual control over information and the design/operation of processing (Salchenberger 1993).

Many findings have indicated the immense growth in EUC over the last 10 years or so (Sumner & Klepper 1987; Davies & Davies 1990). Amoroso & Cheney (1992) observe that a prediction by Benjamin (1982) was reasonably accurate - that by 1990 EUC would have absorbed about 90% of the total computing resources in organisations.

However, Glass (1995) forms the view that, without comprehensive training, business users are unlikely to take over the role of systems developers - essentially due to the complexity of the task. Glass (1996) reports on a survey conducted in 1995 which indicates that most *new* systems are developed by I.S. staff (89%) - as opposed to end users.

Agarwal *et al.* (1995) note that according to Pentagon estimates the increase in number of software professionals will not keep pace with the ever increasing demand - giving rise to corporate policies to decentralise ISD to end users.

Ein-Dor & Segev (1991) conclude that it appears to be individual factors (e.g. personal motivation, rank/role in organisation) which have a strong relationship with the intensity of EUC participation. Others (Boone 1991) state that it can be catalysed by computer automation.

Using a survey technique, an attempt has been made to identify levels of application sophistication, usage sophistication, and end user sophistication (Blili *et al.* 1996). The study uses an instrument which is based on a wide review of previous research in this area. The results showed that more than 1/3 of the 505 respondents (from prominent Canadian banks/insurance companies) were using applications developed by themselves.

Therefore, over recent years, there has been a significant growth in EUC participation in the UK and elsewhere; and this is likely to continue. Before considering the impacts of direct business user involvement in ISD, it is important to identify what range of activities are currently included.

3.2 Types of EUC activity

A study by Sumner & Klepper (1987) showed that the large majority of end user developed applications are of the 'query/reporting' or 'simple analysis' (e.g. spreadsheets) type. Only a very small percentage are shown to be of a 'complex' type (e.g. involving complex data analysis/simulation). Other research shows that programmers in end user departments are most active, as they are able to utilise business knowledge and take advantage of the power of computer based tools (Schiffman *et al.* 1992).

Rockhart & Flannery (1983) classify end users into six types ranging from those that 'simply' use applications through to those that are trained programmers. Rainer & Harrison (1993) describe the 'EUC activities scale', which comprise five factors - beginning EUC activities, intermediate EUC activities, advanced EUC activities, EUC facilitation activities, and EUC infrastructure activities.

Although it is noted that 'clerical' job roles were excluded, a survey showed that 25% of the respondents could be classed as end user programmers (Blili et *al.* 1996).

Ein-Dor P. & Segev E. (1992) have found that end users are diverse, and that users from different cultures exhibit some similarities (e.g. behavioural patterns, level of use) and some differences (e.g. types of software packages). They suggest that much more work needs to be done to understand the effects of culture and language on end user computing.

As the wording of the term 'EUC' does not clearly distinguish between those business users that *use* IT in an operational sense and those users that *develop* applications, this thesis introduces the term *Business User Development* (BUD). 'IT Specialists' have traditionally played the role of systems developers as a service to business users, but here we specifically refer to the business specialists role incorporating the task of developing applications. BUD (Lawrence *et al.* 1997) refers to the activity of *building* computerised information systems of varying size, by people who primarily have a *business role* associated with the information system concerned. BUD embodies the principle that improved outcomes are possible due to business user knowledge being more directly applied to the system development process, compared to traditional approaches.

3.3 Impact of BUD

Khan (1992) has evaluated user-led development in several organisations in Bahrain, finding that it has helped to produce improved user productivity, operational efficiency, and local decision making capabilities. Pettingell *et al.* (1988) conclude, after a 'meta-analysis' of previous studies, that the relationship between *user involvement* and *system success* is positive and significant. This is supported in findings by Nicholas & O'Connor (1990) in their Australian field study. Boone (1991) concludes that the effectiveness of technology increases when more directly in the hands of business developers. A study (Dodd & Carr 1994) of MIS managers concludes that systems development led by end-users combines the strengths of IT specialist and independent user projects.

Huarng (1995) has found, by surveying 162 users in 30 organisations, that user development tends to be more effective than MIS development for *departmental applications*, but slightly less effective for *corporate applications*. Kappelman & McLean (1994) state that it is difficult to make judgements on the value of end user involvement in ISD due to the inconsistent use of terminology, and differences in models and measurements utilised, and go on to make a distinction between the

participation and *involvement* of end users. Gogan (1990) discusses two complementary approaches to assessing user-developed applications:

(i) assessing the opportunities enabled by end-user technologies; and
(ii) assessing the organisation's risk exposure.

The results of a study (Edberg & Bowman 1996) indicate that, under experimental conditions, IS students were much more productive and produced higher-quality applications than did end users. This finding should not be regarded as an indicator of the worth of BUD to organisations, as it is based on an experiment using a *given* set of requirements - as opposed to the two groups needing to elicit and understand user requirements as part of the exercise. One of the most important features of BUD when carried out in the workplace is that the user-developers have a unique understanding of their own business requirements.

Other research assesses the levels of BUD maturity in organisations (Huff *et al.* 1988), and link BUD performance with that of the organisation (Guimaraes & Igbaria (1994). This area of work is important in that it enables the categorisation of organisations in terms of the level of BUD infrastructure and support, and provides a mechanism to justify (in economic terms) increases in end user empowerment within an organisation.

BUD reflects the *empowerment* of business users in that their control of and contribution to the ISD process is significantly increased. The concept of empowerment being viewed as a positive motivating force, is based on general experiential observation and also on psychological research (Deci 1975; Rotter 1966) - which concludes that all individuals have an inherent need for power to influence and control their environment. Recent research used a study of training approaches (to help users work with a newly implemented IS) to demonstrate that empowerment is an effective strategy for change, and can have big pay-offs in terms of motivation and satisfaction (Von Dran *et al.* 1996).

An important feature of BUD is the 'ownership' of the ISD process by people who primarily have 'business knowledge and experience' directly related to the IS. Worden (1989) highlights the importance of business user knowledge by concluding that it is crucial that software developers have sufficient knowledge of the application domain, and suggests that methods such as prototyping should be used to enable developers to gain that knowledge. This is supported by Maass (1988) who describes the findings of an interview survey of 22 designers, who represented a wide range of project sizes and application domains. An interesting finding was that most of the designers agreed that the users' expertise in the application domain is crucial from the point of view of producing the required functionality, and cannot be fully substituted by the designers' knowledge of the domain.

BUD therefore has the potential of making a positive impact on ISD effectiveness; due to the business user-developer possessing important knowledge about the application domain.

Amoroso & Cheney (1992) suggest, based on previous literature, that BUD has the following main advantages: -

- eliminating the problems associated with ineffective communications between analysts and end users;
- ownership transfer to the end users.

Other attributed advantages (Alavi & Weiss 1985) are: -

- enhanced productivity;
- overcoming the shortage of ISD professionals;
- improved user-friendliness in systems;
- overcoming implementation problems.

Previous research, then, has tended to form the argument that the concept of BUD provides the potential for improvements in the 'information system crisis'. This is due to the benefits of increased ownership of projects and the direct application of requirements knowledge. There is also some evidence of the expected improvements, although experiences have varied. Indeed, some research identifies risks of BUD, and this is discussed fully in the next section (3.4).

3.4 Associated risks of user development

There is widely expressed concern about the potential risks associated with BUD. Amoroso & Cheney (1992) note the risks of poor requirements analysis, documentation, training and maintenance resulting from the elimination of the IT specialist role.

Kettelhut (1992) notes that although growing numbers of end users are developing their own database applications, many end users lack awareness of the problems associated with improperly designed database tables, and recommends development support. A study carried out by Sumner & Klepper (1987) shows that end users directly involved in development projects tend not to utilise some of the practices traditionally followed (e.g. data validation, documentation and security). There is growing evidence that errors in the design of spreadsheets built by business users are serious in nature and high in volume (Panko & Halverson 1994).

Klepper & Sumner (1990) have completed a longitudinal study which failed to confirm concerns expressed in previously published literature regarding the need for quality control in user developed systems. However, a significant proportion of the users surveyed had the benefit of MIS experience or training.

A study (Guimaraes & Igbaria 1996) confirmed that there were four dimensions underlying BUD problems: end user management and control, IS user relationship, support and integration, and IS management control and planning.

Speier & Brown (1996) report on an exploratory study designed to investigate potential differences across functional groups in the same organisation for three factors: application tasks, policies to minimise risk and perceived EUC benefits. Significant differences across functional groups were found to exist - suggesting that the nature of the workgroup is an important contextual factor.

This literature search review reveals that there are some difficulties needing urgent attention, and that research into BUD risks is 'maturing' in taking wider views of BUD problems. The tendency for business users not to have adequate specialist IT/IS development skills is a prominent issue, and this thesis deals with the addressing of this aspect in detail in Chapter 9 (section 9.2.2).

There is a clear need for the capability to reliably quantify BUD effectiveness (which relates to the quantifying the impact of BUD). The next section describes research in this area.

3.5 Measuring BUD effectiveness

The importance of identifying measures of BUD outcomes has been stressed in previous research (Igbaria & Nachman 1990; Brancheau & Brown 1993; Rivard *et al.* 1994). There have been many attempts to model and measure the criteria for success of an end user developed application (Cheney *et al.* 1986; Rivard & Huff 1988; Doll & Torkzadeh 1988; Ives *et al.* 1983). It has been shown (Bergeron *et al.* 1993) that criteria can be prioritised (in decreasing order of importance), as follows:

1. Organisational effectiveness
2. User appreciation
3. Quality of applications
4. Efficiency of applications
5. Adequacy of applications (in terms of user autonomy)

Rivard *et al.* (1994) have developed and tested a construct to measure the quality of user-developed applications. It comprises eight dimensions: reliability, effectiveness, portability, economy, user-friendliness, understandability, verifiability, and maintainability. In turn, each quality dimension is composed of a set of criteria that are addressed by survey questions.

Torkzadeh & Doll (1993) interestingly reveal that good quality documentation of 'decision support' applications is an important determinant of end-user satisfaction (and hence a measure of effectiveness). Rivard & Huff (1988) have tested a model that shows that the user friendliness of tools and the user satisfaction with the relationship between end users and DP/IT (data processing/information technology) departments are related to overall user satisfaction.

Mahmood (1995) proposes that the measurement of BUD effectiveness must include the consideration of usage and productivity in addition to satisfaction - in order that its effect on strategic and competitive advantage can be evaluated.

Kappelman (1995) has developed a questionnaire instrument to measure *involvement* of an individual with an information system (IS), and their *participation* in the development of an IS. Smith & Dunckley (1995) have developed a template that can be used to form a profile of the 'user centredness' of a software developer (via self-assessment). This work is important in that it enables differences in outcome performance to be considered in the light of *measured* involvement/participation of end users, and the degree to which assisting IT specialists have a user centred approach.

Hignite *et al.* (1993) outline an approach using *function point analysis* to assess the size of a BUD project - a valuable metric in itself, and also helps in the measurement of productivity, efficiency and effectiveness.

An instrument for measurement of end user computing satisfaction (EUCS) has

been developed (Etezadi-Amoli & Farhoomand 1996). Using exploratory factor analysis, six attitudinal dimensions for measurement of EUCS are first identified. It is shown that the six dimensions ((i) documentation, (ii) ease of use, (iii) functionality of system, (iv) quality of output, (v) support, and (vi) security) account for a significant portion of the variation in user performance. It should be noted that this instrument applies to the evaluation of software systems of a general nature *utilised* by users - and not to specifically assess systems *developed* by users.

It can be seen that there is a variety of approaches being taken to either directly or indirectly measure BUD effectiveness. A universally accepted technique of measurement has not yet emerged, and it is clear that more experimental and investigative work is needed in this area. It is important that new research should attempt to use techniques that have a cohesion with previous research techniques and findings.

The measurement of BUD effectiveness is a fundamental part of quality control. The quality control of BUD is important in order for organisations to avoid BUD risks and optimise impacts of BUD.

3.6 BUD quality control

BUD quality control is the result of attempting to monitor BUD procedures and outcomes - taking action to optimise the effectiveness and success of BUD activities.

Benham *et al.* (1993) propose tool support to help overcome the problem of the tendency for business users to have 'poor' knowledge of 'good' software development methods. The tool is targeted at spreadsheet design and aims to 'foster' end user analysis and design activities and reinforce good techniques. Some recent research that focuses on end user development of spreadsheets has found that errors can be reduced by the use of group development (Panko & Halverson 1994).

Barr *et al.* (1994) recommend the use of a suitably 'non-rigorous' methodology to encompass detailed design, implementation and testing of applications. Bigler (1995) reports on how one major U.S. organisation provided development guidelines specifically for BUD participants, who need IT specialist skills/support - in an attempt to avoid perceived risks of BUD.

Alavi & Weiss (1985) discuss the perceived problems associated with business users that lack software systems development skills in some detail, together with several recommended solutions. Alavi & Weiss (1985) suggest the adoption of accepted 'good development practice' and control/guidance by IT professionals. Salchenberger (1993) describes a comprehensive set of guidelines that might help end users apply a structured approach. A concern must be expressed here though; that the level of skills needed to adopt these kinds of guidelines would require what might be an inappropriately high degree of specialist training - which would need to be especially designed to target the needs of 'business user' developers. The cost may be prohibitive, and it may be inappropriate to expect business users to take on an intense amount of 'IT specialist' skills. This thesis looks ahead to the possibility of developing intelligent tools to support business users in BUD.

A method has been developed (Alter 1995) to be used by business professionals when analysing an I.S. - termed 'Work Centred Analysis (WCA). It is based on the concept that the users can (and should) analyse business systems by concentrating on the *work* done by them (Alter 1995).

Mitchell & Neal (1993) surveyed MIS managers to provide data which indicates that organisations *without* formal policies of BUD control have concerns about stifling the advantages of BUD, whilst those that *do* have formal policies report that BUD system efficiency is likely to be greater.

Barr *et al.* (1994) propose a quality framework for end-users developing software. The framework focuses on the use of a quality 'agent' who can help with

identifying which projects need to be developed within a QMS (Quality Management System), approve requirements specification documents and detailed project plans, and assist with managing departmental and organisational support systems.

Cale (1994) expresses concern about the potential decrease in quality and control of systems due to the growth of BUD, and propose the use of a framework to control the documentation of end user developed systems.

Alavi (1985) makes the following recommendations aimed at improving the quality of end user developed applications: -

i) Documented quality policies that are actively implemented and also supported by all levels of management.
ii) Quality assurance reviews should be made of end user products, especially where systems are multi-user and/or business critical systems. A quality assurance group could provide a service to the end users.
iii) End users could prototype the design of a required system, which could then be 'refined' and fully implemented by an end-user support group.
iv) High quality reusable software modules should be made available to end user developers.
v) End users should receive training in areas such as systems development techniques, use of IT tools, and general problem solving.

It is a sobering thought to note that these recommendations are now over 10 years old, and yet there seems to be little evidence of progress being made with regard to the general implementation of the concepts involved.

The concept of 'information centres' has been introduced by numerous organisations around the world - as a means by which business users can be provided with specific support in their BUD activities. Henry et *al.* (1993) promote

the use of the Information resource centre (IC) as the control mechanism for the BUD environment.

Guimaraes (1996) surveyed 215 organisations in the U.S. and found that organisations significantly benefit from having information centres (or the equivalent) that give specific support to BUD activities. Guimaraes (1996) also warns against allowing IC's becoming 'small islands of support' - recommending an integrative mechanism that encompasses a wider corporate perspective.

Mirani & King (1994) surveyed Information Centres and users at 114 organisations in the USA and found that support was being provided without first assessing the differences in computing sophistication between users. A consequence seems to be that many users were not receiving support appropriate to needs, but end-user satisfaction was greater as the support increased.

Guimaraes & Igbaria (1994) have studied organisations that utilise ICs to support end users and conclude that the benefits from end user performance, is related to the IC effectiveness. However, Rainer & Carr (1992), have found that these centres do not tend to be responsive to end user needs.

The cross-cultural influences (related to trans-national user development teams) on problems faced by BUD are examined by Bento (1995). The paper discusses many issues related to cultural differences and indicates the following in its recommendations with regard to maximising the positive outcomes of cross-cultural teams: -

- Select team members for general cohesiveness
- Plan for cross-cultural 'awareness' training
- Utilise cross-cultural teams for difficult tasks that require creativity and innovation rather than routine tasks.
- Adopt project management approach that promotes mutual respect and creates a synergy between positive forces of team.

Galleta & Heckman (1990) use *Role Theory* to provide a basis for understanding how the many ISD and organisational roles can now be combined together as part of a complex matrix of possibilities. It is suggested that awareness of the roles, and hybrid roles, can help with the management of the human resources involved in systems development.

Grupe (1994) addresses the changing relationship between users and IS personnel, and how the IS staff can alter this relationship by adopting various models (paternalistic model, information giver model, consultative model and collegial model). Mitchell & Neal (1993) suggest that BUD has yet to be addressed as a corporate policy issue, with results that are often chaotic, and that effective planning and control is essential. Parkin *et al.* (1993) report on selected end user computing management models, and suggest that the use of management models can help provide a framework for addressing the organisational changes that occur with maturing BUD activities.

Agarwal *et al.* (1995) focus on micro level control issues (i.e. utilisation of data and models by end users) in the task of building decision support systems - with a view to maintaining user autonomy during the process. Agarwal *et al.* (1995) outline a knowledge-based approach to 'unobtrusively' support users. This appears to have a promising potential for assisting business users when fully developed.

Job rotation between end user areas and EUC support staff is proposed (Moore 1997) with the expectation of yielding the following benefits: increased knowledge and skill sets for end users and end user computing support, reduced communication gap between IS and users, improved organisational integration of end user computing, effective utilisation of end user computing, and, more flexible staffing and career paths for end user computing support personnel.

Harris (1992) notes the growing responsibility of management, in many cases with no computing-related qualifications, to exercise control over substantial IT

resources, and are expected to achieve successful returns on the investments which those resources represent.

A conclusion that can be made after considering the main findings and recommendations from previous research is that there is a possibility that the emphasis is, at least in part, misplaced. The essence of BUD is to empower the business user, and to take advantage of the benefits associated with ISD carried out directly by people with personal knowledge and understanding about the IS issues concerned. There are several detailed comments that can be made with the stance and guidelines previously published, which are as follows: -

i) to suggest that business users should adopt what are complex IT specialist skills is understandable, but has the potential of 'overloading' the people concerned and/or detracting their attention from *business* and *IS* related issues.

ii) the cost of training business users in comprehensive systems development skills would be very high - especially when it is realised that resources would need to be provided to carry out the business related functions whilst business users are being trained.

iii) it appears that guidelines for support and training assume that the needs of a business user are similar to that of a poorly trained IT specialist. Due to their different roles and experiences, the needs of IT specialists and business users are likely to be significantly different.

iv) the use of Information Centres seems to be an approach that can give good results. Business users clearly need technical support when involved in BUD - an important issue though is that the relationship between ICs and business users must be more co-operative and with more mutual understanding than that typically between users and

centralised IT departments.

v) the use of quality agents and quality assurance groups may prove to be very useful approaches to monitoring and improving BUD quality control. They have the advantage of providing a focus of attention to quality, and the resources needed for monitoring and control.

vi) two important features recognised by this thesis, and discussed in a little more detail later (Chapter 9, Section 9.2.1), are that business 'line' managers should take control and responsibility for information systems and their development, and that BUD participants should be provided with intelligent tool support. Both of these aspects will help focus ISD in business terms rather than IT technical terms.

vii) the availability of high quality reusable software modules is a suggestion made many years ago (Alavi 1985) and possibly together with appropriate tool support, this provision may be quite significant to helping with BUD quality control. Chapter 9 (Section 9.2.2) looks at the need for advancing the power and scope of BUD tool support.

3.7 Advanced business user tools

Much of published work on BUD does not particularly consider the characteristics of tools for the business user. However, some interesting work in this area (Agusa 1991; Hirakawa & Ichikawa 1992; Kanda *et al.* 1993) is aimed at using animation and iconic/visual programming to facilitate the representation and manipulation of an application design by a business user.

Agusa (1991) states that: -

> "Efforts in iconic programming will free end users from learning computer-oriented concepts and mechanisms for making programs, and even for

defining requirements"

Siao *et al.* (1992) propose a new interface, named 'visual database interface' (VDI), for the novice end users to design, implement and query database systems. The data definition and normalisation tasks, which are considered to be the most difficult for end users, have been completely automated by the VDI Normaliser and the DB Creator. A predominant feature of this research is to increase the power and control placed in the hands of the business end user. It is clear, however, that much work needs to be done to increase the scope, clarity and flexibility of visual design/programming. Recent research has been carried out into using relational concepts (with regard to designing database systems) *directly*, without intermediate representation such as an entity relationship model (Batra 1997).

It is clear that tool support for business users involved in BUD is an important issue. Amoroso & Cheney (1992) also note that as the quality of end user application development tools increases, end user satisfaction and utilisation of end user-developed applications is improved.

Ko & Hurley (1995) note that there is a strong correlation between the quality of the technology interface and the extent to which business peers are called upon for ad hoc IT support. Ko & Hurley (1995) expand on this finding and suggest that although there is an 'ideal' interface attribute of 'matching a users way of thinking/working', there is a difficulty in that individual users have individual needs. They also state that management needs to be clear on what BUD is intended to achieve or improve upon, and that BUD metrics are an important current need.

There are very active parts of the academic community which research into the visual languages (IEEE Symposium on Visual Languages Sept 3-6 1996, Boulder, Colorado), and into programming environments for end users - especially for school age children ("Child's Play" 1996). Although this latter work has a focus on a particular sub-group of end users, the issues raised and addressed have a relevance

to advanced tool support design for end users in general. Much of the work in this area involves the design of new tools to help children become *fluent* with technological media. They are designed so that they 'connect' to the users interests and experiences, and also so that they help the children 'think' about the concepts involved.

Repenning & Sumner (1995) present the view that visual representations of general-purpose programming *constructs* provide little support to end users in creating applications - true empowerment is gained by tailoring towards specific problem domains. Repenning & Sumner (1995) state that programming environments should not require the user to handle low level constructs, nor to bridge the semantic gap between their conceptual model and the program level model of the problem. They stress that it is important that end users and language designers work together to effectively design and evolve domain specific visual languages. A description is given of a useful framework and a tool that supports this concept (called 'Agentsheets'). The concept has been extended to create a tactile programming language (Repenning & Ambach 1996).

A visual programming approach is described by Cockburn & Bryant (1996) - which promotes programming skills in primary and junior schools. Users can express their programming tasks by clicking buttons and dragging sliders in an iconic language and by typing commands in a normal text-based language. Yourdon (1996) looks to the future, and suggests that 'visual development tools' will need to be targeted at utilising the capabilities of the Internet.

The scope of the research associated with this thesis does not include the detailed design or testing of BUD tools. It is, however, recognised as an important issue and one that will form an important part of research phases borne out of this current research. There is a discussion of early findings and thoughts on this subject in Chapter 9 (Section 9.2.3)

3.8 Indicative BUD research direction

Previous chapters and sections in this thesis have attempted to provide the background to and reasoning behind the choice of research direction and focus of the project described by this thesis. The following serves as a summary of this information: -

i) There are wide perceptions of an information systems crisis, whereby implemented systems tend to have significant mismatches with user needs, requirements, and expectations.

ii) The introduction of CASE tools has not particularly eased the situation, and to an extent has magnified the problem by increasing expectations further, without delivering its promises.

iii) Recent and current research into building 'expert technology' into CASE tools is anticipated to provide useful assistance to technically skilled developers, but is not likely to address what is regarded as a fundamental problem - the analyst/user communication gap.

iv) Much research has been carried out into improving software application development methods and methodologies. The use of metamodels and methodologies that increase the involvement of users (SSM, prototyping, RAD are the main examples) seem to offer a promising potential to combat the IS crisis in general, and partially address the analyst/user communication problem in particular.

v) Advanced end user involvement in directly developing applications (BUD) is identified as an approach that could be regarded as a 'natural' culmination of recent advances in available technology, and awareness/interests of business users in the direct use and control of IT. The greater direct involvement of business users in the development process also offers an excellent opportunity to address the analyst/user communication problem.

vi) BUD activity has increased rapidly over recent years, but there are possible risks with BUD - mainly resulting from business users tending

not to have sufficient systems development skills, and there are many exponents of guidelines to address the problems. The recommendations range from suggesting that BUD participants be trained in systems development techniques, to utilising special resource centres to support BUD, to providing business users with advanced tool support. The latter two recommendations are likely to have greater success due to the focus on forming infrastructure and support *around* the existing skills of the business user rather than attempt to change the characteristics of the business user.

There is evidence, then, that increased and improved adoption of BUD might be an effective approach to combating problems with traditional software application development methods. The main reasons being that the increased *user centredness*, in addition to providing the generally accepted associated benefits of increased 'user ownership' of the development task, is expected to help reduce, or possibly eradicate, the 'analyst/user' communication problem. The communication issue is regarded by this thesis as being a very important one to be addressed. In the presently typical process of an end user communicating requirements to an analyst/designer, who then creates a model which is then validated and verified via further communication with the end user, there is a strong likelihood that there will be misunderstandings - 'energy losses'. The 'energy losses' are in terms of incomplete and inaccurate perceptions (on the part of the development team), and of software applications that do not perform to the expectations of the users. The significance of these 'mismatches' will of course vary - ranging from purely cosmetic to problems of serious consequence to the operation of the system.

Clearly there are several possibilities with regard to continuing and building on the work already completed in the area of increasing the level of user *centredness* in ISD approaches - and more specifically in the field of BUD. There is, however, a common need of all the possible research directions - to gain more knowledge and understanding about BUD participants and the factors that determine the

effectiveness of BUD outcomes (Zinatelli *et al.* 1996).

3.9 Chapter summary

This chapter illustrates that a wide range of research has been carried out in the area of the direct involvement of business users in ISD - looking generally at factors and issues involved, effectiveness measurement, and risk control. The prominence and importance of this ISD approach, in terms of addressing the information systems 'crisis' (and more specifically the analyst/user communication problem), is established based on a wide range of research evidence. The concept of BUD is described and its effectiveness measurement, quality control, and its support by advanced tools is outlined.

The review of previous research shows that although it is an active area of research, there is a lack of knowledge with regard to which and how factors contribute to BUD success, and to accepted methods of quantifying success factors and BUD outcomes. Knowledge about the characteristics of business users (and the range of user types) and of current/potential BUD activities is also not yet particularly comprehensive.

The next chapter (Chapter 4) identifies and describes the issues targeted by the new research contained in this thesis - designed to address those aspects recognised by the literature review as being important gaps in knowledge in this area. The chapter also links the issues to a set of hypotheses, which in turn provide a focus to project deliverables. The project objectives therefore clearly result from the consideration of recognised problems in ISD, and in the perceived gaps in current knowledge in the area of BUD research. This area is established as being of worldwide prominence and one that may successfully address the information system crisis.

CHAPTER 4: Furthering understanding BUD factors

The purpose of this chapter is to: -

- identify the BUD research issues , which are the subject of new research within this project
- state a set of hypotheses that relate to the studied issues
- specify target deliverables that correspond to the issues and hypotheses to be addressed
- describe the Business User Development Effectiveness and Scope (BUDES) model utilised as a basis for the elicitation and analysis of research data
- outline the approach to collect and analyse the survey data

4.1 Targeted BUD research

The search and analysis of previously published work in this area led to the consideration that further research was needed into BUD, its participants and its success factors. This was necessary in order to usefully add to the progress made by contemporary research into ways of addressing the 'information system crisis'. The specific research issues to be addressed by this project can be identified as follows: -

Issue 1: what range, and frequency, of IT related activities do users carry out in typical organisations? In particular, what are the experiences in the UK?

Issue 2: what are the characteristics, experience, and 'systems development' potential of business users?

Issue 3: what are the main contributing factors that help determine the effectiveness of BUD activities, and how do they interact to produce

associated outcome characteristics?

Issue No. 4: to what extent do the existing BUD tools satisfy the needs and aspirations of user developers, and how could tool design be improved?

It is useful to consider the expected findings of this research in terms of *hypotheses*. Hypotheses have been composed, based on a combination of personal awareness of ISD and BUD, and of findings relating to the literature search, to form a focus for the discussion of results. To further define the scope and target outcomes of this project, a set of deliverables have been identified. The following summarises the association between the identified issues, the deliverables targeted by the project, and the hypotheses to be tested by the research.

1) Issue No.1:- what range, and frequency, of IT related activities do users carry out in typical organisations? In particular, what are the experiences in the UK?
   Deliverable :- an appraisal of IT activity types and levels - for a range of UK business users.
   Hypothesis:- that business users tend not to be involved in application *building* activities, even though there is also a tendency for them to have that *interest*.

2) Issue No. 2:- what are the quantified characteristics, experience, and systems development potential of business users?
   Deliverable: - an examination of the attributes (relevant to success in BUD) of a range of business users.
   Hypothesis:- that users can be classified into distinct groups representing varying levels of BUD potential.

3) Issue No. 3:- what are the main contributing factors that help determine the effectiveness of BUD activities, and how do they

interact to produce associated outcome characteristics?

Deliverables: -

a) a means of gaining measures of values to represent factors significant in contributing to BUD outcome effectiveness, and to represent outcome effectiveness of BUD.
b) a method of modelling links between contributing factors and BUD outcome effectiveness - including an attempt to be able to quantify the predicted outcome impact of changes to one or more contributing factors.
c) the evaluation of the significance of identified factors with respect to the effect on the determination of BUD effectiveness - identifying the main enabling and constraining factors.

Hypotheses: -

a) that business users' IT expertise, business/IS knowledge, role authority and power, and the suitability of tool support, are all factors which are significant in the determination of BUD outcome effectiveness.

b) that the measures of business users' IT expertise, business/IS knowledge, role authority and power, and the suitability of tool support, can be used to predict BUD effectiveness.

4) Issue No. 4: - To what extent do the existing BUD tools satisfy the needs and aspirations of user developers, and how could tool design be improved?

Deliverable :- some evidence relating to the extent to which business users are satisfied with BUD tools, and some broad suggestions for improvements.
(note that the project scope only allows this issue to be partially addressed - for more discussion of this issue, refer to Chapter 9).

Hypothesis: - that current BUD tools tend to lack suitability for their purpose.

The targeted project deliverables form a positive and significant contribution to the understanding of this problem area - helping to form a useful foundation for subsequent research. The scope of the project is relatively wide, and so it may help to draw attention to what is regarded as the 'central pillar' of the project - to develop a method of quantifying links between BUD success factors and BUD outcome effectiveness levels (deliverable 3b). The practical implication of this modelling activity is that planned changes to the factors would be able to be evaluated in terms of how they might impact the outcome effectiveness. To achieve this objective with any degree of quantifiable accuracy is not a trivial task - due to the complex human and organisational issues involved.

It was envisaged that the modelling facility would be useful in maximising the potential of BUD by assisting businesses to create effective strategies relating to BUD resourcing, training and tool/infrastructure support provision. This would form part of a wider IT/IS strategy for an organisation.

4.2 Modelling BUD

A simple research model has been constructed (BUDES model - Business User Development Effectiveness and Scope) which represents BUD contributing factors combining to lead to BUD outcomes. The modelling approach is designed to enable

the measurement, and prediction, of BUD outcome effectiveness, based on measured contributing factors. The following factors, which were initially selected on the strength of a literature review and of practical personal experience in the ISD area, are identified as being the main contributors to BUD effectiveness. The aim was to utilise factors that were perceived as significant contributors to BUD effectiveness, and were *measurable* within a research study of this kind. The identified factors were: -

- IT expertise - measure of a users IT skills and experience
- Business/IS knowledge - extent to which a user understands the complexities and business issues involved in an IS
- Role - power and freedom of a user to take part in BUD
- Tool suitability - extent to which tools available meet needs of a business user developer (suitability for their purpose)

The effectiveness of the BUD outcomes is the result of the convergence of how the IT expertise, Business/IS knowledge, Role, and Tool suitability factors interact together.

The point needs to be made here that there are clearly numerous candidate control variables such as demographic features, particular business area, personal characteristics, etc. These aspects were not specifically included for measurement in the study for the following reasons:-

i) where contiguous groups or communities of business users are studied (the intended scenario for the developed instrument), then many of the aspects will be common to all
ii) the influence of the selected factors was expected to far outweigh the

influence of factors not specifically included (early, and subsequent, survey results confirmed this expectation)

The structure and content design of the model was constructed mainly on the basis of personal experience in industry (as an analyst/designer/programmer for several years, and ISD consultancy in more recent years). The model design also benefited from the opportunities for validation and refinement via the many presentations and discussions at international conferences during the project (please note Appendix IV). Significantly, there was also a 'rubber stamping' of the choice of factors and general model structure in the literature - on the strength of findings in a research publication based on a critical survey of published literature leading up to the 1990s (Brancheau & Brown 1993). With regard to the 'outcome' of end user development of systems, Brancheau & Brown (1993) conclude that there are four aspects involved:

i) organisational
ii) workgroup
iii) individual
iv) application

The unit of analysis of this thesis addresses the 'individual' and 'application' levels listed above. The individual level is described by Brancheau & Brown (1993) as incorporating the variables of 'satisfaction' (general satisfaction, and including satisfaction with *tools*), 'effectiveness' (personal performance), and 'end user' (cognitive complexity and *experience/skills).* The application level is described as incorporating the variables of 'maturity' (*scope* and profile), 'quality of application' (including security controls, documentation, *reliability, maintainability and ease of use*), and 'effectiveness' (time/cost, *perceived effectiveness, useful life*). This, then, gives evidence that the BUDES model is in harmony with conclusions made by previous major investigations and studies - which have been comprehensively collated and summarised by Brancheau & Brown (1993).

The model therefore reflects 'conventional wisdom', supported by academic research, which needs to be validated and tested. This research, however, is not simply about showing that there are links between the factors and the outcome effectiveness - rather that the *nature* of the links is to be identified (i.e. the intensities of influences are to be addressed and quantified). Furthermore, the purpose of identifying the nature of the links is to enable BUD outcome effectiveness to be predicted, given particular measured values for the contributing factors for a particular case study. To facilitate this predictive feature, a means of measuring the various aspects and identifying links between contributors and outcomes has been developed and tested in this project.

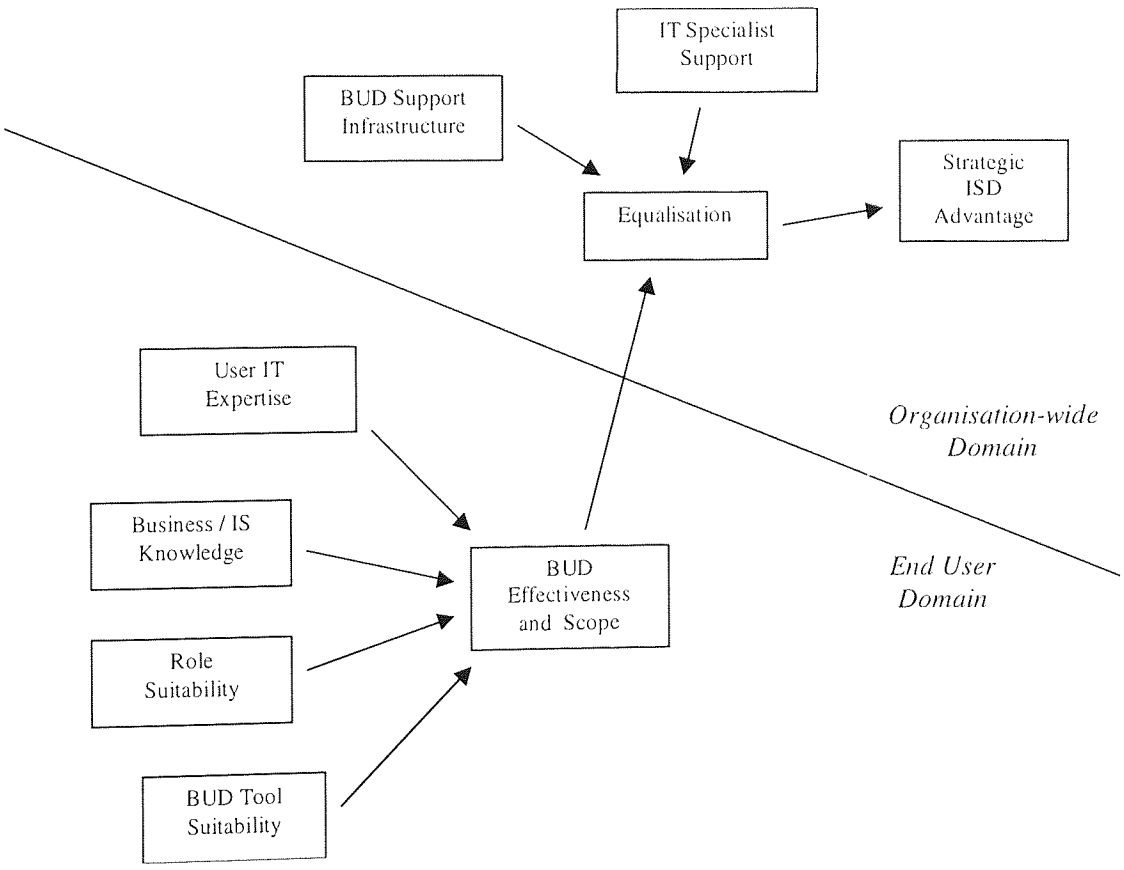

Figure 1: The 'BUDES' model - BUD Effectiveness and Scope

Figure 1 shows that the identified BUD success factors apply at the 'individual' level (within the 'End User Domain' of the ISD environment). It is recognised that, at the corporate level (within the 'Organisational Domain'), there are factors such as IT specialist support and BUD support infrastructure which also affect BUD effectiveness (supported by Brancheau & Brown 1993).

Zinatelli *et al.* (1996) have reviewed work in this area, and describe 'intra-organisational' factors - the elements of which map well on to those factors surveyed in this project. However, the level of business/IS knowledge is not included as an elemental factor in the studies carried out by Zinatelli *et al.* (1996), which is regarded here as being an important omission.

This thesis addresses the study of the factors involved in the End User Domain of the model. Research into the Organisation-wide Domain is seen as an *extension* to this work - due to the immensity of the issues involved and the demands of industry based studies. Importantly, however, it is expected that the studied end user domain factors will *tend* to reflect any organisation wide influences.

4.3 Design of data collection device (Questionnaire)

As discussed in Chapter 1, the quantification of links between success factors and BUD outcome effectiveness (represented in the BUDES model, described earlier in Section 4.2) requires the collection of data. The chosen method of data collection (the selection is discussed in Chapter 1, Section 1.2) is via questionnaire surveys of business users.

The careful design of a questionnaire is extremely important, and is needed to target project deliverables as accurately and thoroughly as possible. In this case, the style of the questionnaire is needed to be such that quantitative values could be extracted from responses - required for modelling and general statistical analysis purposes. Non-ordinal styles (such as text responses to 'open' questions, and checklists) were

also needed for cross reference purposes - to check responses for consistency and meaning. The length and style of the questionnaire also needed to be such that it would stand a good chance of actually being completed thoroughly - bearing in mind how busy the targeted respondents would be in their everyday work. The project supervision team provided substantial guidance based on extensive experience in this area, and this was supported and enhanced by published work on this subject (Moser & Kalton 1979; Preece 1994).

An important influence early in the project was the 'user sophistication' measurement technique (Huff *et al.* 1992). The questionnaire style and its approach to attempting to quantify and analyse user characteristics provided the kernel of how the analysis of success factors and other aspects might be effectively addressed within this project. The principle of building on successful previous research work and techniques was felt to be important.

Appendices I, II, and III show how the design of the questionnaire has evolved across the various surveys - to progressively enhance the way that the various sections of the questionnaire target the measurement of the four identified BUD success factors, and of the BUD outcome effectiveness. Further design detail of questionnaires used in the surveys (including the changes made as a result of early survey findings) is discussed as part of later sections in this thesis (Chapter 5, Section 5.2, and Chapter 6, Sections 6.2 and 6.7).

The user's IT expertise factor is a measure of the IT skills and experience possessed by the end user, and considers the length, type and complexity of IT/ISD experience. The Business/IS knowledge factor is the extent to which the user understands the complexities and business issues involved in an IS, and the Role factor is the degree to which the user has the power and the freedom to participate in application development. The Tool suitability factor addresses the issue of the extent to which the tools available meet the needs of the user. In the initial validation survey study (see Chapter 5), the BUD effectiveness is viewed in terms

of the type and volume of implementations, and the perceived success of those implementations (using aspects such as maintenance requirements, and perceived business benefit as indicators). This view was later to be enhanced (to also address levels of 'user access to information', 'level of use', and 'user satisfaction'), in the light of results from this initial study, and other research, and introduced into the questionnaire instrument and the analysis of subsequent survey results.

4.4 Sample selection

Some studies in this area involve the use of very large survey samples. The resources available to this project meant there were constraints on survey size and so the participants had to be appropriately targeted, and the particular statistical analysis approaches needed to be selected accordingly. Calculations have been made to establish suitable sample sizes, showing that a sample size of 60 (or greater) would allow comparisons to be made between groups. The initial survey involved a smaller sample size, but this study had the purpose of initial validation.

The essential characteristic of the targets for the questionnaire was that they should primarily have a business role in an organisation. It was desirable to include those that tended to have a high degree of involvement with IT and/or ISD, but it was also important to gain a view of those having lower levels of skills and experience. The survey sampling was targeted in the following manner:-

1. Organisations included in surveys were mainly to be those that hosted one or more third year placement students (studying Computer Science, and Business Information Systems degree courses). It was deemed that these organisations would be likely to utilise computerised information systems, and be of an appropriate minimum size and maturity. The target organisations of this minimum size could be reasonably expected to be able to support BUD. It was important that survey participants had the

opportunity for BUD involvement, so that non/poor involvement could be considered in the appropriate context.

The presence of a placement student (from an associated university) was also expected to be of an advantage in that they would be in a position to help with targeting and collection of questionnaires. Furthermore, there is nothing in published literature to suggest that any other criteria for selecting organisations would lead to different findings, or that the range of companies selected would not be representative.

2. As many of the placement sites as possible would be included in mailshots so that the scope of coverage would be maximised. However, some placements were at 'software-development-only' sites, where few if any 'business users' were situated - and so were omitted at the outset, or disregarded after early feedback from the placement student concerned.

3. For each placement site, it was attempted to get several questionnaires completed. The placement students were asked to give questionnaires to those who primarily had a business role and tended to have involvement in the development or use of IT.

4. Some (a minority) questionnaires were sent to other UK organisations - where some previous contact or association had been made.

It was felt that the adoption of the approach outlined above would gain access to very important information about some business users that are most active in user application development, but also provide a general view of a fairly wide range of business users.

Anyone that has conducted research using questionnaires will realise that it is a very difficult task to design a questionnaire instrument that encompasses the scope and

depth of a study in a style understandable to the participants, that is of an acceptable size and complexity, and in a manner which provides data that can be readily analysed. Early testing and rigorous reviewing was felt to be an important aspect to producing a robust instrument. In addition to utilising localised testing of the questionnaire, a 'pilot' study was organised to give early validation of the appropriateness and performance of the questionnaire (see Chapter 5). It was considered desirable that the design would allow for improvements and enhancements to be made to the questionnaire as the project was to progress.

4.5. Analysis approach

The analysis approach adopted for the questionnaire responses was designed to be a mixture of statistical and 'descriptive' statistical techniques (see later in Section 6.4). Statistical analysis was felt appropriate to provide validatory evidence of the questionnaire itself, and to help identify relationships between the various factors under study. In particular there is an interest in enabling BUD outcome effectiveness to be predicted, based on knowledge of measured contributing factors. Descriptive statistical analysis is used to provide information to cross-reference with statistically based information (assisting with questionnaire validation, and to provide alternative means of modelling success factors/outcome effectiveness).

Pearson statistical analysis was chosen to form the basis of testing for correlations and relationships between measures of the factors under study. This technique is a widely accepted approach for this type of study - i.e. to identify the relationships between individual predetermined contributing factors and a particular outcome factor (Peters 1987).

The detail of how the data from questionnaire surveys conducted as part of this research project is collected and analysed can be found within Chapters 5, 6 and 7; where each survey is described and results are discussed.

The general approach, however, has been to use ordinal responses to questions targeted at gaining measures of BUD outcome effectiveness (dependent variable), and the associated contributing factors - to enable the links to be modelled. The BUDES model, described earlier (section 4.2), is based on the linking of four identified BUD success factors to the outcome factor - BUD implementation effectiveness. Several questions grouped together address each aspect, with responses requested in the format of a Likert Scale of 1 (low), through to 5 (high). Specific efforts were made to word the questions for ease of understanding and suitability for participants to be able to provide accurate information about their experiences and skills.

Statistical analysis is used to check for correlations and for the relative influences of the factors. Statistical and non-statistical analyses are used to model how factors relate to BUD outcome effectiveness. It is important to note, however, that the 'cause and effect' relationships explored in this project (i.e. between BUD success factors and BUD outcome effectiveness) are probabilistic in nature (as opposed to deterministic). A probabilistic cause and effect, is where the cause is not *inevitably* followed by the effect in any individual case (after Preece 1994, p.69).

4.6 Chapter summary

This chapter clearly identifies the issues targeted by this new research in the area of BUD, which are borne out of the consideration of previously published work in this area (please refer to Chapters 2 and 3 for literature search discussions). A set of hypotheses and related deliverables are defined which in turn form a focus for the study of the targeted issues.

The newly constructed BUDES model is described which represents how the four identified BUD success factors relate to BUD outcome effectiveness, and how this fits in to the wider ISD context.

The chapter then continues by describing the survey approach adopted for data collection. The questionnaire survey data being necessary to enable the BUDES model to be validated and for links between BUD success factors and BUD outcome effectiveness to be quantified. The principle features of the questionnaire instrument design, sample selection, and analysis techniques are outlined. The detail of each of these aspects is developed in chapters 5, 6, and 7; which discuss the three surveys conducted as part of this research project.

CHAPTER 5: Survey to validate BUDES Questionnaire instrument

The purpose of this chapter is to:

- explain why the validation survey was required, and outline the features of the planned validation technique
- describe the detail of the questionnaire design
- detail the results of the validation exercise, and discuss the findings

5.1 Purpose of survey

The purpose of this survey (which was carried out during 1994, and the first of a series of surveys conducted as part of this research project) was to test question wording and suitability of the original questionnaire design (Appendix I), to test the chosen analysis techniques, and to provide some initial validation of the BUDES model. There had already been much time spent desk-reviewing the questionnaire design, examining its validity (Moser & Kalton 1983; Preece 1994), and developing the data analysis approach. The pilot study was the first opportunity to complete a field trial. It was necessary to validate the instrument so that any required changes to the design could be made in preparation for subsequent surveys. Instrument validation is important so that appropriate confidence can be placed in findings and conclusions associated with the surveys.

The following criteria are used to determine the validity of the questionnaire: -

a) Relevance: whether the ordinal responses seem to be associated with the questions asked, and that individual people/sections are distinguishable.
b) Model testing: whether the data can be used to test statistical

correlations between measured BUD *success factors* and *outcome* levels

c) Scope: whether the questionnaire instrument enables the full scope of the project to be addressed (i.e. to cover the targeted issues, deliverables and hypotheses).

The number of survey participants in this initial 'pilot' study was chosen so that a speedy 'turnaround' time could be achieved, and yet have a sufficient number and 'spread' of participant experiences to give a credible indication of validity. Questionnaires were sent out to a range of organisation types (e.g. insurance, manufacturing, local authority), with the request that they should be completed by personnel who *primarily* had a *business* role within the organisation, and also used IT. A total of 70 questionnaires were sent out, with 15 being returned for analysis. This response rate (21%) is in line with expectations of surveys of this nature, and the quantity and range of participants were both acceptable.

5.2 Detailed design of initial Questionnaire

The detail of the aspects covered by the various sections of this initial questionnaire is as follows: -

The BUDES model, described in section 4.2, identifies four main factors that contribute to the outcome variable - BUD effectiveness. The questionnaire had to be designed such that the questions used would give responses that could be used to establish values for the factors. Each variable under study (i.e. IT expertise, Business/IS knowledge, Tools suitability, Role (power + freedom), and BUD effectiveness) was examined to identify the most effective questions to be used. In essence, personal practical experience in industry was utilised as a basis of deriving the initial set of questions. The experience of conducting the research surveys carried out in this project was also used to improve and enhance the questionnaire design - and this is discussed in later sections (6.2 and 6.7). In addition, as the research progressed, ongoing reference was made to contemporary research in this

area - to attempt to ensure that the aspects covered in the questions were as representative as possible of the targeted factors (this point is discussed in more detail in section 6.2). The initial design of the questionnaire instrument, there are several questions relating to each factor - the detail of which can be seen in Appendix II, with a summary description found below).

The user *IT expertise* factor is addressed in terms of quantities, varieties, and knowledge of packages and tools experienced, the duration and intensity of IT activity experience, and their 'IT related' semantic abilities.

Business/IS knowledge questions relate to familiarity and understanding of the features and business relevance of IS systems chosen by the participant. IS design skills and the ability to prioritise business benefits of the IS were also measured. The participant was invited to select (and name) up to three information systems with which they were most familiar (and stating which was the *most* 'familiar'); so that three sets of responses could be built up.

Role (power and freedom) is measured via responses to questions about the power for participants to propose and/or sanction new IT solutions for IS needs, and the extent to which the participant's role allows time to be spent on designing and fulfilling IS/IT implementations.

Questions targeting *BUD implementation effectiveness* mainly cover the quantity of IT ideas implemented, the scope of their use, their complexity and robustness, the business benefits achieved, and the 'maintainability' of the applications.

The section targeting *Tool suitability* includes questions relating to the type of tools available, their ease of use, and the scope of their power.

Text based questions are also used - mainly to gain information about names of tools used, 'desired' characteristics of BUD tools, and descriptions of IT project

work undertaken, in addition to personal/organisational facts and figures. Additional space is given on the questionnaire for general comments and suggestions. The responses to these questions provide information useful for cross-referencing ordinal responses (to help with explaining any apparent or suspected anomalies), and for planning future work into tool prototyping and business user profiling.

The scores for the ordinal responses are totalled for each section (separate sections address each factor and the outcome effectiveness), and then used with 'correlation analysis' (*Pearson)* to quantify the nature of the links between the contributing factors and the BUD effectiveness.

5.3 Results and conclusions of validation survey

5.3.1 Questionnaire relevance

The ordinal and free text responses for each individual participant have been closely studied to check for consistency. It has been found that (with only one exception) the profiles of IT experience, business/IS knowledge, role, tools suitability, and implementation effectiveness match very well with the profiles provided via the free text information (answers to 'open' questions). In the exceptional case, there was not any free text information to utilise for checking purposes.

Statistical analysis (Pearson) has been used to examine correlations between all the 'ordinal response' type questions on the questionnaire, and a summary is presented in Table 1. Correlations of responses within questionnaire sections (targeting particular BUD factors) and correlations between pairings of questionnaire sections were studied, forming a matrix as shown in Table 1.

Table 1: Correlation ratios matrix

Sections	A	B	D	E	C
A (IT Skills)	9/91	5/126	2/42	10/126	14/140
B (Business/IS)	*	33/36	10/29	3/81	8/90
D (Role)	*	*	1/3	1/27	3/30
E (Tools)	*	*	*	18/36	8/90
C (Effectiveness)	*	*	*	*	44/45

The matrix shows the ratio (x/y) of the number of significant correlations ('x') against the total number of correlations measured ('y') for each particular matrix cell (i.e. the proportion of correlations that are significant). The significance 'threshold' (correlation values of 0.5 and above) is taken from standard tables, which take the sample size into account. In statistical terms, significance is defined as results that are unlikely to be due to chance - i.e. the probability of their otherwise occurring by chance is 1 in 20 (Preece 1994, p.160).

The purpose is to check if the various sections are shown to be addressing separate issues, and if questions within the same particular sections address related issues.

Firstly, we looked at the correlations between individual questions within particular sections to see if they tended to be higher than those between questions in different sections (the idea being that correlations within sections should be much higher indicating that the questions are targeting the same topics). The results show high levels of good correlations between responses for questions within each of the sections respectively dealing with Business/IS Knowledge, Implementation Effectiveness, and Tools Suitability). There is some indication of correlations for questions within the Role (power and authority) section, but little indication for those within the IT skills/expertise section. The low frequency of significant correlations within the IT skills/expertise section could be attributed to the fact that

many of the questions in the section used terms (e.g. 'package' and 'tool') which may have been a little unclear to some respondents (this possibility is revealed in text based comments on questionnaire return) - this may have caused some confusion in the ordinal values selected.

In general there is a lower proportion of good correlations between questions from *separate* sections, except for a few of fairly strong correlations between the IT section and the Tools Suitability section questions. In the case of the Business/IS Knowledge section, and the Role section, many of the questions show good correlations - this suggests that the authority and freedom to express IT ideas increases as the awareness and knowledge of the business area, and the related information systems, increases. Both of these correlations are what one might expect, based on experience in this area.

5.3.2 Model testing

On the strength of the evidence showing that the questionnaire has validity in terms of *relevance*, (Section 5.3.1), the validity in terms of the capability to test the BUDES model is now considered. It needs to be checked whether the results can demonstrate quantified links between the contributing factors and the effectiveness of BUD outcomes. To do this it is necessary to examine the totals for the separate questionnaire sections dealing with each of the factors and with BUD outcome effectiveness.

Table 2: *p* value correlation matrix

(between contributing factors and outcome effectiveness)

	Outcome Effectiveness (C)	
A (IT expertise)	0.396	
B (Business/IS knowledge)	0.625	* significant
D (Role power + freedom)	0.298	
E (Tools suitability)	0.549	* significant

Statistical analysis (Pearson) of the ordinal responses shows that there are clear correlations between the totals for the Business/IS Knowledge section and the BUD outcome effectiveness section, and between the Tools section and the BUD outcome effectiveness section. Moderate correlations apply between the totals for the IT expertise/Role sections and the BUD outcome effectiveness section. These findings, even bearing in mind that these results are based on a small sample, show that the identified contributing factors seem to significantly impact the effectiveness of the BUD outcome - and hence indicates modelling validity. There is also a clear indication that the factors differ in the extent to which they directly impact BUD outcome effectiveness (Business/IS knowledge and Tool suitability appear to have the most impact, based on these results)

It is worth stressing here that it is realised that those experienced in this area will not be particularly surprised that the identified factors are shown to be linked to outcome effectiveness - the more important issue is that the instrument and the adopted analysis approach enables the *nature* of the links to be *quantified.*

5.3.3 Business user categorisation

The questionnaire instrument studies four factors that contribute to BUD outcome effectiveness. Two of those factors relate to characteristics that are personal to the business user completing the questionnaire. It follows that the quantified values attributed to these factors (IT Expertise, and Business/IS Knowledge) can be used to indicate potential that the user *personally* has for effective BUD involvement.

We can use the findings to place the participants into categories of varying Business/IS, and IT 'expertise', and hence into distinct categories of BUD effectiveness potential. This is achieved by forming sub totals for the two factors (for each person). Arbitrary, but carefully chosen, values are then used to act as boundaries to define 'naive', 'fair', and 'expert' delimiters (averages of 'less than 2.5', '>=2.5 and <3.5', and '3.5 to 5' per question were chosen to represent the three

ranges respectively). The terms used have been used have been used previously (Huff *et al.* 1992), and are intended to place values into one of three levels of 'low', 'medium', and high. Please also note that the mapping of responses to naive, fair and expert is assisted in that the range available to the respondent when answering ordinal based questions was 1 (labelled 'low'), through to 5 (labelled 'high') - with 3 being labelled as 'medium' on the questionnaire.

The described categories can be regarded as being in order of 'potential for high BUD effectiveness'. This thesis takes the view that the higher the level of business/IS experience, the higher the potential, and within any level of this experience (i.e. naive, fair, and expert) the potential is increased with increasing IT experience. Table 3a shows three main categories of BUD effectiveness potential - each with three sub-levels.

The majority of the survey participants (11 out of 15) are placed in the top two categories - showing relatively high levels of both business/IS and IT expertise.

Table 3a: Business user categorisation results

Business+IS/IT expert:	3 :	STRONG BUD Effectiveness Potential	(level a)
Bus+IS expert/IT fair:	8 :	"	(level b)
Bus+IS expert/Naive IT:	0 :	"	(level c)
Bus+IS fair/IT expert:	0 :	GOOD BUD Effectiveness Potential	(level a)
Bus+IS fair/IT fair:	0 :	"	(level b)
Bus+IS fair/ IT naive:	0 :	"	(level c)
Bus+IS naive/IT expert:	2 :	WEAK BUD Effectiveness Potential	(level a)
Bus+IS naive/ IT fair:	2 :	"	(level b)
Business+IS/IT Naive:	0 :	"	(level c)

Table 3b shows that the participants in the survey have levels of IT experience of either 'fair' or 'expert' - which is to be expected as computerisation is no longer a new phenomenon in business.

Table 3b: IT expertise levels

Total IT 'Expert' =	5
'Fair' =	10
'Naive' =	0

Table 3c: Business/IS knowledge levels

Total Business/IS 'Expert' =	11
'Fair' =	0
'Naive' =	4

Table 3c shows that four (out of 15) of the participants are categorised as being Naive in terms of 'Business/IS Knowledge'. This aspect could be one in which organisations need to focus in order to raise the BUD potential of particular business users significantly.

The survey results identify participants who might have characteristics and experience suitable for taking part in the prototyping of advanced BUD tools. In the case of this survey, 3 out of the 15 survey participants are likely to be good candidates for BUD tool prototyping. The identified participants demonstrate high levels (in terms of high ordinal scores for relevant questionnaire sections) of IT expertise, and of knowledge in at least one business/IS area.

Table 4a shows a summary of the ratings of scores for the Role (power and authority) factor and for the Tool Suitability factor. The average score per question (out of a maximum of 5) was calculated for the responses to the questions in each of the Role and Tool Suitability sections. It shows that a large proportion of users have BUD tools which have limited scope and suitability, and indicates that a significant proportion of users might be constrained in BUD activities by the nature of their role (authority and power). This is supported by some of the text-based responses received.

Table 4a: Role and Tools ratings

	Role	Tools	
No. High scores	3	1	(3.5 - 5)
No. Medium scores	5	5	(<3.5, >=2.5)
No. Low scores	7	9	(<2.5)

The average ordinal response (each out of a total maximum of 5), included here for interest, for each survey participant (for the Role and Tolls sections) are shown in the following table (Table 4b).

Table 4b: Role and Tools scores (detailed)

Survey Participant	Role	Tools
1	2	2.1
2	4.3	2
3	3	3.3
4	3	0.8
5	3.7	1.4
6	2.3	0.8
7	3	3
8	2.3	1.3
9	4	0
10	2.3	2.7
11	3.3	3.3
12	3	0.7
13	2.3	1.4
14	1	3.9
15	2	2.8

It is interesting to observe that there does not seem to be any relationship between the two factors (i.e. one might have expected tools with greater 'suitability' to be made available to those people with more BUD 'power and freedom' in their role).

In the text based responses, the participants in the survey revealed that they are

involved in a range of computing activities. Typically, they are word-processing, utilising spreadsheets, querying databases, assisting with design/analysis, and using application packages. The small sample suggests that users are not tending to adopt the role of systems builders, whether in small or large projects, and are very much reliant on IT specialists for the provision of the main computer systems. There is, however, an indication that some of the participants have the ability and interest suitable for having a greater involvement in the design and building of software systems, but are somewhat restricted by role constraints and/or the usability of tools available. Several users expressed their feeling that too much power/control is in the hands of IT professionals, and that tools needed to be more user friendly.

5.3.4 Validation of Questionnaire scope

The third element of the criteria identified to determine the validity of the questionnaire (see Section 5.1) relates to checking if the instrument enables the full scope of the project to be addressed.

Chapter 4 describes the issues, deliverables, and hypotheses targeted by this research. The various aspects are considered below in the order as set out in Chapter 4 (Section 4.1): -

a) It had been expected that the combination of ordinal and text based responses would give a clear indication of the range and frequency of IT related activities carried out by the survey participants. This validation study revealed that relevant text based question responses are often not completed, or not completed in a particularly thorough fashion. An enhancement to the questionnaire design was clearly required.

b) A variety of information can be derived from the survey results which relates to the characteristics, experience and systems development potential of business users. Levels of BUD success

factors and of BUD outcome effectiveness can be quantified for individual survey participants, and those surveyed can be categorised in terms of *personal* potential for effective BUD. There was some evidence that the questionnaire needed improvement to increase clarity and accuracy (this aspect is discussed fully in Section 6.2).

c) The questionnaire has been shown capable of gaining measures of contributing factors and of BUD outcome effectiveness. The analysis technique successfully demonstrates that the contributing factors can be quantifiably linked to BUD outcome effectiveness, and hence that the instrument has the potential for *predictive* capability.

d) The issue of the extent to which BUD tools satisfy the needs and aspirations of user developers (and of how their design could be improved) was identified as important, but not to be fully addressed by this project. As expected, the survey provides some useful information relating to the suitability of the tools available to the participants.

5.4 Chapter summary

This chapter has described the scope of this survey, and the results obtained. The purpose of the survey was to test the validity and suitability of the initial questionnaire design and the analysis technique.

The results of the survey demonstrate, via statistical analysis, that the 'ordinal' questions used in the questionnaire appear to be well defined in that they successfully target distinguishable aspects, and that the groups of questions (sectioned to relate to specific factors) seem to give cohesive

responses. The text-based responses tend to support the conclusions drawn from the ordinal responses.

Section 5.3.2 describes how the ordinal-based data collected from the survey is shown to be suitable for testing the BUDES model (introduced in Chapter 4, Section 4.2).

The links between the contributing success factors and BUD outcome effectiveness for the surveyed business users are quantified. The results indicate that the Business/IS knowledge and the Tools factors are particularly significant for the surveyed users. The potential for utilising the analysis approach to predict BUD outcome effectiveness is confirmed. It is also shown how the business users can be categorised into potential for BUD success (based on the *personal* factors of Business/IS knowledge and IT expertise).

Finally, a cross reference is made between the findings of this survey and the set of issues, deliverables and hypotheses targeted by this research (as discussed in Chapter 4, section 4.1). The only targeted aspect which was not particularly well served by this survey was the task of establishing the range and frequencies of IT activities carried out by the survey participants.

The survey and findings discussed in this chapter forms an important foundation to the remainder of the new research described in the following chapters. It is now clear that the combination of the initial questionnaire and analysis technique provides a valid instrument for investigating and quantifying links between BUD success factors and BUD outcome effectiveness. Subsequent surveys were planned so that the instrument could be used to explore the relationships between the factors and BUD outcomes more fully (including BUD effectiveness prediction). The need for improvements to the instrument was recognised, and implemented for use in

the next 'exploratory' survey (the survey is discussed in Chapter 6, and the questionnaire instrument enhancements described in Section 6.2).

CHAPTER 6: Exploratory use of BUDES Questionnaire instrument

The purpose of this chapter is to:

- describe the objectives and scope of a survey , which explores the capabilities of the BUDES questionnaire instrument
- discuss the findings of the survey, including showing how the instrument can be used to monitor and predict BUD effectiveness, and to categorise the BUD potential of survey participants.
- show that the survey indicates that the dominant factors contributing to BUD outcome effectiveness are Role (power and authority), and Tools (suitability), but that each of the contributing factors studied influence the BUD outcome effectiveness.
- describe enhancements and improvements to be applied to the instrument before and after the survey.

6.1. Introduction

The previous *validation* survey (see Chapter 5) concluded that the questionnaire instrument was valid in its design, but also could be improved. A new version of the BUDES questionnaire instrument was devised, and a survey arranged to explore the capabilities of the instrument, and was carried out during the first half of 1995.

The results from this survey were used primarily to establish measures of the effectiveness of BUD, and of associated contributing factors for those surveyed.

The aim was to understand how the various factors inter-relate so that effectiveness could not only be measured, but also so that the potential positive impact of *enhancing* one or more of the factors could be recognised and monitored. Broader aims of the survey were to establish a clearer picture of current IT experiences and BUD potential of business users.

6.2 Improvements to Questionnaire

In preparation for use in this survey, several changes and enhancements were made to the questionnaire instrument utilised in the previous survey. Several of the questionnaires returned as part of the previous (validation) survey contained comments relating to problems faced with completing the questionnaires and suggestions for improvement. Some of the respondents were telephoned, as a follow up to clarify certain responses, and this was also an opportunity to discuss the understandability and appropriateness of the questionnaire instrument. The following quotes some of the remarks:-

> "For those not fully aware of the jargon, brief explanations of such as 'applications/tools' etc would be useful. Possibly include lists of typical applications and tools"

> "questionnaire needs to be condensed"

> "if you are assuming that people who complete this questionnaire are not 'expert' IT users, why have you written the questions as if they are 'experts' ?

> "some people might interpret 'application packages/building tools' differently - suggest explanation of term / examples. Similarly '3 GLs, 4GLs, mis/query/dtp/batch, interactive processing' is technical jargon - may not mean anything to some users"

The comments received, together with a general re-appraisal of the design and its effectiveness led to various improvements described below.

Minor changes were made to the IT Expertise and the Business/IS Knowledge sections (mainly comprising the provision of helpful definitions for technical/potentially jargonistic terms used in questions), but the main amendments have been to the Tools (suitability) section and the BUD outcome effectiveness section. Following Bergeron *et al.* (1993), and Brancheau & Brown (1993), the latter section was enhanced to address levels of 'user access to information', 'level of use', and 'user satisfaction' - in addition to seeking measures of 'business benefit', 'implementation frequency', and 'maintenance need'.). The structure of the Tools section was slightly altered so that the activities and experience of users working with varying tool 'complexities' would be better taken into account.

A new section ('IT Activity Profile') was included in the questionnaire (following McLean & Kappelman 1992), to enable a thorough analysis of the types of IT activities with which business users are involved. In addition, the section queries the degree of assistance that other end users, and IT specialists, give with the various activities, together with an indication of the satisfaction that the user has with the outcomes and the tools utilised. We use a list of tasks, which is an extended and amended version of that used by McLean & Kappelman (1992) in their survey of end users. The results relating to responses to this section of the questionnaire are discussed in Chapter 7. Additionally, with the envisaged increased survey sample size, the plan was to utilise regression analysis of the ordinal scores data, so that the analysis could lead to BUD outcome effectiveness *prediction*. A 'descriptive statistics' method of predicting the outcome effectiveness was also introduced to the results analysis.

Please refer to Appendix II for a copy of the questionnaire utilised in this survey.

6.3 Survey scope

The survey results and conclusions are based on 69 responses received from a total of 24 UK organisations in both the public and private sectors, and covering areas such as financial services, building, public services, retailing, and engineering. The majority of the questionnaires (38) were spread across twenty of the organisations (each returning 4 or fewer questionnaires). The remainder was distributed between locations returning 5-6 questionnaires each. Most of the questionnaires were sent out to UK student placement sites (as this gives a higher chance of completion and these organisations are more likely to utilise computerised information systems). In all cases, the contacts were asked to arrange for questionnaires to be completed by personnel who *primarily* had a *business* role within the organisation, and also interacted with IT. The participants ranged from office clerks, through experienced professionals, to senior management.

The questionnaire survey gains measures of the various factors for particular individuals, using participant's ordinal responses to questions that target each contributing success factor. Total 'scores' are calculated for each of the factors, for each individual participant, and compared to the total 'scores' for the BUD effectiveness measurement questions. The comparison of factor and outcome totals enables links to be *quantified*, and ways to *predict* outcome effectiveness to be established.

The IT Activity Profile section of the questionnaire provides the opportunity to build up a view of business users IT activities and experiences. There are also text-based questions, which are designed for cross-reference purposes.

6.4 BUD effectiveness modelling

A statistical analysis (*Pearson*) of the survey results show that each of the identified contributing factors correlate well with measured BUD effectiveness as follows: -

Table 5: Significance of contributing factors

	Correlation with BUD effectiveness	
IT expertise	0.55 ***	(very highly significant)
Business/IS knowledge	0.38 **	(highly significant)
Role (power+freedom)	0.62 ***	(very highly significant)
Tools (suitability)	0.64 ***	(very highly significant)

(where '***' denotes significance at 0.1% level)

These results (Table 5) give further confirmation that the consideration of the chosen aspects as contributing factors to BUD effectiveness is valid, and that the factors of *IT expertise*, *Role* and *Tools* seem to be particularly significant. A multiple linear regression analysis further shows that role (power and freedom) and Tools (suitability) are the dominant factors (see Table 6).

Table 6: Regression analysis of contributing factors

	coefficient	t ratio	*p* value (< 0.05 is significant)
IT expertise	0.22	1.69	0.096
Business/IS knowledge	-0.02	-0.18	0.858
Role (power+freedom)	1.26	2.78	0.007 **
Tools (suitability)	0.40	2.36	0.021 *

(where: ** represents " highly significant ", * represents significant, and R sq. = 51.2 %)

Table 6 shows that regression analysis gives the impression that the business/IS knowledge factor is not significant in terms of affecting BUD outcome effectiveness

for the data sample. This has to be considered, however, in the light of findings resulting from the use of a statistical technique known as *'path analysis'*. This data analysis approach is used to investigate the influence that multiple variables have on each other when combining to produce outcome variable levels. It is possible to evaluate the extent to which factors *directly* and *indirectly* influence outcomes. Separate to this thesis, path analysis has been carried out on data obtained (i.e. the same data analysed in section 6.4) in the use of BUDES questionnaire instrument (Hannabuss 1995) and includes the following in its conclusions: -

i) The effect of *Business/IS knowledge* on BUD outcome effectiveness is seen to be considerably more significant when its indirect influence via *IT expertise* is included. This implies that without reasonable levels of IT expertise, good levels of Business/IS Knowledge are not enough to significantly influence effective BUD outcomes. This could be because the BUD tools available tend to require substantial IT specialist skills.

ii) The path analysis provided confirmation that the role and tools factors seem to be the dominant contributors to BUD outcome effectiveness, and also had strong indirect influences on each other's affect on BUD outcome effectiveness.

These conclusions confirm that the studied contributing factors cannot be considered in isolation, and that each plays an important part in directly/indirectly determining the level of BUD outcome effectiveness.

The regression analysis of the survey results provides coefficients for each of the factors (together with a *constant* value equal to -10.3), as seen in Table 6. The coefficients can be used with measured values of

the contributing factors to predict the expected level of BUD outcome effectiveness. Based on the results of this survey the following equation can be formed: -

$$\text{BUD effectiveness} = -10.3 + (0.22*\text{IT expertise}) - (0.02*\text{Business/IS knowledge}) + (1.26*\text{Role}) + (0.40*\text{Tools suitability})$$

The shape of the equation is expected to change for different survey groups and as more data is utilised. However, in statistical terms, the equation shows a promising level of explanation (51%). The expected BUD outcome effectiveness, then, can be calculated by substituting values for the identified contributing factors into the equation. The substituted values could be those as measured for a particular person, and/or may include values that represent planned improvements to the factors. Such calculations can be made for a group member, once sufficient data has been gathered via a questionnaire survey of the group to enable the coefficients of the factors to be derived. At this stage of the research, it is suggested that the coefficients are best used in predictions relating to proposed improvements to factors for:

i) those business users surveyed to produce the coefficients

and/or

ii) other users in the same organisation, or users within a recognisably similar organisational domain

Although the statistical methods previously described in this chapter are generally accepted means of validating and processing survey data, it is helpful to also use 'descriptive' statistical techniques. This is to present a more 'pragmatically visible' way of understanding the data and of mapping how the survey instrument provides the capability of predicting and monitoring BUD outcome effectiveness. The technique utilised involves the allocation of *high/medium/low* labels to the

measurements of the contributing factors and the outcome effectiveness (high = average of >= 3.5, Medium >= average of 2.5 and < 3.5, Low < average of 2.5 per question). A simple method of pattern matching of these high/medium/low labels for the four identified contributing factors can be used to indicate an expected high, medium or low BUD effectiveness. Each individual survey participant, then, has a label of 'high, medium or low' for each of the four studied BUD factors, and also for the outcome factor (BUD effectiveness). The four labels for the contributing factors are examined. The *expected* BUD effectiveness (based on the four examined labels for the contributing factors) is taken as being equal to the *weakest* of the four labels. This assertion is based on the premise that each of the four factors has important influences on BUD outcome effectiveness (supported by survey results).

This expected label for outcome effectiveness is then compared to the value of the BUD outcome effectiveness label as determined from the *measured* value (i.e. from the ordinal scores gathered in the appropriate section of the questionnaire).

In practice, it is found that the labels attached to the contributing factors can be used with a reasonable amount of confidence to predict whether the outcome effectiveness is likely to be *high, medium or low*. Evidence of this can be seen in Table 7a. The expected levels of effectiveness match the measured levels in 48 (hits) out of 69 cases (i.e. 70% hit rate).

We have also applied a similar technique to produce Table 7b which shows derived effectiveness levels (based on values calculated using measured contributing factor values as input to the derived regression equation) compared to the effectiveness levels measured in the survey. Each set of values has been converted to high/medium/low labels as described earlier, before the comparisons are made. It can be seen that this approach gives 52 'hits' out of a total of 69 cases (i.e. 75% hit rate). It is interesting to note, therefore, that the 'descriptive' approach seems to provide a degree of reliability very similar to that of the 'regression' approach. Both approaches have the characteristic that almost all those predictions which do not

match measured effectiveness (which are a clear minority), are at a level *below* the measured level. Therefore, where the predictions are inaccurate they are slightly 'conservative' in nature - which is useful in that false high expectations are avoided when using the technique to make predictions.

Table 7a:

'descriptive statistics' based effectiveness prediction

	Expected		
Measured	High	Med	Low
High	6	7	5
Medium	0	1	8
Low	0	1	41

No. of Hits = 48/69

(70% hit rate)

Table 7b:

Effectiveness prediction based on regression equation

	Derived		
Measured	High	Med	Low
High	8	6	4
Medium	0	2	7
Low	0	0	42

No. of Hits = 52/69

(75% hit rate)

The use of the labelling approach to give 'broad' indications of predicted/measured BUD effectiveness is possibly more useful than referring to precise values - we should really only expect a coarse grained image due to the human/organisational complexities involved.

The text responses on the returned questionnaires are used as a clarification and confirmation mechanism when cross-referencing against the above findings. Where the text responses were available, the content gave useful information about the business user and their experiences, and provided valuable further evidence of the validity and reliability of the instrument, and of the ordinal analyses, by either: -

i) confirming the accuracy of the implications of the findings

or

ii) explaining any suspected anomalies (which are rare) in the data

The results analysis techniques described demonstrate that measured, assumed or planned values for the contributing factors can be used to predict an anticipated level of BUD outcome effectiveness. This capability enables several scenarios (i.e. different combinations of contributing factor value levels) to be simulated to check for the various anticipated impacts (on BUD outcome effectiveness). The anticipated 'worth to the organisation' of planned or proposed investments in improvements to one or more of the factors can therefore be identified. Similarly, the impact(s) of any implemented improvements to the contributing factors can be monitored and evaluated.

6.5 Categorisation of business users

As explained earlier (in Chapter 5, Section 5.3.3), two of the BUD success factors can be used to form an assessment of the personal potential of each survey participant to be a successful candidate for BUD activities.

The ordinal scores of responses to sections of the questionnaire which target the measurement of the *Business/IS Knowledge* and of *IT Expertise* contributing factors have been analysed so that the survey participants can be placed into categories of varying business/IS/IT 'expertise'. It can be seen (Table 8) that the nine categories can be translated into three major sections of 'Strong', 'Good', and 'Weak' characteristics of personal BUD effectiveness potential. People within each section can be placed at one of three sub-levels according to the amount of IT specialist support/training that might be required for them to capitalise on their business/IS knowledge.

Table 8: Business user categorisation results

Business+IS/IT expert:	13	:	STRONG BUD Effectiveness Potential (level a)
Bus+IS expert/IT fair:	14	:	" (level b)
Bus+IS expert/Naive IT:	9	:	" (level c)
Bus+IS fair/IT expert:	1	:	GOOD BUD Effectiveness Potential (level a)
Bus+IS fair/IT fair:	7	:	" (level b)
Bus+IS fair/ IT naive:	5	:	" (level c)
Bus+IS naive/IT expert:	3	:	WEAK BUD Effectiveness Potential (level a)
Bus+IS naive/ IT fair:	6	:	" (level b)
Business+IS/IT Naive:	11	:	" (level c)

(Where: level a => minimal IT specialist support/training needed
level b => moderate IT specialist support/training needed
level c => significant amount of IT specialist support/training needed)

Table 8 shows that over half of the survey participants (36 out of 69) are placed in the top category (Strong BUD Effectiveness Potential) - suggesting that, in general, organisations are likely to have many people who have high levels of potential for successful involvement in BUD. The top categories represent business users who are likely to be better suited to being involved in user centred development projects. As BUD tools are developed to be more advanced then the level of IT skills required will reduce.

Table 9a: IT expertise levels

Total IT Expert =	17
Fair =	27
Naive =	25

Table 9b: Business/IS knowledge levels

Total Business/IS expert =	36
Fair =	13
Naive =	20

Using a mapping mechanism as described in Chapter 5 (Section 5.3.3), tables 9a, 9b and 9c collectively provide another view of the survey participants. Table 9a shows that most of the participants (44/69) in the survey have levels of IT experience of either 'fair' or 'expert' - which is to be expected as computerisation is no longer a new phenomenon in business. However, a number are rated as 'IT-naive' which is a little surprising. Table 9b shows that the relatively high number (20 out of 69) of participants who seem to have low levels of Business/IS knowledge (rated as 'naive') could be of concern to business managers.

Table 9c: Role (power/freedom)/Tools suitability

	Role	Tools
No. of High Scores	14	9
No. of Medium Scores	15	13
No. of Low Scores	40	47

Table 9c shows a summary of the ratings of scores for Role (power and freedom) and Tools (suitability). It shows that the large majority of users have BUD tools that have relatively limited scope and suitability, and indicates that a significant proportion of users might be constrained in BUD activities by the nature of their role (power and freedom). These conclusions tend to be supported by the free text responses received, and indicate that the infrastructure for enabling BUD is typically not very well developed in organisations.

6.6 Conclusions from the exploratory survey

i) The analysis of the survey results gives clear evidence of links between the measured contributing factors ('IT expertise', 'Business/IS knowledge',

'Role (power/freedom', and 'Tool suitability') and BUD Outcome Effectiveness. The results indicate that it is the latter two factors which are dominant in terms of determining the effectiveness of BUD outcomes. This is confirmed by *Path analysis*, which also indicates that each factor has important indirect influences (i.e. the effect on the outcome effectiveness of any particular factor is significantly indirectly influenced by one or more of the other factors) in addition to direct influences.

ii) A derived regression equation can be used to calculate (predict) the value of the expected BUD effectiveness level (based on measured contributing factors) - with, in statistical terms, a promising level of explanation of 51%. It is also shown how a 'descriptive statistics' approach can be used to predict whether BUD Outcome Effectiveness is likely to be 'high', 'medium' or 'low' (based on the measured contributing factor values). Predictions are seen as being applicable to those users surveyed, and/or those in the same/similar organisational domain.

iii) The measurement of factors contributing to BUD implementation effectiveness, and the use of analysis techniques to predict outcome effectiveness is useful in that it helps with the strategic resource planning of IS development projects. The modelling information assists with policy decisions on business user empowerment, in identifying improvements needed in the various factors, and in monitoring effects of such improvements.

iv) It has been demonstrated that the survey results can be used to categorise the participants into one of three main categories of 'personal' BUD potential. The responses showed that most of those surveyed seem to have a reasonably high degree of IT expertise, and business/IS knowledge.

v) There are indications that many business users could be constrained in

terms of BUD effectiveness due to role restrictions, and unsuitable tool support.

6.7 Instrument improvements and enhancements

Text responses provided evidence that some survey participants regarded the length of the questionnaire to be excessive, and so making its completion arduous, and unattractive. Although typical completion times were 20-30 minutes per questionnaire only, this time period was clearly regarded by many as an excessive burden. It was therefore a possibility that 'long' completion times might adversely affect response rates and revisiting the questionnaire seemed worthwhile.

Controlled efforts were made to reduce the size of the questionnaire, and yet maintain its comprehensive coverage. The main available way of reducing the size of a questionnaire is to reduce the quantity of questions asked. In the versions of the questionnaire used for the validatory and exploratory surveys, each section (individual sections targeting each of the four contributing factors, plus the BUD effectiveness factor) comprised several questions having related and overlapping content.

In some cases, questions were 'merged' to ensure that sufficient coverage was maintained, and others were removed. Most questionnaire sections were reduced from having several questions down to just two firmly targeted questions. Some of the text-based questions were taken out of the questionnaire - those that had been shown important for cross-referencing purposes were retained.

In order to confirm that the questions that had been selected to be retained in the various sections would still produce meaningful results, the data collected in the previous survey was re-analysed (based on the residual question responses). The findings broadly coincided with those resulting from the use of the *entire sets* of questions - being sufficient evidence to give the go-ahead to carry out a further

survey to utilise the new shortened and enhanced version of the questionnaire.

In some situations, particular questions within questionnaires can be simplified and shortened - in the case of the existing instrument the questions had already been designed to be brief and 'to the point', and so noticeable 'size reductions' due to this type of improvement were not available. However, the clarity of some questions was improved by the further attention to avoiding potentially unfamiliar terminology and phrases.

Although it went against the general objective of shortening the questionnaire, a new section was introduced in order to provide further data for cross-referencing with the ordinal data. In the added section, the participant is asked to tick a series of statements - if they felt they accurately portrayed themselves or their experiences.

In addition, a notable *enhancement* relates to the section that deals with asking the participant about their implementation experience. An extra question needs to be answered (if the participant states that they do not get involved in BUD) - to ascertain reasoning. This response serves as confirmation, and also provides information that may indicate common constraints and causes.

A copy of the enhanced version of the questionnaire, known as the 'BUD Effectiveness and Scope Predictor' (BUD ESP) can be seen in Appendix III.

6.8 Summary comments

This chapter has discussed the findings of a survey that explores the usefulness of the BUDES questionnaire instrument. The evidence provided shows that the instrument can be reliably used to monitor and model BUD outcome effectiveness.

Firstly, the improvements to the questionnaire used in the initial survey are outlined. The changes enabled a more comprehensive measurement of BUD effectiveness,

better catered for the varying complexities of utilised tools, and introduced a new section to give a detailed view of the IT activities carried out by business users. The analysis of the results was also expanded to use statistical techniques to look at the *prediction* of BUD outcome effectiveness.

The survey results indicate that all four of the identified factors (*IT expertise, Business/IS Knowledge*, *Role (power/freedom)*, and *Tools suitability* have highly, or very highly, significant correlations with BUD effectiveness. Regression analysis suggests that the latter two factors are dominant for the business users surveyed, and *path analysis* reveals that each factor has *indirect* as well as *direct* influences on BUD outcome effectiveness.

An outline is also given of how the selected statistical analysis techniques can be used to predict BUD outcome effectiveness based on measured or planned values for the contributing success factors.

The results from the survey are further discussed to demonstrate how they can be used to categorise the surveyed business users, and provide useful information for profiling individual or groups of users (in terms of their IT expertise and business/IS knowledge, and also in terms of possible constraints in role power and freedom, and tools suitability). Most of the business users surveyed seem to have reasonably high degrees of IT expertise, and business/IS knowledge. However, there are indications that their BUD effectiveness tends to be constrained due to role restrictions, and unsuitable tool support.

As a consequence of reviewing the results from the survey, and an ongoing quest to improve the surveying techniques utilised in this research, a few enhancements (for use in subsequent survey work) were described. Essentially, the changes comprised the reduction in the number of questions in the existing sections, and the introduction of a new section (to provide 'checklist' style responses to be used in cross-referencing with ordinal and text based survey responses).

The next, and concluding, stage of this research work was to complete a further survey - using the instrument which is the culmination of the design, testing and exploratory stages already completed. This example survey using the BUD ESP instrument is discussed in the next chapter (Chapter 7).

CHAPTER 7: BUD Effectiveness and Scope Predictor (BUD ESP)

The purpose of this chapter is to: -

- describe the use of BUD ESP, the instrument culminating from the previous survey studies within this project, in an example survey.
- discuss the results and findings of the study.
- conclude that the instrument can provide reliable modelling of BUD effectiveness, and the capability to predict BUD effectiveness and scope for individual business users.

7.1 Introduction

The previous surveys conducted within this research have been used to validate, test, and evolve the concept and structure of a survey questionnaire instrument designed to measure and predict levels of 'BUD effectiveness and scope' - detailed in Chapters 5 and 6. The concluding phase of this research project has been to utilise the resulting BUD ESP instrument - in a small example survey, carried out during late 1995/early 1996. The following sections describe this survey study, detail the results, and discuss the findings and related conclusions.

7.2 Survey scenario

As with the previous surveys, questionnaires were sent out to organisations that hosted placement students. Companies that had participated in the previous two surveys were excluded from this survey's mailshot - to avoid duplication, which might in turn adversely affect the clarity of analysis conclusions. In all cases, the contacts were asked to arrange for questionnaires to be completed by personnel who primarily had a business role within the organisation, and also interacted with IT.

The results and conclusions relating to the modelling of BUD outcome effectiveness, discussed below, are based on 29 questionnaire responses from 9 separate UK organisations. The majority (18) were from seven of the organisations (each returning 4 or fewer questionnaires), with the remainder (11) spread evenly across another two organisations. The job roles of participants range from office clerks, administrators, and managers through to directors.

The modelling approach utilised was as described in Chapter 4 (Section 4.2), and generally as used in the previous surveys. As the number and spread of questions had altered, then the detail of the analysis algorithms had to be adjusted but the principles behind the analysis were maintained.

7.3 Survey results and discussion

7.3.1. BUD effectiveness prediction

The studied contributing factors were shown to correlate well with the measured BUD outcome effectiveness, using *Pearson* statistical analysis, as can be seen in Table 10.

Table 10. Correlation of factors and BUD outcome effectiveness

	Correlation with BUD outcome effectiveness	
IT expertise	0.28	
Business / IS knowledge	- 0.05	
Role (freedom + power)	0.68	*** (highly significant)
Tools suitability	0.50	*** (highly significant)

(where '***' denotes significance at 0.1% level)

These results largely confirm the findings of the previous surveys discussed in Chapters 5 and 6; in particular, showing that the Role and Tools factors seem to be

highly significant in determining the effectiveness of BUD outcomes. The immediate indications of these results are that Business/IS knowledge and, to a lesser extent, IT expertise are not particularly correlated to outcome effectiveness. This is in contrast to expectations, and with findings from earlier studies within this project. There is no apparent explanation for this difference, except that it is noted that the sample size is quite small in this example survey. The negative nature, yet slight in magnitude, of the correlation between Business/IS knowledge and BUD effectiveness is also noted. It is known, however (from analyses of previous data), that the contributing factors indirectly, as well as directly, influence outcomes.

In order that we may see the relationships between the factors and the outcome effectiveness from a different perspective, a regression analysis was carried out on the data. Table 11 shows a summary of the results.

Table 11: Regression analysis of contributing factors

	p value (<0.05 is significant)		t ratio
IT expertise	0.679		- 0.42
Business / IS knowledge	0.004	***	- 3.15
Role (freedom + power)	0.001	***	4.01
Tool suitability	0.007	***	2.97

(where: *** => highly significant)

Confirmation is very clearly shown in Table 11 about the high significance of the user's role (power and freedom), and the suitability of tool support; with regard to BUD outcome effectiveness. The regression analysis also points to a similarly high significance of business / IS knowledge (differing from the indications of the earlier statistical analysis) and quite a low significance of IT expertise.

The previous survey (refer to Chapter 6) produced regression analysis results that seem to be, in part, in conflict with the results of this latest survey - revealing some confusion about the relative significance of the Business/*IS knowledge*, and the *IT expertise* factors. On consideration of the analysis results of the previous survey, which is based on a larger sample, it follows that the difference in the two sets of findings could be due to either the effects of a smaller sample size, or perhaps due to the changes to the questionnaire, or simply because of the differences between the targeted populations. At this stage, due to efforts to maintain consistency between questionnaires, it is reasonable to assume that the difference is related to a combination of population differences and sample size. It is not to be expected that different survey samples will give the same or similar results. The questionnaire instrument does *not* have the purpose of establishing absolute values of links between factors and outcome effectiveness. Its main use is to enable monitoring and prediction of outcome effectiveness for particular users and groups of users. The monitoring and prediction are both achieved by analysing the combined effects of the factors based on the survey results for the *particular group of users* under study.

Observation of t-ratios reveals that the results indicate that both the 'IT Experience' (to a lesser extent) and the 'Business/IS knowledge' factors have a negative impact on BUD outcome effectiveness. This goes against current understanding of how these factors relate to outcomes. However, it is noted that the use of *path analysis* suggests that there is a mixture of direct and indirect influences on outcomes (refer to Chapter 6). The t ratio figures only takes into account the *direct* influences.

The regression analysis of data obtained in this survey produces an equation (BUD Effectiveness = 3.32 - (0.130*IT expertise) + (0.534*Tool suitability) - 0.511*Business/IS knowledge) + (0.788*Role)) which can be used to calculate the expected level of BUD effectiveness, based on measures of the contributing factors (as identified via the survey questionnaire). Although the shape of this equation is expected to change for other studies (i.e. the coefficient values for the factors will

change), the level of explanation is at a promising high level of 65%.

In Chapter 6 (Section 6.4), a 'descriptive' statistical analysis technique is described which involves the use of low/medium/high labelling of contributing factors to lead to broad predictions of BUD outcome effectiveness. This technique can be applied to the results obtained from this example survey, and the findings are illustrated in Tables 12a and 12b.

Table 12a

Broad BUD level prediction
(using 'descriptive' statistics)

	Expected		
	High	Med	Low
Measured			
High	4	6	5
Medium	0	2	2
Low	0	0	10

No hits = 16 out of 29
(55% hit rate)

Table 12b

Broad BUD level prediction
(using regression equation)

	Derived		
	High	Med	Low
Measured			
High	11	4	0
Medium	1	2	1
Low	0	2	8

No of hits = 21 out of 29
(72% hit rate)

Although the hit rate for the 'descriptive' statistics approach (shown in Table 12a) is lower than experienced in the larger previous survey, it is still quite high. In addition, it is noted that all the 'misses' represent an expectation being *lower* than the measured outcome value (this means that the predictions are 'conservative' rather than exaggerated).

7.3.2 Business user categorisation

Chapter 6 (Section 6.5) explains how results from the survey instrument can be used to categorise the business users, and indicate any weaknesses in BUD contributing

success factors for the survey participants. A similar analysis has been made for the results of this example survey.

The examination of the ordinal scores for the separate questionnaire sections dealing with the individual BUD outcome contributing factors shows that 19 (out of 29) of the participants can be placed within the 'top' category of having 'strong BUD potential'. The high majority of participants have IT *expertise* and *Business/IS knowledge* at levels of 'fair' or 'expert'. However, over 50% of the participants reported low scores for both role and *tool suitability* factors. As these factors have been repeatedly shown to be dominant in determining BUD outcomes, these low ratings indicate significant constraints for those business users required to take part in BUD.

7.3.3 Profile of user IT activities

Profiles of IT activities carried out by the users surveyed have been formed for a total of 98 respondents. This profiling is based on responses from the 29 participants in this survey plus the 69 people taking part in the previous survey discussed in Chapter 6 (as both questionnaires utilised identical question grids for the 'IT Activity Profile' section, and the two target populations were identical in nature).

The survey sample, although wide in that many types of organisations covering most market sectors were included, was organised so that where available within a particular organisation, the more 'IT sophisticated' of business users would be selected for participation.

The section of the questionnaire which we consider here is one in which participants were asked about their levels of involvement in various IT activities, and their related experiences. We used an enhanced and extended list of activities identified by McLean & Kappelman (1992). The full set of results are seen in Table 13, and summary extracts are seen in Tables 14-17 (the top ten ordinal scores in each category). For Tables 14-17, the highest possible average ordinal score is five.

Incidentally, Table 13 shows some parts of the table as 'N/A' (not applicable) - these areas were pre-filled as such on the questionnaire to help simplify completion (participants were invited to overwrite these pre-filled areas if appropriate).

Table 13: User IT activity profiles

Description of activity	Amount of personal involvement		Assistance of other end users	Assistance from IT dept/Co.	Satisf'n with outcomes	Rating of tool used
	Total number users	< average scores → (0-5)	(0-5)	(0-5)	(0-5)	(0-5)
Electronic mail (use)	22	3.9	N/A	N/A	3.1	3.0
Wordprocessing	72	3.8	1.1	0.9	3.3	3.1
Database queries(use)	60	3.6	N/A	N/A	2.7	2.6
Company d'bases (use)	44	3.5	N/A	N/A	2.8	2.7
Small d'bases (build)	24	3.5	1.3	0.9	3.0	2.5
D'base queries(build)	38	3.4	1.2	0.9	2.9	2.5
Spreadsheets (use)	70	3.3	N/A	N/A	3.3	3.2
Spreadsheets (build)	49	3.3	1.2	0.8	2.9	2.8
Small databases (use)	38	3.2	N/A	N/A	2.9	2.6
Trans'n systems (use)	16	3.1	N/A	N/A	2.4	2.2
Desktop publishing	28	2.8	1.0	0.7	2.4	2.1
Syst analysis/design	26	2.8	1.7	1.2	2.3	1.3
Voice mail (use)	11	2.7	N/A	N/A	2.5	1.5
Proto'g(as developer)	10	2.7	1.5	1.5	3.1	2.3
Decision support(use)	18	2.6	N/A	N/A	1.8	1.2
Comp'y d'bases(build)	17	2.6	1.2	1.0	3.1	2.4
CAD/CAM (use)	12	2.5	N/A	N/A	2.1	1.3
Decs'n support(build)	15	2.4	0.7	0.7	1.7	1.2
Manufactur'g sys(use)	9	2.4	N/A	N/A	2.9	1.9
Design complex systms	8	2.4	1.0	0.6	2.3	1.3
Comp aided training	21	2.3	0.9	0.6	1.9	2.0
Prototyping (as user)	13	2.3	2.0	N/A	2.5	2.5
Build complex systems	8	2.0	1.0	0.8	2.0	1.0
Multimedia syst (use)	12	1.8	N/A	N/A	2.3	1.9
Expert systems (use)	6	1.5	N/A	N/A	2.0	1.2
Expert systems(build)	6	1.5	1.7	0.8	2.0	1.2
Multimedia sys(build)	7	1.1	0.9	0.7	1.7	1.1
CASE tools (use)	7	1.0	N/A	N/A	1.1	0.9

It can be seen (Tables 13, 14 and 15) that the predominant business user IT activities seem to be at the level of wordprocessing, spreadsheeting, and database use. There is, however, some evidence that business users are actively involved, to varying extents, in simple and complex application building activities. The relatively high score corresponding to the level of use of 'electronic mail' confirms that the organisations selected for survey are of a 'sophisticated' and 'mature' nature.

Table 14:

Highest number of users

Wordprocessing	72
Spreadsheets (use)	70
Database queries(use)	60
Spreadsheets (build)	49
Company d'bases (use)	44
D'base queries(build)	38
Small databases (use)	38
Desktop publishing	28
Syst analysis/design	26
Small d'bases (build)	24

Table 15:

Highest average involvement

Electronic mail (use)	3.9
Wordprocessing	3.8
Database queries(use)	3.6
Company d'bases (use)	3.5
Small d'bases (build)	3.5
D'base queries(build)	3.4
Spreadsheets (use)	3.3
Spreadsheets (build)	3.3
Small databases (use)	3.2
Transaction sys (use)	3.1

Tables 16 and 17 show that all the IT activities have moderate or low outcome satisfaction levels, and that user satisfaction with tool support tend to be moderate or low (particularly when building applications). This confirms that there is ample 'room' for improvement in terms of enhancing the factors that lead to BUD outcome effectiveness. Bearing in mind the relatively high maturity of the tools / packages used in the activities listed, one would expect higher ratings for the 'tool suitability' factor. The implication is that the design approaches used in tool development are not satisfactorily targeting user satisfaction - greater orientations towards *user centred* needs are required. The following, which is a quote from text responses received on selected questionnaires, support this point:-

"Since our It solutions are heavily influenced by a corporate IT culture, the degree of flexibility to match IT tools with what are more and more business-type objectives, can be somewhat limited"

Further evidence is provided by the following suggestions, from survey participants, for desired characteristics of BUD tools:-

"user friendliness"

"instructional clarity"

" The ability to provide a total system which reflects the thought processes of the user, without the need for IT or other support staff"

Table 16:

Highest average outcome satisfaction

Spreadsheets (use)	3.3
Wordprocessing	3.3
Electronic mail (use)	3.1
Comp'y d'bases(build)	3.1
Proto'g(as developer)	3.1
Small d'bases (build)	3.0
Spreadsheets (build)	2.9
D'base queries(build)	2.9
Small databases (use)	2.9
Manufactur'g sys(use)	2.9

Table 17:

Highest average software/tool rating

Spreadsheets (use)	3.2
Wordprocessing	3.1
Electronic mail (use)	3.0
Spreadsheets (build)	2.8
Company d'bases (use)	2.7
Database queries(use)	2.6
Small databases (use)	2.6
D'base queries(build)	2.5
Small d'bases (build)	2.5
Prototyping (as user)	2.5

7.3.4. Non-ordinal responses

The new section, which asked the respondent to give 'yes/no' answers to statements which were related to the various topics addressed by the 'ordinal' questions, proved to be very useful. When used together with text based responses it is possible to gain an indication of the validity of the ordinal responses. In only a few cases out of 29 questionnaires, were there unexplained conflicts between ordinal and text based responses. Three cases concerned the business/IS knowledge factor, and three cases concerned the perception of the implementation outcome effectiveness.

In general, the non-ordinal/text-based responses on the questionnaire give rise to the following comments: -

i) a large number of the respondents (16/29) expressed a clear interest in having a greater involvement in BUD activities.

ii) those that did not currently get involved in BUD, explained that there were various reasons for this - the most common being that it was not adjudged (by them or superiors) to be part of their job role.

iii) Respondents were asked to indicate their "wish list" for BUD tool support characteristics. In the main, there were requests for improved user friendliness, and a greater emphasis on the users (business) perspective.

7.4 Chapter conclusions

This chapter has described the findings relating to the last in a trilogy of business user surveys - using the BUD ESP instrument, which itself has culminated from the analysis of preceding surveys in this project.

One of the most important contributions of this research is that it provides the 'infrastructure' of an instrument and analysis technique which can be used to identify and quantify relationships between factors and outcomes (including the opportunity to calculate, or predict, outcomes based on factor values).

The results from this survey again demonstrated the ability of the BUD ESP instrument to quantify links between the BUD success factors and BUD outcome effectiveness, and hence the ability to predict outcomes based on measured or estimated/planned values for the success factors. The analysis provides further evidence suggesting that the Role (power and freedom) and Tools (suitability) factors are dominant in the determination of BUD effectiveness, but that all four identified factors influence BUD outcomes.

However, the results included some findings which contrast with those from the previous 'exploratory' survey - relating to the correlations between two of the factors (IT expertise and Business/IS knowledge) and BUD effectiveness. The reasons for the difference may be the differences in sample populations and the relatively small sample size of the third survey. However, it is noted that the questionnaire instrument does not have the purpose of establishing absolute values of links between factors and outcome effectiveness. Its main use is to enable monitoring and prediction of outcome effectiveness for particular users and groups of users.

The survey results are also used to categorise the business users in terms of 'BUD potential', and to form a profile of IT activities carried out by the business users. A high majority of the surveyed participants have moderate or high levels of IT expertise and Business/IS knowledge, but it is noted that over 50% reported low ordinal scores for both *Role* and *Tools* factors. Bearing mind that the surveys have repeatedly indicated that these factors are dominant in determining BUD effectiveness, these low ratings could represent significant restrictions to users

wishing to take part in BUD in an effective manner.

In IT activity terms, the business users surveyed mainly carry out word-processing, spreadsheet, and database work. Also, there was evidence that some business users are involved in building simple and complex applications. User satisfaction with the tool support tends to be moderate or low, which is of particular cause for concern bearing in mind that tool suitability has been identified as a dominant factor in the determination of BUD effectiveness. Text based responses reveal that a common wish of surveyed users is for tools with improved user friendliness, and a greater emphasis on the perspective of the business user. A majority of survey participants express a clear interest in having a greater involvement in BUD.

The research work completed during this project is brought to a conclusion with the completion of this third survey, with many findings and conclusions being made along the way. The next chapter (Chapter 8) provides a comprehensive review of project outcomes - in the context of the issues, deliverables and hypotheses set out earlier (in Chapter 4, Section 4.1).

CHAPTER 8: Summary findings and conclusions

The purpose of this chapter is to: -

- summarise the findings of this research
- discuss the findings and draw conclusions in the context of the issues, deliverables and hypotheses identified as targets of the project

8.1. Introduction

The overall aim of this research project was to produce deliverables specifically related to recognised prevailing research issues - as identified via an in-depth literature search (refer to Chapters 2 and 3). Several hypotheses were composed, and formed a focus for the discussion of the results of the research. Chapter 4 states the set of associated issues, deliverables, and the hypotheses identified as targets for this research (refer to 4.1).

Chapters 5, 6 and 7 describe a series of questionnaire surveys, and discuss their results, which culminate in the use of the BUD ESP instrument in an example survey. These surveys were designed to address the identified issues, deliverables and hypotheses. The following sections summarise the findings and main conclusions in the context of the targeted deliverables and hypotheses under test.

8.2 Appraisal of project deliverables

8.2.1 Deliverable No.1

"an appraisal of IT activity types and levels - for a range of UK business users"

Survey participants were asked to indicate their levels of involvement in a given list

of IT activities (using an enhanced and extended list originally identified by McLean & Kappelman (1992)). Tables 13 -17 (refer to Chapter 7) show that questionnaire instrument is capable of quantifying the levels of involvement, and satisfaction levels for a comprehensive list of IT activities.

The predominant business user IT activities seem to be at the level of word processing, spread sheeting, and database use. There is, however, some evidence that business users are actively involved, to varying extents, in simple and complex application building activities. It was somewhat surprising that there was so much use of electronic mail, and this was useful in that it confirmed that the organisations included in the survey were at a suitable level of sophistication.

The responses also indicated that all the IT activities listed had moderate or low outcome satisfaction levels, and that user satisfaction with tool support tended to be moderate or low (particularly when building applications). This confirms that there are many opportunities for improvement in terms of enhancing the factors that lead to BUD outcome effectiveness. Another implication is that the design approaches used in tool development are not satisfactorily targeting user satisfaction - greater orientations towards *business user centred* needs are required.

8.2.2 Deliverable No.2

> *"an examination of the attributes (relevant to success in BUD) of a range of business users"*

A variety of information can be derived from the survey results which relates to the characteristics, experience and systems development potential of business users. Levels of BUD success factors and of BUD outcome effectiveness can be quantified for individual survey participants, and those surveyed can be categorised in terms of *personal* potential for effective BUD.

It has been demonstrated that the survey results can be used to categorise the participants into one of three main categories of 'personal' BUD potential (*strong,*

medium, and *weak* potential for effective BUD). The participants in the surveys have tended to be in the top category (over 50%), which indicates that they have sufficient personal potential (i.e. in terms of IT expertise, and Business/IS Knowledge) to be effective in BUD. The categorisation is useful to organisations in that it provides quantified measures of the effective BUD potential of business users (individually and/or collectively), which can be used to assess and monitor available human resources.

The survey data also provides measures of other contributing factors (the user's role/ power and freedom to engage in BUD and the suitability of the *tools* available to the business user).

The surveys consistently show that the majority of users tend to have BUD tools that have limited suitability for BUD, and seem to be constrained in BUD activities by the nature of their role (power and freedom). This is supported by some of the text-based responses received. The text based responses of many of the questionnaire returns indicated that the participants had an interest in further involvement in BUD activities, and tended to support the view that there are constraints and restrictions in terms of their power/control, and of the tool support available.

8.2.3 Deliverable No.3

> *"A means of gaining measures of values to represent factors significant in contributing to BUD outcome effectiveness, and to represent outcome effectiveness of BUD"*

The initial instrument validation survey (refer to Chapter 5) and subsequent surveys (refer to Chapters 6 and 7) have shown that the instrument is capable of gaining measures of each of the four identified contributing factors and of BUD outcome effectiveness. In the initial survey, statistical analysis was used to validate that questionnaire sections addressed the separate topics as intended. The series of three surveys gives ample evidence that the instrument targets the measurement of the

factors and BUD outcome effectiveness with reasonable accuracy and completeness. The text based and non-ordinal responses gained in the surveys, support the conclusions made based on the detailed statistical analysis of the ordinal data. This shows that the instrument can provide a thorough profile of factors appertaining to particular business users.

The high levels of 'explanation' shown as part of the statistical analysis of the surveys (over 50%) and the pattern of good correlations between contributing factors and the BUD outcome factor suggest that the measurement techniques are effective.

8.2.4 Deliverable No.4

> *"a method of modelling links between contributing factors and BUD outcome effectiveness - including an attempt to be able to quantify the predicted outcome impact of changes to one or more contributing factors"*

Chapter 4 introduces and describes the techniques used to model links between the contributing factors and BUD outcome effectiveness. The subsequent chapters 5, 6 and 7 contain the detail of the related data collection and of the results and conclusions obtained.

Regression analysis can be used to calculate (predict) the value of the expected BUD effectiveness level (based on measured contributing factors). A 'descriptive' statistical approach can also be used to predict whether BUD outcome effectiveness is likely to be 'high', 'medium' or 'low' (based on the measured contributing factor values).

The surveys discussed in chapters 5,6 and 7 successfully demonstrate that the method adopted enables links between contributing factors and BUD outcome effectiveness to be evaluated (refer to sections 5.3.2, 6.4, and 7.3.1) and that the instrument facilitates the *prediction* of BUD outcome effectiveness (refer to sections

6.4, and 7.3.1).

The measurement of factors contributing to BUD implementation effectiveness, and the use of analysis techniques to predict outcome effectiveness is useful in that it helps with the strategic resource planning of IS development projects. The modelling information assists with policy decisions on business user empowerment, in identifying improvements needed in the various factors, and in monitoring effects of such improvements.

8.2.5 Deliverable No.5

"The evaluation of the significance of identified factors with respect to the effect on the determination of BUD effectiveness - identifying the main enabling and constraining factors."

The three surveys (described in Chapters 5,6 and 7) produce results which show that each of the four identified contributing factors play an important part in influencing the effectiveness of BUD outcomes. The factors that are consistently shown to be dominant are the Role (power and freedom) and the Tools (suitability) factors. The surveys also reveal that there is a clear tendency for business users to be constrained with respect to effective involvement in BUD due to restrictive power and freedom in the job roles and poor suitability of available tools. The various survey results demonstrate that the detail of correlations and regression coefficients for particular factors can vary considerably between surveys. This is an illustration of the fact that the purpose of the BUD ESP instrument is to enable the monitoring of BUD success factors and outcome effectiveness, and the prediction of BUD effectiveness for particular groups of business users. It is this feature which makes it so useful to specific organisations, or areas within an organisation. The BUD ESP instrument, therefore, is not designed to measure absolute universal values of links between factors and outcome effectiveness. In the future, further research work (e.g. with the inclusion of "Organisation wide domain" factors) may move towards this capability.

8.2.6 Deliverable No.6

> *"some evidence relating to the extent to which business users are satisfied with BUD tools, and some broad suggestions for improvements"*

Each of the surveys provided evidence that many business users seemed to be constrained in terms of BUD effectiveness due to unsuitable tool support (refer to sections 5.3.3, 6.5, and 7.3.2). Typically, over 50% of survey participants give ordinal responses reflecting a 'low' suitability of BUD support tools available. Survey respondents were asked to indicate their "wish list" for BUD tool support characteristics. Generally, there were requests for improved user friendliness, and a greater emphasis on the users (business) perspective (refer to section 7.3.4).

The survey results clearly show that user satisfaction with tool support tends to be 'moderate' or 'low' at both the levels of 'using' and 'building' applications (see Section 7.3.3).

8.3 Testing the hypotheses

8.3.1 Hypothesis No.1

> *"that business users tend not to be involved in application **building** activities, even though there is also a tendency for them to have that **interest**"*

In essence this, albeit rather subjective, hypothesis is supported by the findings of the surveys.

The use of the 'IT activity grid' meant that quite a comprehensive profile of IT activities carried out by the 98 business users surveyed during this project has been ascertained (refer to Section 7.3.3). The predominant activities are at the level of word processing, spread sheeting, and database use. There is, however, evidence that some business users are actively involved in application building activities.

Many of the questionnaires returned included comments referring to the interest that the participant had in increased involvement in BUD, but that organisational and/or support (tool and specialist skills) constraints were a restriction. In the final survey, extra questions were included to obtain some more quantifiable evidence regarding this issue. A majority of the respondents (16/29) expressed a clear interest in having a greater involvement in BUD activities.

8.3.2 Hypothesis No.2

> *"that users can be classified into distinct groups representing varying levels of BUD potential"*

Section 7.3.2 describes how survey findings can be used to place the survey participants into categories of varying business/IS/IT knowledge and 'expertise'. The categories can be placed in order of increasing potential for high BUD effectiveness into three major levels, with a total of nine sub-levels. The view is taken that the higher the level of business/IS knowledge, the higher the BUD potential. Within any level of this knowledge, the potential is improved with increasing IT expertise. In the main survey, most of the participants (36/69) were placed in the top level of *strong* BUD potential, which is a very promising finding.

This is a useful facility in that the classification of individual business users enables an organisation to form a profile of the potential for BUD within particular areas and across the entire organisation. This helps with resources planning for development projects, and with identifying training requirements.

8.3.3 Hypothesis No.3

> *"that business users' IT expertise, business/IS knowledge, role authority and power, and the suitability of tool support, are all factors which are significant in the determination of BUD outcome effectiveness"*

Support has been found for this hypothesis in that results from the surveys indicate

good correlations between each of the factors and BUD outcome effectiveness. The main survey produced figures that demonstrate that the correlations between the four identified factors and BUD outcome effectiveness are highly/very highly significant. However, in the final example survey, the values of correlations between two of the contributing factors and BUD outcome effectiveness are in conflict with results found in previous surveys. This is partly in contrast to expectations, and with findings from earlier studies within this project (see Section 7.3.1). It is likely that this is due to the nature of the differing sample populations and possibly due to the relatively small sample size of the final survey.

Although all the factors are shown to directly or indirectly significantly influence BUD outcome effectiveness, the Role and Tools factors are consistently shown to be dominant.

The questionnaire instrument does not have the purpose of establishing absolute universal values of links between factors and outcome effectiveness. Its main use is to enable the measurement of factors and modelling of BUD outcome effectiveness for particular users and groups of users.

The complexities involved in this type of research area are widely recognised, and need to be taken into account. Preece (1994, p.36) points out that even relatively straightforward events often have complex sets of causes - suggesting that the study of BUD outcome effectiveness and associated success factors will raise issues difficult to resolve.

8.3.4 Hypothesis No.4

> *"that measures of business users' IT expertise, business/IS knowledge, role authority and power, and suitability of tool support, can be used to predict BUD effectiveness"*

Regression analysis has been used to provide equations, for each set of sample data studied, which can be used to predict BUD effectiveness. The analysis quantifies

coefficients for each of the studied contributing factors (these are quantified via the analysis of links between the factors and BUD outcome effectiveness levels as measured for each survey participant). The coefficients can then be used together with a specific future set of measured/assumed factor values (measured via the survey instrument, or assumed as part of plans to 'improve' one or more of the factors) to give a calculated value for expected BUD outcome effectiveness.

The regression analysis of survey results produces an equation (for example, the final 'example' survey produced: BUD Effectiveness = 3.32 - (0.130*IT expertise) + (0.534*Tool suitability) - 0.511*Business/IS knowledge) + (0.788*Role)) which can be used to calculate the expected level of BUD effectiveness, based on measures of the contributing factors (as identified via the survey questionnaire). Although the shape of this equation is expected to change as different studies are completed, the level of explanation has been shown to be 50% and above, for the various surveys completed within this project.

Sections 6.4, and 7.3.1 describe how, to provide a means of comparison and an alternative to the regression analysis, a 'descriptive' statistical technique has also been used to show how BUD outcome effectiveness can be predicted. The approach can be used to predict whether BUD Outcome Effectiveness is likely to be 'high', 'medium' or 'low' (based on the measured contributing factor values). Tables 7a and 12a (refer to sections 6.4 and 7.3.1) show how the approach gives useful 'coarse grained' predictions.

When compared to the results via regression analysis approach, the 'descriptive' statistical method produces a similar level of accuracy in predicting the effectiveness. This is an interesting finding in that this method has the inherent advantage in that it is likely to be more easily adopted by organisations that do not have expertise in regression analysis. The method utilises the relatively broad approach of predicting levels (high, medium or low) which can be considered appropriate, considering the inaccuracies associated with the human and organisational complexities being modelled.

It is suggested that *predictions* of BUD outcome effectiveness, using the regression analysis equations or the 'descriptive statistics' technique, are best used in the assessing of proposed improvements to BUD contributing factors for:

i) those business users surveyed to actually produce the factor coefficients

and/or

ii) other users in the same organisation, or users within a recognisably similar organisational domain

8.3.5 Hypothesis No.5

"that current BUD tools tend to lack suitability for their purpose."

The results of each of the surveys have given some evidence to support this hypothesis. The ordinal responses from the surveys clearly showed that the majority of the participants were constrained in terms of the suitability of their BUD tool support (for example, in the second survey 47 out of 69 participants recorded 'low' scores for tool support suitability - see Section 6.5). Survey results also show relatively low levels of user satisfaction with tools when involved in BUD activities (see Sections 7.3.3 and 7.3.4). The text responses support this view - in particular, that improvements in the usability of BUD tools are much needed so that they are much more 'user friendly', and with a greater emphasis on the user (business user) perspective.

8.4 Benefits of research findings

The research described in this thesis builds on the findings from a wide review of published literature in this area, and provides an important breakthrough in terms of knowledge and understanding about the relationship between BUD success factors and the outcome effectiveness of BUD. In particular, this work provides the following original contributions to research in the area of business user involvement

in ISD: -

- identifies the main factors contributing to the success of BUD outcome effectiveness - *IT expertise, Business/IS knowledge, Role power/freedom,* and *Tools suitability.*
- provides reliable mechanisms to quantify the levels of the success factors and BUD outcome effectiveness for particular business users (in the form of a tested questionnaire and results analysis facility - the BUD ESP instrument).
- establishes links between BUD success factors and BUD outcome effectiveness - which enables a variety of possible outcomes to be predicted, based on measured or planned BUD success factor values obtained using the BUD ESP instrument.
- indicates the level of involvement of business users in a range of IT activities, and also indicates the apparent levels of user satisfaction in terms of the outcomes of those activities, and in terms of the tool support available.

The BUD ESP instrument, and the associated research findings, has far reaching benefits for both practitioners and academics. The knowledge about the skills and experience (IT/IS and business knowledge) of individual business users, with respect to their potential for effective involvement in BUD activities, is potentially very useful in both research and organisational terms. In particular this knowledge, together with measures of tool support suitability and role power/authority, and direct measures of outcome effectiveness (where BUD already exists) would be useful in the following scenarios as described: -

a) where an organisation is evaluating whether the levels of existing skills and experience of its business users make it a viable proposition to adopt a policy of user empowerment in IS development terms. Knowledge about these levels would help identify the amounts of IT training and/or

IT specialist support required (and whether the exercise would be cost effective).

b) where an organisation has already made a policy decision in favour of supporting business user empowerment, but is now selecting which projects/users are appropriate. There would need to be a matching of projects and business users in terms of required BUD success factors (business/IS knowledge, IT experience, role freedom/power and tool support suitability). A profile of BUD success factor levels for individual and groups of users is a vital ingredient to this matching process.

c) where an organisation has already embarked on a user-empowerment programme - to help the organisation identify what levels of improvements (if any) in the various success factors are needed to meet targeted outcome effectiveness levels, and to model the impact of planned changes to contributing factors, and/or to monitor the actual effect of changes to contributing factors.

d) Scenarios a), b), and c) apply directly to practitioners and management in business user organisations. Equally, the BUD ESP instrument could be utilised by academics to research into issues relating to the specific aspects described. The instrument, together with the findings and conclusions described in this thesis could also form the basis for research into other related areas (e.g. impact on the BUD success factors of human and organisational factors, etc.).

8.5. Additional observations

This section briefly deals with important aspects which have been directly drawn from the research work carried out in this project, but which do not relate specifically to the identified issues, deliverables and hypotheses targeted by the project.

8.5.1. Involvement of business users in progressing BUD

In general, there appears to have been insufficient involvement of business users in

the recent open debates about BUD, and how to best manage and control the processes involved. To an extent this also applies to IT specialists. It is felt that it is time now for IT specialists and business users in particular organisations to get involved in the 'debate' and discuss the issues. IT specialists have played an important role in information systems development (ISD) for many years now and it would be foolish to even consider casting this vast experience aside; to be 'recklessly' replaced by BUD. It is important to move from an era of centralised IT specialist domination, to one in which business users are empowered, but the value and potential of IT specialists is also maximised.

8.5.2 Maximising the potential of IT specialists

It is understandable for IT specialists to have been somewhat 'protective' about their position over recent years as BUD has grown in importance. The immediate assumption is that the job role of the traditional analyst/designer/programmer is threatened by business users increasingly taking on BUD activities. We feel that far from being threatened, IT specialists have the opportunity of an *enhanced* role. Traditionally there has been a divide between IT specialists and business users - essentially attributed to the culture gap (Shah *et al.* 1994), between users and developers. As the ISD understanding and awareness of business users who participate in BUD increases, this culture gap will begin to close - which will help to alleviate some of the problems of communication (between analyst/designers and users). This is important, because even with full empowerment of business users it is not likely (and not in the interests of organisations involved) to result in the disappearance of the IT specialist role in ISD. If we ever reached a scenario whereby business users were able to enjoy 'ideally' powerful and usable BUD tools, a consistent and thorough corporate policy on BUD support and quality control, and appropriate training and management support, the role(s) that could be envisaged for IT specialists are as follows: -

i) consulting with BUD tool designers (in conjunction with business users) with regard to recommendations of design and other systems development standards built into the tools.

ii) helping to manage and provide technical and skills support for BUD participants.

iii) developing application systems within projects (internal and external to the organisation) not suitable for BUD (or simply those projects which are part of a BUD 'backlog' and which are high priority projects).

iv) providing training and consultancy to business users in ISD skills.

v) gaining business skills in particular areas of need and interest, and taking on a BUD role as part of a business department/area of an organisation.

8.6 Concluding comments

This project has completed what is an important phase of research into BUD, and presents many possibilities for subsequent and related research. The next chapter (Chapter 9) discusses some of the possibilities, and provides an account of preliminary considerations on selected aspects - ideas and position statements as developed during the current project.

CHAPTER 9: Further research

The purpose of this chapter is to:

- suggest additional research work that could be carried out which relates to the research discussed in this thesis, and would further increase knowledge in area of BUD
- discuss preliminary ideas regarding some aspects of the suggested further research.

9.1 Introduction

Chapter 8 provides a summary of the results and main conclusions of the research completed within this project, showing that all of the target deliverables were met. The considerable evidence ascertained enables useful observations to be made on each of the project hypotheses. It is clear that this project leads to a wide range of possible further research work in the area of BUD. Examples of possible subsequent related research are as follows: -

i) Surveys of additional samples of business users using the 'BUD ESP' instrument. As the numbers of business users surveyed increases, then the greater the understanding of links between contributing factors and BUD effectiveness and scope. Particular groups of business users could be targeted so that BUD could be modelled for particular types of business user, and for selected domains/IT environments. Cross-cultural surveys could be carried out, to highlight any differences in the nature of links between contributing factors and BUD outcome effectiveness due to factors relating to the organisations being situated in different countries and continents. Interest in collaborative surveys has already been expressed by researchers overseas (in particular in the USA and Canada).

ii) Possibilities for enhancements to the questionnaire instrument could be considered and investigated - for example, the introduction of peer appraisal, the independent assessment of BUD applications, and the inclusion of 'plug-in' instruments established elsewhere (which could duplicate or replace parts of the BUD ESP instrument).

iii) Selected business users (i.e. those shown by survey results to have a high 'potential' for effective BUD) could be invited to assist in the task of prototyping the design of advanced BUD tool support. The general aim being to empower the business user, and to attempt to overcome any specific deficiencies identified during this and other research.

iv) This thesis deals with the 'end user domain' of the BUDES research model - attention is also needed to fully address the 'organisation-wide domain' of the model. In particular, issues related to BUD policy, BUD management, and BUD infrastructure support need to be investigated.

9.2. Preliminary considerations

9.2.1 Management responsibilities with BUD

There is a growing responsibility of management, in many cases with no computing-related qualifications, to exercise control over substantial IT resources, and they are expected to achieve successful returns on the investments which those resources represent (Harris 1992). The scope, functionality and effectiveness of an information system are concerns that are the ultimate responsibility of business managers. The greater the control that business managers have over the process of building an information system, the more accountable they can be for the results of this business activity. Regardless of who is directly building an IS, it seems appropriate that the business manager should take responsibility for monitoring and control (Khan 1992).

So how much should a business manager know about the *process* of developing computerised IS systems? Traditionally such a manager has not needed to know much about this at all. As user-centred methodologies (such as prototyping) increase in use, then business managers are increasingly involved in the process, and so need to gain the relevant skills and awareness. With currently available methods and tools, a manager of a business area that adopts the principle of directly being responsible for the design, development and implementation of its information systems would need a high level of these skills. A possibly more realistic view is that a manager would need to manage *others* within their business area with those capabilities and duties.

Modern organisations utilise a variety of approaches, within a range of environments, to develop and manage the development of their information systems. The type of approaches adopted will partly determine the extent to which business personnel need to know about the process of developing IT solution for a business information system. Table 18 illustrates a framework for identifying such needs. It follows that as the required levels of 'IT development process knowledge' increase then training/education needs of business users will increasingly have to be considered to make up for any shortfall in skills and experience.

However, it is suggested here that typical business users should not be expected to be highly skilled in systems development techniques *and* also build up and maintain extensive business related knowledge. Apart from the practical problem of effectively educating (in terms of IT development process knowledge) business users, there is the potential problem that too much attention might be diverted from their primary abilities (i.e. in terms of practising and maintaining business expertise). The framework in Table 18 indicates that for a given task complexity, and assuming that the project is 'user based', the required level of IT development process knowledge can be reduced by providing improved support for business users in the form of the adopted *culture* and *tool support*.

Table 18: Process Knowledge framework

IT Development Process Knowledge requirement levels (of business users)	INFLUENCES	
	TASK COMPLEXITY	**DEVELOPMENT STYLE**
Higher		
	Multi Dept/Complex systems	User Based Development
	Database Design + Processing	User Led Projects
	Multiple file/screens	User/IT Expert prototyping
	Simple Database Queries	IT expert/User prototyping
	Spreadsheets (build)	IT Specialist led project
	Spreadsheets (use)	
	Decision Support applications (use)	
	Data entry applications (use)	
	View information	
Lower		

	CULTURE	**TOOL SUPPORT**
	(assuming user-based development style)	
Higher		
	Centralised IT dept. (no user support)	Traditional environment
	IT dept user support	Window based environment
	Info Centre support	4 GL/application builders
	Decentralised Specialists	Decision Support Tools
	User Based Support Groups	User Targeted Build Tools
	User Support Infrastructure	
Lower		

9.2.2 Need for BUD tool advancement

Previous research strongly points out the risks associated with BUD (refer to Chapter 3, section 3.4) - which are mainly attributed to the assertion that business users tend not to have adequate application design/implementation skills. Sumner & Klepper (1987) make the observation that end users involved in BUD need

'consulting expertise' in order to avoid the problem of making design errors, facilitate re-use, and to enable quality assurance techniques. One approach is for this expertise to be provided by IT specialist consultants; a second is to train business users in ISD technical skills. A third option is available - perhaps a more direct and effective approach would be to encapsulate this expertise in a tool.

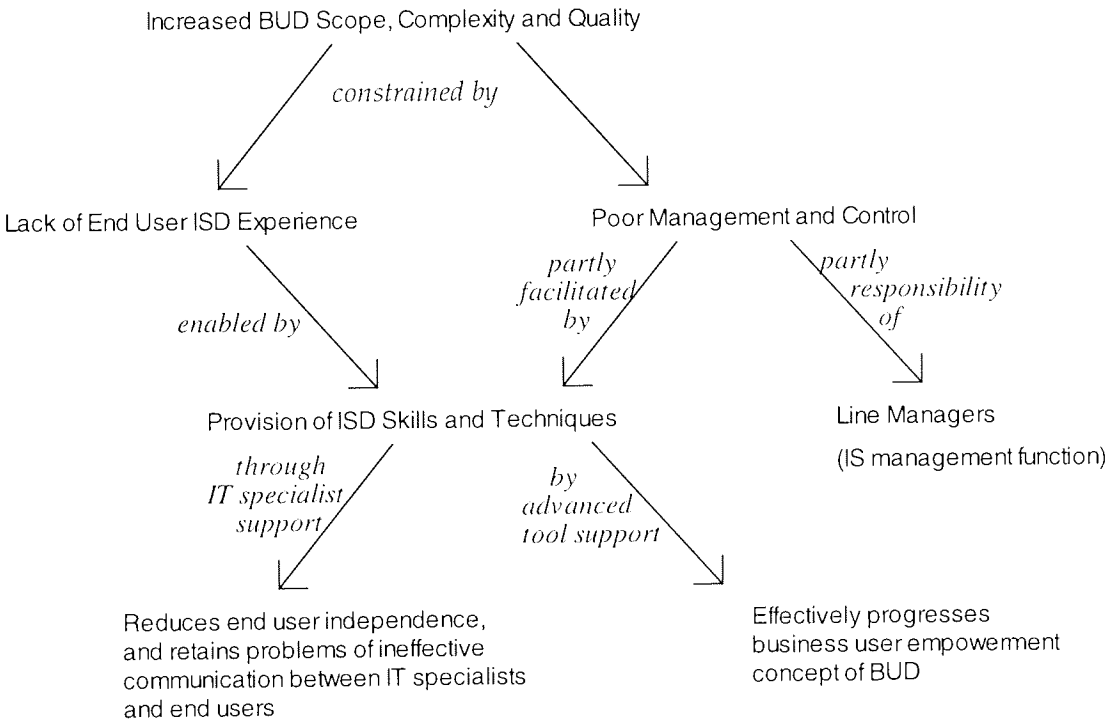

Figure 2. BUD support

Figure 2 traces the paths which lead from the premise of envisaged increased scope, complexity and outcome quality required of BUD applications, and illustrates that the most effective way of satisfying these needs is to provide business users with ISD skills and techniques encapsulated in a BUD support toolset. Figure 2 illustrates an earlier point (see Section 9.2.1) - that it is important for business 'line' management to participate in the management and control of I.S. development activities (to complement facilities provided by advanced tool support for BUD).

Chapter 8 points out (refer to sections 8.2.5 and 8.3.5) that our research findings provides evidence to show that currently available BUD tools tend to lack

suitability for their purpose. Research is needed into *how* BUD tools might be improved. A possible direction is to develop tool support that assists BUD participants with IT design decisions - building the relevant IT 'expertise' into the tool itself. Tool support has been proposed elsewhere (Benham *et al.* 1993) to overcome the problem of users having poor knowledge of 'good' software development methods - in this case the proposed tool is targeted at spreadsheet design and aims to 'foster' end user analysis and design activities and reinforce good techniques.

Alavi & Weiss (1985) refer to the risk of end users being 'distracted' from their primary business responsibilities when involved in BUD activities. This must be regarded as a significant concern when considering BUD tool design - as more time spent on IT specialist tasks means that less time is available for business duties. However, building of an information system *is* a business related task - an approach is needed which enables the development task to remain in a business 'context'. Suitable tool support perhaps could be developed which would enable the user to make business decisions and choices, rather than exercise IT specialist skills.

9.2.3 Advanced tool support for business users

There is a current trend for vendors of database and spreadsheet packages to include 'fast track' help whereby the user is able to select from prompted sets of parameters to provide a fairly quick way of creating an application (a report or a graph for example). This is evidence of vendors recognising the need to make it easier for users to create applications - and to do this by means of improved tool support (Bragg 1996).

It is proposed here that tool developers could provide even greater user empowerment by continuing the development of appropriately designed tools that could be successfully and effectively used by the business user (directly, without the necessity for intervention by an IT specialist). Related research is summarised by Agusa (1991) - involving the use of icons and other images which can be manipulated by end users to produce application designs suitable for use in

automated code generation ('visual programming'). It is clear, however, that much work needs to be done to increase the scope, clarity and flexibility of visual design/programming, but the potential rewards are very attractive.

Although the concept of 'automatic programming' is an attractive one, it must be noted here that several researchers have considered and studied the idea and as yet have tended to conclude that full automation is not possible (e.g. Brooks 1987; Rich & Waters 1990). However, these previous investigations have been from the viewpoint of developing a tool to automate the activities of traditional analyst/designers. The automation process has therefore met with the same problems as are often met in the traditional manual process - difficulties in a technical specialist obtaining a clear and complete set of requirements, and ensuring that the system design/implementation matches what the end user expects. These difficulties are related to problems of communication, comprehension, and conceptual validation (which are not suited to computerised automation).

It may be the case that expert technology cannot fully automate the current role of an analyst/designer in the software development activity. This is supported by Gibson *et al.* (1989), and by Tsai *et al.* (1988) who state that the use of expert systems technology may be inappropriate to the automation of the software engineering process. This is due to the fact that it is regarded by some (Bobrow 1986) that suitable problems are those that do not require common sense knowledge, English language understanding, and understanding of human intentions. It is pointed out here that these three factors prevail mainly because of the need for the communication of requirements and the validation of conceptual models between IT specialists and business users. The aforementioned three factors would be in the realm of the end users' role if they were able to be within the control of the BUD tool support. It may, therefore, be possible to automate the analyst/designer role if that role was reduced in scope - enabling the user to play the role of analyst/designer by virtue of the tool support providing automated development expertise.

It may be regarded reasonable that individual business users, who have suitable levels of business knowledge and are empowered by appropriate BUD tools, would be able to develop much of their localised information system requirements, with satisfactory levels of reliability. However, we point out that there are special requirements for users developing systems in *teams*, especially across departmental boundaries. Where many users have to share knowledge about their IS needs and liaise in the development process, there is a potential return to problematic human communication presently associated with traditional methods of ISD (refer to Chapter 2, Section 2.6).

Tools are needed to help business users directly prototype and build non-trivial application systems within a structured environment. To distinguish this type of tool from traditional CASE tools, it is suggested here that this advanced generation of BUD tools be described as Computer Aided User Systems Evolution (CAUSE) tool support. This description is designed to stress the central role of the *business user*, and reflect that the intended approach of a CAUSE tool would be to facilitate the *evolvement* of a system over a period of time.

It is anticipated that a CAUSE tool will encapsulate the attributes of CASE technology which are already recognised as being helpful and advantageous (these would include integrity checking, documentation provision, central storage of design information, automation of repetitive and time consuming tasks, accuracy, traceability, etc.) in addition to having features which enable the direct operation by business users.

Figures 3, 4 and 5 show how the transition from CASE to CAUSE is perceived in this thesis. Figures 3, 4 and 5 collectively show an illustration of how the CAUSE concept fits in to the wider context of ISD and the associated techniques and characteristics.

Figure 3 illustrates an image of 'mainstream' CASE tools supporting the traditional approach to software system development, with the analyst/designer eliciting

requirements from the business user and consequently building their (analyst/designer) view of what constitutes an appropriate system.

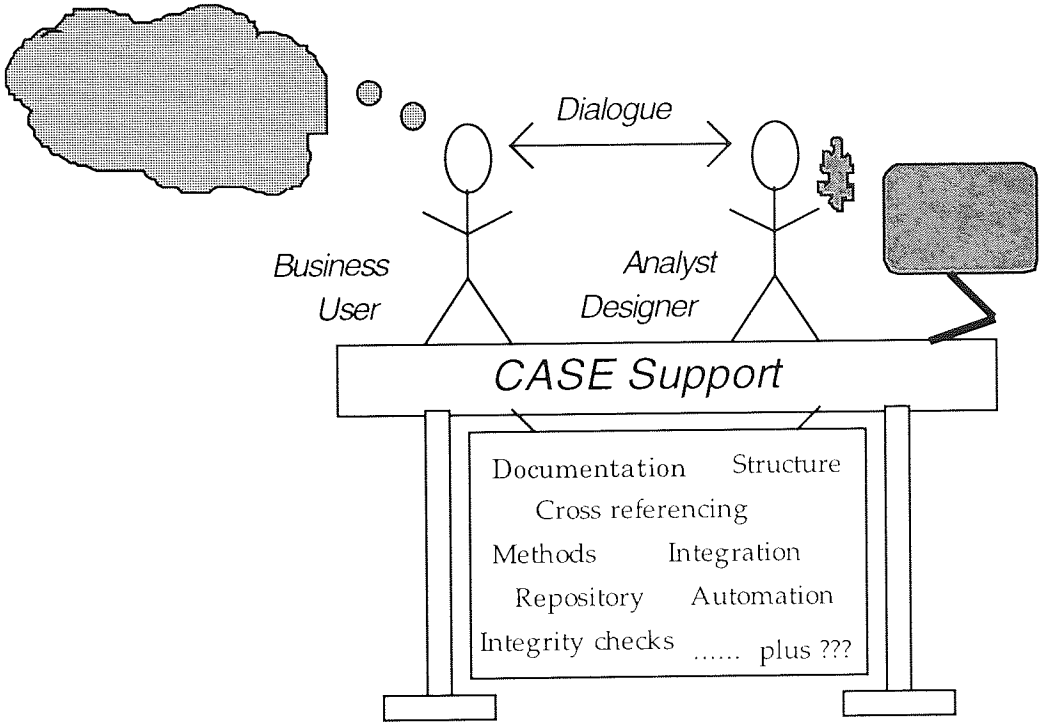

Figure 3 : CASE Approach - supporting the subsidiary role of the business user in ISD

It can be seen that the analyst/designer's view of requirements do not necessarily match that of the business user. The labels attached to the CASE support platform describe the main advantages that are typically attributed to CASE approach compared to the more traditional approaches.

Figure 4 shows that several approaches are being used as a means of assisting the traverse of the proverbial tightrope bridging the IS crisis - the transition leading to more effective and higher quality systems. These approaches are allowing us to progressively overcome the problems posed within the activity of systems development, and increasingly avoid the discomfort of the features of the IS crisis (e.g. budget over-runs, incomplete and unsuitable functionality, poor usability, etc.).

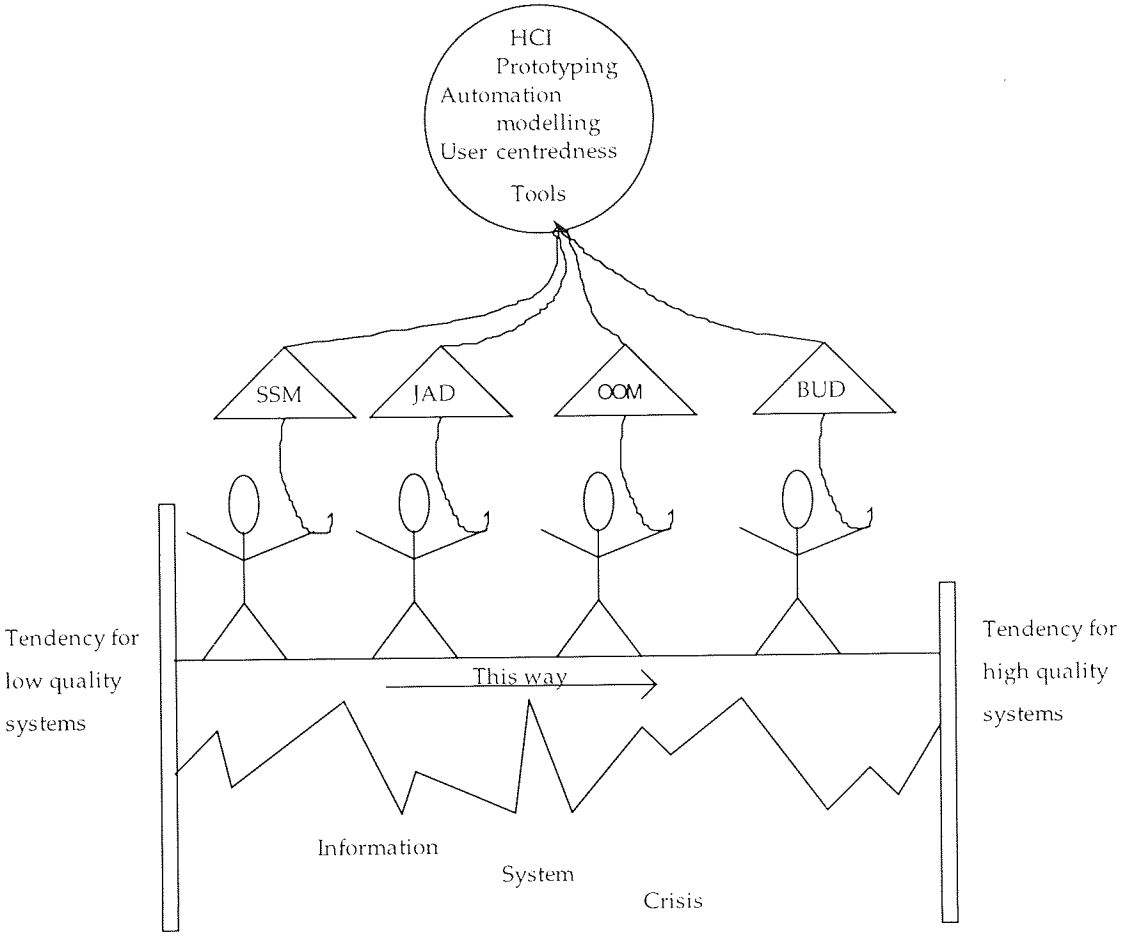

Figure 4 : Transition - Traversing the tightrope across the discomfort of the IS crisis

The concepts of SSM, JAD, OOM (Object Oriented Methodology), and BUD are examples of approaches currently being utilised and explored within industry and academia as means of enabling the transition. A common source of additional balance and buoyancy is provided by the concepts of HCI (Human Computer Interaction), prototyping, automation, modelling, user centredness, and tool support.

CAUSE can be seen as being the destination that is reached as a conceptual culmination of the various innovative approaches currently being practised and researched.

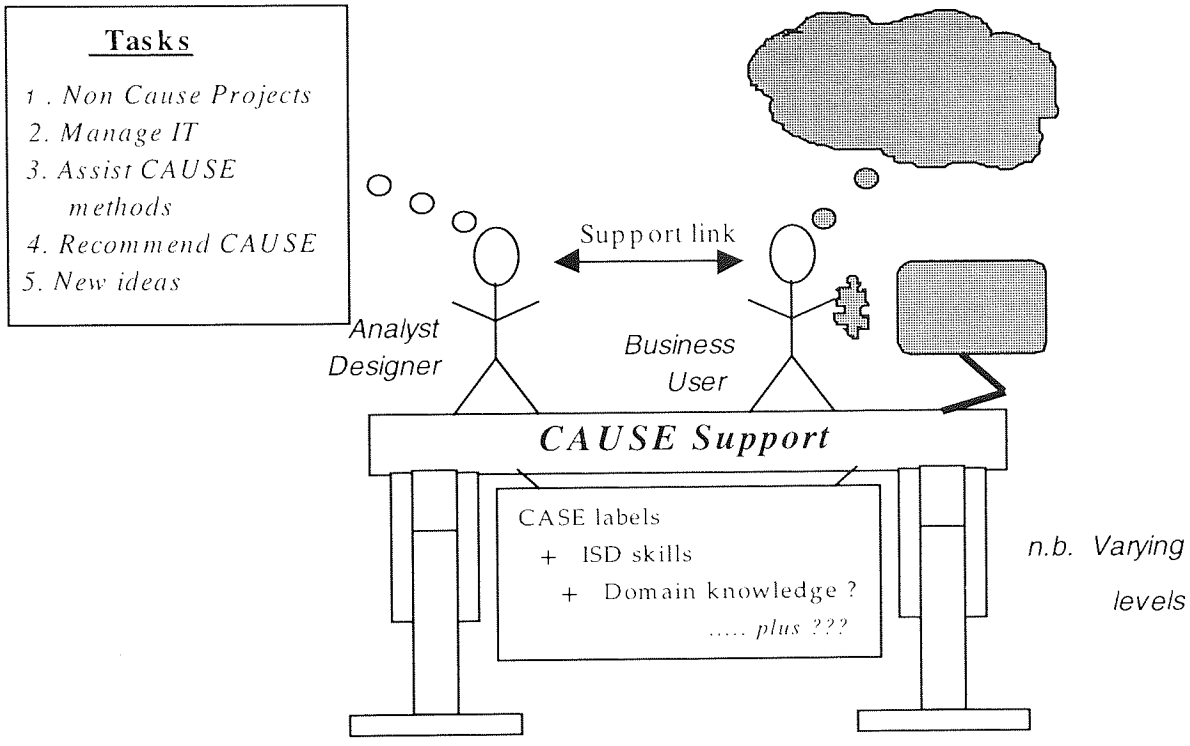

Figure 5 : CAUSE approach

Figure 5 shows that CAUSE gives the business end user the power and opportunity to directly build a system which matches their requirements to a closeness and degree which is under their control. The CAUSE tool support provides the user with the analysis/design skills and system building techniques necessary to complete the task, and also exhibits the advantages of traditional CASE. An advanced CAUSE tool may also provide domain knowledge as well. Note that full control over the process supported by the tool is retained by the business user.

Figure 5 also illustrates that the analyst/designer is now largely free to work on projects unsuitable for the CAUSE approach, co-operatively manage the IT infrastructure, and to assist CAUSE users on a consultancy basis where necessary. The IT specialist department would also have the opportunity to recommend preferred standards and methods to be built into a CAUSE tool (offsetting possible risks of uncontrolled BUD), and to reap the full benefit of their knowledge,

creativity, and IT expertise by developing new ideas for future use in tools and approaches.

Figure 3 shows that the position of traditional CASE support is quite rigid and so tends to successfully apply only to developers at a particular level of technical expertise and experience. Figure 5, however, shows that CAUSE should have the feature of being adjustable to match the requirements of business end users at varying levels of experience and expertise.

It is suggested here that some of the techniques included in structured methods recommended elsewhere for BUD participants (Salchenberger 1993) are more applicable to traditional development projects - rather than where end users themselves play the dual role of developer and user. It follows then, that ISD skills and techniques encapsulated by a CAUSE tool should not simply be those traditionally recommended for IT developer use, but of a nature especially relevant to the target users of the tool.

The interface and functionality of a CAUSE tool would need to be sufficiently powerful to carry the user over a bridge spanning the 'ISD skills divide' - the users will tend to have sufficient ideas and IS knowledge, but lack the traditionally required programming and system building skills to lead to a conventional implementation. In fact the CAUSE user will need ISD skills, but they will be in terms of business and IS expertise, and creativity/innovativeness within an intuitive IT environment rather than in terms of technical IT abilities.

It is anticipated, then, that BUD will be most effective where the user does not need domain knowledge support to be provided by the tool. Furthermore, it is recommended that CAUSE tools should be targeted at the broad domain of traditional business information systems (not at real time or safety critical systems for example).

The aim of this type of tool support is to: -

- Provide business users with the choice of whether to develop their own applications 'personally', and to be able to do that in a secure environment
- produce systems that will match requirements closer, be more effective, and better received and implemented by the users concerned than currently experienced
- reduce development pressure, leaving IS/IT teams more time to build the systems which are inappropriate for users to build, and to provide expert consultancy
- enable chosen standards and methods to be built into the (CAUSE) tool - helping to offset potential risks of uncontrolled BUD

9.3 Chapter summary

This chapter identifies possibilities for further research, which could be as a direct consequence to the new research described in this thesis (which is summarised in Chapter 8). The main suggestions can be summarised as being: -

- further surveys using the BUD ESP instrument
- investigating improvements and enhancements to the BUD ESP instrument
- prototyping advanced tool support for BUD participants
- studying a variety of BUD issues - such as BUD policy, BUD management, BUD infrastructure and support, etc.

In this chapter, ideas and suggested preliminary considerations relating to some of these aspects have been discussed. In particular, a process knowledge framework is described, an argument is presented showing the need for advanced BUD tools, and the features of an envisaged BUD tool (CAUSE) are outlined and related to currently existing CASE tools.

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Appendix I : Initial Survey Questionnaire

A STUDY OF BUSINESS USERS AND THEIR INVOLVEMENT WITH INFORMATION SYSTEMS AND RELATED IT SOFTWARE

undertaken by

Dave Lawrence
University of Wolverhampton

and

Dr. Hanifa Shah
Aston University

Welcome

This study has the general aim of gaining the knowledge necessary to improve our understanding of how end users can best be provided with IT applications and tools, and of how to optimise the involvement of end users in information systems development (ISD). We believe that not enough effort has been made in the past to ascertain the potential of end users and to investigate the range of support that the various types of users need.

You have been chosen as part of a cross section of end users. Your input is important and will be treated with the utmost confidentiality. Your employers, managers and colleagues will not know about your specific responses. Please note that there are no 'right' or 'wrong' answers to any of the questions - but your responses should give an indication of your experience and how you feel.

Though your participation is completely voluntary, we would appreciate you completing the questionnaire and returning it to the address below as soon as possible.

Instructions

Your first impressions are the ones of most interest to us, so do not spend an excessive amount of time on any one question. A few questions ask you to assess your general impression of complex issues. If you find it difficult to determine your exact answer, please give your **best estimate**.

If you find any of the questions confusing or unclear, please add a note (written on the questionnaire) to explain any assumptions you make. At the end of the questionnaire, there is space for you to make other comments - please include mention of any issues that you think should have been addressed by the questionnaire and/or any points that you feel are especially important to analysing the area covered by this study.

Please ignore the question numbering system used on the questionnaire - it has been organised to assist our analysis.

Please return completed questionnaire to:

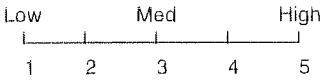
Dave Lawrence
Senior Lecturer
School of Computing and Information Technology
University of Wolverhampton
Wulfruna Street
Wolverhampton
WV1 1SB
UK

SECTION A

This section asks you about your experience with IT in your work.

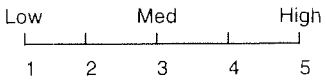
Please circle the appropriate number on the response scale.

B1. With what quantity of application packages do you have at least some experience ?
(low = 1/2, med = 4/5, high = 7 and over)

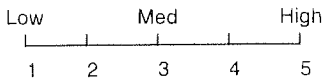


B2. With what variety (i.e. different types) of application packages do you have at least some experience ? (low = 1, med = 3, high = 5 and over)

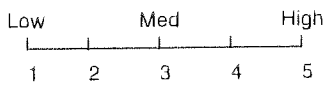
B3. With what quantity of application building tools do you have at least some experience ?
(low = 1/2, med = 4/5, high = 7 and over)



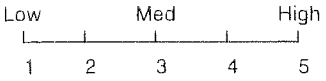
B4. What amount of variety of tool types have you used?
(low = 1, med = 3, high = 5 and over)



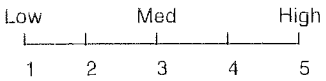
B5. How many years of experience have you in using a computer in your work (low = less than 1 year, Med = 2/3 years, High = over 5 years)?



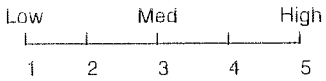
D1. What amount of knowledge do you feel that you have about the packages that you **most** use ?



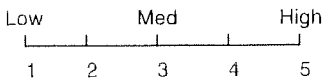
D2. What amount of knowledge do you feel that you have about the tools that you **most** use ?



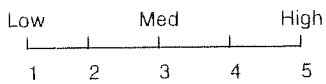
D3. What level of prowess do you have in aspects such as 3 GL's, 4GL's, database design and systems analysis/design ?



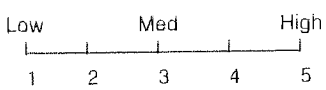
D4. What level of prowess do you have in aspects such as MIS/Query reporting, and/or DTP, Word Processing, and spreadsheet packages?



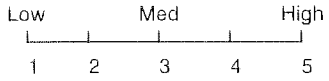
D5. What proportion of your working life (considering up to a max. of last 10 years, and allowing for the % exposure per typical day) have you been working with or being trained in use of IT applications and tools (low = less than 5%, med = 20-30%, high = over 50%)?



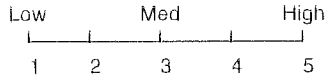
D6. What amount of formal training have you received in the use of IT in your work ? (low = hardly any or none, med = training in main activities, high = thorough training in most activities).



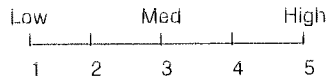
F1. If you are faced with a problem in the running of an application or the use of a tool, what level of confidence do you have in personally analysing and solving the problem ?



F2. What amount of interest have you in improving your business effectiveness by **personally** utilising increasingly advanced **IT tools** ?



F3. With what level of ease can you visualise the style and scope of IT solutions to effectively provide identified IS (information system) needs ?



Do you have ANY awareness/knowledge about ANY information system within your organisation ? **YES/NO** ? (please circle)

If the answer is "NO" then please skip Section B

SECTION B

This section asks you about your knowledge about information systems utilised within your organisation.

Please complete the responses to the following questions an appropriate number of additional times if you have awareness/knowledge of **more than one** information system within your organisation (eg. orders, payroll, MIS, production control). Please indicate (below, in order of familiarity) which responses are for which information system (nb. if you have knowledge about more than three systems, then select those three of which you have most knowledge).

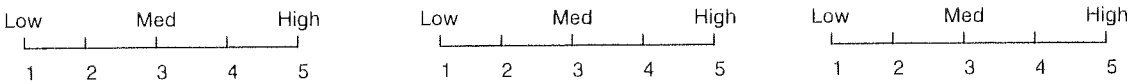
(i).....(I/D*) ii).....(I/D*) iii) .....(I/D*)
(most familiar) (2nd most familiar) (3rd most familiar)

* Please delete as appropriate (I = Implemented D = being developed)

Please circle the appropriate numbers on the response scale(s).

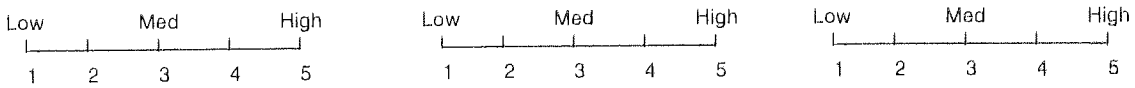
B1. To what extent are you familiar with the general purpose/functionality of the information system ?

(i) (ii) (iii)



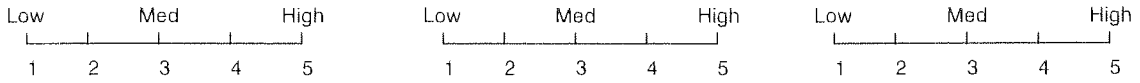
B2. Of what proportion of the total no. of features of the system are you familiar ?

(i) (ii) (iii)



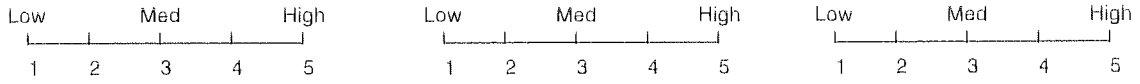
B3 To what extent do you understand the general business relevance of the system ?

(i) (ii) (iii)



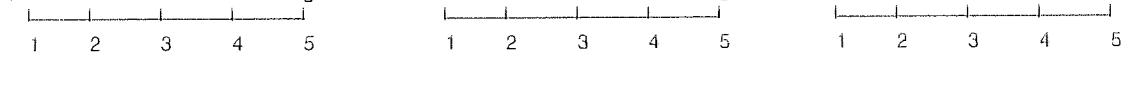
D1. How thorough is your knowledge about the main features of the system ?

(i) (ii) (iii)



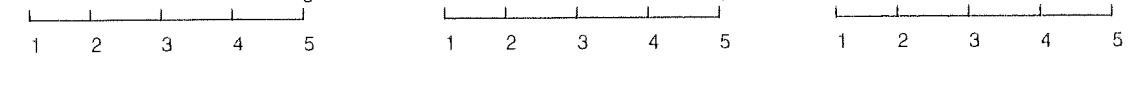
D2 How thorough is your knowledge about the remaining features of the system ?

(i) (ii) (iii)



D3. To what extent do you understand the specific business relevance of specific system features ?

(i) (ii) (iii)

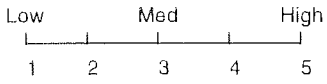


D4. To what extent were/are you involved in the development of the system ?

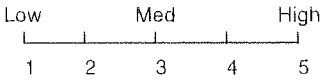
(i) (ii) (iii)

F1. How comfortable would you be in specifying the design of a new IS (information system) to suit known business needs (in the business area concerned)?

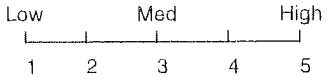
(i)



(ii)

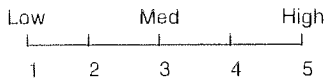


(iii)

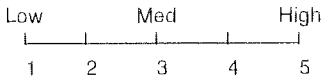


F2. How likely are you to recognise new IS designs which would improve the business effectiveness of the system ?

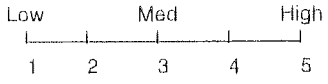
(i)



(ii)

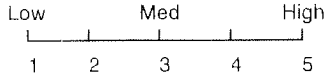


(iii)

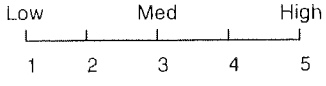


F3. To what extent can you identify and prioritise business benefits associated with the system ?

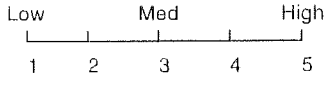
(i)



(ii)



(iii)



Do you regularly implement IT ideas ? **YES** or **NO** ? (please circle)

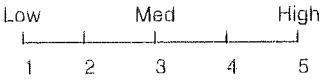
*If the answer is "**NO**" then please skip to question G2 (part (ii)) of Section C..*

SECTION C

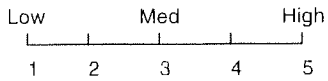
This section asks you about implementations of your own implementations (i.e. IT applications that you personally create - individually or as part of a **user** team).

Please circle the appropriate number on the response scale.

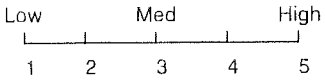
B1. What proportion of IT ideas that you implement is for your own use ?
(low = 10% or less, med = 30%, high = 50% or more)



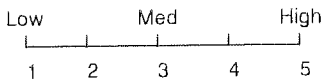
B2. What proportion of IT ideas, that you implement, are implemented on a department/organisation wide basis ? (low = 5% or less, med = 20%, high = 40% or more).



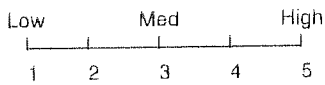
B3. What quantity/rate of IT ideas do you implement ? (low = 1 per 6 months, med = 1 per 2 months, high = 1 per month or more frequent).



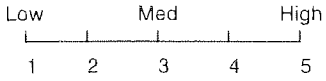
B4. What level of complexity do your implemented applications tend to have ?



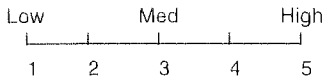
D1. To what extent do your own implementations **avoid** the need for corrections/changes during the first 2 months of operation ?



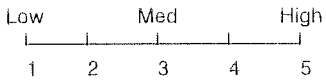
D2. To what extent do your own implementations produce recognisable business benefit ?



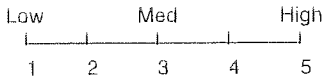
D3. What proportion of your implementations are based on your own business knowledge ?



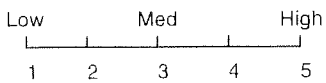
F1. To what degree do you feel confident about personally reacting to teething problems with your implementations ?



F2. To what extent do you personally identify the need for changes and enhancements to your implementations after the design/implementation stages ?



F3. What level of success do you have in effectively (quickly and accurately) making amendments to your implementations, as requested by others (or recognised as needed by yourself) ?



G1. Please briefly describe an Information System Development project in which you have (had) a high involvement (whether a relatively simple system or a complex one). Mention the type of system, your role in the project, and the tools you use(d). Also please comment on what improvements to the tools might help YOU be more effective.

.....

.....

.....

.....

.....

G2. Name an information system used in your department/organisation that you feel is particularly effective;

(i) where you were heavily involved in the development .....
(very/fairly* effective)

(ii) where you were not involved in the development .....
(very/fairly* effective)

* please delete as appropriate

G3. Name any information system(s) in your department/organisation that you feel is/are **not** particularly effective;

..... (heavily/not heavily* involved)

..... (heavily/not heavily* involved)

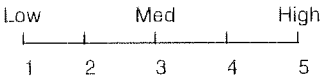
(* delete as appropriate to indicate your participation in the development of the system)

SECTION D

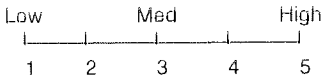
This section asks you about your role and position of authority in terms of IT involvement.

Please circle the appropriate number on the response scale.

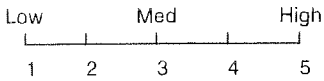
1. What degree of power does your role give you to propose new IT solutions to IS needs ? (i.e. regardless of who sanctions budgets).



2. What degree of power does your role give you to sanction the implementation of these proposals of new IT solutions to IS needs (and proposals from elsewhere) ?



3. To what extent does (or could) your role allow you to spend time working on IS designs/IT implementations ?

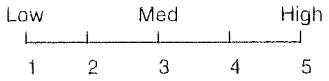


SECTION E

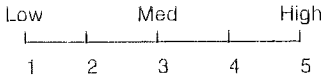
This section asks you about the characteristics and scope of the available tool support.

Please circle the appropriate number on the response scale.

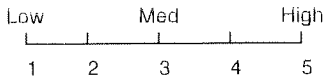
1 a) To what extent do you have tool(s) **available** to assist with the range of MIS type applications (i.e. spreadsheet, database, querying/reporting, graphic display of information, file maintenance, statistics/trends portrayal, etc.) ?



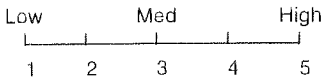
b) With what amount of ease are/were you able to learn and operate these MIS type tools ?



c) To what extent can the user of these tools be successful **without** specialist IT expertise ?



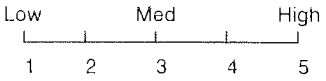
2 a) To what extent do you have tool(s) **available** to assist with complex application design/building (eg. applications involving a mixture of batch and interactive processing, involving a number of dialogue screens and associated processing, in a multi user environment) ?



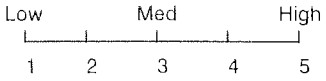
If you do not have this type of tool (or you have no knowledge of the tool(s)), please circle 'N/A' below and go directly to question 3 (Section E).

N/A ?

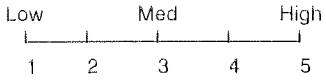
b) With what level of ease are/were you able to learn how to utilise these more advanced tools?



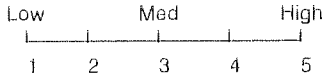
c) To what extent can the user of these tools be successful without specialist IT expertise ?



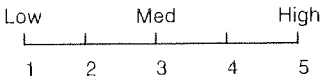
d) What level of accessibility is there for these advanced tools (i.e. how easy is it for you to sit down and get hands on experience) ?



e) What proportion (of each application) of the type of applications produced by the advanced tools can directly be run on the target production environment ?



f) To what degree is your potential to design/build computerised information systems **un**restricted by the power/characteristics of the tools available ?



3. List the names of tools that ;

a) you currently use .....

.....

b) you plan to use .....

c) you would like to use .....

4. What characteristics/capabilities would you like end user computing tools to provide or improve upon?

.....

.....

.....

.....

5. How do you keep up to date with new products/tools as they become available ?
(eg. computer press, vendor marketing, conferences, exhibitions, demos, etc. - please circle as appropriate, and add any other sources below that you use).

.....

.....

SECTION F

This section asks you for information about yourself. You may regard some of these questions as being too personal. If so please leave blank - however we would use the information in an extremely sensitive and confidential manner.

1. Name of Organisation ? .....

2. Which department do you work in ? .....

3. What is your job title ? .....

4. How long have you been working in (i) this type of role ? ..... years
(ii) this organisation ? ..... years

5. If appropriate, what was your previous role (in this or a previous organisation) ?

.....

6. How many people directly report to you ? .....

7. What is your age ? .....

8. What is your gender ? **M / F** (please circle)

9. Do you regard yourself as being part of an ethnic miniority ? **Yes / No** (please circle).

10. Do you have any physical disabilities ? **Yes / No** (please circle).
(if so, please indicate details):- .....

11. What is/are the highest qualification(s) that you have achieved in one or more particular area(s) ? (eg. 'O' levels, GCSE, 'A' levels, ONC, HNC, HND, NVQ, Degree, Masters, Higher degree, etc).

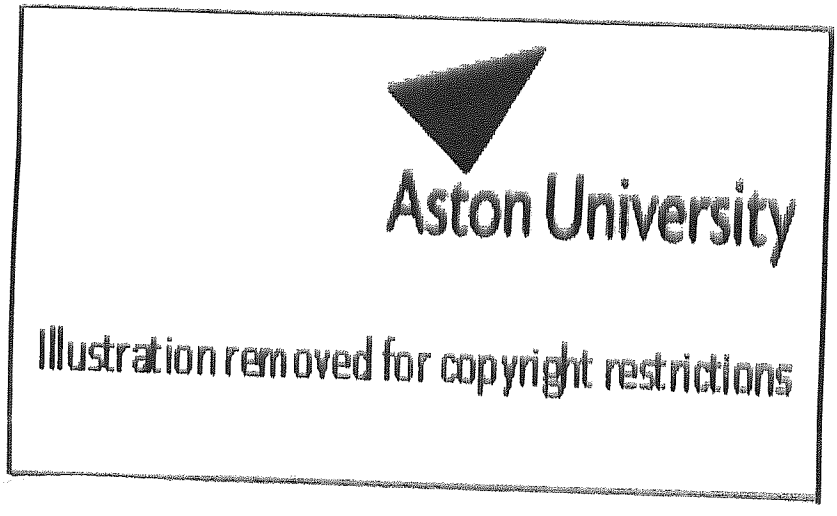
.....

.....

12. Your name ? Surname..... First names .....
(if you prefer not to give your name then leave this blank - however it would help us for clarification purposes, and we would treat this information with extreme confidentiality).

Please add any additional comments and/or suggestions that you wish to make on this page.
Thank you very much for your assistance.

Dave Lawrence
School of Computing and IT
University of Wolverhampton
Wulfruna Street
Wolverhampton
WV1 1SB
Tel. 0902 - 322443
Fax 0902 - 322680



Appendix II: BUDES Survey Questionnaire

A STUDY OF BUSINESS USERS AND THEIR INVOLVEMENT WITH INFORMATION SYSTEMS AND RELATED IT SOFTWARE

undertaken by

Dave Lawrence
University of Wolverhampton

and

Dr. Hanifa Shah
Aston University

Welcome

This study has the general aim of gaining the knowledge necessary to improve our understanding of how end users can best be provided with IT applications and tools, and of how to optimise the involvement of end users in information systems development (ISD). We believe that not enough effort has been made in the past to ascertain the potential of end users and to investigate the range of support that the various types of users need.

You have been chosen as part of a cross section of end users. Your input is important and will be treated with the utmost confidentiality. Your employers, managers and colleagues will not know about your specific responses. Please note that there are no 'right' or 'wrong' answers to any of the questions - but your responses should give an indication of your experience and how you feel.

Though your participation is completely voluntary, we would appreciate you completing the questionnaire and returning it to the address below as soon as possible.

Instructions

Your first impressions are the ones of most interest to us, so do not spend an excessive amount of time on any one question. A few questions ask you to assess your general impression of complex issues. If you find it difficult to determine your exact answer, please give your **best estimate**. If you are not sure what we mean in any of the questions, then please contact me (Dave Lawrence - see last page for contact details), and/or write a comment on the questionnaire to explain any assumptions.

At the end of the questionnaire, there is space for you to make other comments - please include mention of any issues that you think should have been addressed by the questionnaire and/or any points that you feel are especially important to analysing the area covered by this study.

Please ignore the question numbering system used on the questionnaire (eg. B1, B2, B3, etc.) - it has been organised to assist our analysis.

Please return completed questionnaire to:

Dave Lawrence
Senior Lecturer
School of Computing and Information Technology
University of Wolverhampton
Wulfruna Street
Wolverhampton
WV1 1SB
UK

SECTION A

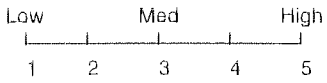
This section asks you about your experience with IT in your work.

Please note that by *'packages'* we mean "software created by someone else which you simply execute to allow you to enter data or receive output"

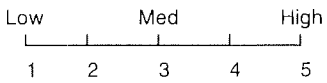
..... and that by *'tools'* we mean "software that allows you to create a new software application - or at least make changes to an existing one".

Please circle the appropriate number on the response scale.

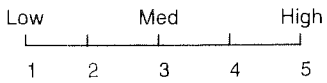
B1. With what quantity of application packages do you have at least some experience ?
(low = 1, med = 3, high = 5 and over)



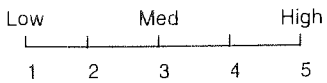
B2. With what quantity of application building tools do you have at least some experience ?
(low = 1, med = 3, high = 5 and over)



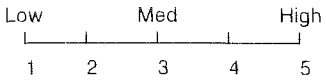
B3. What amount of variety of tool types (i.e. tools to do different types of jobs) have you used?
(low = 1, med = 3, high = 5 and over)



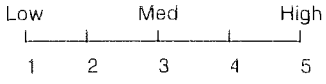
B4. How many years of experience have you in using a computer in your work (low = less than 1 year, Med = 2/3 years, High = over 5 years)?



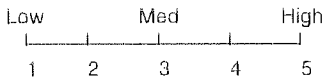
D1. What amount of knowledge do you feel that you have about the **packages** that you **most** use ?



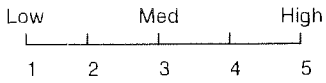
D2. What amount of knowledge do you feel that you have about the **tools** that you **most** use ?



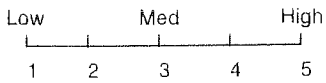
D3. What level of prowess do you have in aspects such as 3 GL's (eg. Cobol, RPG, or other similar programming languages), 4GL's (eg. Powerhouse, Foxpro - i.e. less technical syntax but just as powerful as 3 G.L.'s), database design and systems analysis/design ?



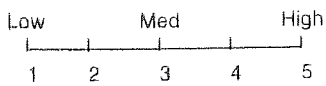
D4. What level of prowess do you have in aspects such as Querying databases, and/or DTP (Desk Top Publishing), Word Processing, and spreadsheet packages?



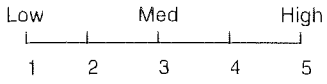
D5. What proportion of your working life (considering up to a max. of last 10 years, and allowing for the % exposure per typical day) have you been working with or being trained in use of software and building tools (low = less than 5%, med = 20-30%, high = over 50%)?



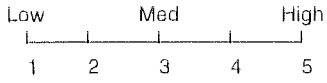
D6. What amount of formal training have you received in the use of IT in your work ? (low = hardly any or none, med = training in main activities, high = thorough training in most activities).



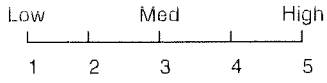
F1. If you are faced with a problem in the running of an application or the use of a tool, what level of confidence do you have in personally analysing and solving the problem ?



F2. What amount of interest have you in improving your business effectiveness by **personally** utilising increasingly advanced **IT tools** ?



F3. With what level of ease can you visualise the style and scope of IT solutions to effectively provide identified IS (information system) needs ?



Do you have ANY awareness/knowledge about ANY information system within your organisation ? **YES/NO** ? (please circle)

If the answer is "NO" then please skip Section B, and turn to page 8.

SECTION B

This section asks you about your knowledge about information systems utilised within your organisation. By the way, our definition of an information system (for the purposes of this study) is "identifiable groups of processes whereby people interact with data to manage and utilise information for a business purpose - probably computerised but could be a manual system".

Please complete the responses to the following questions an appropriate number of additional times if you have awareness/knowledge of **more than one** information system within your organisation (eg. orders, payroll, MIS (management information system), production control). Please indicate (below, in order of familiarity) which responses are for which information system (nb. if you have knowledge about more than three systems, then select those three of which you have most knowledge).

(i).....(C/B/M*) ii).....(C/B/M*) iii) .....(C/B/M*)
(most familiar) (2nd most familiar) (3rd most familiar)

* Please delete as appropriate (C = computerised, B = being computerised, M = manual)

Please circle the appropriate numbers on the response scale(s).

B1. To what extent are you familiar with the general purpose/functionality of the information system ?

(i)

Low Med High
1 2 3 4 5

(ii)

Low Med High
1 2 3 4 5

(iii)

Low Med High
1 2 3 4 5

B2. Of what proportion of the total no. of features of the system are you familiar ?

(i)

Low Med High
1 2 3 4 5

(ii)

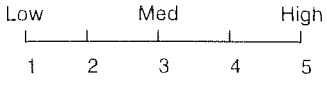
Low Med High
1 2 3 4 5

(iii)

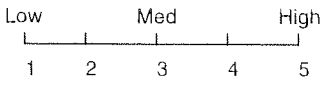
Low Med High
1 2 3 4 5

B3 To what extent do you understand the general business relevance of the system ?

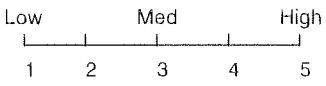
(i)



(ii)

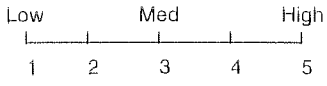


(iii)

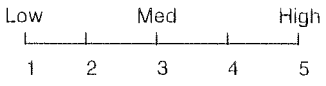


D1. How thorough is your knowledge about the main features of the system ?

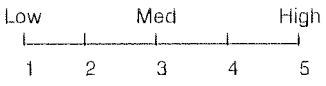
(i)



(ii)

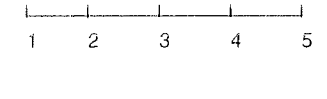


(iii)

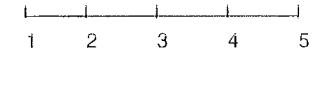


D2 How thorough is your knowledge about the remaining features of the system ?

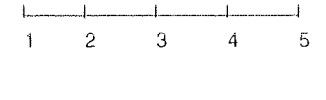
(i)



(ii)

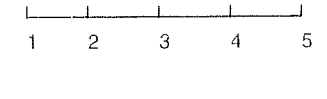


(iii)

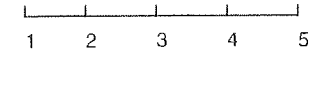


D3. To what extent do you understand the specific business relevance of specific system features ?

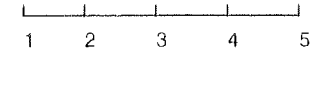
(i)



(ii)



(iii)



D4. To what extent were/are you involved in the development of the system ?

(i)

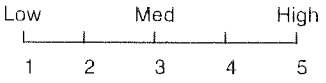
(ii)

(iii)

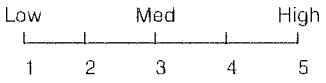
F1. How comfortable would you be in specifying the design of a new IS (information system) to suit known business needs (in the business area concerned)?

(i)

(ii)

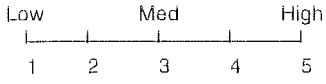


(iii)

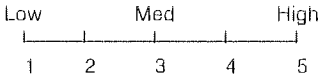


F2. How likely are you to recognise new IS designs which would improve the business effectiveness of the system ?

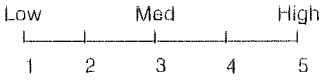
(i)



(ii)

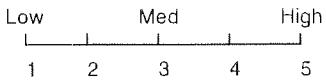


(iii)

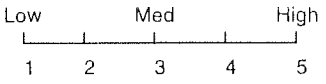


F3. To what extent can you identify and prioritise business benefits associated with the system ?

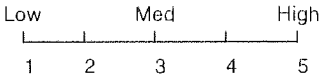
(i)



(ii)



(iii)



Do you (individually, or as part of a USER team) regularly implement IT ideas (i.e. create or change programs or 'computer usable' designs) ? **YES** or **NO** ? (please circle)

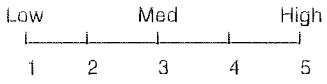
*If the answer is "**NO**" then please skip to question **G1 on page 9.***

SECTION C

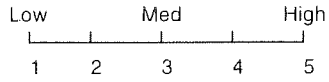
This section asks you about implementations of your own IT ideas.

Please circle the appropriate number on the response scale.

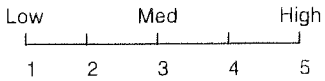
B1. What proportion of IT ideas that you implement is for your own use ?
(low = 10% or less, med = 30%, high = 50% or more)



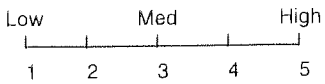
B2. What proportion of IT ideas, that you implement, are implemented on a department/organisation wide basis ? (low = 5% or less, med = 20%, high = 40% or more).



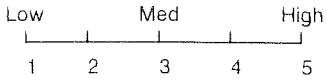
B3. What quantity/rate of IT ideas do you implement ? (low = 1 per 6 months, med = 1 per 2 months, high = 1 per month or more frequent).



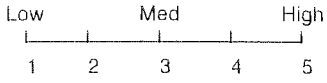
D1. To what extent do your own implementations **avoid** the need for corrections/changes during the first 2 months of operation ?



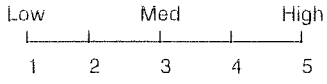
D2. To what extent do your own implementations enable ready access to information needed by the users ?



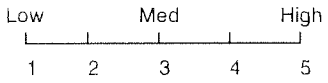
D3. What level of use do your implementations have ?



F1. To what extent do your own implementations produce recognisable business benefit (eg. improved performance, decision making etc.) ?



F2. To what extent do you think that users are satisfied (eg. ease of use, relevance, quality, etc.) with your own implementations ?



G1. Please briefly describe an Information System Development project in which you have (had) a high involvement (whether a relatively simple system or a complex one). Mention the type of system, **your role in the project**, and the tools you use(d). Also please comment on what improvements to the tools might help YOU be more effective.

.....

.....

.....

.....

.....

.....

G2. Name an information system used in your department/organisation that you feel is particularly effective;

(i) where you were heavily involved in the development .....
(very/fairly* effective)

(ii) where you were not involved in the development .....
(very/fairly* effective)

* please delete as appropriate

G3. Name any information system(s) in your department/organisation that you feel is/are **not** particularly effective;

..... (heavily/not heavily* involved)

..... (heavily/not heavily* involved)

(* delete as appropriate to indicate your participation in the development of the system)

G4. Please list and briefly describe the type(s) of IT tasks that you do (please also indicate the approximate proportion of your working time spent on each type of work).

.....

.....

.....

.....

.....

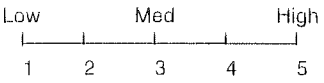
.....

SECTION D

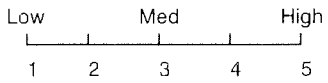
This section asks you about your role and position of authority in terms of IT involvement.

Please circle the appropriate number on the response scale.

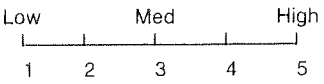
1. What degree of power does your role give you to propose new IT solutions to IS needs ? (i.e. regardless of who sanctions budgets).



2. What degree of power does your role give you to sanction the implementation of these proposals of new IT solutions to IS needs (and proposals from elsewhere) ?



3. To what extent does (or could) your role allow you to spend time working on IS designs/IT implementations ?

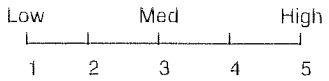


SECTION E

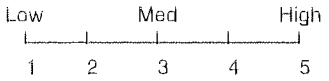
This section asks you about the characteristics and scope of the available tool support.

Please circle the appropriate number on the response scale.

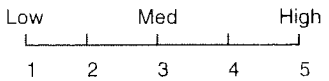
1 a) To what extent do you have tool(s) **available** to assist with the range of MIS type applications (i.e. spreadsheet, database, querying/reporting, graphic display of information, file maintenance, statistics/trends portrayal, etc.) ?



b) With what amount of ease are/were you able to learn and operate these MIS type tools ?



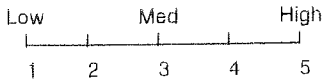
c) To what extent can the user of these tools be successful **without** specialist IT expertise ?



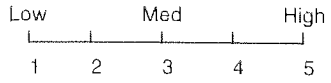
2 a) To what extent do you have tool(s) **available** to assist with complex application design/building (eg. applications involving several screens and processes, and using a number of database 'files') ?

If you do not have this type of tool (or you have no knowledge of the tool(s)), please circle 'N/A' below and go directly to ***question 3 on page 13.***

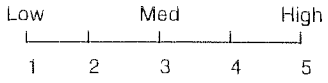
N/A ?



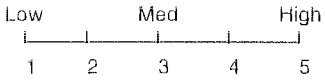
b) With what level of ease are/were you able to learn how to utilise these more advanced tools?



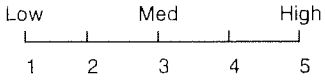
c) To what extent can the user of these tools be successful without specialist IT expertise ?



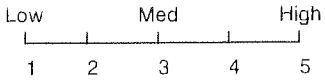
3 a) What level of accessibility is there for software tools at your organisation (i.e. how easy is it for you to sit down and get hands on experience) ?



b) What proportion (of each application) of the type of applications produced by the tools can directly be run on the target computer ?



c) To what degree is your potential to design/build computerised information systems **un**restricted by the power/characteristics of the tools available ?



4. List the names of tools and/or other software that ;

a) you currently use .....

.....

b) you plan to use .....

c) you would like to use .....

5. What characteristics/capabilities would you like end user computing tools to provide or improve upon?

.....

.....

.....

.....

6. How do you keep up to date with new products/tools as they become available ?
(eg. computer press, vendor marketing, conferences, exhibitions, demos, etc. - please circle as appropriate, and add any other sources below that you use).

.....

.....

SECTION F

This section is designed to get a more detailed view of the IT related activities in which you may or may not be involved. Please consider The activities listed below, and place your response values (1 to 5, with 5 = high) in the appropriate columns. There is space near the foot of the table for you to put details about any other activities that we haven't included.

If you are not personally involved in an activity (and also do NOT personally use the product of the service activity), then please leave that line blank. Some parts of the table show 'N/A' - this is where we presume that a response would be not applicable (please feel free to overwrite).

		A	B	C	D	E	
	Description of Activity	Amount of personal involvement	Assistance of other end users	Assistance from IT dept or company	Satisfaction with outcomes	Rating of tool or s/w used	Comments
1.	Spreadsheets (use)		N/A	N/A			
2.	Spreadsheets (build)						
3.	Wordprocessing						
4.	Database queries (use)		N/A	N/A			
5.	Database queries (build)						
6.	Desk Top Publishing						
7.	Electronic mail (use)		N/A	N/A			
8.	Decision support (use)		N/A	N/A			
9.	Decision support (build)						
10.	Small databases (use)		N/A	N/A			
11.	Company databases (use)		N/A	N/A			
12.	Small databases (build)						
13.	Company databases (build)						
14.	Multi media systems (use)		N/A	N/A			
15.	Multi media sys (build)						
16.	Voice mail (use)		N/A	N/A			
17.	CAD/CAM (use)		N/A	N/A			
18.	CASE tools (use)		N/A	N/A			
19.	Systems analysis/design						
20.	Transaction systems (use)		N/A	N/A			
21.	Manufacturing sys (use)		N/A	N/A			
22.	Build complex systems (eg. trans'n, control syst's)						
23.	Design complex systems						
24.	Expert systems (use)		N/A	N/A			
25.	Expert systems (build)						
26.	Prototyping (as user)			N/A			
27.	Prototyping (as developer)						
28.	Computer aided training						
29.							
30.							
31.							
32.							

SECTION G

This section asks you for information about yourself. You may regard some of these questions as being too personal. If so please leave blank - however we would use the information in an extremely sensitive and confidential manner.

1. Name of Organisation ? .....
2. What is the main activity (purpose) of organisation ? .....
3. How many people work at your site ? ..... (approx.)
4. How many people work for the whole organisation ? ..... (approx.)
5. In which department do you work ? .....
6. What is your job title ? .....
7. How long have you been working in (i) this type of role ? ..... years
   (ii) this organisation ? ..... years
8. If appropriate, what was your previous role (in this or a previous organisation) ?
   .....
9. How many people directly report to you ? .....
10. How many indirectly report to you ? .....
11. What is your age ? .....
12. What is your gender ? **M / F** (please circle)
13. Do you regard yourself as being part of an ethnic miniority ? **Yes / No** (please circle).
14. Do you have any physical disabilities ? **Yes / No** (please circle).
    (if so, please indicate details):- .....
15. What is/are the highest qualification(s) that you have achieved in one or more particular area(s) ? (eg. 'O' levels, GCSE, 'A' levels, ONC, HNC, HND, NVQ, Degree, Masters, Higher degree, etc).
    .....
    .....

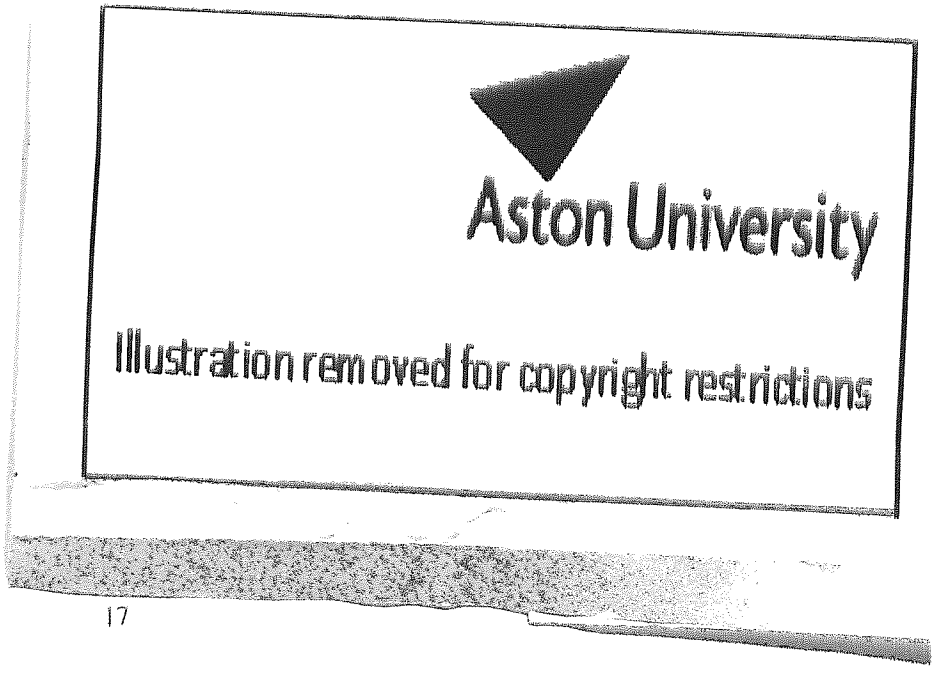
16. Your name ? Surname..... First names .....
    (if you prefer not to give your name then leave this blank - however it would help us for clarification purposes, and we would treat this information with extreme confidentiality).

17. Please provide a contact telephone number .....

18. How long did it take you to complete this questionnaire ? .....
19. Date questionnaire completed ? .....

Please add any additional comments and/or suggestions that you wish to make on this page.
Thank you very much for your assistance.

Dave Lawrence
School of Computing and IT
University of Wolverhampton
Wulfruna Street
Wolverhampton
WV1 1SB
Tel. 0902 - 322443
Fax 0902 - 322680



Appendix III : BUD ESP Questionnaire

A STUDY OF BUSINESS USERS AND THEIR INVOLVEMENT WITH INFORMATION SYSTEMS AND RELATED IT SOFTWARE

undertaken (during 1995/6)

by

Dave Lawrence (University of Wolverhampton) *and* Dr. Hanifa Shah (Aston University)

This study has the general aim of gaining the knowledge necessary to improve our understanding of how to optimise the involvement of end users in information systems development . We believe that not enough effort has been made in the past to ascertain the potential of end users and to investigate the range of support that the various types of users need.

You have been chosen as part of a cross section of end users. Your input is important and will be treated with the utmost confidentiality. Your employers, managers and colleagues will not know about your specific responses. Please note that there are no 'right' or 'wrong' answers to any of the questions - but your responses should give an indication of your experience and how you feel.

Though your participation is completely voluntary, we would appreciate you completing the questionnaire and returning it to the address below as soon as possible.

Please return completed questionnaire to:

Dave Lawrence
Senior Lecturer
School of Computing and Information Technology
University of Wolverhampton
Wulfruna Street
Wolverhampton
WV1 1SB
UK

Tel. 01902 - 322443
Fax. 01902 - 322680
email: cm1994@ccub.ac.uk

SECTION I

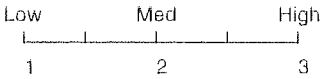
For the following questions, please circle the appropriate number on the response scales.

The first five questions ask about your experience with IT in your work.

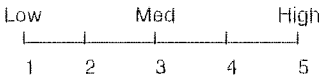
Please note that by ***'packages'*** we mean "software applications previously created, which you simply execute to allow you to enter data or receive output" (eg. data entry/display packages - such as accounts and orders processing; selecting reports from menus; spreadsheet presentations; etc.).

..... and that by ***'tools'*** we mean "software that allows you to create a new software application - or at least make changes to an existing one" (eg. 4GLs, database structure builder, spreadsheet structure builder, report design builder, CASE tools, programming languages).

1. How much IT experience do you have ? (low = less than 1 year, high = over 5 years). *Please circle a score on the appropriate scale only.*

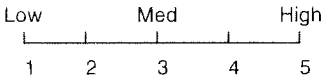


(Packages only)

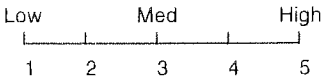


(Packages plus Tools)

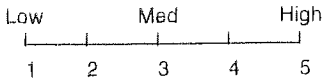
2. If you are faced with a problem in the running of a **package** or the use of a **tool**, what level of confidence do you have in personally analysing and solving the problem ?



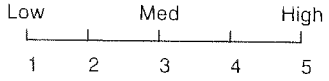
3. What amount of interest have you in improving your business effectiveness by **personally** building software applications.



4. To what extent are the **tools** (those available to you) **suitable** for use by people primarily with business skills (i.e. with moderate IT skills) ? Please write "N/A" if you do not have any tools available.



5. To what extent are the **tools** (available to you) **appropriate** to designing/building ways of manipulating and using your data. ? Please write "N/A" if you do not have any tools available.

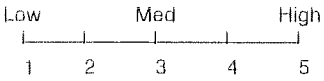


The next three questions ask you about your business knowledge about information systems utilised within your organisation. By the way, our definition of an information system (for the purposes of this study) is **"where people interact with data to manage and utilise information for a business purpose** - probably computerised but could be a manual system" (eg. orders, payroll, personnel, sales, stock control, production control).

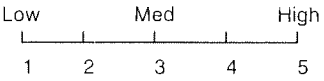
6. Name an information system at your organisation with which you are **most** familiar:

_____

7. To what extent are you familiar with the business purpose(s) of this information system ?



8. To what extent can you identify and prioritise business benefits associated with this system ?



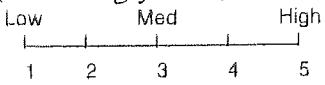
Do you ever (individually, or as part of a USER team) implement IT ideas (i.e. create or change **programs** or 'computer usable' **designs** - eg. 4 GL specifications, spreadsheet designs, screen layouts, report designs, database designs, data manipulation software) ? **YES** or **NO** ? (please circle).

*If the answer is "**NO**" then please explain why you do not get involved - this will help us understand more about this aspect, then please skip to question **11**. If "**YES**" then please continue with question **9**.*

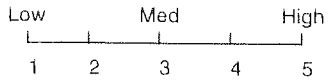
Reasons:- .....

.....

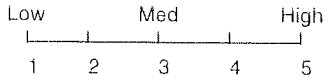
9. To what extent do your own implementations help the organisation and/or improve someone's (including yours!) effectiveness ?



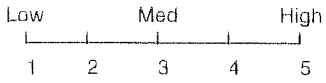
10. To what extent do you think that users (including you!) are satisfied (i.e. based on amount and ease of use, business usefulness, quality, etc.) with your own implementations ?



11. What degree of power does your role give you to propose amended/new software application designs ? (i.e. regardless of who sanctions budgets).



12. To what extent does (or could) your role allow you to spend time working on software application designs/implementations ?



SECTION II

A). Please list and briefly describe the type(s) of IT tasks that you do (please also indicate the approximate proportion of your working time spent on each type of work).

.....

.....

.....

.....

.....

.....

B). What characteristics/capabilities would you like business user computing tools (for information system design/development) to provide or improve upon?

.....

.....

.....

SECTION III

This section is designed to get a more detailed view of the IT related activities in which you may or may not be involved. Please consider The activities listed below, and place your response values (1 to 5, with 5 = high) in the appropriate columns. There is space near the foot of the table for you to put details about any other of your computer activities that we haven't included. Please note that *'build'* means to **create** the structure or design of an implementation, and *'use'* means to **utilise** a finished product for data entry/display or selection of pre-prepared options.

If you are not personally involved in an activity , then please leave that line blank. Some parts of the table show 'N/A' - this is where we presume that a response would be not applicable (please feel free to overwrite).

	Description of Activity	Amount of personal involvement	Assistance of other end users	Assistance from IT dept or company	Satisfaction with outcomes	Rating of tool or software used	Comments
1.	Spreadsheets (use)		N/A	N/A			
2.	Spreadsheets (build)						
3.	Wordprocessing						
4.	Database queries (use)		N/A	N/A			
5.	Database queries (build)						
6.	Desk Top Publishing						
7.	Electronic mail (use)		N/A	N/A			
8.	Decision support (use)		N/A	N/A			
9.	Decision support (build)						
10.	Small databases (use)		N/A	N/A			
11.	Company databases (use)		N/A	N/A			
12.	Small databases (build)						
13.	Company databases (build)						
14.	Multi media systems (use)		N/A	N/A			
15.	Multi media sys (build)						
16.	Voice mail (use)		N/A	N/A			
17.	CAD/CAM (use)		N/A	N/A			
18.	CASE tools (use)		N/A	N/A			
19.	Systems analysis/design						
20.	Transaction systems (use)		N/A	N/A			
21.	Manufacturing sys (use)		N/A	N/A			
22.	Build complex systems (eg.multiple screens/files)						
23.	Design complex systems						
24.	Expert systems (use)		N/A	N/A			
25.	Expert systems (build)						
26.	Prototyping (as user)			N/A			
27.	Prototyping (as developer)						
28.	Computer aided training						
29.							
30.							
31.							
32.							

SECTION IV

This section enables you to quickly summarise your experiences and environment.

***Please tick** those statements which closely match you/your experience.*

ARE YOU ..... ?

..... 1. a person with a **reasonable** level of IT skills and experience ?

..... 2. a person with a **good** level of knowledge about how business related information is generated and utilised within your part of the organisation ?

..... 3. well supported by **usable** tools for information system (software) building ?

..... 4. restrained in "information system (software) building" by limited power / freedom in your job role ?

..... 5. able to come up with software ideas and/or designs for implementation (regardless of your freedom to do so) ?

..... 6. actively involved in personally (or as part of a **user** team) developing **small** software applications - information 'handling' systems to help people to carry out their business duties.

..... 7. same as '6.' but concerning large / or sophisticated applications ?

..... 8. satisfied with the effectiveness of your own IT implementations ?

..... 9. content with the appropriateness of your organisations current information system software applications (i.e. all applications used - not solely those that you have built)?

..... 10. in need of help from people with greater IT experience to enable you to utilise the IT available to you ?

..... 11. interested in playing a more active role in the design / building of your computerised information systems ?

..... 12. in an organisation which has (or is actively creating) an infrastructure to promote, integrate and support **end user** development of computerised information systems ?

SECTION V

This section asks you for information about yourself. We will use the information in an extremely sensitive and confidential manner.

1. Name of Organisation ? .....
2. What is the main activity (purpose) of organisation ? .....
3. How many people work at your site / whole organisation ? ..... / ..... (approx.)
4. Job title / department ? ...../.....
5. How long have you been working in (i) this role ? ..... years
   (ii) this organisation ? ..... years

6. Any previous roles ? .....

7. What is/are the highest qualification(s) that you have achieved ? (eg. 'O' levels, GCSE, 'A' levels, ONC, HNC, HND, NVQ, Degree, Masters, Higher degree, etc). Please also note the subject title of the qualification.

   .....

8. Your name ? Surname..... First names .....

9. Please provide a contact telephone number .....

10. Time taken to complete this questionnaire ? ..... Date? .....

Thank you very much for your assistance.

Please add any additional comments and/or suggestions that you wish in the space below.

Appendix IV : List of publications/presentations

Lawrence D.R. & Shah H.U. (1994a), "Tools for Supporting User Development of Information Systems", Third Conference on Information Technology and its Applications (ITA '94), 2-3 April 1994, Leicester, UK.

Lawrence D.R. & Shah H.U. (1994b), "CAUSE : Towards a CASE tool for Business End Users", Proceedings of the Sixth ISTIP Conference, 6-8 April 1994, Ascot, UK, University of Hertfordshire, 1994.

Lawrence D.R., Shah H.U. & Golder P.A. (1995), "End User Computing - Measuring and Predicting Effectiveness", Proceedings of Workshop 4 CAiSE '95, pp.13-19, June 12-16 1995, Jyvaskyla, Finland.

Lawrence D.R., Shah H.U. & Golder P.A. (1995), "A Study to Validate an End User Computing Model - Towards Predictive Quality", Proceedings of Software Quality Management III, Vol 1,pp.457-468, April 3-5th, 1995, Seville.

Lawrence D.R., Shah H.U. & Golder P.A. (1996), "Business User Development - Success Factor Development", Proceedings of PRIISM '96 International Conference, pp.33-37, 1-3 Jan 1996,Maui, USA.

Shah H.U. & Lawrence D.R. (1996), "A Study of End User Computing and the Provision of Tool Support to Advance End User Empowerment", Journal of End User Computing, Winter 1996.

Lawrence D.R. , Shah H.U. & P. A. Golder, "Business Users and the Information System Development Process: A Need to know Basis", presented at IFIP WG 3.4 International Working Conference 1996, Melbourne Australia 8-12 July 1996.

Lawrence D.R. , Shah H.U. & P. A. Golder, "End User Computing: How an Organisation can Maximise Potential", STEP '97 IFIP Conference, King's Cross London, July 1997.

Lawrence D.R., Sloane A., Price D.E., & Constable G. (1998), "Live Internet Broadcasting - some unique experiences", *BCS Computer Graphics & Displays Group Conference "TV & Broadcasting on the Internet, WWW and Networks"*, 22-23 April 1998, Bradford, UK

Lawrence D.R. & Amado I. (1998), "Live broadcasting of an international multimedia art installation around the Internet", *Proceedings of INDC '98*, Aveiro, Portugal, 15 -17th June 1998.